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**UNIVERSITY OF GHANA
COLLEGE OF HUMANITIES**

**PERCEPTION OF CLIMATE CHANGE AND ADAPTATION STRATEGIES
UNDERTAKEN BY SMALLHOLDER FARMERS IN RURAL GHANA**

BY

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INTEGRI PROCEDAMUS

JULY, 2018

DECLARATION

I, MARGARET MAX ENTSIWAH, declare that with the exception of other works which have been duly cited, this dissertation is entirely my own original work, and has not been submitted elsewhere for another degree. None of the work has been reproduced for the award of an academic certificate. I am therefore solely responsible for any shortcomings that may be found in this research work.

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DEDICATION

This thesis is dedicated to the Lord Almighty and to my dear parents, siblings, nephews and nieces (Richard, Angel, Richlove and Raphael)

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ABSTRACT

This thesis explores the perception and adaptation strategies undertaken among smallholder farmers in agro-ecological zones in rural Ghana. It applies a quantitative analysis of data on 529 farmers in four agro-ecological zones to assess difference in perception of climate change and the influence on their adaptation strategies. Data for the study was obtained from the 2016 Climate Change, Women in Agriculture and Food Security survey collected by Regional Institute for Population Studies. The main objective of the study was to examine the relationship between farmers' perception of climate change and the adaptation strategies undertaken in the four agro-ecological zones in Ghana. Descriptive statistics were employed to assess the characteristics of respondents. Microsoft Excel and Statistical Package for Social Science (SPSS) version 23.0 were used for the analysis of the data. At the bivariate level, gender, marital status, level of education, household size, agro-ecological zones and wealth categories had a significant association with adaptation ($p < 0.05$). A multinomial logistic regression model was employed to assess how perception and socio-demographic and economic characteristics of farmers influence the adaptation strategies undertaken. The model revealed that perception of climate change, wealth categories and agro-ecological zones were significantly associated with adaptation strategies. Finally, the study recommends that dissemination of information through education, financial support to farmers and construction of dams and irrigation systems should be employed.

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LIST OF ABBREVIATIONS

EPA – Environmental Protection Agency

FAO – Food and Agriculture Organisation

GDP – Gross Domestic Product

GHG – Greenhouse Gas

IPCC – Intergovernmental Panel on Climate Change

ITCZ – Inter Tropical Convergence Zone

IUCN – International Union for Conservation of Nature

MoFA – Ministry of Food and Agriculture

NGO – Non-Governmental Organisation

ORID – Office for Research, Innovation and Development

UNFCCC – United Nations Framework Convention on Climate Change

WMO – World Meteorological Organisation

CHAPTER ONE

INTRODUCTION TO THE STUDY

1.1. Background to the study

Climate change is defined by the United Nations Framework Convention on Climate Change (UNFCCC) as “the change of climate, attributed directly or indirectly to anthropogenic activities that affect the composition of the global atmosphere and natural climate variability observed over similar periods of time” (UNFCCC, C.C., 2007; IPCC, 2007). Globally, climate change threatens livelihoods, ecosystems, and agricultural production. Developing countries are especially more vulnerable (Jin *et al.*, 2015; Mertz *et al.*, 2009). Its effects are associated with high temperatures, floods, drought, rise in sea level, etc. (Andersen *et al.*, 2017).

The Intergovernmental Panel on Climate Change (IPCC) report that changes in climatic conditions are predicted to cause more extreme precipitation patterns associated with more floods and drought (IPCC, 2013). For instance, there is an estimation that about 250 million of Africa’s population could be exposed to water stress by 2020 as a result of the changes in climate (Elum *et al.*, 2017; IPCC, 2013).

Currently, the United Nations adopted Sustainable Development Goal (SDG) 2, aims at ensuring zero hunger. Target 2.3 of Goal 2 of the SDG’s is “ensuring sustainable food production systems and implementing resilient agricultural practices that will increase productivity and production” (UN, 2015). To help sustain the ecosystem and build up the capacity for adaptation to climate change by 2030, Goal 13 of the SDGs also brings climate action to the fore and further emphasizes “the need to strengthen resilience and adaptive capacity to climate-related hazards and natural disaster in all countries by 2030” (UN, 2015).

