UNIVERSITY OF GHANA

COLLEGE OF BASIC AND APPLIED SCIENCES

CLIMATE CHANGE ADAPTATION STRATEGIES EMPLOYED BY RURAL WOMEN FARMERS IN THE UPPER WEST REGION OF GHANA: IMPLICATIONS ON WELLBEING

BY

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DECLARATION

I hereby declare that with respect to other people's works, which have been duly acknowledged, this thesis is the result of research work undertaken by **Rose Afful** of the Institute for Environment and Sanitation Studies, University of Ghana under supervision; and that no part of it has been submitted for a degree in any other University.

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Date: August 29 2022

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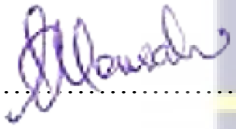

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..... **Date** August 31,2022.

DEDICATION

I dedicate to my Godfather, Rev. Isaac Osei Bonsu. Thank you, Daddy, for your prayers and words of encouragement. This dissertation is also dedicated to two important people in my personal life who are no longer with us. To my father, Mr. Joseph Kwasi Afful and my mother Hannah Bennieh. You will always remain in my heart for your immense contribution towards my upbringing and education and also for your passion for girl child education. You were true feminists. I love you!

I also dedicate this work to my dear husband Daniel Buabeng and to my two adorable daughters, Abena Asiedua Buabeng and Nana Aba Buabeng. Thank you for your prayers and encouragement throughout the entire process, may God richly bless you.

And to all my family and friends who have encouraged my relentless pursuit of this degree – I say a big thank you.

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ABSTRACT

There is increased investment and adoption of adaptation strategies by rural women farmers to reduce vulnerabilities. Studies have shown that most of the adaptation options provided by key district adaptation stakeholders do not address the wellbeing needs of rural women farmers. This research is an effort to substantially incorporate considerations of human wellbeing into how adaptation interventions are comprehended. It therefore employed the wellbeing framework (material, relational and life satisfaction) to unpack some key elements that drive the choices and actions of rural women farmers in adapting to climate variability/change and adaptation options likely to improve wellbeing. A mixed method approach was employed (involving, Focus Group Discussions, community profiling, key informant interview and review of secondary information). Ranking by the Kendall's Coefficient of Concordance revealed that majority of the women farmers employ sustainable land management practices (improved seed variety, mix cropping/legume cropping and changing planting dates) in addressing climate variability/change. The probit linear regression model revealed that factors that affect rural women farmers' choice of adaptation options are age, membership of a farmer-based organisation, farm size and household size. From the ordered logit model, the number of years lived in a community and ownership of a television set by a woman farm is significant to their material wellbeing. Size of household, ownership of a gas/kerosene stove were also considered important to enhancing the relational wellbeing of rural women farmers. Additionally, years of farming/farming experience, anti-erosion measures and improved crop varieties were identified as very important to life satisfaction wellbeing of rural women farmers. The results highlight the need for increased understanding of the critical constituent of individual and household wellbeing needs to ensure the provision of equitable, more effective and sustainable adaptation options for improved resilience.

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LIST OF ABBREVIATIONS

ASSAR	Adaptation at Scale in Semi-Arid Region
AEAs	Agricultural Extension Agents
CSA	Climate Smart Agriculture
CSIR	Center for Scientific and Industrial Research
CSO	Civil Society Organisation
FBO	Farmer Based Organisation
FGDs	Focus Group Discussions
GIS	Geographic Information Systems
GMeT	Ghana Meteorological Agency
KIIs	Key Informant Interviews
LST	Land Surface Temperature
MoFA	Ministry of Food and Agriculture
NANDRIDEP	Nandom Deanery Integrated Development Project
NGOs	Non-Governmental Organisations
SLM	Sustainable Land Management

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Climate change serves as a danger to the economic, ecological and social systems of our planet. The fifth evaluation of the Intergovernmental Panel on Climate Change (IPCC) provides evidence of widespread impacts on freshwater resources, crops, forest products, coastal systems, low-lying regions, industry, cities, population and human health (Solomon et al., 2007; UNDP, 2007). The adverse impact of climate change could also hinder progress toward sustainable development and attainment of global development objectives (IPCC, 2014; UNDP, 2007). The marked decrease in rainfall and a tremendous increase in its variability have already been experienced by developing countries, with consequences for livelihoods development and agricultural production (Akram and Hamid, 2015; UNDP, 2011).

Climate change effects in Africa include rising sea levels, coastal erosion, stress on freshwater resources, deforestation, increased severity and recurrence of disasters and the spread of malaria. These intersect with multiple stressors expressed in the form of poverty, governance deficits, wars, HIV/AIDS and debt to undermine many African countries' ability to respond to the effects of climate change (Solomon et al., 2007). Livelihoods and lives of women and men, their families and communities throughout the African region are adversely affected by climate change. The impacts vary in the form and magnitude of the regions they affect which include both short-term disasters and longer-term changes in the climate system (UNFCCC, 2007). According to Jost et al. (2016), men, women, boys and girls are affected differently by

climate change due to the inequalities that exist between them as a result of the allocation of roles based on gender, and the increase in vulnerability levels.

Women may also face wider negative impacts since climate change continues to intensify current gender inequalities. Poor and disadvantaged sectors of communities are particularly vulnerable to the damaging effects of climate change because they are limited in terms of access to resources and adaptive capacity. They also depend on natural resources for their livelihoods, but these resources are highly vulnerable to climate change (Jost et al., 2016; Elinder and Erixson, 2012; UNDP, 2011).

Research have revealed that climate change impacts and effect are not gender-neutral. Some scholars claim that climate change impacts women overwhelmingly, since they constitute the largest proportion of the world's poor (Team and Doss, 2011). The differences in interaction with the environment and the differences in roles based on gender, limit the adaptation capacity of women. The persistence of gender inequalities in access to physical and social goods; gender disparities in education, income, health and time; and abuse of human rights render women more vulnerable to climate change effects. This invariably affects the effectiveness of their response and adaptation (Bunce, 2015). The demand to adapt to climate change is now extensively recognized because there is increased evidence of its impacts on social and natural systems. However, efforts to adapt to climate change, have not yielded a substantial improvement in the resilience of women in the face of deepening climate risks (Wise et al., 2013). This is because most adaptation actions are focused on proximate causes and not transformational change (Park et al., 2012). Rural women farmers are engaged in some forms of adaptation but a study by Campbell et al. (2009) of adaptation options for female farmers in Burkina Faso has shown that they do not regularly apply a gender-based approach.

The strategies do not address the strategic interests of women, such as access to and influence over assets, or decision-making power. This is because issues of gender are not taken into account during planning of adaptation interventions by adaptation stakeholders. Therefore, most adaptation strategies specifically aimed at women actually have a negative effect by increasing their workload without allowing them more leverage over assets (Campbell et al., 2009). A research by Oxfam (2011) also posited that it is difficult to identify such adaptation methods as good practices, although they do demonstrate some promising adaptation outcomes, since they meet practical needs (access to financial services, training, etc.) and sometimes have an indirect effect by including women's groups in decision-making processes.

Adaptation consists of lifestyle, behaviour and risk management changes and may involve activities such as adjusting the mix of crops, plant types, livestock and fish species; modifying irrigation and flood control systems; introducing programmes for the management of pests and diseases; expanding health systems; building infrastructure; climate resistant home, communities and capital stock climate-proofing against the damaging effects of harsh weather events; and migration (IFPRI, 2011; Bradshaw et al., 2004). Adaptation options which do not take into account gender perspectives can unintentionally enforce existing gender inequalities. Onta and Resurreccion (2011) have noted considerable attention in recent years on climate change adaptation due to the need to ensure that affected populations are sufficiently able to cope and live adequately with levels and types of climate variability. Smallholder farmers are aware of climate changes and the dominant effects noticed are decreased rainfall, higher temperatures and lower yields (Nhamo et al., 2013).

Most communities in Africa depend heavily on natural resources, there is therefore the need for an effective coping strategy or mechanism to counter the adverse effects of climate change on agriculture (Ziervogel et al., 2008). Climate adaptation measures can be used to drastically

reduce such impacts (Waongo et al., 2015; Komba and Muchapondwa, 2012). There are numerous solutions and possibilities for adaptation, ranging from technical options to changes in actions at the personal level. Farmers' adaptation strategies or responses are not only limited to addressing climate variability and change, but are also towards changing socio-economic and political challenges that interact to shape the vulnerability of livelihood systems in rural and resource poor societies in Sub-Saharan African (Nielsen and Reenberg, 2010; Mertz et al., 2010). Gender and climate change have dynamic and unique relations, not only in terms of exposure to the adverse impacts of climate change, but also in terms of way one would respond to climate change impact (UNDP, 2011).

Adaptation is undertaken to preserve the environment, human lives and to secure progress in the period of climate change. However, the field has to date not employed well-being thought, in the framing of adaptation priorities, policies, and research (Lamb and Steinberger, 2017). The three dimensions of wellbeing are key in considering ways in which the various aspects of a "life well lived" come together (material, relational, life satisfaction). MA (2005) believed that well-being is not only viewed as a focused or desired state of being; it is a framework for analyzing human thriving, and also helps to unpack some of the key elements driving the choices and actions of people. Deneulin and McGregor (2010) clarified that there is more to a social understanding of wellbeing than an individualistic notion of what it means to live well since it relies on relational and collective processes (Coulthard et al., 2011). The theory also thrives beyond the conception of material (assets) and essential needs, focusing more on the significance of the social, psychological and cultural needs required to thrive (McGregor et al., 2009). In addition, its material dimension reflects the fact that physical and financial resources are entitlements required for wellbeing. The concept also acknowledges that relationships

between individuals are also essential factors that impact people's decisions or what they are made to do.

For example, it explains why some fishermen continue to fish those species simply to preserve their credibility as successful fishermen, even if a change to other species is required to lead to rational economic action‖ (Coulthard et al., 2011). The concept also illustrates how subjective aspects (e.g. sense of happiness, satisfaction with a way of life) play a major role in the everyday lives of people and their long-term goals. Conventional economic approaches to estimating adaptation benefits do not take into consideration a number of other material and non-material considerations that should be reflected in a more comprehensive approach to evaluating vulnerabilities and impacts; as well as the relative benefits of possible adaptation choices and strategies (Parry et al., 2009; Camfield et al., 2008; Stern et al., 2006; Tol, 2002). Füssel and Klein (2004) have noted that most models do not perform well in the portrayal of human interactions and local adaptation skills‖. Most of the recent impetus behind wellbeing studies is as a result of frustration with the common use of economic methods to measure social change, this method has a number of drawbacks (Stiglitz et al., 2009).

The concept of wellbeing has been increasingly recognized because it gives rise to a variety of material and non-material variables that offer a more holistic approach to the evaluation of vulnerabilities and impacts, as well as the relative benefits of potential options and strategies for adaptation (Britton and Coulthard, 2013). Human wellbeing is complex and disputed. It is also used interchangeably with happiness, human growth, living standards, quality of life or welfare, and has developed to become a catch-all word for promoting and measuring good lives and a good society (Lamb and Steinberger, 2017). Wellbeing is highly subjective, and there is uncertainty about measurement methodologies, but there is an increasing consensus about what needs to be evaluated and how it can be evaluated (Durand, 2013; OECD, 2013).

There are several components of human wellbeing, including the essential material for a good life, such as stable and sufficient livelihoods, adequate food at all times, housing, clothes, and access to goods; health, including feeling good and providing a healthy physical environment, such as clean air and access to clean water; good social relationships, including social harmony, mutual respect, security, including secure access to natural and other resources, personal safety and security from natural and man-made disasters, and freedom of choice and action, including the opportunity to accomplish goals or objectives‖ (Millennium Ecosystem Assessment Programme, 2005). The importance of using the wellbeing framing to determine vulnerabilities and impacts, as well as advantages of adaptation options and strategies was noted by (Smith et al., 2014; Adger and Vincent, 2005). The wellbeing approach brings out the differences and contestations within communities and reflects on the manner in which particular groups are more or less able to reach and benefit from climate change adaptation activities, with consequences for equity and marginalization that further exacerbate the underlying vulnerability (Artur and Hilhorst, 2012; McDowell and Hess, 2012; Eriksen and O'Brien, 2007).

1.2 Problem Statement

The semi-arid region of Ghana experiences extreme climatic events such as shortage of and unpredicted rainfall, dry spells or droughts, and floods. These impacts are influencing agronomy production, the environment, and human livelihoods (Ndamani and Watanabe, 2015). Agronomy, is an important avenue for the generation of revenue in most farming communities, and adaptation strategies are important to build upon the resilience of the agricultural zones, protect human livelihood, and promote the availability of food (Bryan et al., 2013). Women are main players in agriculture in Ghana, accounting for more than half of the agricultural workforce, they produce seventy percent (70%) of the food supply in the country.

They constitute ninety-five percent (95%) of people involved in agro processing and eighty-five percent (85%) of those in food distribution (Oxfam, 2011). In addition to agricultural activities, women smallholder farmers are deeply engaged in domestic and reproductive tasks that are fundamental to the maintenance of the household and the wellbeing of the community (SEND Ghana, 2014). Women's care work are most often than not, seen as an extension of household duties and therefore, remain unrecognized and unpaid for.

Research by Lawson et al. (2019) and Ahmed et al. (2016) in the Upper West Region of Ghana revealed that women tend to have more limited access to assets (physical, financial, human, social, and natural capital) which are likely to enhance their ability to adjust to climate change, despite their contribution to the agricultural and other main sectors of society. These include property, credit, decision-making bodies, farm materials, technology, and facilities for extension and training. Gok (2004) also noted that, a variety of factors such as poverty, cultural constraints, unfavourable government policies, conflicts and national legal structures; over the years have not supported rural women's involvement in decision-making and leadership, thereby making them more vulnerable to climate effect. Daze et al. (2009) said that any climate adaptation plan should focus more attention to the demand to improve the adaptive capacity of women in order to reduce their vulnerability and to sustain or increase more opportunities for the development of women. Some adaptation strategies that have been undertaken in the Upper West Region of Ghana by rural women farmers include the use of modern inputs (Issahaku and Maharjan, 2014). Some women in the region engage in sustainable land management (SLM) practices (Ndamani and Watanabe, 2015; Nyantakyi-Frimpong and Bezner-Kerr, 2015) as well as livelihood diversification (off-farm employment, irrigation, and migration) (Dumenu and Obeng, 2015; RademacherSchulz et al., 2014; Owusu et al., 2011; World Bank, 2010). These strategies have not succeeded in building the adaptive capacity of women farmers in the face

of intensified climate hazards. It is therefore imperative to prioritize the identification of feasible adaptation options in the Upper West Region to reduce the impact of climate change on agriculture that is important to large food insecure rural women farmers (Lobell et al., 2008).

Study of women's adaptation strategies in some African countries revealed that they do not systematically apply a gender-based approach and thus do not concentrate on the strategic interests of women, such as access and control over assets or decision-making power (Oxfam, 2011). According to Wise et al. (2013), existing power structures, norms and systems reinforce the vulnerability of disadvantaged and marginalized populations, so it is imperative to recognize the interdependencies of rules, beliefs, knowledge and culture in assessing the potential of adaptation for transforming wellbeing (Leach et al., 2010; Pelling, 2011; Maru et al., 2014).

Regardless of the contributions made by the climate adaptation community to improving understanding and knowledge of problems related to climate change (Wise et. al., 2013), most of the evaluation of vulnerability, impact and adaptive capacity have limited usefulness for informing peoples' choice between adaptation options (Downing, 2012; Hinkel, 2011). The question therefore is, how effective are adaptation methods employed by rural women farmers in transforming wellbeing? Few studies have employed the use of the wellbeing concept (Adger et al., 2013; Armitage et al., 2012; Coulthard et al., 2011) to assess the vulnerability of rural women farmers. This research therefore employed the concept of wellbeing as an important framework to articulate and understand rural women farmers' motivation, behaviour and decision in adapting to climate variability and environmental changes and how it has transformed lives. The wellbeing framework gives a more holistic approach to assessing vulnerabilities and impacts (Wise et al., 2013).

1.3 Objective of the Study

The aim of the research is to explore the relationship between climate change adaptation and wellbeing of rural women farmers based on the three dimensions of the wellbeing concept (material, relational and life satisfaction).

The specific objectives are to:

1) Identify and rank adaptation responses employed by rural women farmers to address stresses associated with climatic variability and environmental change.
2) Determine factors influencing rural women farmers' adoption of technologies to adapt to climate change.
3) Determine the effect of adaptation on the material wellbeing (the extent to which men, women meet their basic human needs) of rural women farmers.
4) Examine the effect of adaptation on the relational wellbeing (personal and social relations) of rural women farmers.
5) Assess the effect of adaptation on the subjective (life satisfaction) wellbeing of rural women farmers.

1.4 Significance of the Study

Women are mostly concerned with overall family wellbeing. It is therefore imperative to adopt an integrated methodology to climate change adaptation assessment that considers overall wellbeing rather than just livelihood concerns (Larson, 2013). Thompson-Hall et al. (2016) noted that most climate change and adaptation studies have focused on biophysical impacts over the years, not delving into those who are mostly affected by such impacts, and also to recognize the mix of factors that exacerbate risk in times of climate stress.

There is therefore a substantial gap in terms of how disparities in sensitivity and adaptive capacity arise; how these disparities are sustained; and how they affect the resilience of complex systems. This research will therefore demonstrate how approaches that incorporate the notion of wellbeing can provide deeper insight into climate change impact and adaptation effectiveness. Framing the many challenges of adaptation responses through the wellbeing lens will enable people to do things differently and potentially better (Coulthard et al., 2015). The wellbeing approach is very powerful in assessing benefits that matter to the most vulnerable in parallel with more traditional economic measures, and speaks directly to the needs of those involved in exploring adaptation options (Cartwright et al., 2013). The research will address the current major gaps in information on the potential of adaptation in transforming wellbeing of rural women farmers in the face of intensifying climate hazards. It will also provide information to enhance rural women's adaptive capacity and also generate outputs that are policy relevant. It will enable district level adaptation decision makers to develop strategies that focus on differentiation and contestation within communities to prevent marginalization which increases vulnerability. Additionally, it will serve as a basis for advocacy by ecofeminists to ensure that women have access to adaptation strategies that address practical and strategic gender needs.

1.5 Limitation of the Study

The limitations of this study include:

a) The study involved the perception of participants knowledge on what matters to them, adaptation options and how it has impacted their wellbeing. Data was collected from rural women farmers and key stakeholders who are self-reporting their feelings and perceptions. It is therefore likely that respondents will try to please the researcher.

1.6 Organisation of the Study

The study is structured into six main chapters. Chapter One contextualizes the study in terms of background, rationale, the problem definition, research objectives, justification, limitations and how the thesis is organized. Chapter Two reviews both conceptual and theoretical literature related to climate change adaptation and vulnerabilities and wellbeing approach in assessing adaptation effectiveness. In Chapter Three, the methodology employed in the research is discussed. The study area and sampling locations, target population, the research instrument and data collection procedures are all described. The fourth Chapter shows the study results. The fifth chapter discusses the results of the study and Chapter Six presents recommendations drawn from the results and how they can inform adaptation policies, planning and implementation in the study districts.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter examines a core entry point for the research, by defining gender-based disparities that lead to women's vulnerability and unequal exposure to the impacts of climate change; role of women as important agents of climate change responses. It also reviews the concept of wellbeing and how it relates to climate change adaptation. In addition, related concepts within adaptation studies are examined, these include vulnerability and resilience. Attention is drawn to their interconnectedness and links with adaptation. Finally, adaptation and associated aspects are examined. The concept of adaptation is closely related to vulnerability and resilience and overlaps to a great extent with the concept of wellbeing.

2.1 Climate Change Impact in Africa

Climate change has occupied a major role in political, economic, scientific and public spheres. Some studies have shown signs of current shifts in climate and weather trends and have also linked the warming of the earth's atmospheric space to the continual emission of greenhouse gases (IPCC, 2014; UNDP, 2011).

This has economic, socio-political and environmental implications since weather dependent activities and resources can be compromised, leading to possible conflicts (Funatsu et al., 2019). The adverse effects of climate change have increasingly become visible today, including long-term increase in mean rainfall and temperature; changes in the timing, geographic distribution and intensity of rainfall; a rise in the occurrence of severe events such as flooding,

drought and rise in sea level (IPCC, 2014; Verner, 2011). Some studies suggest that one of the continents or regions most vulnerable to the consequences of climate change in the world is Africa (Niang et al., 2014; IPCC, 2014).

The impact of climate change in Africa is highly distinctive and it is likely to be affected more severely than other regions due to the greater exposure of the region's economy to climatic variation. As a result of the adverse impact, high agricultural dependence and limited capacity of Africans to respond to climate change, its impact tends out to be extreme (Collier et al., 2008). Climate variability/change is a leading human and environmental issue in the 21st century, according to Tadesse (2010), and it is difficult for the people of Africa to understand climate change, thereby making the problem a challenge. Certain studies and public statements also indicate climate change as a security problem in Africa. This is because there are going to be a host of social and political issues that could probably disrupt states and economies due to climate change (Holden et al., 2009). Environmental disasters resulting from climate change endanger human security by encouraging mass displacement and creating competition for water and basic resource needs between communities and nations (Tadesse, 2010).

Africa's anxiety about the detrimental consequences of climate change has reinforced concerns that the resulting environmental destruction and demographic pressures will displace majority of people and cause significant social disruption. Many studies researching the impact of climate change have also projected that higher temperatures, increasing sea levels, shifting patterns of rainfall and increased climate variability are likely to occur in Africa, which is likely to influence its population (Tadesse, 2010) . The actual and probable consequences of climate change in Africa are immense and widespread, impacting several aspects of the daily lives of people. Various climate models also predict that climate change in large parts of Sub Saharan

Africa (SSA) would have a harmful effect on the development of agricultural and food security (FAO, 2008).

Moreover, according to research undertaken by the International Panel on Climate Change, by 2020, between 75 and 250 millions of people in Africa are expected to be subjected to increased water stress due to climate change. Agricultural production, including access to food, is also projected to be significantly affected in many African countries, thus reducing food security and increasing malnutrition. The impacts of climate change are likely to cause an increase of 5% to 8% of arid and semi-arid land in Africa, thereby reducing the arable land available for food production which will result in poverty and food insecurity (United Nations, 2007). Furthermore, most Western Africa coastal cities are vulnerable to climate change. The increased impact associated with climate change, such as floods, deforestation, heatwaves, storm surges, sea level rise, saline intrusion, and cyclones for instance, expose the African region to numerous economic consequences (UN-Habitat, 2014).

In West Africa, because of over dependence on sensitive sectors, climate change affects individuals and national economies. For example, it has been estimated that Ghana has experienced a degree of temperature rise and decrease in rainfall in all of its agro-ecological zones since the 1960s (EPA, 2015). Future climate forecast in West Africa however, suggests that temperature rises will occur with uncertainty regarding precipitation (Riede et al., 2016).

There is warming and variation in weather, as well as increased droughts as a result of climate change in the southern sub region of Africa (Intergovernmental Panel on Climate Change, 2007). The conditions are likely to promote the spread of crop pests and diseases, and thus increase the burden of health risks in Africa (Ebi & Burton, 2008). For example, erratic precipitation, decreasing soil fertility, and increased incidence of crop pests and diseases in

Tanzania lead to more frequent crop failure and increased variability in yields, prompting an increase in seasonal migration (Nelson & Stathers, 2009).

2.1.1 Differential Impact of Climate Change

The negative effects of climate change tend to have a differential impact on women and men because of their gender-based roles in society. Climate change is directly related to poverty and economic marginalization. Therefore, since, women make up the largest proportion of the world's poorest people, they are easily and severely impacted by climate change (IPCC, 2007; Toulmin, 2009; Women Watch, 2009). A research conducted by Ashby et al. (2012), showed that women and men have different on-farm tasks and responsibilities and thus are influenced by climate change differently. For instance, in many countries' women manage household kitchen gardens and small livestock, while men take responsibility for commercial crops and large livestock. According to Behrman et al. (2014), women are more likely to face time constraint which affects their ability to engage in climate change adaptation interventions or other practices at the community level that increase their labour burden than men. For example, climate-smart agricultural practices that require higher labour inputs in the first year pose a barrier to implementation by women farmers, although its benefits accrue over time (Huyer et al., 2015).

In Dillon & Gill (2014) work, it was revealed that, the introduction of irrigation in Mali enabled men to increase the value of their total production, and to market surplus to partially offset the negative impacts of climatic shocks. Women on the other hand had lower access to the irrigation technology and therefore did not benefit from its offsetting effects. Women have limited access to farm assets and technology such as motorized tillers which have positive effects on men's agricultural production (Dillon & Gill, 2014). In view of the fact that the

effects of climate change have different levels of susceptibility on different groups in society, men and women also have varied coping and adaptive capacities which result in differences in vulnerabilities and responses (UNDP, 2010). Research shows that the vulnerability of an individual or a group to the effects of climate change is dictated by their adaptive capacity, which is also dependent on resource availability and accessibility. As a result of this, women are seen as being more vulnerable to impacts of climate change than men because they have limited access to resources (UN Women Watch, 2009; Brody et al., 2008).

In addition, the psychological effects of climate change and variability also differ amongst women and men. For example, women in drought affected areas are more anxious and emotionally distressed than men. This is due to the difficulties women face in executing their work as producers and providers within communities (Coêlho, 2004). Mitchell et al. (2007) further asserted that the psychological effects of a flood are more severe for women than men, since they become distressed and also lose their support networks. In most African countries, since women are mostly poorer, less educated and often isolated from decision-making processes that impact their lives, climate change often has a greater effect on women than on men. Women traditionally have less resources and depend more on natural resources for their livelihoods; this makes them more vulnerable to the effects of climate change than men (UNDP, 2010). For example, women are confronted with higher levels of poverty and have less education than men. They are also limited or deprived socially and physically due to some societal customs and norms which make them less resilient in terms of climate change and variability (Chaudhury et al., 2014).

A study by Care International (2010) found that men are more likely than women to have access to information, technology and other critical climate change adaptation resources than women and therefore have the power to use them better than women, thus restricting women's ability

to easily adapt or handle climate-related risk. This makes women more vulnerable to climate change than men. Aside changes in temperature and precipitation, climate change also has the potential of affecting the frequency and magnitude of hazardous weather events. Some studies on the gendered nature of vulnerability to post hazards and disasters of climate change illustrate how women and men are affected differently. The studies further argue that, in post disaster situations, women and girls are more vulnerable due to the lack of access to resources thereby exposing them to food shortages, sexual harassment, unwanted pregnancies, trafficking and vulnerability to diseases. Lack of access to resources can lead to school dropout or early/forced marriage among girls (UNDP, 2010). For instance, majority of people affected by the Hurricane Katrina were African-American women and their children, a group known to be poor in the region, have no access to health care and are also underemployed (Williams et al., 2006; Gault et al., 2005). However, some post-disaster climate related analysis has indicated that men experience higher mortality rates because they take more risks trying to save themselves and their families. Specific examples can be found in Bradshawl (2004) study, which revealed that men suffered higher mortality rates in Hurricane Mitch.

2.1.2 Impact of Climate Change in Semi-Arid Region of Ghana

In semi-arid regions, climate change has numerous physical and socio-economic consequences for communities (Lawson et al., 2019). Many studies have confirmed that, because of multiple stresses and poor adaptive capacity, the arid and semi-arid regions are the most vulnerable areas to climate variability and change. This is due to several factors, including the overuse of natural resources, widespread poverty, weak infrastructure, high rates of illiteracy, conflicts, and the reliance of its economies on climate-sensitive sectors, primarily rain-fed agriculture (Antwi, 2013). Climate change in semi-arid Ghana also results in rising temperatures, dry spells, changes in timing of the beginning and end of rainy seasons as well as changes in duration of

crop growing periods, that are likely to affect agricultural production and threaten household food security in the region (Ogra and Badola, 2015; Sarr et al., 2015). According to various climate change prediction models, as a result of change in climatic condition, there is likely to be a steady rise in temperatures and decline in precipitation trends in semi-arid Ghana (USAID, 2015). Some research also claims that, the standard deviation for the onset of the rainy season will increase (Laux et al., 2007), thereby leading to more severe weather conditions such as droughts, dry spells, and floods (Laube et al., 2012)

2.1.3 Climate Change and Agriculture in Semi-Arid Ghana

In Sub-Saharan Africa, climate change is expected to have a major impact on food security, especially in areas where most livelihoods are heavily dependent on rain-fed smallholder agriculture (Ziervogel et al., 2008; Barrios et al., 2008). The changes in rainfall patterns and rising temperatures have both direct and indirect effect on crop yields, due to changes in the availability of irrigation water, thus exacerbating the impacts of drought, soil depletion and biodiversity loss. For instance, forecast for Sub-Saharan Africa indicates that the continuous change in rainfall patterns and rising temperatures is likely to lead to a decline in rice, wheat, and maize yields by 15%, 34%, and 10%, respectively in the next thirty years (Nelson et al., 2009). Some studies have also revealed that due to increased negative effects of climate change on agriculture, there is the fear of reduced productivity thereby bringing about food insecurity (IPCC, 2007). A study conducted by the Environmental Protection Agency of Ghana indicates that the reduction in total rainfall from 1.1% to 0.5% will lead to a reduction in agricultural productivity (Tetteh et al., 2014).

In addition, climate change models in semi-arid Ghana indicate declining rainfall levels, temperature rises, and a growing frequency of late spring rain onset (Stanturf et al., 2011). The

predicted changes in rainfall and temperature would adversely affect agricultural production in the region due to the fact that agriculture in semi-arid Ghana relies heavily on rainfall, because the region has only one rainy season (Assan et al., 2018). Some studies have also revealed that, an annual average of 5.5% of total output of the major staples for instance, maize, rice, cassava, yams, millet, sorghum, groundnuts, and plantain are lost to climatic, biological, and natural disasters in Ghana (Stutley, 2010). Climate change and variability, such as dry spells and droughts, pose threats to crop productivity, especially at the critical stages of plant growth, limiting the attainment of food security and the growth of livelihoods among vulnerable households in Semi-arid Ghana (Mawunya and Adiku, 2013). For instance, a study conducted by Rademacher-Schulz et al. (2014) showed that a decrease in rainfall patterns and dry spells in Semi-arid Ghana has led to decreases in crop yields. As a result of the damaging effects of climate change and variability in Semi-arid Ghana, majority of farmers within the area have resorted to coping strategies including migration, mix cropping and diversification of livelihoods, rearing of livestock, remittances, and other social networks (Ahmed et al., 2016). Farauta et al. (2011), revealed that the impact of climate change on agriculture outweighs any positive impacts, thus leading to shortage of food. Climate change leads to the reduction in light, low photosynthesis and low oxygen, thereby contributing to low agricultural productivity (Ahmed & Diana, 2015). Climate change combines with land degradation to adversely affect food security (Araya et al., 2015). Climate change's negative effects can be seen in the annual net primary production, ground cover and water use efficiency (Alua et al., 2018).

2.1.4 Rural Women Farmers and Agriculture in Ghana

Women play important roles in Ghana, they also control major productive sectors especially in agriculture (SEND Ghana, 2014). Women make up 52% of the agriculture labour force, contribute 46% to the total GDP and produce 70% of subsistence crops. They play major roles

in production and marketing (Nielsen and Reenberg, 2010). Despite the fact that women account for 85 percent of the country's food distribution and outnumber their male counterparts in agricultural production, several socio-economic factors have an impact on the productivity of women in this sector (MOFA-WIAD, 2002). The participation and success of women in agriculture is very important for the sector's competitiveness. Traditionally, women are also typically active in value chain nodes with lower economic return than men. The role of women in the production of a particular crop is often linked to the assumed value of the crop and is thus typically restricted to local consumption and the local market (Coles and Mitchell, 2011).

Most women participate in agriculture by cultivating their own farms; they can also serve as unpaid workers on family farms as well as paid or unpaid labourers on other farms and agricultural enterprises. Majority of them are engaged in both crop farming and livestock production at subsistence and commercial levels producing food and cash crops as well as the management of mixed agricultural operations such as crops, livestock and fish farming.

Dumenu and Obeng (2015), studying social vulnerability also found the three regions in northern Ghana to be most vulnerable to climatic factors including erratic rainfall, prolonged drought, and shift in crop season. It nonetheless noted that vulnerability is mediated by social factors including demography, economic and social factors proxy by illiteracy, climate sensitive occupation and access to climate sensitive information respectively.

Conversely, numerous studies have sought to demonstrate that the major constraints plaguing smallholder farmers are largely non-climatic. Jayne et al. (2010), in an empirical study of challenges confronting smallholders in South and East Africa, identified non-climatic stressors as main challenges confronting smallholder farmers' production. These include declining land holdings, low market participation of majority of smallholders, high food prices, exodus of rural farm labour to urban center and changing urban consumption pattern. The study

concluded that unless government policy on smallholder farmers is changed radically and backed by the required financial commitment, the world will witness progressively, recurrent and severe economic and social crises in sub-Saharan Africa. Nielsen and Reenberg (2010a), discovered that farmers in semi-arid regions have moved beyond climate through engagement in non-climate sensitive economic activities including labour migration, gardening, selling livestock, working for development projects and small businesses owned by women. The study further noted poor health and infrastructure and unstable political and economic structures as the main threats to the sustained wellbeing of people in the area. A study conducted by SEND Ghana (2014), showed that, women are major players in agriculture in Ghana since they constitute more than half of the agricultural labour force and also produce over 70% of the food stock in the country. Women's contribution to agricultural work is determined by their involvement, activity and the specific crop under cultivation.

2.2 Vulnerability of Rural Women Farmers and Determinants

Although climate change affects everyone around the world, its effects are differentiated between men and women, as well as between countries, generations, age groups, income groups, and occupations (State of the World, 2009). According to Neher et al. (2015), inequalities affect vulnerability and resilience due to its influence on the farmers' capacity to cope and also analyse the differential effect of severe weather events. The existence of gender-based inequalities including the access to and ownership of land and other resources, limits the capacity of women farmers to effectively adapt to the impact of climate change and thus making them more vulnerable (FAO, 2011; World Bank, 2011). Reports suggest that, the economic marginalization of women prevents them from responding adequately to climate change since they have little assets and an insufficient resource base, making them disproportionately vulnerable to the adverse effects of climate change. For instance, most women face gender-

based cultural and legal limitations on land and other resource ownership (FAO, 2011, World Bank, 2011).

Inability of women smallholder farmers to adapt to extreme events that will negatively affect plants, livestock and people, will lead to a reduction in productivity of these farmers (Challinor et al., 2014). According to Goh (2012), rural women, who are predominantly smallholder farmers, are still at high risk of adverse effect from climate change. Women smallholder farmers are mostly occupied with activities which make them particularly climate-sensitive, as they are more involved in agricultural work than men but have less access to agricultural resources including land, extension services and inputs to help them adapt to climate variability and change (FAO, 2011; Nelson and Stathers, 2009).

According to Murray et al. (2016), climate change poses a lot of challenges for the maintenance and improvement of agricultural and labour productivity of smallholder women farmers. The labour productivity of many women smallholders is limited by the lack of access to labour-saving technologies and the most basic of farm implements. As a result of low agricultural and labour productivity of poorer smallholder farmers they are confronted with a trap of poverty, that they cannot easily escape without access to key resources such as rural energy and labour-saving technologies. In a study of selected micro-level adaptation literature, Below et al. (2010) indicated that the consequences of climate variability and change will continue to threaten vulnerable people. Drought/dry spells will be more frequent, rain will be more unpredictable, and torrential rainfalls heavier. Higher temperature will lead to the evaporation of soil moisture, and water stress will aggravate worsening of the already bad water stress situation in Africa (Below et al., 2010). For instance, in Malawi, the agricultural system is predominantly rainfed and largely composed of smallholders who remain vulnerable to climate change and variability shocks. Some determinants of vulnerability of rural women farmers to climate variability and

change are sensitivity of ecological systems, livelihood resilience, information access, decision making and strong institutions as discussed below.

2.2.1 Sensitivity of Ecological Systems

Climate change consists of elements which affect the biological and human systems in different ways. For instance, global average temperature increase brings about differences in temperature rise between land and sea as well as high and low latitudes (Metz and Intergovernmental Panel on Climate Change, 2007). As the planet warms, climate and weather variability will increase thereby creating consequences for the human and natural systems (Field et al., 2012). Many studies have revealed that, amongst the Sub-Saharan African ecosystems, the savannah vegetation is the most vulnerable ecosystem to the effects of climate variability (Midgley and Thuiller, 2011). For instance, the increase in atmospheric carbon dioxide (CO2) concentration or nitrogen deposition has led to the expansions in tree cover in South Africa (Wigley et al., 2010). Changes in temperature and rainfall variability in the Western Sahel Region has also led to a decline in tree density and a significant decline in species richness across the Sahel (Gonzalez et al., 2012).

According to Midgley and Thuiller (2011), short-term responses of ecosystems in African biomes are typically driven by water availability and fire regimes, but in the longer-term African biomes are highly sensitive to changes in atmospheric carbon dioxide (CO2) concentrations. The shift from heat-tolerant grasses to trees which benefit from high carbon dioxide (CO2) concentrations leads to the risk of abrupt vegetation shifts at the local level (Higgins and Scheiter, 2012). In addition, changes in temperature and precipitation is likely to disrupt the growth of forests. For example, if extreme weather conditions increase, forests may shrink at the expense of grasses (Bond and Parr, 2010). Increase in extreme drought and

temperatures are also likely to pose threat of broad scale climate-induced tree mortality (Allen et al., 2010).

Globally aquatic ecosystems or ocean ecosystems also respond sensitively to the effects of climate change and climate variability (Cheung et al., 2010). Drought affects freshwater ecosystems thereby reducing the influx of nutrient as the river inflow is temporarily reduced (Ndebele-Murisa et al., 2010). The increase in freshwater demand in urban areas of large river basins as a result of climate change and variability may lead to reduced river flows, making them insufficient to maintain ecological production, thereby negatively impacting freshwater fish populations (McDonald et al., 2011). Theory and empirical studies suggest that in order to overcome or adapt to climate change and variability, there is the need for shift of ocean ecosystems toward higher latitudes and deeper waters (Cheung et al., 2010). However, as a result of changes in climate there is the risk that some species and even whole ecosystems are likely to go into extinction (Drinkwater et al., 2010).

2.2.2 Livelihood Resilience

According to IPCC (2012), resilience entails the ability of a system and its components to anticipate, absorb as well as recover from the effects of a hazardous event in a timely and efficient manner. It also includes learning, coping with events, adaptation as well as recovery from stresses arising, which eventually leads to the improvement and sustainable ways of dealing with the ever-changing and unpredictable issues (Perrings, 2006). Resilience can also be seen as the amount of disturbance a system can handle before the change of state, also referred to as the capacity; thus, the capacity of a system to return to equilibrium after a disturbance (Maleksaeidi and Karami, 2013; Neubert et al., 2011). This implies that despite the shocks, stresses and other extreme events, resilient systems will still have the same identity,

same structures and function in the same way (Folke et al., 2002). Nelson and Stathers (2009) in their study explained that resilience in a socio ecological context is the process of using resources, the abilities and adaptation capacities of systems to reduce shocks and stresses whiles ensuring self-organisation and enabling recovery. Davies et al. (2013), further assert that resilient livelihoods are reliable, sustainable and have the ability to cope with, and also recover from challenges, shocks and stresses without undermining the environment. Thus, resilience can also be seen as measures of minimizing shocks and stresses by using different resources and capacities to achieve a state of adaptation (Klein et al., 2003). Moreover, the concepts of resilience entail hard resilience, which is the direct strength of structures or institutions when placed under pressure and soft resilience which is also the ability of systems to absorb and recover from the impact of disruptive events without fundamental changes in function or structure. Thus, people with direct access to capital, tools and equipment, have the potential to withstand any disaster that occurs (Proag, 2014).

2.2.3 Information Access

Climate information plays an important role in providing Early Warning Systems (EWS) as well as increasing awareness for building the capacity and disaster preparedness to a changing climate. Information dissemination channels sometimes influences the access and use of climate information being disseminated to enable the vulnerable groups exposed to climatic hazards build adequate response capacities (Bebe, et al., 2012). Climate information and support services mostly relevant to adaptation in semi-arid areas include early warning signals, weather forecasts, food aid distributions, emergency guidelines, and financial support, medical and veterinary assistance (IPCC, 2007; Thornton et al., 2006). However, even though the people living in semi-arid environments are in most need of access to climate information and support services, reports indicate that they are yet to experience the full benefits of climate

research, information and support services to enable them effectively cope and build adaptive capacity to the changing climate (O'Brien et al., 2008). According to Harvey et al. (2009) as a result of poverty barriers, lack of infrastructure, illiteracy and other socioeconomic factors, information sharing among climate change actors in Africa is mostly limited and could be worse in semi-arid environments. Limitations also exist in the information delivery mechanisms in terms of reliability, timing, infrastructural development and even language (Chamboko et al., 2008).

2.2.4 Decision Making.

Decisions influencing the management of natural resources and climate change adaptation and mitigation can take place at the sub-national, national and regional levels, as well as across a number of institutions, including national ministries and regional representation bodies, land commissions, water resource boards or forestry committees (Halle et al., 2013). The knowledge and experience of women are sometimes adopted at the local level due to the fact that, their roles and responsibilities provides a clear entry point to involve them in decision making processes. For instance, male leaders in the Iraqi marshlands have welcomed women's participation in deciding how to manage local water resources (WATEO, 2010). Moreover, effective participation of women in local decision making on the utilization and management of natural resources tends to yield positive results for their communal livelihoods. For example the involvement of women in the design, implementation and monitoring of a watershed management project in Nigeria, led to a reduction in travel time for water collection, enabling local women to spend more time on income-generating activities, such as farming and marketing, as well as the availability or provision of adequate time for women and girls to attend school (Halle et al., 2013).

In addition, the unique experiences and roles of women in productive, reproductive, and community management activities implies that their participation is essential for the success of any climate change adaptation or mitigation effort. However, women still hold a minority of decision-making positions in most public and private institutions, including those dealing with the environment (Habtezion et al., 2011). Whereas this gender barrier is complex, this low level of involvement can be attributed to women's limited access to formal training (UN DESA, 2010). For instance, in Nigeria women represented only 27 percent of college graduates in environment science in 2005 (UN DESA, 2010). Also, the participation of women in climate effort or decision making both at the global and national level is limited (Raczec et al., 2010 in Dankelman, 2010).

2.2.5 Strong Institutions

Institutions can be defined as systems of established and prevalent social rules that structure social interactions. Institutions can either constrain or enable human actions or behaviours through the imposition of rules (Hodgson, 2006). According to Agrawal (2008), institutions are very important in dealing with climate change adaptation. The institutions serve as structures and mechanisms of social order as well as cooperation governing the behaviour of a set of individuals within a society or community. In addition, the availability of strong institutions assist individuals and communities to interpret scientific information and also design and implement adaptation strategies, including the provision of innovative technologies to reduce vulnerability (Amaru and Chhetri, 2013). African traditional institutions in rural communities are known to provide frameworks within which the capacities of the local people can be exercised in their adaptation to climate change, thereby making them very essential (Yaro et al., 2015).

MESTI (2013) asserted that climate change adaptation mostly depends on the dissemination of information and provision of resources by various institutions with the responsibility of enhancing adaptive capacities of communities. For instance, there exists both formal and informal institutions in rural Ghana, including religious institutions, traditional institutions, family networks, clan/elders' networks, community-based organisations, farm-based organisations, and women's groups. The strength of this institutions, helps one to understand the adaptation capabilities of farmers in semi-arid areas (Yaro et al., 2015).

2.3 Adaptation Responses by Rural Women Farmers to Climate Vulnerability and Change

According to IPCC (2007), most women in the world are faced with severe gendered impacts of climate change without equal representation in decision-making or policy and programmatic design. These impacts of climate change are more pronounced in settings that are also affected by violent conflict, political instability, and economic strife. Women tend to be marginalized from political and economic power and have limited access to financial and material resources which can exacerbate their vulnerability to the impacts of climate change (Alam et al., 2015). Despite the fact that women face unique and sometimes disproportionate burdens as a result of climate change, they are not only victims but rather women are also agents with important perspectives and indigenous knowledge, which can inform and influence solutions to address climate change. For instance, in many communities around the world that are already acutely affected by climate change, women are having to adapt their lives to survive and care for their dependents (UNFCCC, 2014).

Women also have unique skills, experience and knowledge of natural resources management, food production as well as climate and weather patterns. Therefore, women's greater involvement in adaptive efforts would render it more equitable, more effective and more

sustainable (Eggerts et al., 2013). Women also hold critical local knowledge that can enhance climate adaptations and assist the development of new technologies to address climate variability in areas related to energy, water, food security, agriculture and fisheries, biodiversity services, health, and disaster risk management. Women's traditional knowledge and practices have the potential to add enormous value to the development of new technologies and adaptations to address climate change (Lane and Mc Naught, 2009). Some common adaptation responses employed by rural women farmers toward climate variability and environmental changes are sustainable land management practices, modern input use, livelihood diversification, irrigation and migration have been discussed below.

2.3.1 Sustainable Land Management Strategies.

Sustainable land management strategies consist of knowledge-based procedure that helps integrate land, water, biodiversity, and environmental management to meet rising food and fiber demands while sustaining ecosystem services and livelihoods. Sustainable land management strategies also entail the preservation and enhancement of the productive capabilities of land in cropped and grazed areas, and mitigation of the adverse effects of degradation (World Bank, 2006). Most women play important roles in conservation and management of sustainable eco-system since they have taken part in the protecting and conservation of natural resources which includes those in mountain areas (Wiafe and Arku, 2014). However, women's roles and concerns in mountainous natural resource conservation remain poorly understood and incompletely acknowledged (Adhikari, 2001).

As a result of the specific roles of smallholder women farmers in food production, most of them are known to have great ideas and knowledge on cultivation, processing, and preservation of nutritious and locally adapted crop varieties. Therefore, if women are given adequate access to

productive resources, farm yields and agricultural produce are likely to increase by 20% to 30% thereby raising total agricultural productivity in Ghana, and thus reduce hunger in the country. Women's potential in agriculture, management of household and food is likely to improve family nutrition, food security, maternal and child health, promote environmental management and minimize poverty levels in the country (SEND Ghana, 2014).

2.3.2 Modern Inputs Use.

According to Awotide et al. (2012), adopting modern or improved agricultural inputs usually gives farmers a comparative advantage over colleague farmers who do not adopt or have access to modern technology. Modern agricultural inputs consist of improved seeds, fertilisers, pesticides, farm machinery and also irrigation facilities and knowledge (World Bank, 2014). Modern inputs like improved seeds are very important for successful crop production since they contribute to farm productivity and profitability and they are able to withstand harsh weather conditions (Almekinder and Louwaars, 2002). Fertiliser supplies nutrient to the soil thereby promoting plant growth (Gregory and Bumb, 2006). Fertiliser application also serves as an essential climate change mitigation and adaptation measure since it has the potential of maintaining soil fertility through the supply nutrients to the soil (Marenya and Barrett, 2007).

According to Brayn et al. (2011) the use of improved seed and crop varieties and the appropriate application of fertiliser has the potential of increasing food productivity thereby promoting food security, ensuring higher income for the population and also increasing livelihood resilience to climatic change and variability. Chemicals such as pesticides, herbicides, insecticides and fungicides are also important modern inputs which increases livelihood resilience to climate change and variability. These chemicals protect crops against harmful insects and plant diseases that afflict crops thereby promoting plant growth and productivity

(Oerke and Dehne, 2004). Finally, technical knowledge and modern agricultural machinery also promotes the effectiveness of human labour and therefore leads to increase in farm productivity and also promote food security (Akinbamowo, 2013).

2.3.3 Livelihood Diversification.

According to Helmore and Singh (2001), the concept of livelihood considers all the possible ways, both monetary and non-monetary, in which people construct their living. It also entails the capabilities, assets and activities as well as human, physical, natural and social capital that enables populace of a particular community to engage in various livelihood activities (Ellis, 2000). Diversification on the other hand is a unique adaptation strategy by which households manage risk and earn extra income to secure their livelihoods (Asfaw et al., 2015). Dumenu and Obeng (2016) asserted that with respect to diversification of rural households only 15 per cent and 20 per cent of rural households in the Guinea and Sudan Savannah of Ghana have respectively diversified their income generating activities outside agriculture. Livelihood diversification especially in a rural context is usually analysed through two closely intertwined dimensions such as type and place of activity (Lerman et al., 2008). This implies that there exist two possible routes for diversification including farm diversification and employment diversification. According to Owusu et al. (2011), there has been an increase in diversification among resource poor households especially those in Northern Ghana.

Rural households in Northern Ghana are mostly known for cropland diversification or on-farm diversification strategies. For instance, reports by the Ministry of Food and Agriculture (MoFA) indicated that the increase on-farm diversification in Northern Ghana in 2008 was because of the introduction of the fertiliser subsidy programme by the government of Ghana (MoFA, 2012). Diversification into the non-farm sector brings about a positive and statistically

significant effect on household income and food security status (Owusu et al., 2011). Due to the devastating effects of climate change such as lower crop yields and increasing crop failures, the non-farm sector is regarded as an important means of securing income (Laube et al., 2012). Antwi-Agyei et al. (2014) posits that the rural non-farm sector of Ghana can be classified into the wage employment and the self-employment sector. For instance, national figures from the Ghana Statistical Service revealed that 46 per cent of all rural households in Ghana operate or own a non-farm enterprise, with women operating 72 per cent of these business ventures (Ghana Statistical Service, 2008). Women in rural Ghana especially Northern Ghana are usually found in the agro-processing businesses, processing groundnuts, shea nuts, cotton ginnery, rice and trading of foodstuffs (Ackah, 2013).

2.3.4 Irrigation

Irrigation entails the application of water to soil basically to meet the water needs of growing plants or crops. In doing this water from rivers, reservoirs, lakes, or aquifers is pumped or flows by gravity through pipes, canals, ditches or even natural streams (Bjorneberg, 2013). Applying water to fields enhances the magnitude, quality and reliability of crop production, and contributes to about 40% of the world's food production and 20% of the world's crop production land (FAO, 2013). Irrigation is also essential for growth as it enables off-season farming, provides the potential for multiple harvests per year, and brings additional land under cultivation (Adeoti, 2012). Irrigation is considered as an essential strategy in addressing climate change adaptation needs since it seeks to mitigate some climate change challenges such as water shortages, droughts and sometimes flood mostly faced by people living in rural communities especially small holder farmers. Irrigation therefore serves as an alternative source of water supply to ensure the availability of sufficient water for agricultural and other livelihood activities (FAO, 2017).

2.3.5 Migration.

Migration is also considered as another form of livelihood diversification strategy in rural Ghana (Asravor, 2017). Income generated from migration into the big cities makes migration an essential livelihood strategy (Lay and Schüler, 2008). During the dry and off farming seasons many people migrate from rural communities into the big cities in search for other sources of income since there is virtually less or no farming during these seasons (Dzanku, 2015). As a result of the effects of climate change, the security and livelihoods of people are affected, thereby bringing about the need for a safer environment with more stable economic opportunities and long-term adaptation solutions. This implies that one's decision to migrate can be determined by climate change related vulnerabilities since most people will like to minimize the rapid effects of climate change on them and also increase their adaptive capacities (Alam et al., 2015).

A study undertaken by Asravor in 2017 also revealed that, the income gained from migration are transient since most household members return to their farms during the farming season to reinvest the money earned from migration. For instance, a panel data study for the Eastern and Upper East Region of Ghana indicates that apart from income from farming activities which is stable, income from diversified livelihood options are transient (Dzanku, 2015). In addition, most migrants also contribute to the creation of decent employment and inclusive social protection systems by transferring remittances, skills, technology and knowledge (FAO, 2016).

2.4. Enablers of Adaptation

Adaptation to climate change to a large extent, depends on the farmers' adaptive ability to counter the impacts and risks of climate change. This adaptive ability is influenced by their socioeconomic characteristics (Smit et al., 2001). Some researchers have argued for

institutional support to enable farmers to adapt to current and future variations in climate and to improve their resilience. Further studies also indicate that, the support could be provided by government agencies, non-governmental organisations, and other stakeholders in agriculture (Assan et al., 2018). Examples of such support include providing community irrigation systems, resourcing research institutions to develop climate-tolerant crop varieties, providing agricultural insurance, building capacity of farmers, creating opportunities for stable income, and providing credit and extension services (Assan et al., 2018; Fosu-Mensah et al., 2012).

There is the need for incorporating gender perspectives in planning institutional support for farmers since men and women farmers may face different constraints to adaptation and may also prefer different types of adaptation support due to differences in adaptive capacities and roles (Jost et al., 2016). For instance, female farmers preferred wells and boreholes, bushfire control, and water harvesting, whereas male farmers preferred irrigation, wells, boreholes, and drought-tolerant crop varieties in adapting to drought conditions (Assan et al., 2018).

2.5 Barriers/challenges to Adaptation

A study conducted by Lawson et al. (2019), indicated that a major and a critical barrier to climate change adaption is ownership and access to land since it is linked to vulnerability, livelihoods and food security. For instance, women who owned and had access to land are able to improve or optimize their livelihoods (Onta and Resurreccion, 2011). According to Akologo and Guri (2016), in a region where agriculture is the main source of food and income, land ownership is important for social wellbeing. The inability of some women farmers to own lands affected their ability to adopt innovative climate change adaptation practices. Some of the lands they farm on was acquired through insecure means which includes borrowing from relatives as well as renting from land owners (Lawson et al., 2019). Bryan et al. (2009) and Kithiia (2011)

in their studies indicated that financial constraint comprising of inadequate capital, lack of credit services, also hinders farmers from adopting climate change adaptation strategies. The inadequate financial resources limit the farmer's access to fertiliser and improved crop varieties.

In addition, residential status of farmers also influences their climate change adaptation options. For example, farmers who were born and had lived most of their lives in the communities were much more familiar with the climatic conditions in the area as compared to the migrants, therefore enabling them to formulate adaptation measures easily. Women farmers who are non-migrants are likely to adapt better to manifestations of weather extremes than migrants since they have a relatively better access to resources (Lawson et al., 2019). Fatuase and Ajibefun (2014), further asserted that, formal education to senior high and tertiary levels also influences adaptation options. Lower levels of education limit the ability of people to gain extra employment opportunities particularly in the non-farm sector (Minot et al., 2006). However, sociocultural barriers in gendered roles and social status often limit women from effectively adapting to climatic risk (UNDP, 2011).

2.6 Determinants of Adoption to Technologies for Adaptation.

Decision to adopt new technologies for climate change adaptation depends mostly on the relationship between the technology itself, the conditions and also the circumstances at hand (Loevinsohn et al., 2013). Hall and Khan (2002), also assert that, new technology diffusion amongst a group of people also depends on a series of individual decisions to try the technology which comes as a result of a comparison of the uncertain benefits of the new invention or technology. Previous economic analysis of technology adoption explained adoption behaviour in relation to personal characteristics, endowments, imperfect information, risk, uncertainty,

institutional constraints, input availability and also infrastructure (Uaiene et al., 2009). A study conducted by Akudugu et al. (2012) categorized the determinant of new agricultural technology adoption into three different groups including; economic, social and institutional factors. Lavison (2013) also grouped the determinants that influences the adoption of new technology into social, economic and physical categories.

Despite the fact that, there exists many themes for categorizing determinants of technology adoption for climate change adaptation, there is no clear distinguishing feature between variables in each category (Bonabana- Wabbi, 2002). Based on the various categorization of the determinants it can further be categorized into technological, economic, institutional and household specific factors as discussed below:

2.6.1 Technological factors.

The features of a particular technology or invention serves as a precondition for its adoption, also the degree to which it can be tried before adoption serves as a major determinant for its adoption (Doss, 2003). Mignouna et al. (2011), also added that, the characteristics or features of a particular technology plays a very important role in determining its adoption. According to them farmers who perceive that, the technology will be consistent with their needs and also compatible to their environment are likely to adopt the technology. This implies that perception of farmers on the performance of the technology also influences its adoption. Furthermore, in order to enhance or ensure adoption of any new technology beneficiaries should be involved in its evaluation to find suitability to their circumstances (Karugia et al., 2004).

2.6.2 Economic Factors

In the adoption process of a new technology, farm size is a very important component of the economic factor. Farm size has the tendency to affect and also be affected by the other factors

influencing adoption (Lavison 2013). According to Bonab-Wabbi (2002), some agricultural technologies depend on the size of farm, thereby making the size of the farm an important component in determining the adoption of a particular technology. Hence, there exists a positive relationship between farm size and the adoption of agricultural technology (Mignouna et al., 2011). For instance, farmers with large farm size are likely to adopt a new technology since they can afford to devote part of their land to try new technology unlike those with less farm size (Uaiene et al., 2009). Another key economic determinant of the adoption of a particular technology is the net gain or profit the farmer will gain from adopting the technology, considering the costs involved in adopting the new technology (Foster and Rosenzweig, 2010). A study conducted by Muzari, et al. (2013) revealed that, the cost involved in the adoption of a new technology can also serve as a determinant to its adoption. In a study conducted by Wekesa et al. (2003) in Kenya in analyzing determinants of adoption of improved maize variety in coastal lowlands of Kenya revealed that high cost and unavailability of seeds as one of factors responsible for low rate of adoption.

2.6.3 Institutional factors

According to Mignouna et al. (2011), being a member of a social group enhances social capital allowing trust as well as idea and information exchange, thus increasing social network. Most farmers within a social group easily learn from each other on the benefits and the usage of a new agricultural technology, making social network a very important determinant of technology adoption for adaptation. Uaiene et al. (2009) also asserts that social network effects are important for individual decisions since farmers share information and learn from each other. For instance, a study in Uganda by Katungi and Akankwasa in 2010, revealed that farmers who are active members in community based organisations were likely to engage in social learning about the technology thereby increasing their possibilities in adopting new

technologies. In addition, farmer's access to extension services can also be considered as an institutional factor that determines or influences technology adoption decisions of farmers. Extension services provides farmers with information on the existence as well as the effective use and benefit of a particular technology, thereby making extension agents middlemen between innovators and farmers (Genius et al., 2010). According to Uaiene et al. (2009) exposing farmers to information through extension services based on innovation-diffusion theory increases the possibility of adoption of new technologies. The influence of extension agents usually counters and transforms the negative effect of lack of years of formal education in the overall decision to adopt new technologies for adaptation (Bonabana-Wabbi, 2002).

Access to credit institutions, which promotes the availability of funds also stimulates technology adoption for adaptation (Mohamed and Temu, 2008). Reports have revealed that, access to credit promotes the adoption of risky technologies through relaxation of the liquidity constraint as well as through the boosting of households-risk bearing ability (Simtowe and Zeller, 2006).

2.6.4 Household-specific factors.

Another factor to consider in determining the adoption of new technologies is human capital of the farmer which is mostly measured through the farmer's education, age, gender, and household size (Keelan et al., 2014). According to Namara et al. (2013) education of the farmer has a positive influence on his or her decision to adopt a new technology, since education level of the farmer increases his or her ability to obtain, process and use important information for the adoption of a new technology. A typical example was revealed in Okunlola et al. study in 2011 on adoption of new technologies which revealed that education had a positive and significant influence on the adoption of a new technology. With respect to age in the adoption

of a new technology, older farmers are assumed to have gained knowledge and experience overtime putting them in a better position to evaluate technology information better than younger farmers (Mignouna et al., 2011; Kariyasa and Dewi, 2011). On the other hand, other studies revealed that there exists a negative relationship between age and the adoption of new technology (Mwangi and Kariuki, 2015). According to Mauceri et al. (2005) as farmers grow older, there is an increase in risk aversion and a decreased interest in long term investment in the farm as compared to young farmers who are usually less risk averse and are willing to try new technologies. A study by Alexander and Van Mellor (2005) revealed that the adoption of genetically modified maize increased with age for younger farmers as they gain experience and increase their stock of human capital but declines with age for those farmers closer to retirement.

Gender issues in agricultural technology adoption have been investigated for a long time and most studies have reported mixed evidence regarding the different roles men and women play in technology adoption (Bonabana-Wabbi, 2002). For instance, a study by Lavison (2013) revealed that, male farmers were more likely to adopt organic fertiliser unlike their female counterparts.

2.7 Theoretical Perspectives of the Study

This research draws specifically on the wellbeing and vulnerability theories to frame the analysis. Vulnerability can be conceptualized as a function of three elements; exposure, sensitivity and adaptive capacity (Adger, 2006). The wellbeing theory also considers the activities, and abilities that make up a well-lived life. This aspect of wellbeing has influenced various approaches of wellbeing such as the capabilities concept (Nussbaum, 2003), the multidimensional poverty index, (Alkire and Santos, 2014) and the theories of fundamental

human needs. There exist many theoretical constructs of wellbeing but two theories are mostly dominant in wellbeing research and they include the objective theory and the subjective wellbeing theory. According to Watson et al. (2012), the objective wellbeing theories basically focuses on the quality of life indicators which includes social attributes such as health, education, social networks and connections, and also material resources such as income, food and housing. Objective theories of wellbeing largely emanate from Amartya Sen's work in welfare economics, which is aimed at focusing on agreed core human capabilities necessary for quality life. For instance, body health and integrity, the ability to think and imagine, the ability to express emotions, the ability to exercise practical reasoning and autonomy in contributing to one's own education, work as well as political and social participation (Bourke and Geldens, 2007). On the other hand, subjective wellbeing theories deals with life evaluations comprising of two main components such as feelings, emotions and mood and life satisfaction, a distinct construct defined relatively to specific domains in life such as school, work and family (Diener and Ryan, 2009). In view of the fact that, subjective wellbeing is centered on people and perceptions or opinions, subjective wellbeing has direct utility in explaining or describing and facilitating peoples' social and emotional wellbeing (Watson et al., 2012).

2.7.1 Concept of Vulnerability.

The concept of vulnerability has become a central theme in the climate and development debate and also forms the basis for understanding and responding to changes in socioecological system such as climate change (Tschakert et al., 2013; Preston, 2012). Vulnerability is usually referred to as the consequence of the interactions between socioeconomic conditions such as poverty, income distribution, available infrastructure and institutional structures such as quality of governance, rule of law and decentralization. For instance, in the developing countries poverty increases vulnerability due to the fact that, poor people are dependent on the direct use of

natural resources and have limited resources to adapt or deal with economic shocks caused by natural disasters (Rodenberg, 2009). According to Adger et al. (2004), there are two broad classes of vulnerability which include the vulnerability to biophysical determinants such as climatic conditions, topography, land cover, primary productivity, and natural hazards and the vulnerability to socio-economic determinants such as population density, poverty, trade, employment, gender, and governance.

Vulnerability to the socio-economic determinants conceptualizes vulnerability as being inherent to a social system (social conditions, historical circumstances and the political economy of groups). This indicates that climate change impacts will interact with changes in demographics, markets, technology, social pressures and many other factors that cannot always be anticipated. Thus, determining a community's ability to cope with and adapt to change whether social or environmental (FAO, 2015). According to Proag (2014) vulnerability is the degree to which a system, or part of it, may react adversely during the occurrence of a hazardous event. This vulnerability concept implies a measure of risk associated with the physical, social and economic aspects and implications resulting from the system's ability to cope with the resulting event. Most often, an individual or a group's vulnerability to climate change is largely determined by their adaptive capacity (Care International, 2010). Hence, the higher the adaptive capacity the lower the vulnerability, whereas the lower the adaptive capacity the higher the vulnerability. Some studies indicate that, in order to assess the vulnerability of various groups in society, it is important to disaggregate information in relation to different groups and individual's ability to adapt to climate change, as well as the gender and social difference (Mainlay and Tan, 2012). Furthermore, the concept of vulnerability in terms of a socio-political perspective, entails a set of general characteristics that impair the ability of a

social group to cope with and respond effectively to external shocks, as well as adapt to a situation of persistent climate change (Rodenberg, 2009).

2.7.2 Concept of Exposure

Exposure can be likened to the inventory of elements in an area in which hazard events may occur or the location of population, economic and environmental resources in potentially dangerous settings or areas (UNISDR, 2009b). Even though exposure is necessary in risk determination it is not a sufficient determinant of risk since one can be exposed and still not be vulnerable as a result of some measures put in place to mitigate potential disasters or dangers. Nevertheless, one's exposure also determines his vulnerability, since it's not possible to be vulnerable to an extreme event without being exposed to it (Cardona et al., 2012).

According to Lavell (2003), just as the environment offers resources for human development, it also exposes population to dangerous and hazardous conditions. For instance, the increase in population and the increase demand for land decreases the availability of safer lands thereby leaving the rest of population with no choice than settling in potential dangerous and hazardous areas. Due the fact that exposure cannot be avoided in certain areas there is the need to put in place structural and other risk mitigation methods in order to reduce the risk or vulnerability (UNISDR, 2009a). Exposure is also seen as a multidimensional concept, with some frameworks considering it as a very important component of vulnerability (Turner et al., 2003a). Cardona et al. (2012) also asserts that, sometimes actions designed to mitigate potential hazards such as provision of embankments, channel modification, and other physical alterations of the floodplain environment are more likely to increase human beings' exposure to other dangerous and hazardous situation. In addition, the physical exposure of a population to hazards has been partly shaped by patterns of settlement of hazard-prone landscapes for the

countervailing benefits they offer (UNISDR, 2004). Exposure in the context of climate change is increasing in many areas and regions due to the spatial extension of natural hazards, such as floods and wind storms (Cardona et al., 2012).

2.7.3 Concept of Sensitivity

Sensitivity is concerned with the degree to which a particular system, community or an object is impacted be it adversely or beneficially, by climate related stimuli, such as average climate characteristics, climate variability and the frequency and magnitude of extremes (Australian Greenhouse Office, 2003). The effect could be direct such as a change in crop yield in response to a change in the average, range, or variability of temperature or indirect like the damages caused by an increase in the frequency of coastal flooding due to sea level rise (IPCC TAR, 2001). According to UNDP (2005), whereas vulnerability is the degree to which a system is susceptible to harm from stress or shocks, sensitivity affects the magnitude and rate of a climate related perturbation or stress. The degree of a system's sensitivity to climatic hazards depends not only on geographic conditions but also socio-economic factors such as population and infrastructure. Indicators of sensitivity can encompass geographical conditions, land use, demographic characteristics, and industrial structure such as dependency on agriculture and extent of industrial diversification (Ludena, 2015). The vulnerability of livelihoods to impacts of climate change depends on the extent of exposure, sensitivity and adaptive capacity of the people affected (IPCC, 2007). More than 70% of people living in the semi-arid areas are highly dependent on climate sensitive natural resources and agriculture for their livelihoods (Siri et al., 2008).