Though climate change is globally problematic, the need for adaptation in developing countries is very high. Thus the level of vulnerability in these countries are very high (Adger *et al.*, 2003; Elum *et al.*, 2017). Adaptation is defined as “the process of adjustment to actual or expected climate and its effects” (IPCC, 2013 p.5). Adaptation to climate change can be classified based on its flexibility, reversibility and robustness (Refsgaard *et al.*, 2012; Smit *et al.*, 2000). Adaptation can also be categorized by intent, timing of action and their temporal and spatial scope (Refsgaard *et al.*, 2012). Regarding intent, adaptation could be autonomous or planned which is in relation to climatic stimulus. It could also be reactive or anticipatory based on timing. This could be a result of observed prior modification (Refsgaard *et al.*, 2012; Schneider *et al.*, 2000; Smit *et al.*, 2000).

Adaptation strategies used in the agriculture sector include planting drought tolerant crops, irrigation, extensification and intensification of agriculture, crop diversification and early warning systems. Other strategies include migration, livelihood diversification such as selling livestock and other non-farm assets, use of ecological indigenous knowledge, crop insurance and receiving assistance from the government (Bryan *et al.*, 2013; Goldman & Riosemena, 2013; Jin *et al.*, 2015; Van Aelst & Holvoet, 2016).

According to Maddison (2006) adapting to changes in climate is a two-step process, which include perception of climate change and response to the changes through adaptation.

The perceptions individuals have regarding change in climatic elements, may go a long way to influence their decision to use an adaptation strategy in the first place, and subsequently, their decision whether to use a single or multiple adaptation strategies (Bryant *et al.*, 2000; Codjoe *et al.*, 2014; Elum *et al.*, 2017; Mertz *et al.*, 2009). In other words, if an individual perceives

that climatic elements have remained the same, then he or she may maintain the status quo and do nothing, i.e. undertake no adaptation strategy. On the other hand, if an individual perceives that there is a change in climatic elements, he or she may decide to undertake an adaptation strategy (Bryant *et al.*, 2000). Furthermore, depending on the magnitude of the changes based on the individual's perception, multiple adaptation strategies may even be used (Elum *et al.*, 2017). Studies have shown that farmers' perception of climatic elements vary and so are adaptation strategies being used to minimize the negative implications of the changing climate (Mertz *et al.*, 2009). Furthermore, adaptation measures taken (Maddison, 2006) due to perception or awareness of change in climate (Akter & Bennett, 2009; Deressa *et al.*, 2011; Semenza *et al.*, 2008) are influenced by different environmental and socio-demographic characteristics. This study sets out to ascertain whether perception of changes in climatic elements influence the adaptation strategies undertaken by farming households in selected communities from the four agro-ecological zones in Ghana.

1.2. Statement of Problem

Climate change has serious implications for our daily lives through its impact on health, ecosystem services, food production, critical infrastructure and disruption of livelihoods (IPCC, 2007). Lack of adequate reliable data on the effects of climate change with respect to agricultural production is a vital issue especially in developing African countries with Ghana as no exception. This has been a hindrance to long term sustainable agriculture (Kotei *et al.*, 2007 cited in Kemausuor *et al.*, 2011) within the sub-region. The adverse effect of climate change on agriculture has resulted in damage of crops due to droughts and floods, resulting in food insecurity. This has affected the well-being of the population due to shortage of food

(Desersa *et al.*, 2011). Also, climate change has impacted population processes such as rural-urban migration resulting from crop failure in rural areas (Meze-Hausken, 2000). At the national level, welfare is found to be reduced by climate change impacts through the disruption of agricultural activities resulting in poor standards of living, especially in farming communities (Arndt *et al.*, 2015).

In Ghana, climate change has had dire impacts on social, environmental and economic state of the country, especially in agricultural production (Fosu-Mensah *et al.*, 2012). Agricultural production in Ghana is largely rain-fed and therefore sensitive to changes in patterns of rainfall. Given that agriculture is a major contributor to the economy of Ghana, climate change as well as its associate variations in rainfall pose a developmental challenge (Codjoe *et al.*, 2012; Teye & Owusu, 2015). In Ghana, small-scale subsistence farming constitutes about 80 percent of total agricultural production (MOFA, 2011). Agriculture in developing countries, is a source of livelihood for several people, particularly the rural underprivileged dwellers (Bryan *et al.*, 2009). As such, climate change perceptions and existing adaptation strategies could have implication for food security and malnutrition.