2.7.4 Concept of Adaptive Capacity

According to Smit and Wandel (2006), adaptive capacity can be referred to as the ability of an individual, group or a system to adapt, recover or cope with change to reduce the level of vulnerability as a result of the change. Adaptive capacity is mostly shaped by the environmental, social, cultural, political and economic forces that induces vulnerability. It comprises of two dimensions including; coping ability which is the absorption of shock and adaptive capacity to change which is related to time (Smit and Wandel, 2006). Gupta et al. (2010) also defined adaptive capacity from a sociocultural perspective as the various features of institutions or organisations that builds or strengthens social actors to adapt or adjust to short and long-term impacts. However, there is no single approach used for the assessment of a systems adaptive capacity since its components extremely depend on a system at stake.

Moreover, a study conducted by Engle (2011), revealed that an individual or a systems adaptive capacity is usually activated in response to a crisis or opportunity. A high adaptive capacity increases an individual, community or system's ability to withstand challenges helping them to maintain a desired state (Folke, 2006). Assessments of adaptive capacity have adopted various measures which includes, inductive theory driven methods (Gupta et al., 2010), the assessment of secondary data sources (Adger and Vincent, 2005), self-assessment methods (Raymond and Cleary, 2013) and futures modelling (Bussey, 2012). Furthermore, strong social cohesion and support networks between individuals, communities and institutions are very important in terms of building the adaptive capacity of vulnerable populations (Klinenberg, 2002). For instance, some studies on adaptive capacity, vulnerability and climate change have shown how a focus on capabilities and social cohesion in adaptation policy can strengthen support networks, adaptive capacity and wellbeing on individual, community and institutional levels (Klinsky et al., 2016).

2.7.5 Wellbeing Concept

The concept of wellbeing is ambiguous and abstract, with numerous interpretations and no universally acceptable definition (Brown and Westaway, 2011). According to McGregor (2008), wellbeing can be seen as a state of being where the needs of human are met and are able to pursue their goals as well as the enjoyment of a satisfactory quality life. The wellbeing of humans can be assessed through three dimensions which include, material, relational and a cognitive dimension. Material dimension of wellbeing deals with the resources people have and the extent to which their material needs or resources which includes food, income, assets, shelter, employment, access to services and natural resources, as well as environmental quality are met. The relational dimension of wellbeing also entails the extent to which social relationships enables an individual to achieve what they regard as wellbeing. It also considers how an individual's relationship and interactions with others as well as the state and social institutions, determines access to resources (Britton and Coulthard, 2013). Whereas the cognitive dimension of wellbeing also considers the level of satisfaction of individuals or a group of people as a result of the quality of life they achieve (McGregor, 2007).

2.7.5.1 Dimensions, Domain and Indicators of Wellbeing.

The concept of wellbeing has developed gradually over the past several decades revealing its multidimensional, person-specific and culture-specific nature. Also, the ecological aspect of wellbeing has gradually gained recognition, and thus requires the development of new conceptual frameworks and applicable methodological processes or methods for assessing the quality of life within a socio ecological context (King and Reno, 2013). According to Lamb and Steinberger (2017), the wellbeing of humans is a complex and contested concept which is mostly used interchangeably with happiness, human development, living standards and quality of life. He further classifies wellbeing into two major themes which includes; hedonic and

eudaimonic wellbeing. Hedonic wellbeing seeks to establish a subjective state of encouraging or motivating humans (O'Neill, 2006). This aspect of wellbeing views good life or welfare of humans through the balancing of pleasure over pain, enjoying life, and feeling good (Layard, 2005). Hedonic wellbeing is also applied in the assessments of subjective wellbeing which comprise of happiness assessments, life satisfaction, as well as the presence of positive or negative mood. It further argues that, individuals are in the best position to understand and work towards their own desires as well as the rejection of shared set of universal values or norms (Ryan and Deci, 2001). Hedonic wellbeing also indicates that a good society is built upon the maximization of individual happiness (Layard, 2005).

However, the eudaimonic theory of wellbeing derives wellbeing from flourishing and that it lies distinct from a state of happiness or pleasure. Aristotle argued that, wellbeing mostly deals with the actions, content and processes of an individual's life, and not in transitory and subjective mental states (Ryan et al., 2008). A study conducted by Nussbaum (2003) revealed that inter-cultural consensus of eudaimonic wellbeing materialized from the identification of fundamental capabilities that enables one to live as they prefer, not defining particular form of good-living. The most common aspect of human wellbeing amongst all eudaimonic wellbeing approaches is its multidimensionality. These dimensions integrate both physical and social needs as well as psychological aspects, but sometimes differ from other records of human wellbeing. However, the dimensions are mostly not ordered in a hierarchy and can also not be replaced or reduced to a smaller set (Lamb and Steinberger, 2017). Gasper (2005) said that hedonic wellbeing focuses on subjective and adaptive self-assessments and eudaimonic wellbeing is grounded in objective and universal conditions. The individualistic framing of wellbeing in the hedonic aspect or theory also differs from a more social emphasis in the eudaimonic aspect or theory of wellbeing. Despite the differences in the various approaches,

they are seen to be complementing each other, and also capturing different aspects of a wellbeing concept that cannot be replaced with a single paradigm.

2.7.6 Wellbeing Framework

According to Coulthard et al. (2011), human wellbeing studies mostly combines objective, subjective and inter-subjective approaches to understanding human wellbeing especially in areas where needs are often not met as well as areas where freedoms and quality of life are frequently under threat. McGregor et al. (2009) however, affirmed that the approaches does not usually define wellbeing in a particular society but rather serves as a framework which defines the sets of needs, freedoms and quality of life conditions contributing to wellbeing likely to vary in different geographical, societal and cultural contexts. Ryan and Deci (2001), observed that proposed wellbeing concepts mostly focuses on eudaimonic at the expense of hedonic wellbeing. Thus, for a human to achieve wellbeing it must go beyond basic needs and further focus on human social and psychological needs which are usually constructed by the people in the society. The social and psychological needs are guided by the meaning on how people in a particular society live their lives which enable them to relate well with each other. Thus, providing yardsticks to enable one measure if he or she is living well and also assess the wellbeing of others (Seel, 1997).

The wellbeing meanings generated and shared within a society guides people with what they can aspire in society, how to achieve these aspirations as well as the subjective evaluation of their lives. Thus, attributing the state of wellbeing to an outcome that is continuously generated through conscious and sub-conscious participation in social, economic, political and cultural processes (Coulthard et al., 2011). The framework adopted by the study measures wellbeing with six distinct components out of which data is generated in three different categories

(Outcomes, Structures and processes) as outlined in the figure below. The outcomes usually are organized into three dimensions including material wellbeing, relational wellbeing and quality of life (QoL) (Gough and McGregor, 2007).

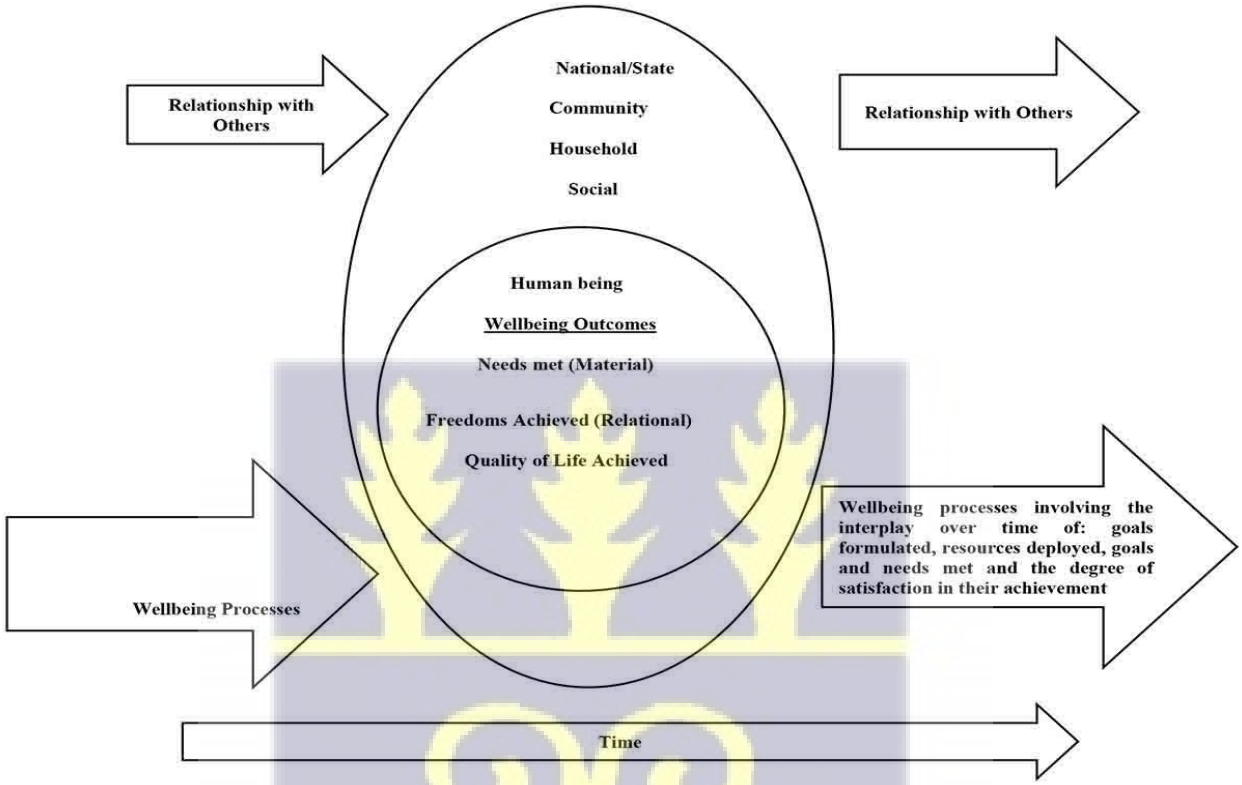

Figure 2.1: Wellbeing Framework.
Source: Adapted from Gough and McGregor 2007

According to Coulthard et al. (2011), the framework puts the human being at the center of the analytical scheme; it identifies the three dimensions of human wellbeing and indicates that these are outcomes that are achieved over time, through relationships with others in the household, community and in wider social collectivizes. In the case of rural settings, the relationship between the human being and the environmental resource is also important and is

both direct and mediated through relationships with others due to the fact that relationship with others constitute the wellbeing processes that promotes the generation of outcomes.

2.7.7 Vulnerability Framework.

A report by the FAO in 2015 revealed that there is a greater need to the understanding of vulnerability from a more holistic and socio-ecological perspective because socio ecological systems are vulnerable to a variety of drivers, thereby making climate change an additional driver of change and stress to the system (FAO, 2015). Figure 2.2 below indicates a commonly used framework for vulnerability assessment to climate change.

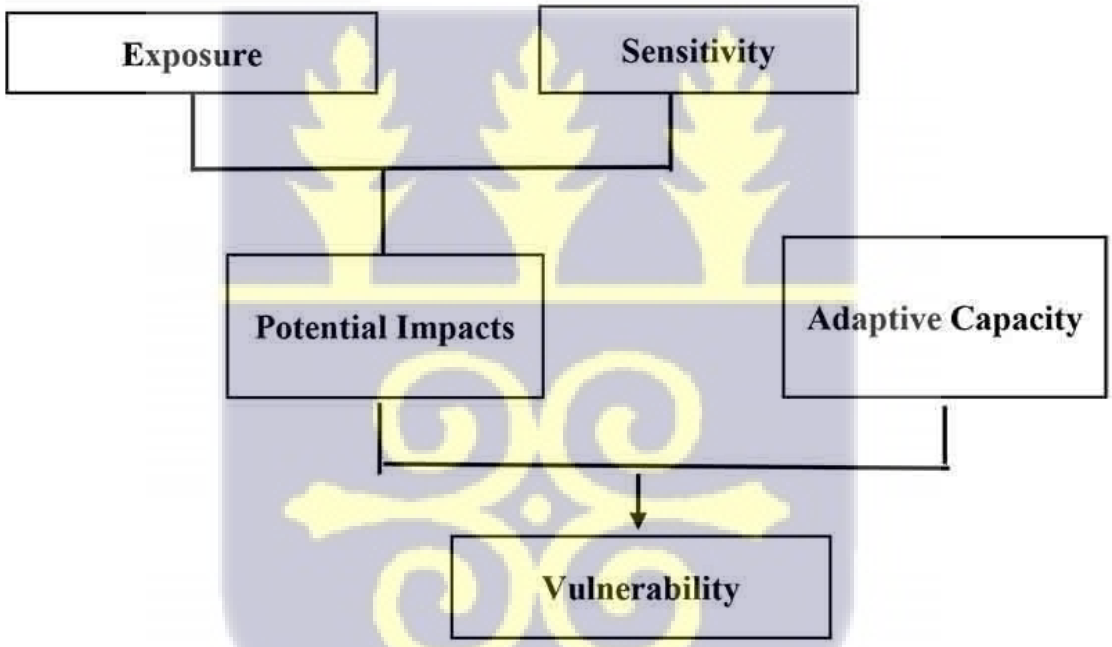

Figure 2.2 Vulnerability Framework

Source: Johnson & Welch, 2010.

From the framework above, vulnerability can be conceptualized as a function of three elements; exposure, sensitivity and adaptive capacity (Adger, 2006). Exposure relates to the influences

that impact on a system or group of people, and represents the background climate conditions, as well as any changes within the climatic condition. Sensitivity reflects the responsiveness of a system or a group to climatic influences, and the degree to which changes in climate affect current form. Adaptive capacity is the ability of the system or group to adapt or reduce consequences of climate change. Exposure and sensitivity usually determine the potential impacts that a system or group experiences, which will be tempered by its adaptive capacity to determine the vulnerability level of the system, community or group (Johnson and Welch, 2010).

2.7.8 Conceptual Framework for the Study

Adaptation decisions of individuals, households, groups and communities is likely to affect their wellbeing outcomes. For instance, their basic needs, income levels, livelihood sustainability, personal and property-related security, as well as their degree of empowerment are very important in determining an individual or a community's level of adaptation to climate change (Behrman, 2014). Goh (2012) said that the impact of decisions taken to adapt to climate change is determined by the type of responses available and those chosen. For example, some of the approaches or methods that increase resilience to climate risks, including the diversification of livelihoods or taking out insurance, will have positive influences on wellbeing, whereas coping strategies adopted after climate change related shocks happens, including selling of assets, or expanding agricultural production unsustainably, may have negative impacts on wellbeing. Wellbeing outcomes sometimes also influence future vulnerability to climate change and, thus, future adaptation options.

The framework below explains the differential impacts of climate change pointing out the relationship that exists between adaptation, vulnerability and wellbeing. It also brings out how

district level policy response and actions can address different levels of impacts for enhanced wellbeing. Climate impact is set against a vulnerability context that includes a set of interrelated factors such as user characteristics, biophysical characteristics, information and technology, and institutional arrangements. User characteristics implies that some individuals, households or groups may be more vulnerable to climate change impacts given their livelihood activities, assets, sociocultural norms, or cognitive ability. Biophysical characteristics describe the sensitivity of physical or ecological systems, for example, agricultural systems that individuals, households, or communities rely on for livelihoods. Information and technology refer to the access of actors to information about climate risks and appropriate responses, while institutional arrangements consider the markets, laws, policies, and sociocultural norms that Influence how different actors are affected by and respond to climate change (Goh, 2012).

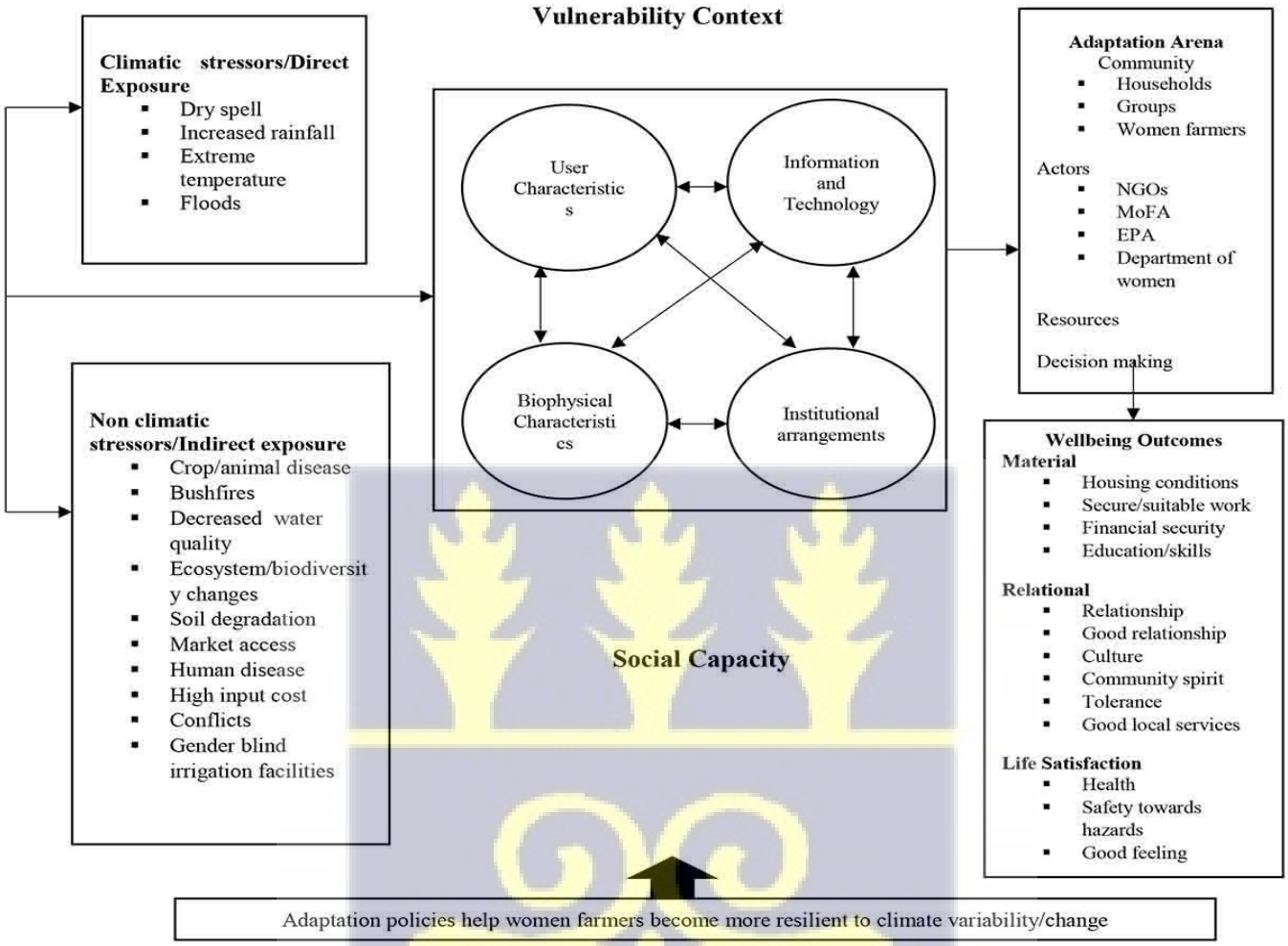

Figure 2.3: Conceptual Framework for Adaptation for Wellbeing.
Source: Adapted and modified from IFPRI, 2011.

From the framework, there are climatic and non-climatic stressors which affects individuals, households or groups differently based on their assets and adaptation strategies in the

adaptation arena with different wellbeing outcomes at different spatial and temporal scales (Goh, 2012). With regards to the adaptation arena, households with larger asset base will be able to easily adapt to climate change since they may be able to change their farm practices to better withstand climate change and variability. Thus, ability to adapt to climate change may differ especially between men and women based on their assets and control of the sociocultural context which determines their rights, roles and responsibilities (Carr, 2008).

One central issue in the framework is differential vulnerability to climate change risks. Climate change will disproportionately affect socially, culturally and economically vulnerable groups and individuals who may lack the basic capabilities, social networks and resources to respond to exposures and shock events (Boylan et al., 2018). The framework identifies that vulnerability is a mediating factor between exposure and effect, and a threat multiplier.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter presents the research methodology that will guide the entire research process. It comprises background information on the study areas and the procedures for the selection of the study areas, methods, sampling, research instruments, data collection and data analyses.

3.1 Description of Study Area

The study focused on ten (10) selected communities in the Lawra Municipality and Nandom District of the Upper West Region of Ghana (Figure 3.1), located in North-West of Ghana. The region shares borders with Burkina Faso to the north, with the Northern Region to the south, with the Upper East Region to the east and with La Cote D'Ivoire to the west. The region covers a land size of 18,476 square kilometers, which is about 12.7% of the total land of Ghana and a population of 702,110 (GSS, 2014).

3.1.1 Location and Size of Study Area

The Nandom District and Lawra Municipality lie in the north western corner of the Upper West Region of Ghana between Longitude 2°25 W and 2°45W and Latitude 10°20 N and 11°00 S. Nandom is surrounded to the East and South by the Lambussie District and Lawra Municipality respectively and to the North and West by the Republic of Burkina Faso. The total area of the district is put at 567.6 square kilometers. This constitutes about 3.1% of the Region's total land area. The district is made up of 88 communities with 86% of the inhabitants living in rural

areas. The population density is about 89 per square kilometers. It is the most densely populated in the region. Nandom is closer to Burkina Faso which makes it a strategic location for international interactions and exchanges. This however, poses a challenge with the influx of Fulani herdsmen into the district from the Sahel (Nandom District Development Plan, 2018).

Lawra is also surrounded to the north by Nandom District, to the East by Lambussie District, to the South and West by the Republic of Burkina Faso. The total area of the municipality is put at 1,051.2 square kilometers. This constitutes about 5.7% of the Region's total land area, which is estimated at 18,476 square kilometers. Lawra is estimated to have 98 communities with 95 percent of the inhabitants in the rural areas. The population density is about 89 per square kilometre (Lawra Municipal Development Plan, 2018).

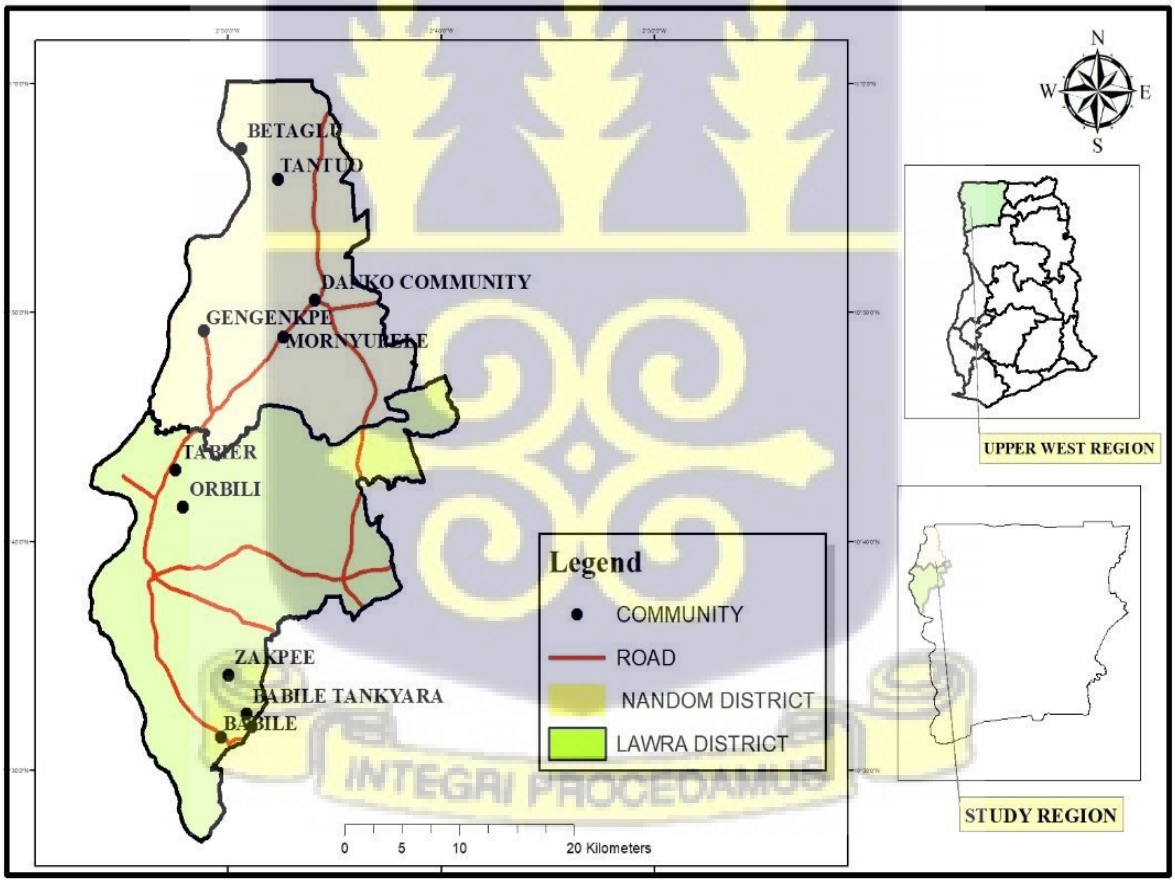

Figure 3.1 Map of the study districts in the Upper West Region of Ghana
Source: Remote Sensing/GIS Laboratory, Department of Geography, University of Ghana, 2019).

3.1.2 Relief and Drainage.

The topography of Nandom District could be described as gently undulating. Generally, the district is located about 180 metres above sea level with a few isolated hills. The district is poorly endowed with water bodies. This is attributed to the low underground water table. The only natural water bodies are a few interconnected streams flow into the Black Volta which cuts through the district (GSS, 2014). The Black Volta River is considered by the district as a potential for aquaculture and irrigation farming. There are a number of dams and dugouts which provide water for irrigation, domestic chores, and construction. The interconnected water bodies in the district facilitate storm water drainage, thus making the district less floodable, except in few low-lying areas. A significant characteristic of most of these rivers and streams is the perennial nature of their flows. Many of these water bodies are reduced to intermittent pools in the dry season while others completely dry up. Many of these streams could be developed to support dry season farming (Nandom District Development Plan, 2018). The Lawra Municipality is gently rolling with a few hills ranging between 180 and 300 meters above sea level. It is drained by the main river, the Black Volta, to the west making a boundary between the municipality and the Republic of Burkina Faso. The Black Volta has several tributaries in the Municipality; notable amongst them are the Kamba/Dangbang, Nawer, and Duodaa.

3.1.3 Vegetation and Climate.

The Lawra Municipality and the Nandom District fall within the Guinea Savannah vegetation belt. The vegetation consists of grasses with scattered fire-resistant trees such as the Shea and Baobab trees. The heterogeneous collections of these trees meet domestic requirements for firewood and charcoal, construction of houses, cattle kraals and fencing of gardens (Ahmed et al., 2016). Mango and cashew trees are also found in Lawra and Nandom in significant

numbers. Human activities particularly annual routine bush burning, indiscriminate tree felling for fuel wood, charcoal and other purposes and poor animal husbandry practices have continuously decreased the vegetation cover and increased soil erosion and depletion of soil fertility. The shea tree is one great economic assert of Lawra and Nandom. The picking, processing and marketing of the Shea nuts engage thousands of households in the area seasonally. It has therefore contributed in increasing household incomes and reducing poverty among the people in Lawra and Nandom (Nandom District Development Plan, 2018). The shorter shrubs and grasses in the vegetation provide fodder for livestock. This has resulted in periodic influx of Fulani herdsmen into Lawra and Nandom (Ahmed et al., 2016).

Inappropriate practices such as shifting cultivation, road construction, sand and gravel winning has increased land degradation. Farming and construction along and in watercourses has also resulted in the silting of water bodies and destruction of vegetation protecting the water bodies in Lawra and Nandom. Lawra and Nandom are tropical continental as experienced in the northern regions of Ghana. Throughout the year, temperatures are high with a minimum of 23^0C at night and a maximum of 42^0C during the day. This favours plant growth. The mean monthly temperature ranges between 21^0C and 32^0C. The highest monthly maximum temperature rises up to 40^0C before the rainy season usually in May with lowest minimum temperature falling to about 12^0C in December when the Harmattan winds from the Sahara dry up the vegetation. As a result of the single maximum rainfall season prevailing in Lawra and Nandom, crop production is mostly done during the rainy season (May to September/October). The dry season is a potential for the preservation industry that could use the sunshine as a natural preservative. By implication, however, since farming is the major occupation of the people, it means that their major sources of livelihood and income are limited during the dry

season apparently resulting in the migration of the youth to the south in search of greener pastures (GSS, 2014).

3.1.4 Geology and Soils

With a gently undulating topography, the Nandom District is bound with fresh granite. The main soil types in the District are sandstone, gravel, mudstone, alluvia, granite and shale that have weathered into different soil grades. Due to seasonal erosion, soil types emanating from this phenomenon are sand, clay and laterite ochrosols (Beotto and Mckinnon, 2013). These soil types are better suited for the cultivation of cereals and root tuber crops including millet, maize, sorghum and yam. They respond well to the application of organic manure and commercial fertilisers to give high yield. With adequate rains and good farming practices, these soils have the potentials of improving agriculture production (Beotto and Mckinnon, 2013).

The well-developed fracture pattern in the rocks makes access to ground water in the Lawra Municipality very high, this give Lawra a huge potential of using both ground water for both agricultural and domestic purposes. The soils in Lawra consist mostly of laterite soils. These are developed from the birimian and granite rocks which underlie the area. There are also strips of alluvial soils along the flood plains of the Black Volta as well as sandy loams along some of its tributaries. The general nature of the soils, coupled with the traditional land use practices and type of rainfall, tend to have adverse effect on crop production resulting in persistent short fall in food production. This forces the youth to look for sustenance elsewhere at the expense of their lives or health (Lawra Municipal Development Plan, 2018).

3.1.5 Environment

The Nandom District has a total of 1515.1 hectares of forest reserves; however, the natural environment of the district has witnessed all kinds of degradation over the years to the extent that the vegetative cover has dwindled and soils have become poor. Widespread bushfires are annual occurrences in almost all the communities. Indiscriminate felling of trees for fuel wood (the major source of energy), inappropriate farming practices, soil erosion, over grazing of livestock, sand, gravel and stone winning are other acts of environmental degradation in the district (Nandom District Development Plan, 2018).

The Lawra Station Forest Reserve which is currently the only Reserve in the municipality is situated in the North-Eastern Part of Lawra. The municipality has a total of 127 hectares of forest reserves, out of which 39.5 hectares has been converted into a protected area with an overall perimeter of 5.2 kilometers. The environment has undergone considerable degradation largely attributed to human activities with the remaining 87.5 hectares being a natural reserve and attributable to human activities. This has resulted in the dwindling of the vegetative cover and poorer soil fertility. The degrading human activities span from felling of trees as fuel wood or for charcoal production, bush burning, inappropriate farming practices, soil erosion, to over grazing of livestock. The reasons for this act range from cultural beliefs to that of being the sources of livelihoods (Beotto and Mckinnon, 2013).

3.2 Demographic Characteristics

3.2.1 Population Size

The 2010 National Population and Housing census results put the Nandom District's population at 46,040 with a growth rate of 1.9 percent which is below the national growth rate and an average household size of 4.1. By projection, the district currently has a population of about

52,589 which comprises of 25,466 males and 27,123 females. The distribution of the population into rural and urban is (86 percent) and (14 percent) respectively. The population is distributed among eighty-eight (88) communities (GSS, 2014).

The Lawra Municipality has a youthful population. About 51 percent of the people are within 15-64 age cohorts, 41 percent are children of less than 15 years, whilst the remaining 8 percent are the aged of above 64 years. The projected population for 2017 is 62,672. This is made up of 30,082 males and 32,589 females (GSS, 2014).

3.2.2 Ethnic Groupings

The most predominant tribe in Nandom District is the Dagaabas, but there are however dialectical variations. There are other minor tribes such as the Hausa, Mossi, Sissalaa, Asante etc. Though there are diverse religious practices in the District, the district has not experienced any religious or tribal disputes. There exists a very peaceful co-existence among all groups of varying ethnic and religious backgrounds (GSS, 2014).

3.2.3 Migration

The Nandom District as previously indicated shares boundaries with Burkina Faso. This makes it one of the transit districts for migrants from Burkina Faso and the Sahelian countries. There is therefore a considerable population of people of Burkinabe, Nigerian and Malian backgrounds in the district. Out-migration among the people is also a common phenomenon. Due to the low soil fertility in the district coupled with the long dry season, some of the people usually migrate to the south of the country for agricultural activities. Some of the youth also migrate to the southern part of the country, especially Accra, Kumasi, Obuasi and Techiman, in search of greener pastures. Another major cause of out-migration is the pursuance of higher education. The promotion of coping strategies to the soil degradation and the promotion of an

enabling environment for the creation of small and micro enterprise can be harnessed to reduce out migration and its effect on the development of the district (GSS, 2014).