Globally, studies have been done on perception of climate change and adaptation strategies both in developing (Desersa *et al.*, 2011, Elum *et al.*, 2017; Fosu-Mensah *et al.*, 2012; Gbetibouo, 2009; Mertz *et al.*, 2009) and developed countries (Akter & Bennett, 2009; Leiserowitz, 2006; Semenza *et al.*, 2008).

Numerous studies have been done on perception of climate change and adaptation strategies at the farm level (Kemausuor *et al.*, 2011; Mertz *et al.*, 2009; Ziervogel *et al.*, 2006), however, few studies have been done that the household level to examine the factors that influence the

type of adaptation strategies undertaken by smallholder farmers to respond to their perceived climatic climate. In addition, the socio-demographic and economic characteristic differences regarding the number of adaptation strategies undertaken at the household level is not much explored.

This study aimed at identifying how smallholder farmers perceived changes in climate, the types of adaptation strategies and the multiplicity of strategies undertaken in the four agro-ecological zones in rural Ghana. The study also looked at how socio-economic as well as the demographic characteristics of smallholder farmers' influence their adaptation strategies choices at the household level.

1.3. Research Question

The study sought to answer the following research questions.

1. How do smallholder farmers perceive climate change?
2. What adaptation strategies are undertaken by these farmers?
3. What socio-demographic and economic characteristics influence the choice of adaptation strategies?
4. Do perception of climate change influence the choice of smallholder farmers' adaptation strategies used?

1.4. Research Objectives

The main objective of the study is to explore the association between how smallholder farmers perceive climate change and adaptation strategies undertaken in the four agro-ecological zone in Ghana

Specific objectives

Specifically, the study aims:

1. To examine how smallholder farmers perceive climate change.
2. To identify the adaptation strategies undertaken by smallholder farmers.
3. To identify how socio-demographic and economic characteristics influence the choice of adaptation strategies.
4. To examine how perception of climate change influence the choice of adaptation strategies undertaken by smallholder farmers.

1.5 Rationale of the Study

Climate change adaptation is one major problem within developmental polices which lacks empirical evidence in decision making and planning in the agricultural sector. In sub-Saharan Africa much is not known about smallholder farmers' experience of the negative implications of climatic hazards and how they go a long way to face the impact. There is the need to manage the impacts of the changes in climate especially in developing nations like Ghana.

First of all, this research will complement existing literature on the subject matter by providing an assessment of how smallholder farmers perceive climate change and the adaptation strategies undertaken in the four agro-ecological zones in rural Ghana.

Again, it will assess how socio-demographic as well as economic characteristics of smallholder farmers influence their choice of adaptation strategies at the household level. This is because knowing how these characteristics influence adaptation will contribute in policy making on climate change and adaptation.

The study will also be relevant to the government, as well as key stakeholders to understand the perception of climate change and adaptation strategies undertaken by smallholder farmers at the household level.

1.6 Organisation of the Study

This study is organized in seven chapters as follows. Chapter One discusses the introduction which consists of the study background, statement of the problem, research questions, objectives and the rationale of the study. Chapter Two reviews literature on climate change, perception of climate change, adaptation. The chapter also presents the theoretical and conceptual frameworks and hypotheses of the study. Chapter Three employs the methodology used in the study. It consists of the profile of the study areas, source of data, sampling techniques employed in the study, sample size and data analysis. Chapter Four examines the background characteristics of respondents in terms of perception of climate change, adaptation, age, gender, marital status, level of education, wealth categories, household size and agro-ecological zones. Chapter Five presents results of bivariate analysis of the perception of climate change, the socio-demographic characteristics and adaptation strategies undertaken by respondents. Chapter Six focuses on the discussions and interpretation of results from the multivariate analyses of the perception of climate change and socio-demographic and economic characteristics of respondent's associated with the adaptation strategies used. Finally, Chapter Seven presents the summary, conclusions on the major findings and recommendations for policy intervention.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter explore the knowledge on climate change, perception of climate change and the adaptation strategies undertaken among smallholder farmers. The chapter also discusses key concepts, reviews works of related literature published in books, journals and on the internet websites. Again it discusses the theoretical and conceptual frameworks underpinning the study.