There is out migration by some citizens in the Lawra Municipality to other parts of the region especially along the eastern belt where comparatively the soil is more fertile. Some of these migrants return after harvest while others settle permanently for farming activities. There is also the movement of people especially the youth from the municipality to southern Ghana during the lean season in search of menial jobs. There is a worrying trend of the migration involving basic school pupils who during vacations move to galamsey areas in Tinga, Kuie, Danyorkura, etc. as well as other towns and cities to engage in various activities ranging from galamsey to kayaayei (Lawra Municipal Development Plan, 2018).

3.2.4 Traditional Political System

Alongside the decentralized governance system, Nandom has a supportive traditional governance system which is in harmony with the District Assembly System thereby promoting development in the local area. The District has one paramountcy, that is, the Nandom Paramountcy headed by the Nandom Naa. He is supported by Seventeen Divisional Chiefs and several Sub-Division Chiefs. A remarkable feature of the traditional governance system in Nandom is that there are no chieftaincy conflicts like in other parts of the country (Nandom District Development Plan, 2018).

The Lawra Municipal administrative system comprises of the District Assembly/Secretariat, Departments of the District Assembly, four sub-districts; (namely, Lawra Town Council, Babile, Zambo and Eremon Area Councils) and the Unit Committees. Traditional administration is under the Lawra Traditional Council (Lawra Municipal Development Plan, 2018).

3.3 Economic Activities.

Agriculture is the major activity that engages about 85 percent of Nandom District's 46,040 population. Out of the 7,417 total households in the district, 85.3 percent are agricultural households while 14.7 percent are non-agricultural households. Agricultural production is centred mainly on crops and livestock production largely at a smallholder (0.8-1.2 hectare holdings) subsistence level with low outputs (Average 0.2-0.3meters/acre for maize). A higher proportion of households (98 percent) is engaged in crop farming, followed by livestock rearing (55.7 percent); with significantly low proportions engaged in tree planting (0.3 percent) and fish farming (0.1 percent). The crops mainly grown by the farmers are rice, sorghum, millet, maize, soybean, cowpea, groundnut, bambara groundnut, yam and sweet potato (GSS, 2014).

Livestock production mostly under semi-intensive management system involves the rearing of large (cattle) and small ruminants (heap and goats), pigs, local poultry and guinea fowls.

The District's agricultural sector barely grows at 2.1 percent per annum compared to 3.7 percent as national average growth rate for 2012-2015 periods against a target of 6 percent (Beotto and Mckinnon, 2013).

Agriculture, forestry and fishing are the largest sectors in the Lawra Municipality, employing about 72 percent of the employed population. The second largest sector is manufacturing which includes shea butter extraction, brewery, soap making, weaving, etc. The sector employs 8.9 percent of labour which is followed closely by commerce with 8.6 percent. The occupational structure in the municipality indicates how a vigorous agricultural development can contribute to poverty reduction. Agriculture, forestry and fishing are the largest sectors in Lawra, employing about 72 percent of the employed population. The second largest sector is manufacturing which includes shea butter extraction, brewery, soap making, weaving, etc. The

sector employs 8.9 percent of labour which is followed closely by commerce with 8.6 percent (GSS, 2014).

3.3.1 Seasonality of Agricultural Practices.

The Nandom District lies in the guinea savanna zone and has one main rainy season for agricultural production thus from May to September. The rest of the year is dry and can only be used for dry season gardening. However, the low development of the irrigable agriculture has limited productivity in the dry seasons where farmers become dormant and have no major farming activities to undertake (Ahmed et al., 2016).

Agriculture is the major economic activity in the Lawra Municipality, employing about 78 percent of the working population. About 80 percent of the farmers are subsistence farmers, producing small quantities of maize, millet, groundnuts, soya bean and cowpea. Animal production is a major agricultural activity undertaken by the people to supplement incomes from crop farming.

The local agricultural sector in Lawra and Nandom is confronted with depleting soil fertility, unreliable rainfall pattern, limited investment capital and skills, pests and diseases, inadequate access to extension service and low access to market. These challenges are making agricultural productivity very low, thereby rendering farming not lucrative. Many of the active population therefore migrate to other parts of the country to farm or search for other greener pastures (GSS, 2014).

3.3.2 Land Tenure.

The majority of the farmers in the study area, 97 percent, depend on family land for agricultural purposes. This has led to fragmentation of the land under cultivation, thus limiting large-scale agricultural activities. Average farm size is as low as 0.8-1.2 hectares per farmer compared

with the national average of 4.0-6.1 hectares. The small farm sizes that characterize the study areas agricultural practices have negatively affected crop production, food security and consequently income that characterize the Lawra and Nandom economy (Beotto and Mckinnon, 2013).

3.3.3 Methods of Farming.

About 75 percent of farmers in the study area rely on traditional methods of farming using simple tools such as cutlass and hoe and are highly dependent on rainfall for crop production. Only about 25 percent of the farmers rely on intermediate technology using tractor services, animal drawn implements and irrigation. These methods of farming do not only lead to the depletion of the soils, but also, result in low yield which is responsible for the low income and hence low standard of living, as well as food insecurity in the study area (Beotto and Mckinnon, 2013).

3.3.3.1 Farming Systems

The main farming system in the study area is mixed (crop farming and livestock rearing) farming based on bush fallowing and compound farming. Majority (97 percent) of the farmers practice mixed cropping, 25 percent practiced mono cropping and 30 percent plant with fertiliser and improved seeds. Due to limited availability of arable land, bush fallowing is practiced on a small scale as a method of replenishing soil fertility. Livestock production in the study area is under the semi-intensive management system. In the dry season, both small and large ruminants as well as pigs are on free range often with little attention to ensure housing them overnight. In the rainy season however, due to crop farming, cattle are herded while small ruminants are tethered with poor overnight housing facilities provided. Poultry production is equally under semi-intensive management system throughout the year with few numbers kept for subsistence (GSS, 2013).

3.3.3.2 Crop Production

The major food crops grown in the study area are millet, sorghum (guinea corn), maize, cowpea, and yam mostly under subsistence levels. Cash crops cultivated include groundnuts, cotton, cowpea, soybeans, cassava, and pepper. The cultivation of cash crops has not received much attention as a result of market uncertainties. However, in recent times, a few local investors continue to establish and expand banana plantations under irrigation along the Black Volta River (Beotto and Mckinnon, 2013).

3.3.3.3 Livestock Production

In the study area, animals including poultry (chicken and guinea fowl), small ruminants (goats and sheep), pigs, and large ruminants (cattle) are important investments for rural households as well as a potential source of food. The average household in the area practices mixed farming; crop farming alongside livestock rearing both under subsistent level of operations. The livestock serves as an alternative household income source as well as insurance against crop failure. They also go to meet other social commitments, e.g. payment for dowry or bride price, and for traditional sacrifices and festive occasions (GSS, 2014). Livestock species kept include ruminants large (cattle); and small (goat, rabbit, sheep), local poultry (chicken, doves, ducks, guinea fowls, ostrich, turkey) and pigs. Average livestock sizes kept are four animals for the ruminants, eleven for the poultry and eight for pigs (Lawra and Nandom Development Plans, 2018). All livestock and poultry are reared under semi-intensive management system characterized by makeshift housing with little or no supplementary feeding. Ruminants are either tethered or open-shepherded during the rainy season, while released for free range during the dry season. Poor animal management practices and the inadequate veterinary and extension services constrain the productivity of animal rearing (Beotto and Mckinnon, 2013).

3.4 Research Design

The study employed the explanatory research approach to better understand why adaptation initiatives in the research area have or have not impacted the wellbeing of rural women farmers. Data was gathered through participatory methods to test the theory underlying the research (Saunders et al, 2012). The participatory action research method enabled the researcher to give each participant the opportunity to describe their perception of wellbeing and how adaptation strategies and intervention have enhanced wellbeing needs (Vaessen, 2010). The research ascertained the vulnerabilities and wellbeing of rural women farmers, encouraged people to talk about a wide range of adaptation options that enhance their wellbeing. The interviews ensured that views and perception of marginalized individuals are not under-represented. The participatory research allowed for both qualification and quantification of data generated from the various methods of data gathering. The study used a mixed method approach as indicated in Fig. 3.2. The mixed method approach is however criticized as having the tendency to expand the scope of a study beyond the initially planned (Teye, 2012). That is, in trying to get the appropriate research questions right under this approach, it could lead to broadening the scope of the study beyond the optimal (Teye, 2012). Moreover, the mixed method approach is not appropriate under time and resource constraints. This is because mixed method is regarded as expensive and time-consuming as compared to either qualitative or quantitative approaches (Teye, 2012; Creswell et al., 2003).

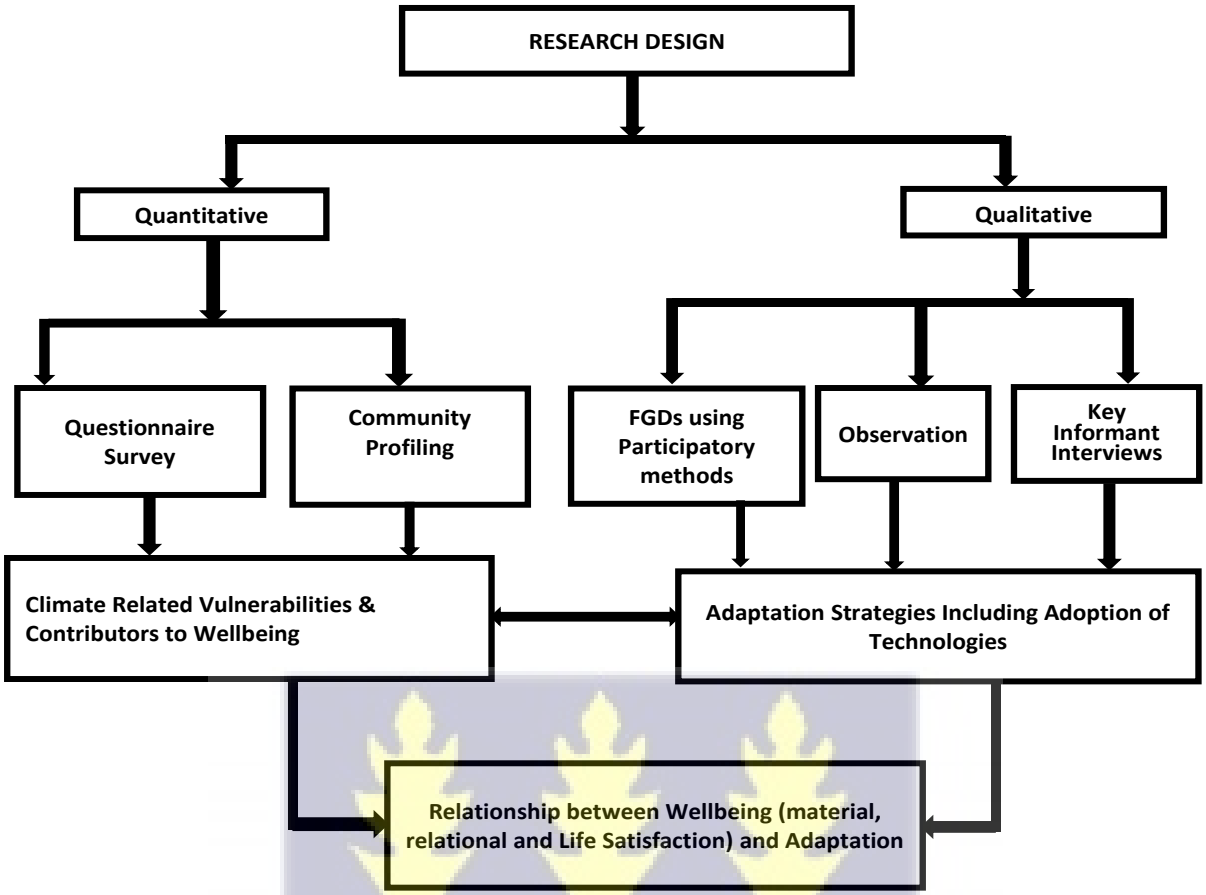

Figure 3.2: The Research Design

3. 5 Source and Nature of Data

Both primary and secondary data were collected from the research area.

3.5.1 Primary Data

Both qualitative and quantitative data was collected (Creswell, 2014), through questionnaire surveys, farm and field surveys, focus group discussion, community profiling through participatory methods, observations and key informant interviews. In examining how adaptation impacts wellbeing of rural women farmers, it was necessary to use both quantitative and qualitative methods, as standalone methods would neither be able to convey a holistic

image of how climate change adaptation relates to wellbeing. Larson (2013) and Antwi-Agyei et al. (2012) argued that because climate variability and change are complex societal problems that are stitched on top of a series of more traditional considerations, qualitative and quantitative methods are suitable for a holistic understanding of the various dimensions of the problem. The qualitative aspect of the research explained and explored experiences, attitudes and life circumstances of rural women farmers in the context of the phenomena under study (Bryman, 2001). The quantitative part used statistical techniques to analyse quantifiable aspects of the research problem and made predictions and generalizations (Teye, 2012). Qualitative and quantitative methods are based on the idea that no single data gathering method ever really solves, delineates, or validates a particular problem (Creswell & Plano Clark, 2011). Thus, the need for the adoption of both methods in tandem to strengthen the study (Creswell, 2014). It is regarded as an effective means of comprehensively cross-validating data from multi-methods. Thus, in some instances, researchers use quantitative evidence to validate qualitative claims and vice versa (Sharan, 2002). Seven research assistants from the MoFA offices of Nandom and Lawra were trained and engaged during data collection process. They served as interpreters during FGDs, in-depth interviews and questionnaire administration. They also conducted interviews during the questionnaire administration process. These people had prior experience with community engagement and data collection.

3.5.1.1 Reconnaissance survey

A reconnaissance visit was made to the study area in February 2019 which enabled the researcher to familiarise with the study area and establish rapport with the study participants. The visit was also aimed at firming up the research questions and better situating the research in the context of participants.

3.5.1.2 Community profiling

Community profiling was employed to set the scene, and compiled information about relevant social, economic, political, historical, cultural and environmental factors. Types of data gathered included: physical/environmental resources such as ecosystem resources available to women and the benefits. Environmental and non-environmental resources were mapped, institutions that support environmental management and adaptation efforts, variability such as seasonal calendars, wealth profiling as well as participatory discussions of subjective wellbeing and how wellbeing and ill-being are symbolized in the local context. Daw et al. (2015) and Abunge et al. (2013) have used such methods to explore changes in wellbeing and how differently people have been affected.

3.5.1.3 Focus group discussions (FGDs).

FGDs preceded the questionnaire survey and key informants' interviews. FGDs comprising a cross section of smallholder women farmers in the communities as well as some key community men were conducted. The FGD's explicitly allow each participant an opportunity to describe their perception of climate vulnerabilities of women and how they impact wellbeing (Vaessen, 2010). The use of FGDs as a participatory method is regarded as a very effective method in eliciting farmers understanding about climate change vulnerabilities and possible barriers to change as well as what contributes to their families' wellbeing (Larson, 2013; Roncoli et al., 2009). FGDs were conducted to generate detailed information from women farmers through semi-structured interview guides. According to Darlington & Scott (2003), FGD allows for group interaction that may be absent in one-on-one interview and allows the exploration of varied meanings rural smallholder farmers have about climate change variability (Bryman & Bell, 2007). Twenty FGDs were conducted; two in each community (women only and men only groups). Disaggregation of FGDs discussants according to gender was informed

by the fact that socio-cultural consideration in the study area constrained females from expressing themselves in the midst of their male counterparts (Yiridoe, 1995). Some key male farmers participated in the FGDs for views and perception pertaining to wellbeing and climate adaptation being investigated. The participants for the FGDs were purposively selected with the help of the local people. The criteria for selection was based on a person's availability and willingness to participate in the process as well as the type of farm household (male- or female-headed) each represented.

A focus group discussion guide was used in the data collection. All the interviews and focus group discussions were audio-recorded with permission from participants and later transcribed for processing and analysis. The FGD conversation was translated into Dagaare since most people in the communities could not speak the English language. The sessions lasted between 90 and 120 minutes. The composition of groups ranged between 7 and 12 people. Discussions in all communities were held at the community meeting grounds. Additionally, FGDs were used to validate major adaptation strategies identified from literature and how they have helped in addressing the wellbeing of rural women farmers. Further, adaptation response of rural women farmers and their relation to wellbeing indicators was also explored.

3.5.1.4 Key informant interviews.

The key local stakeholders interviewed during the study included officials from the District Department of Agriculture (DoA) under Ministry of Food and Agriculture, Forestry Commission, Environmental Protection Agency, the Department of Women and Non Governmental Organisations such as NANDRIDEP (Nandom Deanery Integrated Development Project), CARE-Ghana, CIKOD (Centre for Indigenous Knowledge and Organisational Development) and some community leaders. A total of fifteen in-depth

interviews were conducted; seven in Nandom and eight in Lawra. Interviews were also held with key members within Lawra and Nandom who are integral district stakeholders of the climate change discourse (women traditional leaders, traditional environment leaders, leaders of women farmer groups and agricultural and environmental workers).

Purposive sampling was used to select the participants for the key informant interviews. Purposive sampling was used because it allowed the collection of information from participants who are well versed in the phenomenon under investigation. Marshall (1996) stated that this sampling strategy is used by researchers who actively want to select the most productive and credible respondents to answer a particular research question. Marshall confirmed this to be a more intellectual strategy though age, gender, or social class may be considered as important variables. The key informant interview explored factors that increase rural women farmers' vulnerabilities and practices that build households' resilience to climate change and identified interventions that will help rural women farmers adapt to future climate impacts and how this impact their wellbeing. The key informant interview was conducted first and the information generated used to revise the household survey instrument. The KII was conducted in English language as all respondents in this category could speak English. The key informants were interviewed using a structured questionnaire with both open ended and close ended questions. Interviews from both FGDs and key informants' interviews were digitally recorded and transcribed. Permission of discussants and interviewees were sought before recording took place. Permission was also sought before pictures were taken during interviews or discussions.

3.5.1.5 Questionnaire surveys

Semi-structured individual questionnaires were used to gather quantitative data to complement the data obtained from the FGDs and the KIIs. The survey questionnaire was prepared after a review of relevant literature and pre-tested for content, context and clarity. The sort of information gathered from the questionnaire included demographic and socioeconomic data, perceptions on vulnerability and adaptation strategies used by rural women farmers and how adaptations impacts wellbeing. The survey was conducted using a combination of both English and Dagaare languages depending on the respondent's preference to speak English or not.

3.5.2 Secondary Data

Available relevant literature and information on the topic including reports and working documents prepared by government agencies and Non Governmental Organisations (NGOs) were reviewed. The data was collected from the Ministry of Food and Agriculture (MoFA), Environmental Protection Agency (EPA), NGO's, Department of Women, District Assemblies in Lawra and Nandom. The review of literature for secondary sources of data included archival research from books, journal articles, magazines, articles, published and unpublished theses, videos, related websites, and other related information. Also, secondary data comprising rainfall and temperature data was obtained from the Ghana Meteorological Agency (GMet).

3.6 Target Population

The population is an aggregate or totality of all the objects, subjects or members that conform to a set of specifications (Polit and Hungler, 1999). Women farmers from the age of 16 to 84 years, various educational status, religious background, marital status, physically challenged and socio-economic status who fit the criteria for the population were randomly selected in the various communities for the study. Women at the age of 16 years were added to the sample

because it became evident during the reconnaissance survey that there exist such young mothers who have drop out of school as teenage mothers and have resorted to farming. The research also involved vulnerable participants hence standard procedure (e.g. for seeking consent) was employed and for some group (physically challenged) their specific requirements were considered and addressed when designing and undertaking research.

3.7 Sampling Approach

A multi-stage sampling procedure was adopted considering the nature of the study. First, the Upper West Region was selected purposefully because studies have shown evidence of climate change and variability in the region (Ndamani and Watanabe, 2015; Rademacher-Schulz et al., 2014). Evidence shows that the Upper West Region is relatively the most vulnerable region to the impacts of climate change and variability in Ghana (MESTI, 2013; Etwire et al., 2013). Lawra and Nandom were also purposively selected from the districts in the Upper West Region. Data obtained from the Regional Coordinating Council indicated that the districts have the highest climate change interventions in the region. Besides, a good number of communities in the district are located along the Black Volta which makes them prone to both drought/dry spells and floods. Additionally, Nandom and Lawra were part of a project from which this research was funded (Adaptation at Scale in Semi-Arid Regions-ASSAR).

The process of selecting a portion of the population to represent the entire population is known as sampling (Polit and Hungler, 1999 and LoBiondo-Wood and Haber, 1998). Out of 98 and 88 communities in the Lawra and Nandom respectively (Lawra and Nandom District Development Plans, 2018), five communities were randomly selected from each district for the study. The communities selected were communities which have highest vulnerabilities in the Upper West Region according to literature. Additionally, a lot of scooping activities have been

undertaken in the communities as a result of the Adaptation at Scale in Semi-Arid Region (ASSAR) project. Being part of the Grant for Local Adaptation Support (GLAS) project implementation team, accorded me an opportunity to also do my own scooping which informed the selection of the communities. The series of scooping in the selected communities provided information on adaptation activities employed by rural women farmers in the research communities and their implications on women and households. Table 3.1 shows communities selected for the study and sample selection.

Table 3.1: Selected Communities and Sampling

No.	Research Communities	Questionnaire Survey	FGD		KII
	Nandom		**Women**	**Men**	
1	Gegenkpe	30	6	3	7
2	Munyupele	30	6	4	
3	Betaglu	30	6	3	
4	Tantuo	30	6	3	
5	Danko	30	5	3	
	Lawra				
6	Zagkpee	30	6	3	8
7	Tankyara	30	7	3	
8	Susu	30	8	4	
9	Orbile	30	6	3	
10	Tabier	30	7	5	
	Total	300	63	34	15

Source: Computed from Fieldwork (2020)

3.7.1 Sample size.

Statistics from the GSS (2013) census report, indicated population size of Lawra to be 54,000 and that of Nandom was estimated at about 45,000 people. The number of smallholder farmers in the Lawra and Nandom Districts as per information from the Department of Agriculture offices in both study areas revealed the total number of smallholder farmers to be about 45,000 and 38,000 respectively. Yamane (1967) provides a simplified formula to calculate sample sizes at 95% confidence level. The Yamane formula is used to calculate an appropriate sample size given a known population size and a preferred value for a margin of error, hence its application in this study in calculating the sample size.

The equation below is the formula for sample size calculation:

$$n = \frac{\mathrm{N}}{1 + \mathrm{N(e)2}}$$

Equation 1

Where n is the sample size, N is the population size, and e is the level of precision.

Estimating sample size for Lawra

$$n = \frac{\mathrm{N}}{1 + \mathrm{N(e)2}}$$

$$n = \frac{45{,}000}{1 + 45.000(0.05)2}$$

n= 203.1603

Estimating sample size for Nandom

$$n = \frac{\mathrm{N}}{1 + \mathrm{N(e)2}}$$

$$n = \frac{38{,}000}{1 + 38.000(0.05)2}$$

n= 202.9915

From the above calculations, the total sample size for this study was approximately 400 respondents. However, due to financial and time constraints, the original sample size of 400 was reduced to 300. It was also assumed that the FGDs and KII data will help offset the reduction in number since the study employed a mixed method approach. In view of that, the questionnaire survey was conducted with a sample size of 300 respondents.

3.7.2 Sampling Technique.

A multi-staged sampling procedure was adopted for this study. The multi-staged procedure was purposive, systematic and simple random sampling approach. The purposive sampling procedure is the deliberate choice of an informant due to the qualities the informant possesses (Tongco, 2007). Simple random sampling is a sampling in which every member of the target population has a similar chance of being involved in the sample (Kitchenham and Pfleeger, 2002). The researcher selects what needs to be acknowledged and sets out to discover individuals who will be able to and are ready to make available information by virtue of experience/knowledge (Lewis and Sheppard, 2006; Bernard, 2002). The sampling was done in stages; for stage one, communities were chosen purposively on a fair geographical spread. In stage two, the selection of the houses in the communities were done using systematic random sampling approach. For every household being interviewed the third house from the first house was chosen to be interviewed to avoid bias answers. Where a road divides a community, homes were selected from both sides with the same systematic random approach. The fact that every third house is chosen in the community makes the sampling systematic because there is an interval system. Likewise, it is random sampling because the researcher cannot control the spatial arrangement of houses within the communities. Women farmers were randomly sampled in stage three, on the basis that women were the target group for the research. Thirty women farmers from households in each of the selected communities were chosen. From the

sample size calculated above, a total of 300 respondents participated. For reliability and validity of research, various measures were adopted. In instances where responses by respondents were not clear, the researcher further clarified the objectives to minimize biases. For errors arising from data recording and processing, critical checks were undertaken to correct them. In certain instances, Research assistants based in the districts were tasked to crosscheck authenticity of information.

3.8. Data Analysis

The questionnaire and focus group transcripts were reviewed. Dominant themes and concepts were identified. Using open coding (Babbie, 2010), transcripts were coded, drawing on existing literature on gender and vulnerabilities, climate change adaptation and wellbeing as per the study objectives which helped in extracting the salient themes and improve data organisation. The themes obtained were compared across the data sources and areas of similarities and differences identified (Babbie, 2010).

Software Used in Data Analysis

The STATA software version 14.0 was used to analyse objective 1, 2, 3,4 and 5. However, in the computation of wellbeing, the MS Excel spreadsheet was used. Again, excel was used to perform analysis on the socioeconomic characteristics of the women farmers as presented in chapter 4.

The various objectives and the analytical methods employed have been presented below:

1. Identify and rank adaptation responses employed by rural women farmers to address stresses associated with climatic variability and environmental change.

In this study, adaptation strategies, identified during Focus Group Discussion and literature search, were presented to women respondents to rank in order of importance. A value of one was assigned to the highest ranked adaptation strategy, and it followed in that order.

There are a number of statistical ranking methods in the literature. These include Pearson's correlation coefficient, the Spearman rank correlation, Freidman's two-way analysis of variance, Garrett's ranking technique and Kendall's coefficient of concordance. However, for advantages associated with the Kendall's coefficient of concordance and the Garrett's ranking technique, they are the most widely used methods to address ranking challenges. It is imperative to state that, the Kendall's coefficient of concordance and the Freidman's two-way analysis of variance are the same. The only difference between the two is the statement of hypothesis associated to the Kendall's coefficient of concordance.

Following Garrett's method, the adaptation responses are ranked according to order of importance. The rank scores are then converted into percent positions. Using the Garrett and Woodworth (1981) tables, the percentage positions of each rank are then converted into scores. Each farmer's scores are then summed up and the total is divided by the total number of farmers (respondents) who ranked the particular factor. This represents the mean adaptation score of each farmer. The mean scores are then ranked, with the highest mean score being the most important of all the adaptation responses. The Garrett's method of ranking has two main demerits. One is that, it does not test for any hypothesis and level of agreement among rankings by rankers, whereas the Kendall's coefficient does. This study therefore adopted the Kendall's coefficient of concordance. The Kendall's coefficient of concordance (W) is the measure of the degree of agreement among 'm' (number of rankers) of 'n' (number of constraints) ranks.

Kendall's coefficient of concordance (W) was used to measure the level of agreement among the rankings of the adaptation responses employed by the rural women farmers using their rank scores. Kendall's *W* has positive value ranging between zero (0) and one (1).

Given that T = the sum of ranks of each adaptation response being ranked, the variance of the sum is given by;

$$Var_T = \frac{\sum T^2 - (\sum T^2)/n}{n} \quad (1)$$

And the maximum variance of T is then given by $\frac{m^2(n^2-1)}{12}$ (2)

Where, m = Number of sets of ranking by the women farmers and n = the number of specific adaptation response being ranked.

The coefficient of concordance (W) is therefore given as,

$$W = \frac{[\sum T^2 - (\sum T^2)/n]/n}{m^2(n^2-1)/12} \quad (3)$$

Equation (3) is further simplified to the computational formula as;

$$W = \frac{12[\sum T^2 - (\sum T^2)/n]/n}{nm^2(n^2-1)} \quad (4)$$

The hypothesis and the significance of the rankings are further assessed using the F-test as follows:

The null(H_o) and the alternative (H_a) hypothesis are stated as follows;

H_o: There is no difference in rural women farmers' ranking of adaptation responses.

H_a: There is difference in rural women farmers' ranking of adaptation responses.

The coefficient of concordance (W) was tested for significance using the F-statistic. This is given by,

$$F = \frac{[(m-1)w_c]}{(1-w_c)} \quad (5)$$

If the $F_{calculated}$ is greater than the critical F^* from Fisher's F-statistics distribution table, the null hypothesis is rejected; otherwise, it is accepted.

Descriptive statistics such as percentages, frequencies and means were presented in tables, charts and graphs showing the number of farmers who holds the view that the adaptation responses being adopted by the rural women farmers are able to address climate change impact.

2) This objective is aimed at determining the factors influencing rural women farmers' adoption of climate change adaptation strategies. It is a known fact that women in the study area are engaged in agriculture as one of the major livelihood options. An econometric problem of choice therefore arises if the factors influencing their adoption of adaptation strategies would have to be determined. The econometric choice problem is therefore whether or not all rural women farmers in the study area are adopting at least one adaptation response to counter climate change impact(s). The data collected indicates that some women farmers are not adopting any of the responses at all whilst others are adopting the responses. In this case, the dependent variable, adoption of climate change adaptation strategies, assumes a dichotomous behaviour. As a result of the behaviour of the dependent variable, qualitative response models are usually and widely used by researchers to analysed the relationship of choice problems, that is, whether a farmer is adopting or not adopting at least an adaptation strategy.

There are a number of qualitative response models. These include the logit, probit, multinomial logit, multinomial probit, ordered logit and ordered probit models among others (Gujarati, 2004). The choice of a model depends on the nature of the data being collected and the nature of the dependent variable. It is a discrete choice probability model that takes care of the "Yes" and "No" responses. The binary dependent variable therefore takes the values of 1 and 0. If the response is such that a respondent adopts at least one strategy, it takes on the value of 1 and zero (0) if the response is otherwise.

The generalized probit model with a latent dependent variable is specified as;

$$\Pr(Y = 1 / X) = \Phi(X'\beta) \qquad 1$$

Pr , represents the probability that a woman farmer adopts at least one adaptation strategy/response or otherwise.

Y is the observed variable

Φ also represents the cumulative density distribution of the normal distribution.

A latent variable Y^*, which is unobserved, is the underlying utility function which ranks the preference of the ith woman adopter and is assumed to be a function of an adopter specific attributes, the X's. It is therefore determined by the following model:

$$Y^* = X'\beta + \mu \quad 2$$

Where Y^*=the latent dependent variable

X' is the explanatory variable of the regression

β is the parameter to be estimated

μ is the error term which is independently, identically distributed with zero mean and constant variance.

The observed variable Y, is linked to the latent variable, Y^* as follows:

Y=0 if $Y^*<0$ 3

Y=1 if $Y^*\geq 0$ 4

Thus, the probability of observing Y=1 is:

$$P_i = P(Y_i = 1) = P(Y^* \geq 0) \quad 5$$

$$= P(\beta_0 + \beta_1 X_i + \mu, \geq 0) \quad 6$$

$$= P(\mu \geq -\beta_0 - \beta_1 X_i) \quad 7$$

$$= 1 - \phi(-\beta_0 - \beta_1 X_i) \quad 8$$

The binary probit model is therefore specified as

$$\Pr(Y^* = 1/X) = \Phi(X'\beta) = Y^* = \beta_0 + X_i\beta + \mu_i \quad 9$$

Pr = Y^*=probability (1 = a woman farmer adopts at least one adaptation strategy, 0 = otherwise),

β = Coefficient to be estimated

Following the above, the empirical model can be specified as:

$$AdoptWomen = \beta_0 + \beta_1 Age + \beta_2 EduSts + \beta_3 FBOmem + \beta_4 FrmSZ + \beta_5 HHSZ + \beta_6 IncTmp + \beta_7 IncRain + \beta_8 IncDrgt + \beta_9 DecTmp + \beta_{10} \text{Re}\, dRain + \beta_{11} \text{Re}\, dDrgt + \beta_{12} ErtcRain + \mu$$

Table 3.2 indicates the interpretations, measurements and the apriori expectation of the dependent and independent variables included in the probit model.