2.2 Climate and climate change in Ghana

Climate refers to the average weather condition of a place observed over a long period: whilst weather is the day to day or climate-related events that occurs at the same location (WMO, 1992). Climate as weather average over a period of time includes humidity, temperature, rainfall and numerous meteorological factors.

Climate in Ghana is influenced by the Inter Tropical Convergence Zone (ITCZ), the interaction between warm, dry air from the Sahara desert and cooler moist air from the South Atlantic Ocean characterized by an increase convective activity resulting in high levels of precipitation (Diaw & Schmidt-Kallert, 1990). According to the Ghana Agricultural News Digest (2012), natural resources like vegetation, water bodies, forests and land, as well as human capital of Ghana are adversely affected by climatic variability. There has been noticeable adverse effects of climate change experienced in Ghana including a steady rise in temperature, sea level and rainfall variability over the past decades, resulting in an increase in frequent drought and flooding in Ghana (EPA, 2000).

Furthermore, the reduction in trend in mean annual rainfall throughout the country has resulted in the country experiencing changes in climatic events with shorter durations for major as well as minor rainy seasons leading to decreasing length of growing season resulting in low crop yield. Consequently, farmers in the transition and coastal savannah agro-ecological zones are not able to farm more than once in a year (Owusu & Waylen, 2012). Therefore, climate change have significant effect on resource which depend on climatic elements such as the agriculture; specifically, food production and fisheries sectors and eventually on food security (Ghana Agricultural News Digest, 2012).

2.3 Causes of climate change

The industrial and agricultural sectors are the main causes of climate change worldwide. According to Olivier *et al.*, (2015) industrial countries in the world are the major contributors to climate change with about two thirds of emission of greenhouse gases (GHG) both past and present. Again, the emission of greenhouse gases from farming activities also contribute to climate change (Deressa *et al.*, 2010; Kemausuor *et al.*, 2011). Activities such as raising of farm animals and use of chemical fertilizers are the major contributors of methane, a type of greenhouse gas (Lappé, 2011). In short industrial and agricultural activities have resulted in the increase in temperatures globally and will continue to increase (Blunden & Arndit, 2016). The Intergovernmental Panel on Climate Change (IPCC) expect that ongoing emissions of greenhouse gas at or above present rates will further warm the earth. This will further bring about many variations in the 21st century global climate system. These are likely to be greater than the climatic events experienced in the past century (Meehl *et al.*, 2007).

2.4 Overview on impact of Climate Change

Climate change impact has a potential dire effects on the environment, humans and economy. The Intergovernmental Panel on Climate Change (IPCC) define climate change as “any change in climate over time whether due to natural variability or as a result of human activity” (IPCC 2007).

Climate change is a great worldwide peril causing harm each year through floods, drought, and severe heat waves destroying lives and properties (IPCC, 2007). It is also a threat to the economy in all countries (Boyd, 2014). Groups such as the young, elderly and poor are susceptible to climate change problems (IPCC, 2007).

According to Morton, (2007) the impact of climate change is not equally distributed, even though it is experienced across countries globally. He further opines that, poor countries are more vulnerable to it than rich countries Developing countries, however are more susceptible to climate change compared to developed countries. This is because of developing countries’ sole dependence on rainfall for agriculture and lack of funds for adaptation measures due to economic hardship and instability (IPCC, 2007). This makes other issues such as poverty and economic instability not related to climate change a priority. Climate change affects the environment in many ways which including the reduction in the quality of water, depletion of underground water source and destroying the habitat of aquatic animals and plants (Udmale *et al.*, 2014). This occurs when there is a decrease in oxygen which promote the growth of algae bloom and bacteria and fungus in water bodies (Elshehy, 2013).

Moreover, changes in climate is not only affecting the environment, but also, having a serious impact on human health and livelihood. Health related problems caused includes diarrhea,

respiratory diseases and even death from flooding and droughts (IPCC, 2007).according to Lee, (2009) Climate change as a big challenge, neither has a single answer nor solution.

The impact of climate change in the southern and northern parts of Ghana, show different manifestations. These include high temperatures, drought in the dry seasons, extensive flooding in the rainy season and a widespread of pests and diseases (Codjoe *et al.*, 2012; Yaro, 2013). These impacts have resulted in the loss of properties and lives of citizens' worth several millions of Ghana cedis. Drought is a major climate change impact in the northern part of Ghana, which has led to a vast loss of farm produce resulting in famine (Yaro, 2013). The southern parts, especially in the flat plains like Accra, experience flooding every year due to climatic changes during the rainy seasons (Codjoe & Afuduo, 2015; Twumasi & Asomani-Boateng, 2002). These impacts affect residents in these areas rendering them homeless during the period.

2.5 Impact of Climate Change on Agriculture

“Climate change affects agriculture and agriculture also affects climate change” (Deressa *et al.*, 2011). In Africa, climate change is said to have a high negative effects on agriculture (Yaro, 2013). The impact of climate change on agriculture includes decrease in rainfall, increase in rainfall variability and high temperatures, resulting in droughts and floods (IPCC, 2007: Deressa *et al.*, 2011). Climate change affect the output of crop yield leading to the risk of food security especially in developing nations (Deressa *et al.*, 2011; Edwards-Jones *et al.*, 2009).

Agriculture as a major contribution sector to Ghana's economy, has 55% of the country's population in farming. (MOFA, 2011). The agriculture sector accounts for about 35% of the

Gross Domestic Product (GDP) and generates about 30%-40% of the country's foreign exchange (MOFA, 2011). Climate change has a serious implications on agriculture in Ghana, since the sector is solely dependent on rainfall with little irrigation possibilities (Fosu-Mensah *et al.*, 2010; Yaro, 2013). Vulnerability to changes in climate is very high in Ghana, especially in the northern part of the nation, where there are perennial droughts and flooding (Yaro, 2013). This has eroded the livelihood of many households into poverty.

2.6 Perception of Climate Change

Solvic (1992) opines that perception is “various kinds of attitude and judgments” Peoples’ perception of climate change issues and causes may differ, especially due to how vulnerable they are (Kemausuor *et al.*, 2011). An individual’s perception is normally based on the experience of a climate change impact (Elum *et al.*, 2017). According to Stedman (2004) as cited in Falaki *et al.*, 2013, perception determines the social mental image of climate change, but other variables such as the socio-demographic and economic characteristics or ideological orientations of an individual influence their perception and mental image of climate change. Radaen-Fessenden & Heath (1987) also cited by Falaki *et al.*, 2013, opined that peoples’ perceptions are based on their personal experience, knowledge and character. A study done by Leiserowitz (2006) on perceptions of climate change found that majority of people misunderstand the science of changes in climate and are normally confused about the causes and impact of climate change. Perception of the effects of climate change is a vital factor that leads to the usage of adaptation strategies (Jin *et al.*, 2015). Again, farmers’ ability to perceive changes in climate is an important precondition for his/her choice to adapt to the phenomenon (Gbetibouo, 2008). For example, a study by Jin *et al.*, (2015), in Yongqiao District in China,

found that farmers notice severity of extreme weather conditions, particularly drought and this influence their choice of adaptation as they were undertaking adaptation strategies to decrease the negative impact of droughts in the area. Again, what people perceive and how they perceive impact of climate change influence their willingness to put in place strategies to escape from the impacts (Yaro, 2013). Public perception is another type of perception that influences adaptation usage. Public perception of climate change risk varies among individuals and between geographical locations (Taylor *et al.*, 2014). The geographical disparity and direct experiences to climatic element hazards may result in different responses to climate change adaptation policies and measures.

However, Solvic (1987) argues that public perception of risk is very complex. Also, peoples' perception are based on information they get from friends and the media (Wachinger *et al.*, 2013). However it is important to comprehend how communities in different geographical location share particular risk factors, their perception and respond to changes in climate. Yaro (2013) revealed in his study that perception of climate change and variability among fishermen and farmers cut across all categories of social groups and locations in Ghana. Also, a study on public perception on climate change by Leiserowitz (2006) found that many people misunderstand changes in climate and are confused about the nature, causes and consequences of climate change.