Table 3.2: Description of Variables for the Binary Probit Regression

Variable	Interpretation	Measurement	Apriori Expectation
AdoptWomen	Adoption of Strategies	1=Yes, 0=No	NA
Age	Age of Farmer	Years	+
EduSts	Educational Status	Years	+
FBOmem	FBO membership	1=Yes, 0=No	+/-
FrmSZ	Farm Size	Acre	+
HHSZ	Household Size	Number	-
IncTmp	Increasing Temperature	1=Yes, 0=No	+
IncRain	Increasing Rainfall	1=Yes, 0=No	+
IncDrgt	Increasing Drought	1=Yes, 0=No	-
DecTmp	Decreasing Temperature	1=Yes, 0=No	-
RedRain	Reducing Rainfall	1=Yes, 0=Otherwise	-
RedDrgt	Reducing Drought	1=Yes, 0=Otherwise	-
ErtcRain	Erratic Rainfall	1=Yes, 0=Otherwise	-

3) This objective is to determine the effect/impact/influence of adaptation on wellbeing of rural women farmers in Lawra and Nandom Districts. The qualitative choice model used to quantify factors that influences the wellbeing of rural women farmers is the ordered Logit Regression Model. The ordered logit regression model was selected due to the ordinal nature of the dependent variable. The dependent variable was categorized into four groups namely unsatisfied, somewhat satisfied, satisfied and very satisfied. Given the specification of the ordered logit model, the respondents for the study will be classified:

$$Adoption\ Level = \begin{cases} 1\ if\ Unsatisfied \\ 2\ if\ somewhat\ satisfied \\ 3\ if\ satisfied \\ 4\ if\ very\ satisfied \end{cases}$$

The independent variables specified are the variables hypothesized to affect the wellbeing of rural women farmers. This model therefore aims at determining the probability of a farmers' wellbeing amidst climate change impact and adaptation. The framework for the ordered logit regression model is specified as

$$Y_i = \beta_0 + \sum_{i=1}^{k} \beta_i X_i \qquad 1$$

Where;

Y_i is dependent variable

X_i is the independent variables (the factors that influences the wellbeing of farmers)

β_i is the coefficient to be estimated, interpreted as the log-odds of farmers' wellbeing.

β_0 is the intercept parameter

ε_i is the error term

We assume that the variance of the error term Var (ε_i) = 1

Thus,

$$P_i = Prob\ (Y_i = 1) = Prob\ [\varepsilon_i > -\beta_0 \sum_{i=1}^{k} \beta x)] = 1 - F[\beta_0 + \sum_{i=1}^{k} \beta x \quad 2$$

F is the cumulative distribution function of ε_i

The above equation is the log-odds ratio that farmers' wellbeing would be enhanced. The left-hand term of the equation above is a linear function of the independent variables.

Y (Farmers wellbeing) is a function of Y*, that is not observed or measured. The values of the unmeasured latent variable Y*, determines the value of the observed ordinal variable Y.

$$Y_i^* = \sum_{i=1}^{k} \beta x_i + \varepsilon_i = Z + \varepsilon_i \quad 3$$

In the study, the continuous latent variable Y* has (M-1) two thresholds (U). The value of the observed variable Y depends on whether or not a particular threshold has been crossed.

$Y_i = 1$ if $Y_i^* \leq U_0$

$Y_i = 2$ if $U_0 \leq Y_i^* \leq U_1$

$Y_i = 3$ if $Y_i^* \geq U_1$

$Yi = 4$ if $U_0 \geq Y_i^* \geq U_1$

The ordered logit model estimate is

$Z_i = \Sigma\beta X_i = E(Y^*)$

Due to the nature of the random disturbance term, the unmeasured latent variable Y* can either be higher or lower than Z. The βs and the two cut points are the parameters needed to compute the equation

$Z = \Sigma\beta X_i$

In this study, two thresholds (U_0 and U_1) are used to estimate the wellbeing which as stated above will be in four categories (M=4)

$$P(Y = 1: unsatisfied) = \frac{1}{1+\exp\,(Z_i - \varepsilon_0)} \quad (4)$$

$P_i = 1$ is the probability that rural women farmers wellbeing will be unsatisfactory.

$$P(Y = 2: Somewhat\ satisfied) = \frac{1}{1+\exp\,(z_i - \varepsilon_1)} - \frac{1}{1+\exp\,(z_i - \varepsilon_0)} \quad (5)$$

$P_i = 2$ is the probability that rural women farmers' wellbeing will be somewhat satisfactory.

$$P(Y = 3: Satisfactory) = \frac{1}{1+\exp(z_i - \varepsilon_1)} \quad (6)$$

$P_i = 3$ is the probability that rural women farmers' wellbeing will be satisfactory.

$$P(Y = 4: Somewhat\ satisfied) = \frac{1}{1+\exp\,(z_i - \varepsilon_0)} - \frac{1}{1+\exp\,(z_i - \varepsilon_1)} \quad (7)$$

$P_i = 4$ is the probability that rural women farmers' wellbeing will be very satisfactory.

Therefore, using the estimated value of Z and the assumed logistic distribution of the disturbance term, the ordered model can be used to estimate the probability that the unobserved variable Y* falls within the various thresholds.

There will be no intercept since the intercept is not identified independent of the threshold. The coefficient estimated in the model are ordered log-odds (logit) coefficients. Since the interpretation of the coefficients of the ordered logit is complex, the marginal effects will be used. The marginal effects give the probability of being in each category can therefore be attained and interpreted.

Empirical Model

Given that W, is the wellbeing with four categories of the dependent variable, three cut points will be generated (W-1). Since the study is treating wellbeing as three different (material,

relational and life satisfaction) types, there will be differences in the set of independent variables for each type of wellbeing. Therefore, the functional form for each of the wellbeing types are specified as follows:

(i) Material Wellbeing = f(Years lived in community, Television, Bicycle, Iron Roofed house, Cell phone, Belong to an FBO, Farm size, Farming type, Years of farming, Mixed cropping/Legume intercropping, Composting, Conservation agriculture, Changing planting dates, Chemical fertilisers, Weedicides and Pesticides, Off-farm employment and irrigation)

(ii) Relational Wellbeing = f(Age, Household size, Years lived in community, Gas/kerosene stove, Radio, Iron Roofed house, Refrigerator, Cell phone, Belong to any organisation, Farm size, Years of farming, Mixed cropping/Legume intercropping, Anti-erosion measures, Improved varieties, Chemical fertilisers, Weedicides and Pesticides, and Migration)

(iii) Life Satisfaction Wellbeing = f(Eeducation, Household size, Years lived in community, Gas/Kerosene Stove, Radio, Cell phone, Belong to any organisation, Farm size, Years of farming, Anti-erosion measures, Conservation agriculture, Improved varieties, Chemical fertilisers, Weedicides and Pesticides and Migration).

The ordered logistic regression model which expresses the relationships on wellbeing and its determinants is empirically specified as;

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \ldots\ldots + \beta_{26} X_{26} + \varepsilon \quad (8)$$

Where;

Y is the dependent variable

$X_{1....}$ X_{13} are the independent variables

β_0 is a constant term

$\beta_{1.....}\beta_{13}$ are the coefficients of the independent variables

ε_i = the error term

Therefore, wellbeing would be expressed as

$$W = \beta_0 + \beta_1 Age + \beta_2 Educ + \beta_3 HHSZ + \beta_4 YrsLvCom + \beta_5 GKstove + \beta_6 Radio + \beta_7 TV + \beta_8 Bcle + \beta_9 IronRH$$
$$\beta_{10} \operatorname{Re} frgta + \beta_{11} Cfon + \beta_{12} BelOrg + \beta_{13} FarmSZ + \beta_{14} FarmType + \beta_{15} YrsFarm + \beta_{16} MxdCrpng +$$
$$\beta_{17} AntEroMrs + \beta_{18} \operatorname{Im} pVar + \beta_{19} Compos + \beta_{20} ConcAgric + \beta_{21} ChgingPltnDates + \beta_{22} CheFert +$$
$$\beta_{23} WeedPest + \beta_{24} Off - farmEmp + \beta_{25} Irrigtn + \beta_{26} Migratn$$

Variables Measured

Wellbeing (W): This is the dependent variable and it is the probability of the farmer to be unsatisfied, somewhat satisfied, satisfied and very satisfied. To obtain the measured wellbeing of women farmers, it was computed compositely by taking into consideration a number of sub-factors under each of material, relational and life satisfaction wellbeing. In the case of material wellbeing, housing condition, secure/suitable work, financial security, education and skills of farmers were the sub-factors. The relational wellbeing had relationship, good relationships, culture, community spirit, tolerance and good local services as the sub-factors. Finally, the life satisfaction wellbeing had health of the women farmers, their safety towards hazards as well as how they feel good as the sub-factors. These sub-factors were scored individually, and then aggregated. Their means were calculated and that represented the measured value for a particular wellbeing type. Due to the fact that wellbeing of women farmers is being influenced by some factors, known in the research as independent variables, they are identified and explained as;

The independent variables are;

Age (Age): Age variable represents the real age of the farmer. Older farmers' wellbeing is likely to be better off than younger farmers' wellbeing. But this can be subjective and contested as the farmers grow older and older.

Education Level (Edu): This variable refers to any level of formal schooling reached by the farmer. Educational level is expected to improve the wellbeing of farmers.

Household size (HHsize): This variable refers to the number of people in a typical farm household. Household size may likely improve farmers' wellbeing as there may be more labour to work in the farm and increase farm productivity. On the other hand, it may make farmers' wellbeing worse as a farmer may have so much burden to take care of.

Years Lived in the Community (YrsLvCom): This is a variable explaining the number of years a farmer lived in a community. As more and more a farmer lives in a community, they turn to have better knowledge about the community and easily adapt to the social, economic, cultural and institutional norms of the community, and that enhances wellbeing.

Gas/Kerosene Stove (GKstove): Ownership of physical properties by a farm household is a show of increased wellbeing. Gas/kerosene stove serves better and quick option for fire source. Ownership of it can reduce stress associated to continuously depending on firewood and charcoal. It may likely reduce the number of trees being cut down for firewood and charcoal, and this eventually contributes positively to the environment.

Radio (Radio): Radio is a source of information. Farmers who owned radio are more likely to be more informed in terms of climate change adaptation measures than those without radio.

Television (TV): This variable has same explanation with the radio variable.

Bicycle (Bcle): Women are normally given poor lands to cultivate. A farm household may have fertile land but which is far away from the house. Ownership of a bicycle by a woman farmer can encourage her to farm at such distant but fertile land, since she can ride to the farm.

Iron Roof House (IronRH): It is a prestige within the community to have a house roofed with iron sheets. Many houses are roofed with thatch and sometimes mud and wooden materials. It

is also known as corrugated metal sheets. A farmer who has her house roofed with such a material may likely increase her "life satisfaction wellbeing".

Refrigerator (Refrgta): Ownership of a refrigerator also increases a farmers' prestige and therefore enhances the "life satisfaction wellbeing of farmers".

Cell phone (Cfon): A farmer who owns a cell phone can easily call for information related to climate change adaptation. Ownership of it is therefore expected to increase farmers' wellbeing.

Belong to an FBO (BelOrg): Being a member of a farmer organisation increases the chance of being a beneficiary of farm extension. Research and other developmental projects usually target farmers who are into organisations and associations.

Farm Size (FarmSZ): Farm size (FrmSze) variable refers to the size of land under cultivation.

Farm Type (FarmType): Farm type refers to a farm which is either sole crop, mix crop or farm with crops and animals.

Years of Farming (YrsFarm): This is the number of years a farmer has been engage in farm activities. This variable is directly related to the "age" variable.

Mixed Cropping/Legume Intercropping (MxdCrpng): This is an adaptation strategy that has to do with a combination of more than one crop in a field.

Anti-Erosion Measures (AntEroMrs): This is a strategy that is expected to counter soil erosion, especially, in crop land.

Improved Varieties (ImpVar): It is the different type of seed materials within a particular seed type designed for climate sensitive geographical areas.

Composting (Compos): An adaptation strategy made from biodegradable household waste.

Conservation Agriculture (ConcAgric): Agricultural practice may also likely destroy the environment. This variable is concern with the protection of the environment while still able to farm at optimum levels.

Changing Planting Dates (ChgingPltnDates): Amidst unstable climate patterns, changing planting dates have been adopted in order to adapt to the climate pattern.

Chemical Fertilisers (CheFert): It is mostly a solid substance applied to growing crops to obtain optimum crop yield. The fertiliser provides the soil essential nutrients needed by the plant to grow well.

Weedicides and Pesticides (WeedPest): This refers to both liquid and solid substance apply to a crop field to either kill growing weeds or pest.

Off-farm Employment (Off-farmEmp): This is all other activities women farmers are engaged in mostly in the dry season.

Irrigation (Irrigtn): Irrigation refers to the transfer of water from a source to vegetable crops. This is usually practice by women farmers in the dry season as alternative source of income.

Migration (Migratn): This refers to the physical movement of women farmers from the study area to any other place in search of alternative livelihoods.

Statement of Hypothesis

The statement of hypothesis was stated for all the variables. However, for the sake of same pattern followed to state the hypothesis, only the represented variables hypothesis were stated. The following Null Hypothesis (H_0) were tested against the Alternate Hypothesis (H_1)

H_0: $\beta_1 = 0$ (Age of a woman farmer has no effect/impact/influence on her wellbeing)

H_0: $\beta_1 = 0$ (Educational level attained by a woman farmer has no effect/impact/influence on her wellbeing)

H_0: $\beta_1 = 0$ (Household size of a woman farmer has no effect/impact/influence on her wellbeing)

H_0: $\beta_1 = 0$ (Anti-erosion measures adopted by a woman farmer has no effect/impact/influence on her wellbeing)

H_0: $\beta_1 = 0$ (Conservation agriculture adopted by a woman farmer has no effect/impact/influence on her wellbeing)

H_0: $\beta_1 = 0$ (Off-farm employment activities adopted by a woman farmer has no effect/impact/influence on her wellbeing)

Validation of Statement of Hypothesis

The significance levels were evaluated using the t-statistic for each of the estimated coefficients. The estimated (calculated) t was compared with the t-statistic (Critical) at 5% significant levels.

$t_{calculated} = \beta_I / SE(\beta_i)$ ($p < 0.05$), where β_i is the estimated parameter ranging from β_0 .....β_{26} and $SE(\beta_i)$ is the estimated standard error of β_i.

The Null Hypothesis (H_0) will be rejected in favour of the Alternate Hypothesis (H_1) on condition that each of the estimated (calculated) t for each of the independent variables is greater that than the t-statistic at a significance level of 5%

$t_{calculated} > t_{critical}$, the Null Hypothesis ($H_0$) is rejected

On the other hand, if the estimated coefficients for each of the independent variables is less than the t-statistic we fail to reject the Null Hypothesis (H_0).

$t_{calculated} < t_{critical}$, the Null Hypothesis ($H_0$) is not rejected

Table 3.3: Description of Variables for the Ordered Logit Regression

Variable	Description	Measurement	Apriori Expectation
Age	Age	Years	+/-
Education Level	Edu	Level	+
Household size	HHsize	Number	+/-
Years Lived in the Community	YrsLvCom	Years	+
Gas/Kerosene Stove	GKstove	Yes=1, 0=Otherwise	+
Radio	Radio	Yes=1, 0=Otherwise	+
Television	TV	Yes=1, 0=Otherwise	+
Bicycle	Bcle	Yes=1, 0=Otherwise	+
Iron Roof House	IronRH	Yes=1, 0=Otherwise	+
Refrigerator	Refrgta	Yes=1, 0=Otherwise	+
Cell phone	Cfon	Yes=1, 0=Otherwise	+
Belong to an FBO	BelOrg	Yes=1, 0=Otherwise	+
Farm Size	FarmSZ	Acres	+/-
Farm Type	FarmType	1=Single, 2=Multiple	+/-
Years of Farming	YrsFarm	Years	+
Mixed Cropping/Legume Intercropping	MxdCrpng	Yes=1, 0=Otherwise	+/-
Anti-Erosion Measures	AntEroMrs	Yes=1, 0=Otherwise	+
Improved Varieties	ImpVar	Yes=1, 0=Otherwise	+
Composting	Compos	Yes=1, 0=Otherwise	+
Conservation Agriculture	ConcAgric	Yes=1, 0=Otherwise	+
Changing Planting Dates	ChgingPltnDates	Yes=1, 0=Otherwise	+
Chemical Fertilisers	CheFert	Yes=1, 0=Otherwise	+/-
Weedicides and Pesticides	WeedPest	Yes=1, 0=Otherwise	+/-
Off-farm Employment	Off-farmEmp	Yes=1, 0=Otherwise	+
Irrigation	Irrigtn	Yes=1, 0=Otherwise	+
Migration	Migratn	Yes=1, 0=Otherwise	+/-

3.9 Ethical Considerations

The research involved qualitative and quantitative methods. The qualitative aspect involved a sustained and intensive experience with participants. This introduced a range of strategic,

ethical, and personal issues into the qualitative research process (Locke et al., 2013). With these concerns, the researcher explicitly identified participants' biases, values, and personal background, such as gender, history, culture, and socioeconomic status that shaped their interpretations during the study. In addition, gaining entry to a research site and the ethical issues that arose were also addressed. Ethical clearance was obtained from the University of Ghana, Institute of Environment and Sanitation Studies in January 2020 to undertake the study. The study also employed participatory community entry approaches to seek the permission of gatekeepers (chiefs, individuals from relevant agencies or organisations, assembly men and others in authority) before the initiation of the data gathering activity. All respondents were informed of the nature of the study to get their consent before proceeding with the interview. The research ensured that participants were not exposed to any risk of physical and psychological threat. Participation in the research was voluntary and respondents had the right to partake or not.

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter presents the results and findings of the study. They have been categorized into the five objectives of the study. A description of demographic and socioeconomic characteristics of rural women farmers in the Nandom and Lawra Districts is also presented. Further, the chapter identifies and rank adaptation responses employed by rural women farmers to address stresses associated with climatic variability and environmental change. It proceeds to determine factors influencing rural women farmers' adoption of technologies to adapt to climate change. Finally, it examines the effect of adaptation on the three dimensions of wellbeing (material, relational and subjective/life satisfaction) of rural women farmers using specific indicators of wellbeing relevant to the research participants.

4.2 Sociodemographic Characteristics of Study Participants

This section discusses the sociodemographic characteristics of surveyed farmers. The characteristics discussed include marital status, age, educational status, marital status, household size, ethnic background, years of stay within community, among others (Table 4.1). The majority of the respondents, corresponding to about 74% were married while the remaining 17% were single, and 9% were widows. The age distribution of the surveyed farmers showed that their ages ranged from 16 to 84 years. The mean age was 47.5 years. Majority of the women farmers (26.3%) were within the ages of 35-44 years while 14% of the respondents were 65 years and older.

Majority of the women interviewed (65.3%) had no formal education. Only four percent (4%) confirmed having vocational education, with the remaining having basic and middle school level education. Evidence has revealed that exposure to education or training is influential in improving women farmers' perception of climate variables and hence adaptation options (Sipho, 2016). Mean household size of the respondents in the study area was nine and ranged from a minimum of two to a maximum of 27. Based on the 2010

Population and Housing Census (PHC) the average household size is about six for both Districts whiles the region's average household size is 6.4 (GSS, 2013). The ethnic distribution of the surveyed farmers in the area shows a fairly homogeneous pattern, where 97.7% of the respondents are Dagaabas and the remaining 2.3% belonging to other ethnic groups especially Akan tribe. The findings of the study also revealed that majority (74%) of the respondents have lived within their current communities for 20 years and above. Only 3.0% indicated they have lived in the current communities for five years and below:

Table 4.1: Socio-demographic Characteristics of Respondents

Variable	Frequency	Percentage
Marital status		
Married	222	74
Single	51	17
Widow/widower	27	9
Total	**300**	**100**
Age of Respondents		
16-24	19	6.3
25-34	36	12.0
35-44	79	26.3
45-54	72	24.0
55-64	52	17.3
65-74	30	10.0
75-84	12	4.0
Total	**300**	**100.0**
Educational Status		
No formal education	196	65.3
primary	33	11.0
JHS/Middle	41	13.7
SHS/O'level/A'level	13	4.3
Tertiary	9	3.0
Vocational	3	1.0
Others	5	1.7
Total	**300**	**100.0**
Ethnic Background		
Akan	3	1
Dagaare	293	97.7
Others	4	1.3
Total	300	100.0
Years of Stay in Community		
less than one year	3	1.0
1-5 years	6	2.0
6-10years	30	10.0
11-20years 20-	39	13.0
39years over 40	60	20.0
years born there	21	7.0
Total	141	47.0
	300	100.0

Household Size	
Mean	9
Minimum	2
Maximum	27

Source: Field Survey Data (2019)

4.2.1 Household Assets Owned by Respondents

Assets are important for women because they can help them cope better with shocks, including climate shocks and the longer-term impacts of climate extremes (Goh, 2012). Results from the survey, FGDs and relevant literature reviewed revealed that rural women farmers own fewer assets (e.g. traction livestock, car, plough, gas/kerosene stove, television, bicycle iron roofed house, refrigerator and cellphone) compared to their male counterparts. For all the items listed, less than 15% out of the women farmers interviewed indicated having and owning such items. This is also confirmed by Goh (2012) that women suffer more negative impacts of climate change in terms of their assets and wellbeing; due to social and cultural norms limiting their gender roles as well as access to and control of assets.

Over half of the respondents had bicycles and cell phones, this could be a good indicator for mobility and communication. Most of the respondents claimed ownership of the iron roofed houses they occupy. Analysis from the marital status revealed that about 74% indicated they were married; this is evident of why majority of the women indicated ownership of the iron roofed houses they occupy which from the FGDs belonged to their husbands. Quisumbing (2010) also affirmed that women mostly have fewer assets and rights than men and that they are more vulnerable to loss of these assets and rights due to separation, divorce or widowhood.

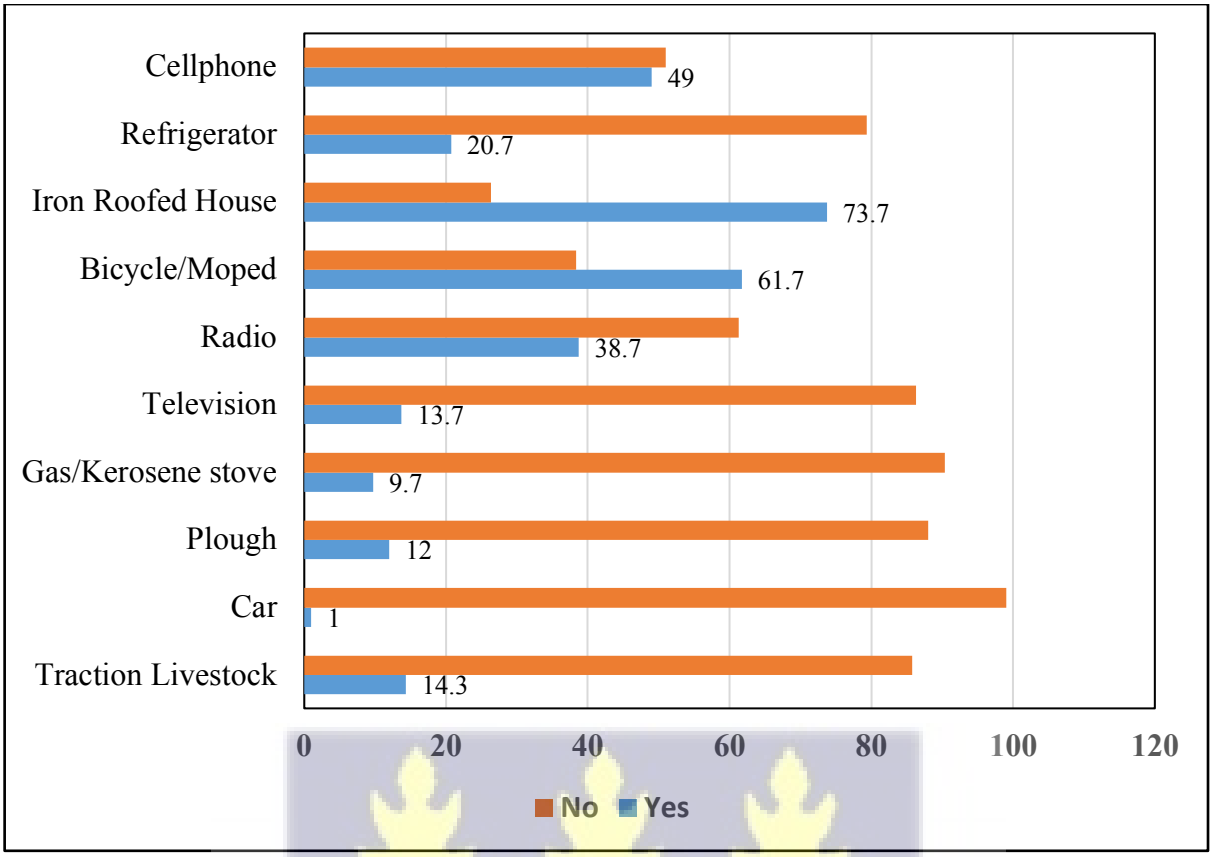

Figure 4.1: Household Assets.
Source: Field Survey Data (2019)

4.2.2 Membership in Farmer Based Organisations

Most (70.3%) of the women farmers interviewed indicated belonging to one farmer-based organisation or other; while 29.7% said they don't belong to any farmer-based organisation (Table 4.2). Those who said they belong to women groups constituted 23% of the respondents; 20.7% are members of various religious groups in the communities. Some of the women farmers belong to other groups within the communities. 29.7% claimed they do not belong to any group at all.

Table 4.2: Membership Associations

Variables	Frequency	Percentage
Government	7	2.3
Religious institution	62	20.7
Youth	7	2.3
Women	69	23.0
Community self help	22	7.3
Union	8	2.7
NGOs/ Development	3	1.0
Education	1	0.3
Business	9	3.0
Others	23	7.7
None	89	29.7
Total	**300**	**100.0**

Source: Field Survey Data (2019)

4.2.3 Ownership of Land and Type of Land Ownership by Women Farmers.

Data gathered from the study also revealed that a large percentage of women farmers in the study communities have no land and rely on various arrangements to secure land for farming. In the context of climate change, access to and control of assets such as land can be particularly important for the poor, and can help individuals and households adapt to increasing variability of production. There is an important difference between access to land on which women labour and ownership of land, which most of the women do not have (Mehar et al., 2016). Research has shown how a lack of land ownership can limit women's adaptive capacity (Jost et al., 2016; Fon, 2011). Their land rights are user rights and not ownership rights (Njoh et al., 2017). Out

of the 2.7% who own land it was revealed that the means of land acquisition included inheritance (75.7%), rented (9.7%), purchased (0.7%) or through other alternative arrangement of tenure (14%).

4.2.4 Farm Size of Women Farmers

Women farmers cultivate small acreages of land mostly for household consumption and also sale of a portion to support household budget. Majority of the women farmers (82.7%) cultivate between 0-5 acres annually (Figure 4.3).

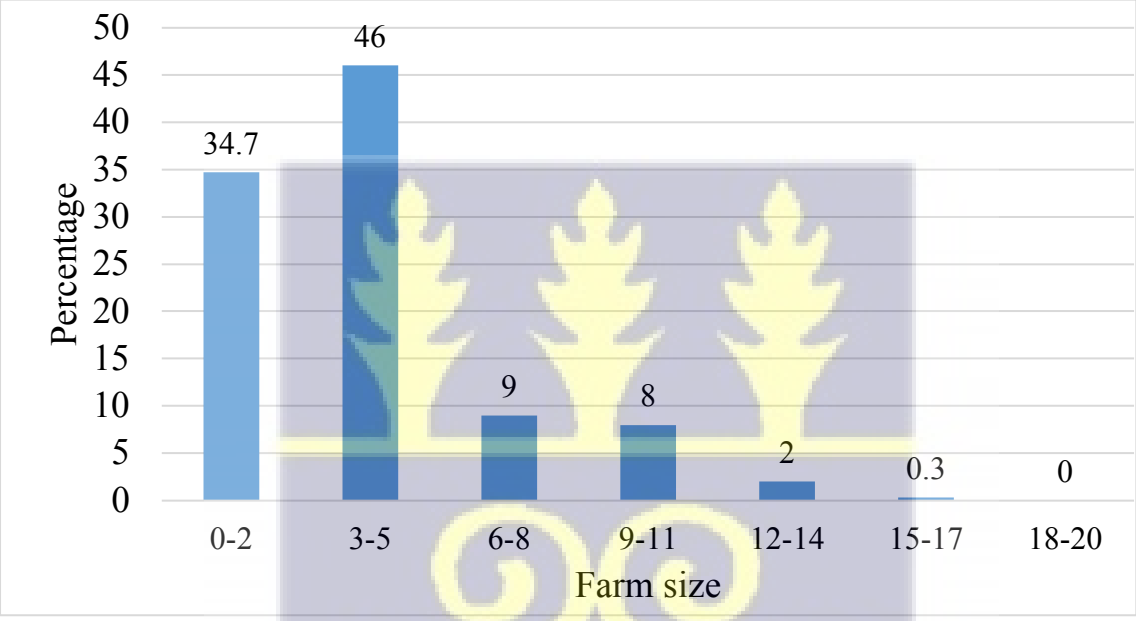

Figure 4.3: farm Size of Women Farmers
Source: Field Survey Data (2019)

4.2.5 Type of Farming Engaged in.

Majority of the women farmers (73.3%) were engaged in mixed farming where they grow crops and raise livestock as shown if Figure 4.4. Although women cultivate small acreages of land, the mixed farming is to ensure household food security and additional household income to

meet basic family needs, health care, education, reinvestments into farming activities as indicated from the FGDs.

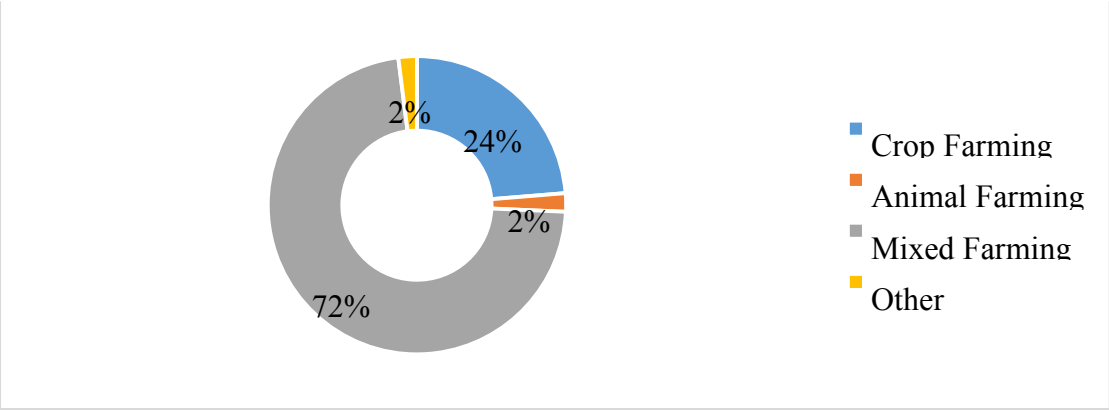

Figure 4.4: Type of Farming Activities Undertake
Source: Field Survey Data (2019)

4.2.6 Women Farmers Experience in Farming

For majority (80.3%) of the women, farming has been a lifetime experience and livelihood and they have engaged in farming between 11 and 30 years. A few women (6.7%) interviewed had less than a year's experience and these were young women (Figure 4.5).

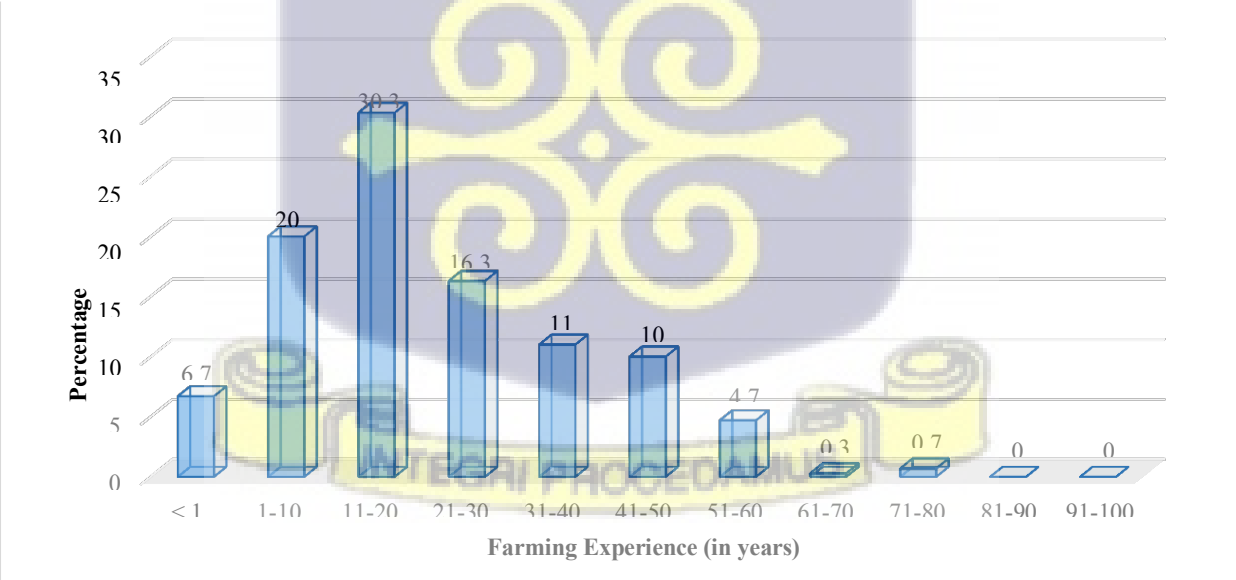

Figure 4.5: Experience of Women in Farming.
Source: Field Survey Data (2019)

4.3 Perception and Knowledge on Climate Change/Variability.

This section presents the findings on women farmers' level of knowledge on climate change/variability as well as how they perceive such changes. Knowledge and perception are amongst the factors that influence women's agrarian choices, to either adapt or not adapt to climate change/variability (Alessa et al., 2008; Berkes and Jolly, 2001). This will decide the choices to be taken by women farmers as well as what wellbeing means to them.

4.3.1 Awareness of Climate Change/Variability.

Majority of the women farmers (84%) indicated having knowledge of climate change/variability (Table 4.3). Such women also perceive the climate variation as real because of the various manifestations they are experiencing. Notwithstanding, some (16%) either had no knowledge or were not sure of the information they had received. However, women farmers' awareness is not due to their level of education (Table 4.1), but because of many years of engagement with organisations that are promoting climate information for livelihood transformation in the research districts. Lately, subjects of changing climate have been the talk all over the world and in Ghana. Nevertheless, there is a deficit in knowledge and perception of climate change/variability particularly in areas where propagation of information is a challenge (Egbe et al., 2014).

Table 4.3: Respondents' Awareness of Climate Change/Variability

Awareness of Climate Change	Frequency	Percent
Awareness	252	84.0
Not Awareness	40	13.3
Not Sure	8	2.7
Total	**300**	**100.0**

Source: Field Survey Data (2019)

4.3.2 Respondents Understanding of Climate Change/Variability.

Women farmers understand climate change/variability in the form in which they experience the manifestation of the impact. Most of the respondents (66.3%) understand it as increasing temperature with a p-value of 0.000; while 64.7% of the respondents also understand it as increasing drought. Yet another 64% also understand it as reducing rainfall (Table 4.4) where p-values are highly significant (p-value<0.000). This means that those factors are perceived to contribute greatly to climate change. From the FGDs, erratic rainfall pattern came out as one of the means respondents understand climate change and variability, but this was not evident during the questionnaire interviews, majority of respondents (64%) did not understand erratic rainfall as a manifestation of climate change and variability.

Table 4.4: Respondents' Understanding of Climate Change

Percieved understanding factor		Respondents (N=300) Frequency	Percent (%)	p-value
Increasing temperature	Yes	199	66.3	<0.000
	No	101	33.7	
Increasing rainfall amount	Yes	40	13.3	<0.000
	No	260	86.7	
Increasing drought period	Yes	194	64.7	<0.414
	No	106	35.3	
Decreasing flood incidences	Yes	19	6.3	<0.000
	No	281	93.7	
Decreasing temperature	Yes	32	10.7	<0.191
	No	268	89.3	
Reducing rainfall amount	Yes	193	64.3	<0.000
	No	107	35.7	
Reducing drought period	Yes	20	6.7	<0.000
	No	280	93.3	
More erratic rainfall	Yes	78	26.0	<0.000
	No	222	74.0	
Increasing flood incidences	Yes	109	36.3	<0.000
	No	191	63.7	

Source: Field Survey Data (2019)

4.3.3 Source of Information on Climate Change

The sources of information named in this section were examined in both the survey and FGDs. From Figure 4.6, major sources of information listed by respondents included: Radio (60.3%) and, family and friends (54%). Most of the respondents also confirmed receiving the information from multiple sources. Constraints on women's time and spatial mobility may limit their access to timely weather information. Roncoli et. al. (2009) asserted that gender, as well as ethnicity and politics, profoundly shaped the way that climate forecast information gained

from participatory workshops was shared and accessed in Burkina Faso. Most of these workshop participants (93.4%) were men.

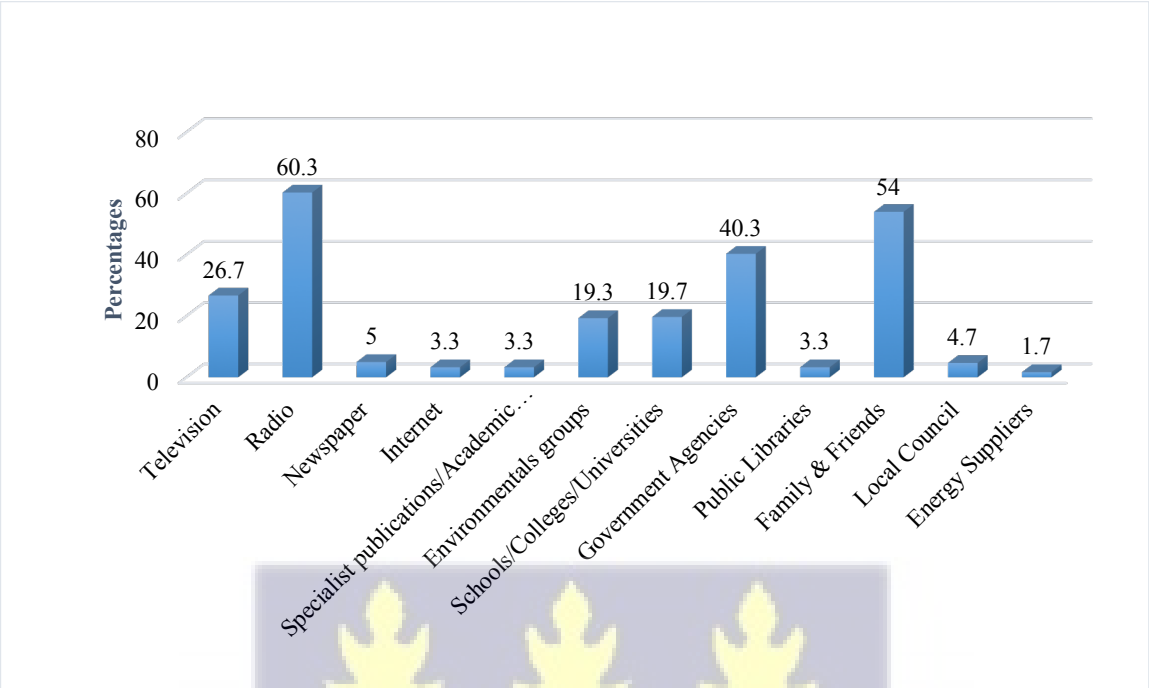

Figure 4.6: Respondents Source of Information on Climate Change.
Source: Field Survey Data (2019)

4.3.4 Level of Trust of Information Source

Results from the survey also indicated that, women farmers trusted information they received from sources such as family and friends, scientists, government agencies, environmental organisations and the media. This is very strategic for extension delivery and educational activities to empower rural women farmers. Contrary to the general view that farmers trust information received from family and friends, the result indicated otherwise (49%), the most trusted sources were information from scientist and the media.

Table 4.5: Respondents Level of Trust of Information Source

Source of Information	Level of Trust of Information Source				
	A lot (%)	A little (%)	Not much (%)	Not at all (%)	Can't Choose (%)
Family member or a Friend	49.7	41.7	5.0	2.0	1.7
A scientist	81.3	11.7	4.7	.3	2.0
The Government	63.3	26.0	4.7	3.0	3.0
An environmental organisation	67.0	21.7	8.0	.7	2.7
The media (television, radio, newspaper)	72.0	18.7	2.7	1.6	5.0

Source: Field Survey Data (2019)

4.4 Adaptation Strategies Employed by Rural Women Farmers to Adapt to Climate Change

This section presents the findings on objective one of the study. The study sought to assess the adaptation strategies employed by rural women farmers to address stresses associated with climatic variability and environmental change. Adaptation strategies, identified through Focus Group Discussions and literature search, were presented to women respondents to rank in order of importance. These adaptation measures are a combination of autonomous (indigenous) and planned interventions (introduced by NGOs and the DoA under MoFA).

The adaptation options consist of both on-farm and off-farm practices. The result in Table 4.6 shows the ranked adaptation strategies in descending order: mix cropping/legume intercropping, anti-erosion measures, composting, water harvesting, conservation agriculture, changing planting date, improved varieties, chemical fertilisers, weedicides and pesticides, off-farm employment, migration and irrigation

Kendall's Coefficient of Concordance (W) was used to test for the level of agreement among the ranking of the adaptation strategies employed by rural women farmers to address stresses associated with climatic variability and environmental change. The Kendall's Coefficient of Concordance (W) was estimated from the study to be 0.667; chi-square statistic was estimated as 551.696 with 11 degrees of freedom and asymptotic significance of 0.000.

Kendall's Coefficient of Concordance (W) estimated as 0.667 indicating that there is 66.7% agreement among the respondents on the rankings of the adaptation strategies used. With a mean rank of 4.76; farmers' use of improved seeds varieties came out as the most important adaptation strategy employed by rural women farmers to address stresses.

The next second and third most important adaptation strategies employed by rural women farmers are mixcropping/legume intercropping and changing planting date respectively. Farmers adopted these approaches with a clear focus that if one crop failed the other crop would survive. However, as the rainfall pattern changes, farmers develop other means of shifting their planting dates in order to reduce loses during germination stage.

Furthermore, chemical fertilisers and anti-erosion measures were employed by farmers in reducing their vulnerability situation. According to farmers in the study area, farmlands are generally infertile. As a result, farmers result to the use of fertiliser as means of improving soil fertility. Finally, farmers ranked use of irrigation as the last adaptation strategy in addressing poor rainfall patterns in the research area.

Table 4.6 Ranked Adaptation Strategies Employed by Rural Women Farmers to Adapt to Climate Change

Adaption Strategies	Mean Rank	Ranking
Improved varieties	4.76	1st
Mix cropping/legume intercropping	5.09	2nd
Changing planting date	5.21	3rd
Chemical fertilisers	5.64	4th
Anti-erosion measures	5.83	5th
Off-farm employment	5.99	6th
Composting	6.03	7th
Water harvesting	6.85	8th
Migration	7.12	9th
Conservation agriculture	7.33	10th
Weedicides and pesticides	8.3	11th
Irrigation	9.83	12th
No of observation	300	
Kendall's W	0.167	
Chi-Square	551.696	
Degree of freedom	11	
Asymp. Sig.	0.000	

Source: Field Survey Data (2019)

4.4.1 Adaptation Practices by Rural Women Farmers Identified During FGDs and Wellbeing Outcomes

Aside the adaptation practices that were investigated in the questionnaire survey, several adaptation practices used by rural women farmers also emerged during the FGDs. As shown in

Table 4.7, these practices are a combination of planned and individual adaptation measures which women farmers use to reduce vulnerability.

Table 4.7 Adaptation Practices Identified During FGDs and Wellbeing Implications

No.	Adaptation Strategies Used by Women Farmers	Wellbeing Outcomes Impacted	FGD Ranking
1	Livelihood diversification	Expanded market, increased household income, meet health, educational and other social needs	1st
2	Improved livestock breeding	Improved nutrition and household health	2nd
3	Improved cultural practices	Increased farm yield and income	3rd
4	Mechanized farming	Availability of food, increased household income, expanded market and processing activities; meet health and educational needs	4th
5	Provision of adequate credit facilities to aid farming activities	Increased yield, income, food security, enhanced financial autonomy and decision-making power for women, expanded social networks	5th
6	Early provision of fertilisers and other farming implements	Increased yield, food security and income	6th

Source: Field Survey Data (2019)

4.5 Factors Influencing Rural Women Farmers' Adoption of Adaptation Strategies

The study sought to determine the factors influencing rural women farmers' adoption of climate change technologies. The dependent variable adoption of climate change technologies is limited and therefore propels the use of the probit regression model. The independent variables included in the model were; Age, Educational status, FBO membership, Farm size, Household size, increasing temperature, increasing rainfall amount, increasing drought period, decreasing temperature, reducing rainfall amount, Reducing drought period and Erratic rainfall. The probit

regression results (Table 4.8) shows that educational status, FBO membership, Farm size, Household size, increasing temperature, reducing rainfall amount and Reducing drought period all had influence on rural women farmers' adoption of climate change technologies in the study area. The probit regression results show a likelihood ratio chi-square value of 151.56954 which is significant at the 1% level of significance. This means that the explanatory variables or factors included in the model jointly explained the decision of rural women farmers to adapt of climate change technologies. The Pseudo R^2 value of 0.6015 also provides an indication that all the explanatory variables included in the model were able to explain about 60.1% of the probability of the decision of rural women farmers' adoption of climate change technologies.

Specifically, the analysis shows that FBO membership was significant at 5%, whiles, the rest educational status, Farm size, Household size, increasing temperature, reducing rainfall amount and Reducing drought period were significant at 10%.

Table 4.8: Factors Influencing Rural Women Farmers' Adoption of Adaptation Strategies from the Survey (Probit results)

Variable	Coefficient	Standard error	P-value
Age	0.0030	0.0065	0.639
Educational status	0.0365*	0.0192	0.058
FBO membership	0.0015**	0.0057	0.003
Farm size	0.0518*	0.0227	0.023
Household size	0.3321*	0.1822	0.068
Increasing temperature	0.4392*	0.1817	0.016
Increasing rainfall amount	0.3456	0.2742	0.208
Increasing drought period	0.2562	0.1774	0.149
Decreasing temperature	-0.4580	0.4263	0.283
Reducing rainfall amount	0.5180*	0.2802	0.065
Reducing drought period	0.3292*	0.1954	0.092
Erratic rainfall	-0.1120	0.1778	0.529
Cons	-0.9485*	0.4290	0.027
N	**300**		
LR chi^2(3)	**34.26**		
Prob > chi^2	**0.0006**		
Pseudo R^2	**0.6015**		
Log likelihood	**-151.56954**		

Note: *10% significant, **5% significant, and ***1% significant.

Source: Field Survey Data (2019)

The factors have been discussed in detail below:

Educational status

Probit regression results reveal positive significant (10%) relationship between respondents' education and their adoption of climate change technologies. The coefficient of education, measured as number of years of formal schooling completed, was 0.0365 as shown in the Table 4.8. This indicates that one-unit increase in number of years of formal schooling completed is

likely to increase the probability of adoption of climate change technologies by 0.0365, holding other variables constant. Education and for that matter literacy has been largely established to have effect on farmers' understanding and adoption of agricultural technologies.

FBO membership

FBO membership of respondents was found to have a positive significant influence on adoption of climate change technologies in the study area. This means that when a rural woman farmer belongs to an FBO, there is the likelihood that such a rural woman farmer would increase adoption of climate change technologies. With a coefficient of 0.0015 and significant at 5%, indicates that with an increase in FBO membership by one person, the probability of the rural farmer to increase adoption of climate change technologies by 0.0015 is very high, if all things remain the same.

Farm size

The variable farm size has a positive and significant effect on adoption behaviour of rural women farmers, suggesting that rural women farmers with large farm size are more likely to intend adoption of climate change technologies than those with smaller farm size (Table 4.8). The co-efficient revealed that a unit increase in farm size increases the probability of adoption of climate change technologies by 0.0518 as shown in the Table 4.8.

Household size

The study also found significant and positive (at 10% level) relationship between household size of respondents and their adoption decision towards climate change technologies. The co-

efficient of the variable 'household size' as shown in Table 4.8 is 0.3321. This signifies that one unit increase in respondents' household size will increase the likelihood of adoption of climate change technologies by 0.3321, if things remain the same.

Increasing temperature

The study also found significant and positive (at 10% level) relationship between increasing temperature and respondent's adoption decision towards climate change technologies. The co-efficient of the variable 'increasing temperature' as shown in the Table 4.8 is 0.4392. This signifies that one unit increase in temperature will increase the likelihood of adoption of climate change technologies by 0.4391, if things remain the same.

Reducing rainfall amount

The study also found significant and positive (at 10% level) relationship between reducing rainfall amount and respondent's adoption decision towards climate change technologies. The co-efficient of the variable 'reducing rainfall amount' as shown in the Table 4.8 is 0.5180. This signifies that, one unit increase in rainfall amount will increase the likelihood of adoption of climate change technologies by 0.5180, if things remain the same.

Reducing drought period

The study also found significant and positive (at 10% level) relationship between reducing drought period and respondent's adoption decision towards climate change technologies. The co-efficient of the variable 'reducing drought period as shown in the Table 4 is 0.3292. This

signifies that, one unit increase in drought period will increase the likelihood of adoption of climate change technologies by 0.3292, if things remain the same.

4.6 The Effect of Adaptation on Material Wellbeing of Rural Women Farmers

Farmers' welfare maximization is the ultimate aim of adapting to climate change (Fagariba et al., 2018). The ability to adopt adaptation strategies may be different for women and men depending on the assets they have access to or control of and the sociocultural context, which determines their rights, roles, and responsibilities and the welfare benefits they attain (Carr, 2008). The material wellbeing of the rural women farmers was measured based on their housing condition, secure/suitable work, financial security, and education and skills acquired. Each of the measures were assessed on a four-point Likert scale as unsatisfied, somewhat satisfied, satisfied and very satisfied. From Table 4.9, the chi-square statistic (54.10) shows that at least one of the independent variables does have a non-zero coefficient. The model is therefore statistically significant at the 1% level of significance, indicating that the independent variables included in the model jointly explains the material resources own or enjoy by rural women farmers in both Lawra and Nandom Districts. From the analysis the number of years a woman famer has lived in the community and ownership of a television set positively influence rural women farmers' material wellbeing. Conversely, ownership of a cell phone, farming type, use of chemical fertilisers as well as use of weedicides and pesticides negatively influence rural women farmers' material wellbeing.

Table 4.9: Ordered Logistic Results of Adaptation on Material Wellbeing of Farmers

Variable	Coefficient	Standard error	P-value
Years lived in community	.1548*	.0774	0.046
Television	.6035*	.3451	0.080
bicycle moped	-.3298	.2969	0.267
Iron Roofed house	.3784	.2899	0.177
Cell phone	-.4519*	.2721	0.097
Belong to FBO	-.2434	.2705	0.368
Farm Size	-.0253	.0227	0.265
Farming type	-.4985***	.1421	0.000
Years of Farming	.0105	.0069	0.124
Mixcropping/Legume intercropping	.6236	.4287	0.146
Composting	-.4014	.4463	0.369
Conservation Agriculture	.3051	.4566	0.504
Changing Planting Dates	.5578	.4308	0.195
Chemical Fertilisers	-1.2317***	.3460	0.000
Weedicides and Pesticides	-1.8599**	.5372	0.001
Off-Farm Employment	.2927	.4515	0.517
Irrigation	.7169	.5091	0.159
/cut1	-3.597576	.9523167	
/cut2	-1.859734	.914777	
/cut3	.8059763	.9120157	
N		**299**	
LR chi^2(17)		**54.10**	
Prob > chi^2		**0.0000**	
Pseudo R^2		**0.0797**	
Log likelihood		**-312.14884**	

Note: *10% significant, **5% significant and ***1% significant.

Source: Field Survey Data (2019)

Marginal Effect Analysis

The marginal effect analysis was used to further analyse the level of satisfaction of rural women farmers with the adaptation strategies and other household or economic factors. From Table 4.10, a unit increase in the number of years lived in the community by a woman farmer decreases the probability of unsatisfied and somewhat satisfied farmers' material wellbeing by about 0.5% and 1.7% respectively. Only the satisfied women farmers were not influenced by the number of years lived in the community variable since it shows no significant p-value. On the other hand, a unit increase in the number of years lived in the community by the women farmers increases the probability of the very satisfied farmers' material wellbeing by about 2.9%. Ownership of a television set as a material product decreases the probability of somewhat satisfied women farmers' material wellbeing by about 1.7% whiles it increases the very satisfied women farmers by about 11.3%. The probability of very satisfied women farmers' material wellbeing decreases by about 8.5% if a woman farmer owns a cell phone.

Farming type had an impact on all category of women farmers. Farming type adopted by women farmers increases the probability of unsatisfied, somewhat satisfied and satisfied farmers material wellbeing by about 1.7%, 5.4% and 2.2%. It however decreases the material wellbeing of the very satisfied women farmers by about 9.3%.

Table 4.10: Marginal Effects of Adaptation on the Material Wellbeing of Women Farmers

Variables/Adaptation Strategies	Unsatisfied	Somewhat Satisfied	Satisfied	Very Satisfied
Years lived in community	-0.0053*	-0.0169*	-0.0068	0.0289*
	(0.068)	(0.049)	(0.160)	(0.046)
Television	-0.0207	-0.0658*	-0.0264	0.1128*
	(0.102)	(0.085)	(0.193)	(0.082)
Bicyclemoped	0.0113	0.0359	0.0144	-0.0617
	(0.281)	(0.268)	(0.338)	(0.268)
Iron Roofed house	-0.0130	-0.0412	-0.0165	0.0708
	(0.197)	(0.180)	(0.263)	(0.176)
Cell phone	0.0155	0.0493	0.0197	-0.0845*
	(0.119)	(0.103)	(0.196)	(0.097)
Belong to any FBO	0.0084	0.0265	0.0106	-0.0455
	(0.376)	(0.373)	(0.405)	(0.367)
Farm Size	0.0009	0.0028	0.0011	-0.0047
	(0.280)	(0.272)	(0.322)	(0.265)
Farming Type	0.0171**	0.0543**	0.0218*	-0.0932***
	(0.006)	(0.001)	(0.080)	(0.000)
Years of Farming	-0.0004	-0.0011	-0.0005	0.0019
	(0.148)	(0.131)	(0.210)	(0.122)
Mixcropping/Legume intercropping	-0.0185	-0.0614	-0.0461	0.1260
	(0.117)	(0.113)	(0.306)	(0.172)
Composting	0.0157	0.0470	0.0072	-0.0699
	(0.436)	(0.400)	(0.445)	(0.331)
Conservation Agriculture	-0.0095	-0.0311	-0.0196	0.0602
	(0.466)	(0.476)	(0.613)	(0.524)
Changing planting dates	-0.0162	-0.0543	-0.0431	0.1136
	(0.155)	(0.145)	(0.371)	(0.228)
Chemical fertilisers	0.0625*	0.1576**	-0.0337	-0.1864***
	(0.023)	(0.002)	(0.394)	(0.000)
Weedicides and Pesticides	0.1286*	0.2439***	-0.1372	-0.2353***
	(0.053)	(0.000)	(0.124)	(0.000)
Off-Farm Employment	-0.0091	-0.0299	-0.0186	0.0576
	(0.478)	(0.490)	(0.624)	(0.537)
Irrigation	-0.0189*	-0.0651*	-0.0680	0.1521
	(0.087)	(0.088)	(0.349)	(0.200)

Note: *10% significant, **5% significant, and ***1% significant.

p-values are in parenthesis

Source: Field Survey Data (2019)

The adoption and use of chemical fertilisers as an adaptation strategy increases the probability of the material wellbeing of unsatisfied and somewhat satisfied women farmers by 6.3% and

15.8% respectively but decreases the material wellbeing of the very satisfied women farmers by about 18.6%. Weedicides and pesticides use also showed an increase in the probability of the material wellbeing of unsatisfied and somewhat satisfied farmers by about 12.9% and 24.4% respectively. On the other hand, the same adaptation strategy showed a decrease in the probability of the material wellbeing of the very satisfied farmers by about 23.5%. Irrigation as an adaptation strategy decreases the probabilities of the material wellbeing of both unsatisfied and somewhat women farmers by about 1.9% and 6.5%.

4.7 The Effect of Adaptation on the Relational Wellbeing of Rural Women Farmers

Another important aspect of wellbeing worthy to understand is the relational wellbeing. It has relationship, good relationships, culture, community spirit, tolerance and good local services as indicators. Therefore, the relational wellbeing of women farmers was measured on these indicators. Following the same criteria as used in objective 3, the adaptation strategies and such other household or economic factors that are likely to influence adaptation were regressed, on the relational wellbeing measured for all 300 women farmers. Table 4.11 shows the chi-square statistic of 62.95 and a probability value of 0.0000. This means that, at least one of the adaptation strategies and the household factors included in the model regression jointly explains the relational wellbeing among the women farmers in both Lawra and Nandom.

Adaptation options and items such as age of the farmer, ownership of a radio set, ownership of a cell phone, farm size of a farmer and use of weedicides and pesticides (Table 4.11) were considered not important to the relational wellbeing of rural women farmers. On the other hand, factors and items including household size, ownership of gas/kerosene stove, number of years

of farming and mixed/legume intercropping were identified as very important to relational wellbeing by majority of rural women farmers.

Table 4.11: Ordered Logistic Results of Adaptation on the Relational Wellbeing of Farmers

Variable	Coefficient	Standard error	P-value
Age	-0.0826*	0.0464	0.075
Household Size	0.0279*	0.0156	0.073
Years lived in community	0.1044	0.0789	0.186
Gas Kerosene Stove	1.6850***	0.4531	0.000
Radio	-0.7661**	0.2773	0.006
Iron Roofed House	-0.4172	0.2949	0.157
Refrigerator	-0.3852	0.3101	0.214
Cell phone	-0.6411*	0.2726	0.019
Belong to an FBO	-0.3935	0.2789	0.158
Farm Size	-0.0786**	0.0227	0.001
Years of Farming	0.0231**	0.0080	0.004
Mixcropping/Legume intercropping	1.1485**	0.4294	0.007
Anti-erosion Measures	0.5158	0.5584	0.356
Improved Varieties	0.5739	.44966	0.202
Chemical Fertilisers	-0.4666	0.3393	0.169
Weedicides and Pesticides	-1.6906**	0.5319	0.001
Migration	-0.7605	0.5061	0.133
/cut1	-3.008512	1.169694	
/cut2	-1.775593	1.154651	
/cut3	1.657297	1.155425	
N	296		
LR $chi^2(23)$	62.95		
Prob > chi^2	0.0000		
Pseudo R^2	0.1011		
Log likelihood	-280.00422		

Note: *10% significant, **5% significant, and ***1% significant.

Source: Field Survey Data (2019)

Marginal Effect Analysis

From Table 4.12, a unit increase in the age of a woman farmer increases the probability of unsatisfied and somewhat satisfied women farmers' relational wellbeing by about 0.4% and 0.7% respectively. On the contrary, age of a woman farmer decreases the probability of the very satisfied farmers' relational wellbeing by about 1.1%. The size of a household decreases the probability of the unsatisfied and somewhat satisfied women farmers relational wellbeing by about 0.1% and 0.2% respectively but increases that of the very satisfied rural woman farmer a proportion of 0.3%. The use of gas/kerosene stove decreases the probability of unsatisfied and somewhat women farmers' relational wellbeing by about 7.9% and 13.8% respectively but increases that of the very satisfied rural woman farmer by about 21.8%.

The probability of owning a radio set increases the relational wellbeing by 3.6% and 6.3% for unsatisfied and somewhat satisfied women farmers respectively. However, it decreases the very satisfied women farmers' relational wellbeing by about 9.9%. Access to a cell phone by a woman farmer increases the probability of unsatisfied and somewhat satisfied farmers' relational wellbeing by about 3% and 5.2% respectively, but decreases the probability of the very satisfied farmers' relational wellbeing by about 8.3%. The size of a women farmers' farm had significant effect on their wellbeing, particularly their relational wellbeing. The results show that, except for the satisfied women farmers, it had a significant effect on the unsatisfied, somewhat satisfied and the very satisfied farmers. Thus, the size of the farm increases the probability of the relational wellbeing of unsatisfied and somewhat satisfied women farmers by about 0.4% and 0.6% respectively, but decreases the probability of the very satisfied farmers by about 1%. Years of farming is also the same as years of farming experience had significant effect on all category of women farmers, except the satisfied category. The relational wellbeing

of the unsatisfied and satisfied farmers decreases respectively with decreasing probabilities of 0.1% and 0.2%. Conversely that of the very satisfied farmers increases by 0.3%.

Mixed cropping or legume intercropping decreases the relational wellbeing of unsatisfied and somewhat satisfied women farmers' by about 4.3% and 7.8% respectively. However, intercropping legumes with other crops increases the probability of the very satisfied women farmers by about 18.3%. The application of weedicides and pesticides had a significant effect for all category of women farmers. Thus, weedicides and pesticides application increase the probability of unsatisfied and somewhat satisfied women farmers' relational wellbeing by about 14.5% and 16.7% respectively. On the contrary, the same adaptation strategy reduces the probability of the satisfied and very satisfied farmers' relational wellbeing by about 16.9% and 14.4% respectively. Migration as an adaptation strategy reduces the probability of the very satisfied women farmers' relational wellbeing by about 7.9%.

Table 4.12: Marginal Effects of Adaptation on the Relational Wellbeing of Women Farmers

Variables/Adaptation Strategies	Unsatisfied	Somewhat Satisfied	Satisfied	Very Satisfied
Age	0.0039*	0.0068*	0.00001	-0.0107*
	(0.091)	(0.079)	(0.995)	(0.076)
Household Size	-0.0013*	-0.0023*	-3.77e-06	0.0036*
	(0.087)	(0.083)	(0.995)	(0.074)
Years lived in community	-0.0049	-0.0085	-0.00001	0.0135
	(0.197)	(0.189)	(0.995)	(0.189)
Gas/Kerosene Stove	-0.0796**	-0.1378**	-0.0002	0.2177***
	(0.002)	(0.001)	(0.995)	(0.000)
Radio	0.0362*	0.0627**	0.0001	-0.0989**
	(0.012)	(0.009)	(0.995)	(0.006)
Iron Roofed House	0.0197	0.0341	0.00006	-0.0539
	(0.167)	(0.166)	(0.995)	(0.160)
Refrigerator	0.0182	0.0315	0.00005	-0.04977
	(0.229)	(0.220)	(0.995)	(0.216)
Cell phone	0.0303*	0.0524*	0.00009	-0.0828*
	(0.030)	(0.026)	(0.995)	(0.019)
Belong to an FBO	0.0186	0.0322	0.00005	-0.0508
	(0.171)	(0.167)	(0.995)	(0.159)
Farm Size	0.0037**	0.0064**	0.00001	-0.0102**
	(0.003)	(0.002)	(0.995)	(0.001)
Years of Farming	-0.0011*	-0.0019**	-3.12e-06	0.0030**
	(0.010)	(0.007)	(0.995)	(0.004)
Mixcropping/Legume intercropping	-0.0425**	-0.0776**	-0.0623	0.1825*
	(0.004)	(0.003)	(0.217)	(0.024)
Anti-erosion Measures	-0.0202	-0.0369	-0.0199	0.0770
	(0.268)	(0.290)	(0.652)	(0.418)
Improved Varieties	-0.0229	-0.0416	-0.0204	0.0849
	(0.144)	(0.153)	(0.545)	(0.258)
Chemical Fertilisers	0.0252	0.0412	-0.0119	-0.0546
	(0.236)	(0.206)	(0.548)	(0.131)
Weedicides and Pesticides	0.1449*	0.1674**	-0.1686*	-0.1437***
	(0.048)	(0.003)	(0.081)	(0.000)
Migration	0.0477	0.0721	-0.0404	-0.0794*
	(0.251)	(0.180)	(0.458)	(0.060)

Note: *10% significant, **5% significant, and ***1% significant: p-values are in parenthesis

Source: Field Survey Data (2019)

4.8 The Effect of Adaptation on the Life Satisfaction Wellbeing of Rural Women Farmers

The third wellbeing type affecting the behavioural pattern of rural women adaptation is the life satisfaction wellbeing. The sub-components that make up the life satisfaction wellbeing are health of the women farmers, their safety towards hazards as well as how they feel good.

The household and or economic factors that are likely to influence adaptation as well as the adaptation strategies were again used as independent variables in the ordered logit model while the measured life satisfaction wellbeing were used as a dependent variable. The reason is to determine the effect of adaptation on the life satisfaction wellbeing of rural women farmers. Table 4.13 indicates the chi-square statistic of 59.96 and overall model p-value of 0.0000, indicating that at least one of the adaptation strategies and the factors that are likely to influence adaptation jointly explains the life satisfaction wellbeing of rural women farmers in the study districts. The variables and household factors that were significant in the overall model include the number of years lived in the community by a woman farmer, ownership of a radio set, ownership of a cell phone, farm size and number of years of farming. These factors and strategies were very important to the life satisfaction wellbeing of rural women farmers. Strategies and factors such as anti-erosion measures taken by women farmers, improved varieties of crops adopted, chemical fertilisers use as well as the application of weedicides and pesticides (Table 4.13) were considered unimportant to the life satisfaction wellbeing of rural women farmers.

Table 4.13: Ordered Logistic Results of Adaptation on Life Satisfaction Wellbeing of Farmers

Variable	Coefficient	Standard error	P-value
Education	-0.1005	0.0899	0.264
Household Size	0.0195	0.0147	0.184
Years lived in community	0.1483*	0.0756	0.050
Gas/Kerosene Stove	0.4928	0.4233	0.244
Radio	-0.4925*	0.2553	0.054
Cell phone	-0.6798**	0.2564	0.008
Belong to an FBO	-0.3279	0.2613	0.210
Farm Size	-0.0395*	0.0238	0.097
Years of Farming	0.0225**	0.0071	0.002
Anti-erosion Measures	1.0631*	0.5216	0.042
Conservation Agriculture	-0.4793	0.4821	0.320
Improved Varieties	1.2068**	0.4134	0.004
Chemical Fertilisers	-0.5573*	0.3151	0.077
Weedicides and Pesticides	-1.6815**	0.5071	0.001
Migration	-0.2854	0.5066	0.573
/cut1	-3.4980	1.1069	
/cut2	-1.6324	1.0775	
/cut3	1.1893	1.0762	
N	300		
LR chi^2(23)	59.96		
Prob > chi^2	0.0000		
Pseudo R^2	0.0877		
Log likelihood	-311.8797		

Note: *10% significant, **5% significant, and ***1% significant.