2.7 Response to climate change

It is relevant for countries to act with urgency to the impact of climate change since its effects are massive and can potentially exacerbate existing vulnerabilities (Fankhauser & Stern, 2016). However, despite the need to respond to the adversative effect of climate change, most developing countries lack sufficient capacity and finance to cope with climate change (IPCC,

2007). Countries were obliged to reduce greenhouse gas emission to a certain level. The IPCC then suggested two major strategies to policy makers to help minimize and manage the adverse effects of climate change and these strategies were mitigation and adaptation. Countries are required to have an effective implementation of both mitigation and adaptation since there is no single option adequate to tackle the adverse effect of climate change (IPCC, 2014). Mitigation is the reduction in emission of greenhouse gases and increase in carbon stock which causes climate change and adaptation adjusting to the already changing climate while taking advantage of opportunities (IPCC, 2014).

2.8 Overview on Adaptation to Climate Change

The second response to climate change is adaptation. Adaptation in human dimension context of a global change generally refers to an action, a process or outcome in a system, (individuals, households, communities, groups, regions or a countries) that enable the system to better have a capacity to control or adjust to changes in state, stress, risk, hazards or opportunity (Smit *et al.*, 2006). In the milieu of climate change, adaptation is the ability to respond and adjust to actual or possible impact of climate change effects or conditions in the way to cause modest hazard or take benefit of any positive chances that the climate may offer (IUCN *et al.*, 2004, Smit *et al.*, 2000).

Adaptations can be based on their timing and degree of spontaneity. It can be anticipatory or reactive based on their timing and autonomous or planned based on their degree of spontaneity (Refsgaard *et al.*, 2012; Schneider *et al.*, 2000; Smit *et al.*, 2000; Smit *et al.*, 2006). Adaptation in itself comprises policies and measures to lessen the impact of climate variability and changes

and also strengthen adaptive capacity. According to the International Union for Conservation of Nature and associates (IUCN *et al.*, 2004) adaptation processes includes having knowledge about risks, assessing response choices, creating the conditions that allow adaptation, mobilizing resources, applying the adaptations and revising choices with new learning. Adaptation to climate change refers to the strategies undertaken to decrease and control the negative impacts related with the phenomenon (IPCC, 2014). Adaptation is considered as a suitable climate change impact response, particularly for smallholder farmers (Ozor *et al.*, 2012).

At the international and national levels, policies on adaptation have increased during the last decade (Hammer & Rahman, 2014). This is to help reduce poverty and maintain sustainable development in countries (Harmeling *et al.*, 2012). Humans have been adapting to climate change for a long time, but due to the increasing magnitude of the impact of climate-related hazards, additional adaptation measure need to be put in place to manage the adverse effect of global warming and climate variability (Burton *et al.*, 2006; IPCC, 2007). Adaptation are normally required for many developing countries to help secure their livelihood and enhance food security, because most of these countries are susceptible and have low adaptive capacity to the impact of climate change (FOA, 2012; Wheeler, 2011). Different groups within countries have different ways of responding or coping to the adverse effect of climate change. Rich or wealthy countries with better resources have good and more opportunities to create measures whereas less resourced and poor countries need to create unique ways to fight the negative impact of climate change (IPCC, 2014).

2.9 Adaptation strategies by smallholder farmers

Smallholder farmers in developing countries are known to be the most susceptible group to climate change impacts (Lappé, 2011). According to Gbetibouo (2008), the extent to which farmers experience the adverse impacts of climate change depends on the extent to which they adapt to climate change. However, without adaptation to climate change in agriculture, climate change would be a major harm to agriculture. Adaptation to climate change on the one hand, is the degree of which the impact of climate change can be reduced and managed to avoid danger. (Smit *et al.*, 2006).