Source: Field Survey Data (2019)

Marginal Effect Analysis

From Table 4.14, the number of years lived in the community by women farmers decreases the probability of the life satisfaction wellbeing of unsatisfied and somewhat satisfied farmers

by about 0.6% and 1.9% respectively, but increases the probability of the very satisfied farmers by about 2.3%. Ownership of a radio set increases the probability of unsatisfied and somewhat satisfied women farmers' life satisfaction wellbeing by about 1.8% and 6.2% respectively, but decreases the probability of the very satisfied life satisfaction wellbeing by about 7.5%.

The probability of unsatisfied and somewhat satisfied women farmers' life satisfaction wellbeing increases by about 2.5% and 8.6% respectively when they own a cell phone, but that of the very satisfied farmers had their probability reduced by about 10.3% for the same ownership of the cell phone. The farm size cultivated by women farmers is only significant for the very satisfied category. Thus, a unit increase in the acreage of their farm sizes decreases their life satisfaction wellbeing by about 0.6%. Years of farming is directly proportional to farming experience. It relates to how long a woman farmer has been engage in farming activities. The results posited that, a unit increase in the number of years a woman farmer has been engage in farming decreases the probability of the life satisfaction wellbeing of the unsatisfied and the somewhat satisfied farmers by about 0.08% and 0.3% respectively but the same factor increases the life satisfaction wellbeing of the very satisfied farmers by about 0.3% respectively.

Table 4.14: Marginal Effects of Adaptation on the Life Satisfaction Wellbeing of Women Farmers

Variables/Adaptation Strategies	Unsatisfied	Somewhat Satisfied	Satisfied	Very Satisfied
Education	0.0037	0.0127	-0.0012	-0.0153
	(0.274)	(0.266)	(0.624)	(0.266)
Household Size	-0.0007	-0.0025	0.0002	0.0029
	(0.201)	(0.188)	(0.621)	(0.184)
Years lived in community	-0.0055*	-0.0187*	0.0017	0.0225*
	(0.070)	(0.051)	(0.602)	(0.051)
Gas Kerosene Stove	-0.0183	-0.0623	0.0058	0.0748
	(0.259)	(0.248)	(0.628)	(0.245)
Radio	0.0183*	0.0623*	-0.0058	-0.0748*
	(0.073)	(0.057)	(0.604)	(0.055)
Cell phone	0.0252*	0.0859*	-0.0079	-0.1032**
	(0.020)	(0.010)	(0.600)	(0.008)
Belong to an FBO	0.0122	0.0414	-0.0038	-0.0498
	(0.226)	(0.213)	(0.623)	(0.211)
Farm Size	0.0015	0.0049	-0.0005	-0.0060*
	(0.119)	(0.103)	(0.615)	(0.096)
Years of Farming	-0.0008**	-0.0028**	0.0003	0.0034**
	(0.009)	(0.002)	(0.598)	(0.002)
Anti-erosion Measures	-0.0270*	-0.1043**	-0.0736	0.2049*
	(0.011)	(0.007)	(0.334)	(0.085)
Conservation Agriculture	0.0211	0.0654	-0.0215	-0.0649
	(0.402)	(0.352)	(0.574)	(0.263)
Improved Varieties	-0.0317**	-0.1203***	-0.0775	0.2296*
	(0.003)	(0.000)	(0.183)	(0.012)
Chemical Fertilisers	0.0245	0.0758*	-0.0245	-0.0718*
	(0.148)	(0.098)	(0.351)	(0.048)
Weedicides and Pesticides	0.1165*	0.2393**	-0.1841*	-0.1717***
	(0.048)	(0.001)	(0.043)	(0.000)
Migration	0.0118	0.0380	-0.0095	-0.0403
	(0.613)	(0.591)	(0.737)	(0.543)

Note: *10% significant, **5% significant, and ***1% significant. p-values are in parenthesis

Source: Field Survey Data (2019)

Anti-erosion measures as an adaptation strategy decreases the probability of the life satisfaction wellbeing of the unsatisfied and somewhat satisfied women farmers by about 2.7% and 10.3% respectively. It however increases the probability of life satisfaction wellbeing of the very satisfied farmers by 20.5%. The adoption of different improved varieties of crops for

agricultural purposes also decreases the probability of the life satisfaction wellbeing of unsatisfied and somewhat satisfied rural women farmers by about 3.2% and 12% respectively. Conversely, it increases the likelihood of life satisfaction wellbeing of the very satisfied women farmers by about 23%. The use of chemical fertilisers as an adaptation strategy increases the probability of the life satisfaction wellbeing of somewhat satisfied women farmers by about 7.6% but decreases the wellbeing of the very satisfied farmers by about 7.2%. The application of weedicides and pesticides increases the probability of the life satisfaction wellbeing of the unsatisfied and somewhat satisfied women farmers by about 11.7% and 23.9% respectively. The same variable decreases the probability of the life satisfaction wellbeing of the satisfied and very satisfied women farmers by about 18.4% and 17.2% respectively.

CHAPTER FIVE

DISCUSSION

5.0 Introduction

This chapter synthesizes the study to show their relationship to the main research topic. It discusses the demographic and socio-economic characteristics of smallholder farmers, their perception and knowledge of climate variability and environmental changes as well as vulnerability and adaptation patterns. It also highlights adaption strategies employed by rural women farmers and ranks the factors that influence the adoption of technologies by rural women farmers. Lastly, the chapter concludes with a discussion on the implication of adaptation strategies on the three dimensions of wellbeing of rural women farmers i.e., material, relational and life satisfaction.

5.1 Demographic and Socio-economic Characteristics of Rural Women Farmers which Shape Adaptive Choices and Wellbeing

According to Adger et al. (2008), it is vital to understand the demographic characteristics of respondents, before assessing their perception and adaptation strategies; because certain demographic characteristics of individual women farmers may impact on how they effectively manage and respond to climatic threats. Sipho (2016), for example, observed that demographic and socio-economic factors such as age, education, access to extension services, access to climate materials, household size, access to funds, marital status among others influence rural women farmers' perception and adaptation responses. Nyantakyi-Frimpong (2017) and Rao et al. (2017) also affirmed that age, marital status and migrant status are significant social factors in the research area. This is further confirmed by Lawson et al. (2019) that such demographic

and socio-economic factors influence the extent of access to and ownership of land, the most important economic and natural resource on which survival of most households depends.

Majority (74%) of respondents were married. According to the respondents, women are typically always engaged with reproductive and economic roles hence have little or no time to listen to news and also attend trainings; as a result, climate and adaptation information received from radio, television, friends/family and non-governmental organisations are most often than not disseminated from their partners to enhance their adoption of adaptation strategies.

Age is known to have influence on adaptation options in the sense that the majority of the respondents who were within the age range of 35-44, have many years of farming experience and might use indigenous knowledge in their farming activities. Defang et al. (2014), for example, observed farming activities to be vigorous and therefore require experience. Thus, age plays a significant importance in the adaptation options employed by rural women farmers. Shangwe (2014) also observed that old age has a negative relationship to adopting climate change adaptation strategies because agriculture is labour intensive and requires healthy individuals. Notwithstanding, older people have experience in farming which can be applied to enhance adaptive skills.

High illiteracy rates and low educational attainment among farmers in the upper regions of Ghana have been widely reported (Abu et al., 2014; Mustapha, 2012; Al-hassan, 2008). Gaining of formal education to senior high and tertiary affects the adoption of adaptation technologies. Fatuase and Ajibefun (2013) and Defang et al. (2014) observed that better and higher education improves consciousness of potential benefits and readiness to partake in adaptation options. In Lawra and Nandom, formal education also affords farmers the

opportunity to engage in other alternative sources of livelihoods as a form of adaptation strategy to improve wellbeing.

Household size of rural women farmers are high in the study communities, with a mean household size of 9.0, ranging from a minimum of 2.0 to a maximum of 27. This is more than double the national average of 4.0 and significantly higher than the average household size for Nandom and Lawra, as per the 2010 Population and Housing Census (PHC), while the regions average is 6.4 (GSS,2013). In a related study, Nyantakyi-Frimpong and Kerr (2014) found household size among rural farmers in the Upper West Region to be 7.8. Other studies have noted smallholder farming households in the savannah agro-ecological region of Ghana to be associated with large household (Abu et al., 2014; Kuwornu et al., 2010). Elsewhere in Kenya, Margaret (2015) found smallholder farming household to be large (5.6) and higher than the national average. The probable reason smallholder farming households maintain large household size is to ensure adequate supply of family labor (Al-hassan, 2008).

The majority (95%) of women farmers in Lawra and Nandom are indigenous Dagabas, which has implications on individual's adaptation options. Women farmers who are the native of the land appear to have better understanding of recent manifestations of weather extremes than those have migrated to the area. Lawson et al. (2019) observed in a related study within the same research area that residential status influenced adaptation options. They observed that farmers who were born and had lived most of their lives in the communities were much more familiar with the climatic conditions in the area as compared to the migrants, for that reason they are able to more easily formulate adaptation strategies. The study by Lawson et. al. (2019) showed that women farmers who are non-migrants appear to have adapted better to manifestations of weather extremes than the migrants since they had a relatively better access to resources. With majority being indigenes (74.4%), they would have relatively more

knowledge about their environment and understand the local climatic conditions better than the migrant, and for that reason may be able to better adopt adaptation strategies.

Assets are important for the poor because they can help them cope better with shocks, including climate shocks and the longer-term impacts of climate extremes (Goh, 2012). These include secure land and water rights, agricultural technologies, livestock, knowledge, and social capital can help individuals and households adapt to increasing variability of production. In the context of climate change, access to and control of assets can be particularly important for the poor. Women usually have fewer assets and rights than men, and are more vulnerable to loss of these assets and rights due to separation, divorce, or widowhood, and have less access to capital, extension, inputs, and resources for agricultural production (Peterman et al., 2010; Quisumbing, 2009; Deere and Doss, 2006; Antonopoulos and Floro, 2005).

The research revealed that although women own fewer assets (e.g. cell phone, refrigerator, iron roofed house, traction livestock, plough, radio, bicycle, gas/kerosene stove and television); their asset holdings often have positive effects on household food security and human capital formation (FAO, 2011). Empowering women to gain more access to and control of key assets will improve adoption of adaptation technologies leading to improvement in their wellbeing in the context of climate change. Digital technology assets are also known to provide a unique opportunity to overcome isolation and bridge knowledge gaps creating new opportunities for smallholder farmers and transforming rural communities (Rose, 2016).

Overall, land holding of smallholder farmers in the research area is small (0.8-1.2 hectares), with a small fraction (2.7%) owning land. Other studies such as Martey et al. (2012) have related average landholding for smallholder farmers in Efutu Municipality in southern Ghana as 1.2 ha as well as in Kenya where Margaret et al. (2015) found smallholder farmers

landholding to be 1.8 ha. In contrast, the average landholding of smallholder farmers as established by Chamberlin (2008) is 3.2 with the estimate for Upper West Region being 2.7 ha. Research by Lawson et. al. (2019) in the Upper West Region also emphasized that most of the women farmers could not own land, which affected their willingness to adopt innovative adaptation practices. They acquired land through insecure means. Akologo and Guri (2016) affirmed that in an area where agriculture is the main source of food and income, land ownership is critical to social wellbeing. Land is a very strategic asset to rural women empowerment, a number of studies have recommended land reforms to ensure improved land access (Rao et al., 2017; Ahmed et al., 2016; Nyantakyi-Frimpong and Bezner-Kerr, 2015; Rademacher-schulz et al., 2014; Yaro, 2010;).

Women farmers are often excluded or have their participation restrained in farmer-based organisations (FBOs) where they can easily access productive assets, finance, education and technology. When women farmers establish FBOs or become more active in integrated FBOs, it helps them overcome challenges, increase their economic and social power and improve access to needed services (FAO, 2011). Majority (70%) of rural women farmers in the study area indicated that they belong to FBOs. The remaining 30% either belong to some women groups or religious groups. From the FGDs and KIIs, such groups are formed by MoFA, Department of Women, the District Assembly and other CSOs operating in the research area; to the women farmers, such groups are a great support in terms of information and access to services.

The importance of farmer based organisations was emphasized during the FGDs:

"Apart from the community self-help groups which women in this community are part of, most NGO"s and the Department of Women has also established women groups within this community. We have received training in business and financial management and they have

also provided us with credit to support our farming and other small-scale business activities" (Temi Dekoder-Gegenkpe).

For majority of the women, farming has been a lifetime experience and livelihood, with almost half of the respondents being engaged in farming for between as a lifetime livelihood. Experienced farmers, as a result of their many years of farming have acquired in-depth indigenous knowledge. The long-term experience has given such women farmers better understanding on various weather patterns; for instance, they can predict beginning of the rainy season on an annual basis (Lawson et. al., 2019; Sipho, 2016).

5.2 Knowledge and Perception of Rural Women Farmers on climate variability and environmental changes

One of the many reasons in adjusting to changes happening in the climate system is the ability to understand the particular change taking place. Women farmers' knowledge and perception about climate change/variability have also become very important as adaptation strategies (Maddison, 2007). This is because the way women farmers perceive climate disparities in their surroundings can have an impact on the type of adaptation strategies to employ. Majority (84%) of the women farmers interviewed in the study indicated having some knowledge of climate change/variability and they perceive the variations as real because of the various manifestations they are currently experiencing.

Women farmers understand climate change/variability in the form in which they experience the manifestations of the impact with about two-thirds understanding it as increasing temperature, increasing drought, and reducing rainfall. Several other studies have also reported some of the manifestations of climate variability and change such as: increase temperatures, decrease and more variable rainfall pattern in northern Ghana (Lawson et al., 2019; Ndamani and Watanabe, 2015; Nyantakyi-Frimpong and Bezner-Kerr, 2015; Teye, 2014). Most

respondents mentioned that temperature had increased tremendously and that sun shine was hotter now compared to years back. Previous studies had also reported similar perceptions of respondents (Deressa et al., 2011; Gbetibouo, 2009). Deressa et al. (2011) also affirmed that temperature increase is likely to cause crop failure, hence, leaving farmers in severe indebtedness.

Perception, knowledge, experience of life-threatening climatic events and effects influence women farmers to follow precautions (Thieken et al., 2007; Siegrist and Gutscher, 2008, 2006; Grothmann and Reusswig, 2006;); and whether or not to follow adaptation options (Alessa et al., 2008; Berkes and Jolly, 2001). Moreover, indigenous perceptions on climate change/variability can reflect local concerns to women farmers (Danielsen et al., 2005), whilst the real effects of changing climate will provide an insight on the next steps to be taken (Laidler, 2006). Additionally, women farmers' experiences and opinions on the past climatic happenings can assist women to foresee likely effects in the future (Lorenzoni and Pidgeon, 2006).

In the study area, major sources of information to women farmers in order of importance are: radio, family and friends, government agencies, Television, environmental groups and educational institutions. Most of the women receive information from multiple sources that they trust especially from family and friends. According to a research conducted by Cudjoe et al. (2013), local knowledge that is gained from familiar sources, provides useful information about variations in the seasons and the weather within a locality. Women farmers perceive information on climate variables as vital for rain-fed agriculture as it stimulates investment decision in relation to the amount of input used. The importance of sustained information dissemination and proper perception, therefore, cannot be emphasized (Sipho, 2016).

5.3 Identification of Adaptation Strategies and their Importance to Rural Women Farmers

Climate change research agendas are increasingly moving away from 'proving the existence and measurability of anthropogenic climate change' to finding 'ways of preparing for and responding to climate change in its many variations' (Livingston et al., 2018). Singh et al. (2020) also stated that coordinating, sequencing and prioritizing adaptation and mitigation actions are imperative to minimize climate risk and impacts. Findings from the survey, FGDs and profiling revealed that women farmers in the research area are faced with a variety of hazards in their farming activities ranging from climatic stresses like drought/dry spells, floods, increased temperature to non-climatic stressors including water stress, farm input prices, marketing, high food prices and decreasing soil fertility among others. Drought and dry spells were identified by all respondents as the most recurring hazard in the research area. This was emphasized with an experience by one of the women farmers who lamented during the FGDs that: …….. *„Nowadays the weather is hot and the rains erratic, we find it difficult to predict when rains will start and end and also what time to start cultivating our crops. This has made the land infertile, we therefore need to spend a lot of money in land preparation and application of fertilisers. This situation you called climate change is making farming unattractive and life unbearable"* (Madam Elizabeth Koneware-Susu a 60 year old farmer with over 30 years farming experience). This contradicts the observation from the questionnaire survey where majority of respondents (64%) did not understand erratic rainfall as a manifestation of climate change and variability.

Dumenu and Obeng (2015) indicated that climatic factors including drought and dry spells are noted to pose significant threat to crop yield and food security of farmers in the northern savannah zone. In Tanzania, Westengen and Brysting (2014) confirmed that farm households

ranked drought, conflict/competition over water and the unreliable onset of rain as the three worse stress factors. Contrary to the findings above, Nyantakyi-Frimpong and Bezner-Kerr (2015) identified non-climatic factors including land tenure, lack of credit, poor roads, labor and access to granaries as more pressing challenges to smallholder farmers in the Lawra District. The major approaches of adaptation strategies in farming includes; using new crop varieties, irrigation, drought-resistant crop variations, mixed cropping, mixed farming, livestock agriculture techniques, and changing sowing and harvesting time (Kurukulasuriya and Mendelsohn, 2008; Nhemachena and Hassan, 2007; Bradshaw et. al., 2004).

Fadina and Barjolle (2018) observed crop–livestock diversification, mulching, organic fertiliser, use of improved varieties, chemical fertilisers and pesticides, agroforestry and perennial plantation (oil palm, orchard, tree species) and diversification of income-generating activities as adaptation strategies employed by farmers in Zou Department of South Benin. According to them most of the respondents used these strategies in combination.

Twelve (12) strategies were identified from the survey, FGD's and KIIs as mostly employed by rural women farmers in the study area to address stresses associated with climatic variability and environmental change. These include mixcropping/legume intercropping, anti-erosion measures, composting, water harvesting, conservation agriculture, changing planting date, improved varieties, chemical fertilisers, weedicides and pesticides, off-farm employment, migration and irrigation.

Some studies have given reports on adaptation strategies in farming in Ghana, which includes, crop variety, changing of sowing and harvesting time, hybrid varieties, and soil moisture preservation practices (Lawson et. al., 2019). For instance, revenue changing, construction of drainage systems, and utilization of drought-resistant crop varieties have all been taken into

consideration in Uganda. Additionally, mixed farming, mixed cropping, tree planting, utilization of crop varieties, changing harvesting and sowing time, and improved use of irrigation have been reported in Nigeria and South Africa (Singh et. al., 2020; Evans et al., 2016; Ndamani and Watanabe, 2015) Bruin (2011) also identified adaptation strategies such as switching crops, shifting crop calendar, engaging new management practices for a specific climate regime, changing irrigation system and selecting different cropping technologies.

Respondents who are into mixed farming reported that mixed farming has been the most profitable adaptation strategy. This is because in hard times, livestock was sold out and the income spent on foodstuff to sustain households after they have run out of food from their individual farm and also on production in terms of buying farm inputs. Apata (2011) and Hesselberg and Yaro (2006) reported that for most agriculture dependents in African households, mixed farming signifies prosperity and serves as an essential assurance mechanism because families can trade their animals to purchase grains.

A forty-two-year-old woman farmer with fifteen years farming experience during the FGDs confirmed that *"my farm is small so I keep fowls and small ruminants to support my income from the farm. The number of my fowls and ruminants have increased because the agricultural extension agents provide me with information on how to keep them. I sell some of them and also use some to support household protein needs" (*Madam Kutumi Saaka- Orbile*)*. Farmers' use of improved seeds varieties ranked the highest adaptation strategy employed by rural women farmers to address stresses from the study. It ranked 1st in order of relevance to climate change adaptation. Farmers and other opinion leaders from the FGDs suggested that improved seeds could withstand droughts, high temperatures, and dry spells.

The next 2nd and 3rd adaptation strategies employed by rural women farmers are mix cropping/legume intercropping and changing planting date, respectively. Farmers adopted these approaches with a clear focus that if one crop failed the other crop would survive. Notwithstanding, with changes in rainfall pattern, farmers shift their planting dates in order to reduce loses during germination stage. There is also high adoption of strategies related to sustainable land management practices. This holds a huge potential for climate change mitigation and adaptation. However, Ndamani and Watanabe (2015) have rather suggested that, the use of sustainable land management practices including mulching, mixcropping, and changing planting dates is low among farmers in the Lawra Municipality. The finding is also contrary to the observation by Huyer et al. (2015) that sustainable land management practices require high labour inputs in the first year; this poses a barrier to implementation by women farmers even though its benefits accrue over time. According to the respondents, most of the sustainable land management strategies conform to the traditional farming practices of the Dagaaba people. Besides, the financial cost involve in the use of these strategies is relatively less compared to other strategies. Key informant's interview also indicated that these strategies were vigorously pursued by the district office of the MoFA as well as non-governmental adaptation and decision-makers as part of their strategies to promote climate smart agricultural practices in the study area.

Furthermore, use of chemical fertilisers and anti-erosion measures ranked 4th and 5th in order of relevance to climate change adaptation options used by women farmers in reducing their vulnerability situation. According to the farmers, farmlands in the study area are generally infertile. As a result, farmers resorted to increased use of fertiliser as means of improving soil fertility. Use of inorganic fertiliser was considered expensive, but efficient with a rapid result. Adjei-Nsiah and Kemah (2012) affirmed that farmers adopted scientific methods presented to

them by agricultural extension officers and non-governmental organisations. The scientific measures adopted included the use of fertilisers, switching to short maturing crop varieties and improved crop varieties. Adger et al. (2013) reported that the use of modern agrarian technologies to improve production of crop and livestock is a better practice and a key adaptation strategy to climate change/variability. Modern agricultural technologies are very important because they can improve crop yields and livestock production which would make access to markets easier (Egyir et al., 2015). Soil in the Upper West Region is associated with poor fertility level with low organic matter content, high pH, low percentage total nitrogen, and low available phosphorus and calcium content (MoFA, 2013). The poor soil fertility signifies why the use of fertiliser ranked 4th among the highest used adaptation options. A similar observation is made by Becx et al. (2012), reporting declining soil fertility as one of the major factors that constrain agriculture productivity of smallholder farmers in Northern Ghana, noting continuous cropping, bush burning, poor application of both organic and inorganic fertiliser and poor rainfall as the main reasons for the declining soil fertility. From the FGDs, women farmers stated that climate change has created high demand for farm inputs including fertilisers, improved seeds and tractor services. The high input demand for yield improvement has led to high cost of inputs hence increasing the cost of farming. Findings from a study conducted by Lawson et al. (2019) also revealed the low use of agrochemical inputs and irrigation schemes among socially differentiated groups of women farmers in Nandom and Lawra.

Irrigation was ranked the 12th and the last strategy used by some women farmers in addressing poor rainfall pattern in the area. Most of the communities have boreholes and dugout wells and the Black Volta also flows through some of the communities enabling dry season backyard gardening by women farmers to supplement household income and nutrition. Declining and unpredictable rainfall pattern coupled with emphasis of development projects on irrigation,

have made irrigation more popular among smallholder farmers in semi-arid areas (Nielsen and Reenberg 2010). In the Guinea and Sudan savanna agro-ecological zones of Ghana, 34.6 and 61.5% of farmers engage in irrigation as an adaptation (Dumenu and Obeng, 2015). Inadequate capital to invest in high mechanized irrigation and tedious nature of traditional irrigation methods were considered the major constraints affecting respondents' participation in irrigation. Studies such as Fagariba et al., (2018) have revealed that dugout, dams, and wells constructions near farms or homes for irrigation could help in fresh vegetable production to supplement main farming season yield. However, in the study area, observations indicate that developing irrigation facilities in the communities could contribute tremendously to poverty and hunger alleviation in communities with extreme climatic condition. Nyantakyi-Frimpong et al. (2015) have also indicated that alternative source of livelihoods such as beekeeping, weaving, livestock rearing and dry season gardening reduce over-reliance on the main farming season for food and income in certain farming communities in Ghana.

A study by Fadina and Barjolle (2018) in Benin also ranked 14 adaptation strategies such as increased use of irrigation which was ranked first and thus most important, among farmers' adaptive strategies to climate change. Practicing crop diversification was identified as the second ranked adaption strategy. The third most important adaptation strategy was integrated farming system‖ (being engaged in two or more enterprises which act symbiotically with one-another) this to them is becoming more popular throughout the country because of its economic returns. Crop insurance was ranked as the least important adaptation strategy.

The work by Dillon and Gill (2014) revealed that the introduction of irrigation in Mali allowed men to increase the value of the cereal production and marketed surplus and to partially offset the negative impact of climate shocks. However, women had lower access to irrigation technology and therefore did not benefit from its offsetting effects.

Women farmers also resort to off-farm jobs, like food aid, the sale of livestock, petty trading, labour and remittance as a means of adapting to climate impact. Others also migrate to the south as porters for income and return during the farming season. Migration was ranked 9th in order of importance as an adaptation strategy. From the FGDs, although majority of women prefer to migrate during the off-farming season, they have more domestic responsibilities that keep them home.

5.3.1 Factors Influencing Rural Women Farmers' Adoption of Technologies

Farmers' choices on adoption of given adaptation strategies could have two purposes; either for expected profit or avoiding risk (Gebreeyesus, 2017). All strategies developed by farmers to adapt to climate variability/change are informed by these two purposes. Some women farmers have the ability to change and adapt better than other women depending on a number of factors such as farm management practices, land management practices, farm characteristics, livelihood strategies and women farmers' socio-demographic characteristics (Deressa et al., 2009). According to Yesuf et al. (2008) farmers' adoption of climate change adaptation strategies is influenced by frequent and more accurate climate information from meteorological centres, formal and informal institutions, access to credit and extension information, amount of seasonal rainfall, geographical location, household size, age and literacy of household head. Nhemachena and Hassan (2007) found that markets, access to electricity and technology, land ownership and sex of the household head significantly influence household choice when adapting to climate change while Gbetibouo (2009) cited poverty, lack of secure property rights, lack of savings, farm size, lack of technical skills and off-farm employment as additional barriers to adoption of climate change adaptation strategies. Deressa et al. (2008) urged that livestock ownership, local temperature and amount of precipitation also determine the choice of households when adapting to climate change. Fadina and Barjolle (2018) also identified

farming experience to positively and significantly affect the choice of all strategies except the diversification of income generating activities.

As observed by Deressa et al. (2009), all the factors below (educational status, FBO membership, farm size, increasing temperature, increasing rainfall amount, increasing drought period, decreasing temperature, reducing rainfall amount and reducing drought) had influence on rural women farmers' adoption of climate adaptation technologies in the study area. Educational status strongly influences women farmers' decision to use an adaptation strategy. Literate farmers are able to search for information and make choices based on their preference and level of information gathered. Involvement in FBO is also significant and has strong effect on rural women farmers' choice of adaption strategies. This implies that the probability of adaptive strategy adoption is higher for those farmers who have connections with different farmer-based groups compared to farmers not participating in such coordinated actions and groups. Membership and engagement in FBOs encourage farmers to engage in a united strategies orientation; farmers involved in FBOs share knowledge and innovation ideas, discuss problems and challenges with others, and engage in collaborative decision-making (Uddin et al., 2014). This was reinforced by a quote from a 30 year old participant in the FGDs with ten years farming experience: *"We are able to receive support from the AEA"s when we are in groups. Group meetings also serve as safe space for us to discuss issues bothering us and our families and also to bond with other sisters. Such safe spaces are very important to us, we can't trade for anything"* (Anna Naab- Zagkpee).

According to Deressa et al., (2008), the larger the farm, the more farmers opted for the combination of several strategies such as agroforestry and perennial plantation, crop–livestock diversification, improved varieties and others.

Other studies such as Acquah (2011) in a similar research undertaken in the Sissala West District of Ghana have rather showed that increasing size of a farm decreases the probability of farmers' adoption of adaptive strategies to climate change. Acquah further asserted that, large farmers employed traditional technologies rather than modern technologies to climate change adaptation and also, large farms require greater levels of investment to implement adaptive strategies to climate change. Acquah (2011) further explained that larger farms require inputs such as seeds, fertiliser, pesticides, irrigation facilities, and more at rates which are stressors on farm budgets. For adaptation behaviour it may be that these inputs were not available or are too expensive in the study area at sufficiently large quantities. Another potential explanation, was that all inputs were available but, due to a lack of proper management capacity in relation to farm size, large farms fail to adapt efficiently. Scarcity of labour may also be an additional motive not to engage in adaptive strategy adoption (Armah et. al., 2010).

Large family size also provides more labour, better facilitating the adoption of adaptive measures against climate change effects. This assumption was in line with the results of similar work on climate change adaptation strategies done by Deressa et al. (2008, 2009), as well as the large body of literature on technology adoption such as Mignouna et al. (2011), Tiamiyu et al. (2009) and many others. Other studies, such as that of Quayum and Ali (2012) have shown that family size was negatively and significantly related to adoption of technologies. Factors such as increasing temperature, reducing rainfall amount and reducing drought period, all have influence on rural women farmers' choice of adoption of strategies when adapting to climate variability/change. According to Yesuf et al. (2008) farmers' adoption of climate change adaptation strategies is influenced by frequent and more accurate climate information from meteorological centres, formal and informal institutions.

In the study area, age has no positive effect on the choice of adaptation by rural women farmers, this reinforces findings from other studies such as Fagariba et al. (2018) which have indicated age to be negative and significant (at 10% level). The probability of choosing an adaptation option therefore significantly decreases the older a respondent farmer is. Such farmers have less interest or less incentives in taking climate change adaptation measures. Perhaps older farmers do not see the necessity to adapt to climate change effects. Moreover, these older farmers may be more 'set in their ways', interested in following traditional methods familiar to them rather than adopting modern farming techniques (Fagariba, et al., 2018). Nyantakyi-Frimpong (2017) and Rao et al. (2017) observed age, marital status and migrant status as significant social factors influencing adaptation decisions in the Upper West Region. Such social factors influence the extent of access to and ownership of land, the most important economic and natural resource on which survival of most households depends (Lawson et al., 2019). Fadina and Barjolle (2018) also affirmed the above observation that adoption of adaptation strategies to climate change effects depend on the socioeconomic characteristics of the farmers.

5.4. Effect of Adaptation on the Material Wellbeing of Rural Women Farmers

Farmers' welfare maximization is the ultimate aim of adapting to climate change (Fagariba et al., 2018). The subjective approach to the analysis of wellbeing considers individual experiences and have the capacity to help people understand and communicate interpretations, priorities and needs of the people (Diener & Suh, 1997). The study revealed that the number of years a woman farmer lived in the community and ownership of a television set positively influence rural women farmers' material wellbeing. A study by Lawson et al. (2019) observed that residential status influenced adaptation option. As such farmers who were born and lived most of their lives in the communities are better able to formulate adaptation strategies because

they are much more familiar with climatic conditions in the area as compared to migrants. Conversely, ownership of a cell phone, farming type, use of chemical fertilisers as well as use of weedicides and pesticides negatively influence the rural women farmers' material wellbeing. Women farmers were delighted in having such items but they are not satisfying in terms of wellbeing needs. According to the women, they hold less of such assets and are restricted by overburdening reproductive and care roles within the households in using such assets for information and knowledge building. This was affirmed by Goh (2012) that assets are important for the poor and marginalized because they can help them cope better with shocks and the longer-term impacts of climate extremes.

Women and men change their farming practices in response to climate variability with different impact on wellbeing. Conversely, farming type adopted by women farmers was found to be negatively significant. This is contrary to other findings that women farmers are able to grow mix of crops and rear animals to increase household food security and make some income for themselves. In Tanzania, Nelson and Stathers (2009) observed changes to the mix of crops grown to alter farmers access to and control of the income from crops, as well as their respective workloads. These result in increased marketing of food crops (e.g. sorghum and maize) which are grown by women; increase women's workloads even though they do not benefit from the profits. Additiona.ly, increased sale of groundnuts, Bambara nuts and cowpeas, traditionally sold by women, provided women with more access to and control of income (Nelson and Stathers, 2009). This was confirmed by a 50-year-old woman farmer with 25 years of farming experience in the FGDs: *"I cultivate small area compared to my husband; even if I change the crops farmed, it will not make any impact on my life. My income from the farming will not be significant. When I support my husband too on his farm, I get small money which I just use to support housekeeping, it does not transform my life in any way"* (Mary Mateng-Munyupele).

The adoption and use of chemical fertilisers, weedicides and pesticides, insecticides and irrigation showed a decrease in the level of satisfaction by women farmers in terms of material wellbeing. The problems the farmers face with inputs purchase was seen as one of the major constraints plaguing farmers. Agriculture inputs including fertilisers, insecticides, improved varieties are readily available in the market (Anaglo et al., 2014) but farmers saw the high price of inputs and lack of funds to acquire them as significant problems. According to Becx et al. (2012), the decline of soil fertility is one of the major factors that constrain the agriculture productivity of smallholder farmers in northern Ghana; they noted continuous cropping, bush burning, low application of both organic and inorganic fertiliser and insufficient rainfall as the main reasons for the declining soil fertility. According to the respondents during the FGDs, climate change had created a high demand for farm inputs including fertilisers, improve seeds and tractor services. High input demand for yield improvement has led to the high cost of inputs hence increasing farming expenses. For example, the insufficient use of agrochemical inputs and irrigation schemes among socially differentiated groups of women farmers in Nandom and Lawra (Lawson et al., 2019) could be due to the financial obligation involved in the purchase of such household and economic items used for adaptation to improve wellbeing.

In the study area, variables such as farm size, farming type, ownership of a cell phone, iron-roofed house, membership of FBO had no significant influence on the material wellbeing of all categories of women farmers. Contrary to this, under objective two, FBO membership came out as one of the significant factors influencing rural women's adoption of adaptation strategies, there is the need for further studies into such contradiction. Decisions on what to farm and the acreage to farm in the household is dependent on men since majority of women have no access to and control over land. Thus, due to the tedious nature of manual farming, most men prepare the farmland while the women provide support in sowing, harvesting and marketing of farm

produce (Mubaya et al., 2010). In Lawra and Nandom, women also do not own houses; the majority of the respondents are married and live in homes owned by their spouses. Ownership of a cell phone was not significant to the material wellbeing of women farmers because their most trusted and reliable source of information was from radio, family and friends.

Ownership of a bicycle had no significant influence on the material wellbeing of women farmers. Women usually are given infertile and small lands to cultivate; meanwhile, farm household may have fertile land but which is far away from the house. Ownership of a bicycle by a woman farmer can encourage her to farm at such distant but fertile land since she can ride to the farm. This finding needs further investigation because the majority of women in the study area use bicycles with a few having motorcycles. Some respondents said that the bicycles and motorbikes belong to their spouses as such, they have limited usage. Probably that is the reason the women feel the bicycles and the motorcycles do not contribute to their wellbeing needs, but it facilitates their movement. However, they are not the real owners; as they have no ownership and decision-making rights over such items.

Ownership of iron-roofed house also had no significant influence on the material wellbeing of women farmers. It is a prestige within the community to have a house roofed with iron sheets, it is also known as corrugated metal sheets. Many houses are roofed with thatch and sometimes mud and wooden materials. A farmer who has her house roofed with such a material may likely increase her wellbeing. In the study area, most of the women were married (Table 4.7) and the houses they were living in belonged to their spouses. This was emphasized by Quisumbing (2010) that women usually have fewer assets and rights than men, and are more vulnerable to loss of these assets and rights due to separation, divorce, or widowhood.

5.5 Effect of Adaptation on the Relational Wellbeing of Rural Women Farmers

The age of a woman farmer as a factor that influences adaptation did not affect their relational wellbeing. Older women farmers in Nandom and Lawra were not satisfied with improved adaptation options. This implies that the probability of adaptation significantly decreases the older a respondent farmer is. Such farmers have less interest or fewer incentives in taking climate change adaptation measures (Uddin et al., 2014). Perhaps older farmers do not see the necessity to adapt to climate change effects. Moreover, these older farmers may be more set in their ways‖, interested in following traditional methods familiar to them rather than adopting modern farming techniques to improve their wellbeing (Acquah et al., 2011; Quayum & Ali, 2012).

The size of the household improves the relational wellbeing of rural women farmers; this gives them an opportunity to employ labour intensive adaptation options. Fagariba (2018) established that large households are likely to adapt to climate change better than small household due to the availability of labour for more demanding adaptation strategies than a small home. A related study indicated that large household mostly relies on family labor to adapt to climate change so as to enhance family food security (Tiwari et al., 2014).

Ownership of physical properties by a farm household is an indication of increased wellbeing. Women farmers found the use of gas/kerosene stove satisfying in terms of relational wellbeing. A gas/kerosene stove serves better and quick option for fire source and ownership of it can reduce stress and time wastage associated with continuously depending on firewood and charcoal. Women would therefore be saved from 'time poverty', a concept Bardasi and Wodon (2006) used to describe individuals' lack of time for rest and leisure after considering the time spent working.. It may also likely reduce the number of trees being cut down for firewood and charcoal, and this eventually contributes positively to the environment. It will enable women

time to participate in social activities and networks, this will strengthen social bonding and sharing of ideas. Strong social cohesion and support networks between women farmers, communities and institutions are essential for building their adaptive capacities. A study by Boylan et al. (2018) on adaptive capacity, vulnerability and climate change has shown how a focus on capabilities and social cohesion in adaptation policy can strengthen support networks, adaptive capacity and wellbeing on individual, community and institutional levels. Boylan et al. (2018) also said that residents without such support systems tend to be more vulnerable to climate risks.

Radio is a source of information. Farmers who owned radio are more likely to be more informed in terms of climate change adaptation measures than those without radio. Access to information by women farmers, will enable them to change farming practices or diversify their crops to better withstand drought conditions (Goh, 2012). But owning a radio set did not have any significant influence on the relational wellbeing of women farmers. Contrary to this observation, radio was seen as one of the major sources of information to women farmers in the study area. It was also revealed from the FGD's that such source of information is always and readily available. Rural women are overburdened with heavy reproductive and care roles they, therefore, rely on accessible sources of information within reach. Farnworth et al. (2013) emphasized the need for more equal gender relations within households and communities to ensure agricultural and rural development, including gains in productivity and nutrition.

Access to a cell phone by women farmers was critical but not significant to their relational wellbeing need. Cell phone, use of chemical fertiliser, weedicides, pesticides and others were all found to negatively influence the relational wellbeing of rural women farmers. Findings from the FGDs revealed that cell phones are a good source of communication and information and most environmental CSOs, local government and district level environmental and climate

agencies are providing them to farmers for sustained information access towards improved adaptation.

The size of women farmers' farm has negative influence on their relational wellbeing. A 43-year-old woman farmer with 18 years of farming experience had this to say: *' Once am able to expand my farm, I am able to get more money and food crops to support the home. My husband and my family members are always happy and the relationship with my husband is cordial, no fights and frownings'* (Grace Kaliebu-Danko). Farm size determines the decision to combine multiple strategies to cope with climate change. The marginal effects analysis revealed that farm size did not improve the satisfaction level of respondents. Decisions on issues of what to cultivate and the acreage to cultivate within the household are normally taken by men; also, women mostly cultivate small acreages hence do not derive much welfare benefits from their farming efforts. This is confirmed by Sani and Chalchisa (2016) who also reported that large-scale farmers are more likely to adapt to climate change because they have more capital and resources. Years of farming/years of farming experience had no effect on all categories of women farmers. Women farmers in the study area were found to be delighted in intercropping legumes with other crops because such method serves to organically improve soil fertility and crop yields. The application of weedicides and pesticides had no significant effect on all categories of women farmers. Weedicides and pesticides application increase farming budget and sometimes the application is also tedious for women.

Migration as an adaptation strategy reduces the probability of the delighted women farmers' relational wellbeing. During the off-farming season or when crops fail due to climate variability, men migrate down south, leaving household responsibilities on women. According to some women, their husbands do not even remit the family, leaving all household responsibilities on women. The finding agrees with Slavchevska et al. (2016), who also

observed that the significant male out-migration from rural areas is a factor increasing women's workload.

5.6 Effect of Adaptation on the Life Satisfaction Wellbeing of Rural Women Farmers

The number of years lived in the community by women farmers decreases the probability of the life satisfaction wellbeing of all categories of women farmers. The number of years lived in a community had no significant influence on the life satisfaction wellbeing of rural women farmers. Lawson et al. (2019) however, observed that residential status influenced adaptation options which could in turn increase yield and food security rural households. And that farmers who were born and had lived most of their lives in the communities were much more familiar with the climatic conditions in the area as compared to the migrants, for that reason they can formulate adaptation strategies quickly to improve productivity.

It was also observed by Fadina and Barjolle (2018) that the number of years farmers live in a community enable farmers acquire more competence in weather forecasting as well as their knowledge and experience of environmental conditions in the area. This significantly affect their choice of adaptation strategies. Farmers who have lived long in the study area have some level of extensive networks to major stakeholders which to them is a form of social capital. This contradicts the quantitative observation made during the study because such extensive networks should have given women farmers some sense of belonging and security and also help with access to information for improved adaptation for wellbeing.

Ownership of a radio set and cell phone decrease the wellbeing of rural women farmers. A farmer who owns a cell phone can quickly call for information related to climate change adaptation. But from the above observation, ownership of a cell phone had no significant influence on the relational wellbeing of women farmers. Notwithstanding, district-level

policymakers as well as non-governmental adaptation decision makers and practitioners, in the study area are currently using mobile phones as a key adaptation strategy to disseminate climate and weather information to farmers in the project area. This is a good source of adaptation in terms of information dissemination, especially for women because they can quickly move about with the phones. In view of the fact that they have to spend some money on airtime, they find mobile phones as a drain on their already limited resources hence not satisfying in terms of wellbeing.

The farm size cultivated by women farmers was not significant to their wellbeing. A unit increase in the acreage of farm sizes by women farmers decreases their life satisfaction wellbeing. Access to and ownership of land is a challenge in the study area. This finding conforms with Martey et al. (2012) who observed average landholding for smallholder farmers in Efutu Municipality in southern Ghana as 1.2 hectares as well as in Kenya, where Margaret et al. (2015) found average smallholder farmers landholding to be 1.8 hectares.

The results posited that a unit increase in the number of years a woman farmer has been engaged in farming increases the probability of the life satisfaction wellbeing of women farmers. Experienced farmers as a result of their many years of farming have acquired in-depth indigenous knowledge. Sipho (2016) also affirmed that such experienced farmers have a better understanding of weather pattern such as the beginning of the rainy season on an annual basis.

Adoption of improved varieties of crops and anti-erosion measures had significant influence on life satisfaction wellbeing of women farmers. Women farmers in the study area lamented the long-term negative effects of high input agriculture which could lead to contamination of soils and water, water scarcity and losses in biodiversity. Women farmers therefore see the adoption of sustainable agricultural practices including improved seeds, changes in planting

season, drought-resistant crops, short-duration crops, composting, mulching as a good intervention for adaptation to improve wellbeing (Larson, 2013)

The use of chemical fertilisers, weedicides and pesticides as an adaptation strategy decreased the probability of the life satisfaction wellbeing of all categories of women farmers.

Declining soil fertility coupled with women farmers' inability to afford farm input such as fertilisers, weedicides and pesticides, and tractor services increases their susceptibility to climate change impact (Fagariba et al., 2018). Fertiliser use was one of the essential adaptation strategies employed by rural women farmers in the study area. Even though the use of inorganic fertiliser was seen as expensive, it is efficient with a rapid result. According to Adjei-Nsiah and Kemah (2012), fertiliser, weedicides and pesticides, switching to short maturing crop varieties and improved crop varieties are some of the scientific methods presented to farmers by agricultural extension officers and non-governmental organisations for adaptation to climate change impact.

Notwithstanding the high cost involved in the use of fertiliser, weedicides and pesticides, farmers resort to their usage because soil in the study are is associated with poor fertility level with low organic matter content, high pH, low percentage total nitrogen, and low available phosphorus and calcium content (MoFA, 2013). The poor soil fertility signifies why the use of fertiliser ranked 4th among the highest used adaptation options in the study area but they did not enhance the quality of life of rural women farmers.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

This chapter presents the conclusions from the study. The first section presents the major findings of the study. The second section covers recommendations based on findings. The final section presents the conclusion of the study.

6.1 Summary and Conclusion

Women farmers are faced with climatic stresses such as drought, dry spell, floods, increased temperature and non-climatic stressors such as water loss, high farm input prices, marketing, high food prices, farm theft, decreased soil fertility among others. To moderate the impact of these hazards, over 85% indicated that they employ some adaptation strategies. An adaptation ranking (Kendall's coefficient of concordance) employed by the study revealed strategies of relative importance to rural women farmers. Twelve adaptation strategies were identified from the survey, FGDs and KIIs as mostly employed by rural women farmers in the study area (mixcropping/legume inter cropping, anti-erosion measures, composting, water harvesting, conservation agriculture, changing planting date, improved seed varieties, chemical fertiliser, weedicides, pesticides, off-farming employment, migration and irrigation). In order of relevance to climate change adaptation, improved seed varieties came out as the first and most important to rural women farmers for adaptation. The second is mixcropping/legume intercropping, the third is changing planting dates to counter rainfall pattern. The fourth is the use of chemical fertiliser and the fifth is anti-erosion measures. This trend reveals high adoption

of strategies related to sustainable farming practices. This holds a huge potential for climate change adaptation and Climate Smart Agriculture (CSA) in the study area. It was evident from the FGDs that most of the sustainable land management practices conform to the traditional farming practices of the Dagaaba people and also less expensive to use. The KIIs also indicated that those strategies were vigorously being pursued by the District MoFA as well as Non Governmental Organisations as part of their strategies to promote CSA practices in the study area.

The high use of chemical fertiliser by respondents (4th rank) was attributed to the impoverished nature of the soils in the study area hence the fertiliser is used as a means to improve soil fertility. Respondents however, lamented the long-term effect (soil and water contamination, water scarcity and biodiversity loss, health implications) as well as high cost involved in purchasing fertiliser. Irrigation was ranked last (12th) as the least adopted strategy, and respondent cited inadequate capital and technical know-how to invest in high mechanized irrigation including the tedious nature of traditional irrigation methods as the reason for the low usage of irrigation as an adaptation strategy.

The Probit regression model was used to determine factors that influence rural women adoption of technologies. Findings revealed that factors such as: educational status, FBO membership, farm size, household size had significant influence on the adoption of adaptation strategies. Other climatic factors such as increasing temperature, reducing rainfall amount and reducing drought period also influenced rural women farmers' choice of adaptation options. FBO membership and farm size were significant and influenced rural women farmers' choice of adaptation options. Therefore, it is concluded that these two factors can be identified as influential characteristics of women farmers who adopt adaptation strategies to climate change effects. These results point out the importance of FBOs as a resource for information, finances

and networking to women farmers. Farm size also empowers women farmers to opt for a combination of adaptation strategies. Studies have revealed that larger farms require inputs such as: seeds, fertiliser, pesticides, irrigation facilities and more at rates which are stressors on farm budgets.

For material wellbeing, the findings from the Ordered logit model revealed that key adaptation strategies, economic and household factors such as: ownership of a television set, cell phone, iron roofed house; use of chemical fertiliser, weedicides and pesticides; FBO membership had no significant influence on the material wellbeing of respondents. Strategies and factors such number of years one lived in the community and ownership of a television set positively influence rural women farmers' material wellbeing.

Strategies and factors such as ownership of a radio, cell phone; use of chemical fertiliser, weedicide and pesticides; farm size, years of farming and migration had no influence on the relational wellbeing of rural women farmers. Household size, ownership of gas/kerosene stove, number of years of farming and mixed/legume intercropping as an adaptation strategy had significant influence on the relational wellbeing of rural women farmers. Large households are known to provide labour for adaptation for enhanced welfare benefits. Use of gas/kerosene stove provides quick energy source for household activities thereby reducing the drudgery of long and tedious cooking processes and with positive benefits to the environment and extra time for women farmers to engage in other activities. Factors and strategies such as ownership of a cell phone, radio set, number of years lived in a community, use of fertilisers, weedicides and pesticides had no influence on the life satisfaction wellbeing of rural women farmers. Years of farming/farming experience, years lived in the community, improved crop varieties and anti-erosion measures were found to influence life satisfaction wellbeing of rural women farmers. Experienced farmers are known to have better understanding of weather pattern to improve

farming practices for increased yield. The adaptation ranking also revealed high adoption of adaptation strategies related to sustainable farming practices. This is a good opportunity for climate change adaptation. Most of these strategies and factors are considered highly important by district level policy makers and non-governmental adaptation decision makers for effective resilience building but women farmers were not satisfied with such adaptation options and items in addressing their wellbeing needs as revealed by the analysis.

The study has revealed the need to incorporate considerations of human wellbeing into how adaptation interventions are planned and developed by key district level adaptation intervention developers.

6.2 Recommendation

The study does not intend to promote the exclusion of men, but rather to advocate for interventions that will give women and men equal opportunities and utmost support in implementing effective climate change adaptation for improved agricultural activities to benefit rural households. In view of the findings, the following recommendations are made to ensure that adaptation responses provided to rural women farmers will strengthen their resilience as climate change become more frequent and climate related problems more severe. These are discussed below:

6.2.1 Promotion of sustainable farming practices

There is high adoption of adaptation strategies related to sustainable farming practices (improved seed varieties, mix cropping/legume intercropping, changing planting dates) as revealed by the research; this holds a huge potential for climate change adaptation and Climate Smart Agriculture (CSA) in the study area. In terms of policy implications, the identified adaptation strategies related to sustainable farming practices should be promoted and supported

by district level policy makers and non-governmental adaptation decision makers to further improve adaptive capacity of rural women farmers and communities to climate change impacts.

6.2.2 Strong Farmer Based Organisations

FBO membership, is one of the factors that positively influence adoption of technologies by rural women farmers in the study area. The formation of groups promotes farmer to farmer learning, knowledge transfer as well as strengthens social cohesion. It is recommended that the district level institutions that encourage group formation and empowerment activities (Department of Women, Department of Cooperatives, National Board for Small Scale Industries (NBSSI), Rural Enterprises Project (REP), the Social Welfare Department and other Non Governmental Organisations in the districts), should still strengthen their farmer-based group formation activities; since it is considered a contributor to wellbeing and also enhances the adaptive capacity of women farmers.

6.2.3 Sustained Information

The study also revealed that the major sources of information for rural women farmers are from family and friends as well as radio. Such sources of information should be strengthened to ensure sustained and harmonized information and support from key stakeholders providing adaptation services in the research districts for women farmers enhance agricultural activities, ensure food security and improve wellbeing.

6.2.4 Incorporate wellbeing analysis into adaptation responses

For all the wellbeing domains, key household and economic factors as well as adaptation strategies such as radio, cell phone, bicycle, fertiliser, weedicide, pesticide, irrigation, etc. which are being aggressively promoted by key adaptation stakeholders does not satisfy rural women farmers wellbeing needs. In view of that, adaptation strategies developed for rural

women farmers by CSOs and district level stakeholders should not be a 'one-size-fit-all' approach. They should understand the critical constituents of individual and households' wellbeing needs to inform decision making and development of adaptation responses.

6.2.5 Future research

Lastly, there should be further research using the wellbeing framework to determine the timing and scale of adaptation implementation focused on sustainable farming practices by rural women farmers.

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APPENDICES

Appendix A: Questionnaire on Rural Women Farmers Adaptation for Wellbeing in the Semi-Arid Region of Ghana

Introduction

My name is Rose Afful; I am currently working on a research project about rural women farmers' vulnerability to climate change, their capacity to adapt and how adaptation has enhanced wellbeing. I am a graduate student from the University of Ghana, working towards my PhD in Environmental Science. As part of my studies, I am interviewing women farmers and households in selected communities within Lawra and Nandom Districts. Your organisation has been sampled by the researcher to ensure a representative picture of people's views. Your help and assistance in completing the questionnaire will be invaluable for the study. If you agree to participate, all the information you provide will be completely anonymous and confidential. The questionnaire starts by asking you about a range of climate change and vulnerability issues, as well as issues that may affect rural women farmers wellbeing and moves on to ask how adaptation impacts the wellbeing of such women. If you don't want to answer all of the questions, you don't have to - please just do what you can. The completion should not take more than an hour, and I hope you'll enjoy it.

This survey will provide valuable insight into how adaptation impacts the wellbeing of women farmers and how their resilience could be built upon to enhance overall wellbeing‖.

Important Note

- This questionnaire is completed anonymously.
- Participation is voluntary.

- If there is any question which the respondent feels strongly about not to answer, then he/she is not compelled to do so.
- Information gathered is for research purposes only.

I agree to participate ☐ Yes ☐ No

To be completed by the interviewer

ENUMERATION COMMUNITY:.....……

RESPONDENT CODE:……

DATE……

Section A. About You

"(First and foremost, just so that I can compare the views of different people, please could you tell me about yourself):

1. Are you

☐ Married ☐ Divorce ☐ Widow ☐

Other……

2. Please indicate the age bracket you are in:

☐ 16-24 ☐ 25-34 ☐ 35-44 ☐ 45-54 ☐ 55-64 ☐ 65 -74 ☐ 75-84 ☐ 85 or over ☐ Prefer not to say

3. What is your highest qualification?‖

[1] —No formal education [2] primary [3] JHS/Middle [4] SHS/'O'level/'A'level [5

] Tertiary [6] Vocational [7] Others

4. Ethnic Background

[1] Hausa [2] Mossi [3] Sisala [4] Akan [5] Mixed [6] Dagaare

[7] Other……..

5.Who is the head of the household?.....

5a. What is the size of the Household (this include those away)? ……

5b. What is the composition of your household members (please complete the table below)‖

Age Range	**Gender**	
	Female	**Male**
Children (0-17 years)		
Adults (18-55)		
Aged (56 above)		

—5c. Who makes decisions at the household level?.....

6. How many years have you lived in this community? [1] less than one year [2] 1-5 years [3] 6-10 years

[4] 11-20 years [5] 20-39 years [6] over 40 years [7] born there

6a. Has any of your family members migrated into this community within the last six months?

☐ Yes ☐ No

6b. What was the reason for migrating into the community?.....

6c. If you or any member of your household have migrated from this village in the last ten years, complete the table below for the migrant‖.

Name of migrant (indicate as many as applicable)	Type of migrant (use codes1.Permanent 2 Seasonal; 3. Returned	Age	Gender (1. Male; 2 Female)	Destination (1. urban area within U/W/R; 2 Rural area within U/W/R 3. Kumasi/Accra 3.Rural area outside U/W/R 4. Outside Ghana (specify)	Reasons for Migration (multiple allowed) 1. Education 2. Marriage 3. Declining/unreliable rainfall 4. Rising Temperatures 5. Shortage of farming land 6. Floods 7. Lack of jobs here 8. Other (specify)	Has migrant ever remitted money/Food home? 1. Yes 2. No

7. What is your main source of income? .....

7a. Are you able to meet your needs with your primary source of income? ☐ Yes No

7b. If no, how do you supplement? (Other sources of income)

……

7c. Major items owned (Tick as many as applicable):

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

—8. Do you belong to any organisation in the community? ☐ Yes ☐ No

8b. If yes which, of the organisations do you belong? [1] government [2] religious institution [3] youth [4] women [5] community/self-help [6] union [7] NGO/development [8] education [9] business [10] Other

8c. Do you hold any leadership position? ☐ Yes ☐ No

8d. Do you take part in decision making in the community? ☐ Yes ☐ No

Section B: Identification and Ranking of Climate Change Adaptation Responses by Rural Women Farmers

When we say 'adapt to climate change' we mean those things in our lives, we change to respond to the impacts of climate change.

9. Before this interview, had you heard of climate change? [1] yes [2] no [3] I don't know

10. If yes, where have you heard about climate change? Tick as many as you feel apply:

☐ Television ☐ Public libraries

☐ Radio ☐ Friends/ family ☐ Newspaper ☐ Local council

☐ Internet ☐ Energy suppliers

☐ Specialist publications/academic journals ☐ Other_____

☐ Environmental groups (e.g. Worldwide Fund for Nature)

☐ School/ college/ university

☐ Government agencies/ information

11. If yes what do you understand it is? .....

12. Which kind of change do you think is happening? (Choose from the list below)

☐ Increasing temperature ☐ Decreasing temperature

☐ Increasing rainfall amount ☐ Reducing rainfall amount ☐ More erratic rainfall

☐ Increasing drought period ☐ Reducing drought period ☐ Increasing flood incidences

☐ Decreasing flood incidences ☐ Others

13. By ticking one box on each row, please indicate how much you would trust information about climate change if you heard it from.

	A lot	A little	Not very much	Not at all	Can't Choose
A family member or a Friend	☐	☐	☐	☐	☐
Extension officer	☐		☐	☐	
	☐		☐	☐	
The Local Government	☐		☐	☐	☐
	☐				
An environmental organisation	☐		☐	☐	☐
	☐				
The media (television, radio, newspaper)	☐		☐	☐	☐

14. What kind of information would you need more of?.....

—15. Would you say you understood what climate change means?

1] yes [2] to some extent [3] not really [4] no [5] I don't know

16. Do you agree there has been changes in rainfall patterns and temperature over the years?

[1] yes [2] no [3] I don't know

17a. What kind of changes do you think will happen in the next 10 or 20 years?

……

19. How significant are the changes in rainfall, temperature etc. to you personally?

☐ Very important (go to question 17)

☐ Quite important (go to question 17)

☐ Not very important (go to question 18)

☐ Not at all important (go to question 18)

20. Why is it important to you? ……

21. What do you think causes these changes? …….

22. What impacts, if any, do you think changes in temperature and rainfall patterns may have? …….

23. Which of the following manifestations of climate change is affecting you or going to affect you personally?

☐ Increasing temperature ☐ Decreasing temperature

☐ Increasing rainfall amount ☐ Reducing rainfall amount ☐ More erratic rainfall

☐ Increasing drought period ☐ Reducing drought period ☐ Increasing flood incidences ☐ Decreasing flood incidences

24. What do you think can be done to tackle changes in temperature and rainfall patterns?

……..

25. How can it be done?.....

26. What do you do to minimize or respond to the changes in temperature, rainfall, drought, floods, etc. to prevent its adverse effects? ……

—27. Which of the following adaptation strategies did you adopt to cope with the identified climate related hazards? For each of the adaptation strategies adopted, rank in order: the strategies that are highly adopted and important in this community. Highly adopted and important=1 and Least adopted and important =12

Adaptation Strategy	**Type of Hazard Addressed**	**Rank (from 1 to 12)**
Mix cropping/legume Intercropping		
Anti-Erosion Measures		
Composting		
Water Harvesting		
Conservation Agriculture		
Changing Planting Date		
Improved Varieties		

Chemical Fertilisers		
Weedicides and Pesticides		
Off-Farm Employment		
Migration		
Irrigation		
Others (indicate)		

"Section C: Factors Determining Rural Women Farmers' Adoption of Technologies to Adapt to Climate Change".

(Existing Resources and Material Structures for Managing Uncertainty and Supporting Successful Adaptation)

28. Do you farm in this community? ☐ Yes ☐ No

29. I f yes how did you acquire the land?

☐ Lease ☐ Family Land (who does it belong to) …….

☐ Rented ☐ Inherited ☐ Purchased

☐ Other specify……

30. What is the acreage? (Size of land)

31. What type of farming are you engage in? [1] Crop farming [2] Animal husbandry [3] Mix farming [4] Other

32. Which crop and or livestock do you grow or rear? (tick from table below)

No.	**Type of Crop**	**Tick**	**Type of Livestock**	Tick
1			Cattle	
2	Rice		Chicken	
3	Yam		Duck	
4	Millet		Goat	
5	Sorghum		Guinea fowl	
6	Groundnuts		Pig	
7	Soya bean		Rabbit	

8	Cowpea		Sheep	
9	Vegetables		Turkey	
10 (others)				

33. How many years have you been farming?.....

35. What farming practices do you adopt on your farm? .....

36. Has your farming practices changed over the past 10 years?

36a. If yes why?.....

—37. Have you changed your livelihood due to changes in temperature, rainfall patterns, droughts etc.?

☐ Yes ☐ No

37a. If yes, how did you take that decision?.....

38. Did you take that decision alone? ☐ Yes ☐ No

38a. Do you get any support in taking such decisions ☐ Yes ☐ No

39. Do you receive support from any organisation for your farm activities?

39a. If yes what kind of support? ☐ Financial ☐ Information ☐ Technical ☐

Others……..

40. What are the most important relationships or interactions with other people that affect your life here as a member of this community?

Scale	1	2	3
Type of Relationship	Not so Important	Important	Very Important
Household			
Peers			

Farming community			
Wider community			
Organisations and Institutions			
Others……			

41. Explain why they are important ……

42. Out of the important relationships selected, which of them influence your farming decisions and adaptation options?.....

Section D. Influence of Adaptation on the Wellbeing (Material, Relational and Subjective) of Rural Women Farmers

—43. What aspects of life are required/important for you to live well in this community?

Scale	1	2	3	4
Classification/Wellbeing indicators	Don‘t know	Not so Important	Important	Most Important
Shelter				
Health				
Relationships				
—Good Relationships‖				
—Safety‖				
—Secure/suitable work‖				
—Financial security‖				
—Culture‖				
Skills and education				
Community Spirit				
Tolerance				
Good local services				
Feeling good				
Others				

44. Is this different between men and women? ☐Yes ☐No

45. If Yes which aspects?.....

46. How will you describe, a person (male, female or both) that is not doing well?

.....

.....

47. As a female farmer, what else is needed to live in this community and why?

.....

—48. From the list below select up to seven wellbeing areas that you consider important to your life and explain their importance (indicate your level of satisfaction using the scale below)‖.

Scale	1	2	3	4
—Classification/Wellbeing indicators	—Very Dissatisfied	Somewhat dissatisfied	Satisfied	Very satisfied‖
Housing				
Health				
Relationships				
Good Relationships				
Safety				
Secure/suitable work				
Financial security				
Culture				
Skills and education				
Community Spirit				
Tolerance				
Good local services				
Feeling good‖				

49. Which of the wellbeing indicators do you think the above mentioned manifestations of climatic change will impact

☐ Health ☐ Access to water ☐ Access to food ☐ Education ☐ Shelter ☐ Others

50. In what ways will the changes affect the option selected?

……

……

—51. What are the key climatic events that have occurred over the last 10 years that have affected your ability to meet these wellbeing needs (these can be positive or negative) ☐

Increasing‖ temperature ☐ Decreasing temperature

☐ Increasing rainfall amount ☐ Reducing rainfall amount ☐ More erratic rainfall

☐ Increasing drought period ☐ Reducing drought period ☐ Increasing flood incidences

☐ Decreasing flood incidences ☐ Others

52. Reflecting on these important changes/events (above) in the community, have people (men and women) been affected differently? ☐ Yes ☐ No

52a.If yes how?.....

53. Is life for male and female farmers getting better or worse? ☐ Better ☐ Worse

53a. Why?.....

—54. Which of the following adaptation strategies did you adopt to cope with the identified climate related hazards? For each strategy adopted, state whether it was able to improve any of the wellbeing criteria identified for‖ household members (HH) or not‖.

Adaptation Strategy	**Type of Hazard Addressed**	**Did strategy impact any wellbeing indicators for all HH members throughout the last year?** **1. Yes 2. No**	**If yes, which of the wellbeing indicators and how?**

Mix cropping/legume Intercropping			
Anti-Erosion Measures			
Composting			
Water Harvesting			
Conservation Agriculture			
Changing Planting Date			
Improved Varieties			
Chemical Fertilisers			
Weedicides and Pesticides			

Off-Farm Employment			
Migration			
Irrigation			
Other (indicate)			

—

Focus Group Discussion Guide

A. Background

Date:	Number of Participants:
Community:	Number of HH:
Population:	Duration:
Number of compounds:	

B. Introduction of participants/Personal Data on FGD Participants

No.	Initials	Name	Gender	Age	Main crops grown	Farm size (acres)	Highest education level

Discussions

Vulnerability Context	
1) —What are your current perceptions and understanding of what climate change actually is and the impact you believe it may have (i.e., how climate change is defined in the minds of the respondents)? 2. What extent do you believe changes in temperature, rainfall patterns, incidence of floods and droughts etc. will affect you personally and the community? 3. Where do you receive information about changes in the weather pattern? 4. Which source would have been more trusted and clearer?‖	

Adaptation Response and Wellbeing	
5. —What changes in behaviour are you taking to reduce your level of risk of changes in temperature, rainfall patterns, incidence of drought and floods and why are you taking these steps and not taking others, that is if you are taking any at all? 6. What extent do you perceive that, the recent changes in temperature and, rainfall patterns are affecting your community and which groups may	
be more vulnerable to the effects a. What wellbeing indicators are impacted by the risks identified? b. To what extent do they impact such wellbeing indicators? (Shelter, Education, Food security, Access to water, Health, Access to credit etc.).	
Climate resilience and enhanced wellbeing Strategies	

a. —What adaptation strategies do you think are beneficial and will improve the wellbeing of women farmers? 6. How do you perceive individual and community‘s role in facilitating climate change adaptation? 7. What is the nature of household decision making or taking? 8. How does it affect adaptation and wellbeing of women farmers within the community?‖	

Experts/Key Informants' Interview Guide

Date:	District:
Community:	Moderator:
Note Taker:	Name of Respondent:
Sex:	Social Group:

Questions

1. —Indicate the kinds of challenges farmers experience in this area.
2. Explain how different these challenges vary between male and female farmers
3. What interventions or services do you give to farmers in the face of climate change and variability challenges (Changes in temperature, rainfall patterns, incidence of flood and drought etc.)? (Mention and explain)
4. What specific/special interventions or services do you give to different groups (male and females)? (Groups vary in their needs, priorities and resources available).
5. Explain how the interventions/adaptation strategies are adopted by men and women.
6. Explain how these interventions or adaptive strategies have influenced the vulnerability or wellbeing of women farmers.
7. Explain how women participate in the development of your interventions and adaptation programs.
8. What factors (cultural, socioeconomic or political) influence the adoption of technologies you provide to women farmers?
9. Which of these practices do believe can build to enhance wellbeing within the community/district and why?‖

Appendix B: Pictures of Data Collection Process