Adaptation strategies are undertaken by agrarians to assist them manage with the unfavourable impact of climate change. Some of the commonly used adaptive strategies by farmers in response to climate change include using new crop varieties, crop diversification, irrigation, intensification and extensification of agriculture, livelihood diversification, tree planting, early and late planting and planting drought tolerant varieties and use of mixed crop and livestock farming systems (Bryan *et al.*, 2013; Deressa *et al.*, 2011; Goldman & Riosemena, 2013; Jin *et al.*, 2015; Van Aelst & Holvoet, 2016). Though several researches have been conducted on farmer's adaptation to perceived climate change in developing countries, these studies do not look at the type of adaptation strategies undertaken by farmers whether single or multiple (Deressa *et al.*, 2011; Elum *et al.*, 2017; Mertz *et al.*, 2009).

Despite the need for adaptation, there are barriers that influence the need to adapt to climate change, these constraints include the inability to withstand natural systems, financial, technological, cognitive, behavioural, societal norms and socio-demographic factors (Islam *et al.*, 2014). Climate change adaptation in Ghana requires measures intended to decrease and manage the implication of climate change on the individuals, communities and agricultural

sector, also strengthen the capability of individuals to absorb, subsist with and recuperate from unexpected changes in climate (Ensor & Berger, 2009). Also, in the agricultural sector climate change adaptation will help increase food production, in order to help achieve the SDG, which aims at ensuring zero hunger.

2.10 Socio-demographic and economic characteristics differentials in adaptation to climate change

At the household level, the ability to perceive climate change and adapt to its effects normally depends on the head of the household and their socio-demographic and economic characteristics that influence these perception and choice of adaptation.

In particular, age of household head is a vital factor that determines their perception and adaptation to climate change. Researchers have shown that the age of household head account for their experience and decisions made in agricultural activities, thus they are more likely to perceive changes in climate (Ishaya & Abaje, 2008; Deressa *et al.*, 2011).

Gender is also an important variable affecting the perception on effects of climatic changes and decisions in adaptation strategies at the agricultural level by individuals and groups (Bayard *et al.*, 2007; Bryan *et al.*, 2009; Jin *et al.*, 2015; Jost *et al.*, 2016; Tibesigwa *et al.*, 2015; Wanjiku *et al.*, 2007). Male and female headed households may have different responses to climate change adaptation, since their perception of climate change may differ. There is a growing knowledge on climate change adaptation and gender especially in developing countries with sub-Saharan Africa not an exception (Andersen *et al.*, 2017; Bhattarai *et al.*, 2015; Jin *et al.*, 2015; Tibesigwa *et al.*, 2015; Van Aelst & Holvoet, 2016). Women are largely

dominate in small scale subsistence agriculture in sub-Saharan Africa, consisting close to 80% of farmers. Yet, women have lower adaptive options than men in agriculture (Lambrou and Piana, 2006; Tibesigwa *et al.*, 2015). Again, studies show that women are more negatively impacted by climate change than men (Goh, 2012; Jost *et al.*, 2016).

Also, gendered social norms and roles can affect women's adaptive strategies (Kakota *et al.*, 2011; Jost *et al.*, 2016; Van Aelst & Holvoet, 2016), since women are noted for household responsibilities such as cooking and taking care of children. Also assert by Steady (1998), women are a lot of times confronted with cultural and socioeconomic problems that can affect their adaptive capacity. Furthermore, most communities in sub-Saharan Africa do not give women ownership to land. Due to that women are known to have little capacity to adaptation (Jost *et al.*, 2016). Jost *et al.*, (2016) found that in the Upper West Region of Ghana, men use wider variety of agricultural adaptation which includes tree crops planting, like papaya, mango and oranges, new crops varieties and new livestock species such as rabbits and pigs to cope with perceived climate change. Male-headed households normally have a higher chance of undertaking adaptation strategies which helps in better adapting to changing climatic conditions (Deressa *et al.*, 2011). Again male household heads often have a higher chances of adopting better agricultural technologies than female-headed households (Buyinza & Wambede, 2008). Moreover, male-headed households receive more agricultural support compared to female-headed households which enable them undertake more adaptation as revealed in a study by Hart and Aliber, (2012), on South Africa's black farmers.

Numerous studies have revealed that the level of education of an individual is vital in influencing the perception and usage of adaptation strategies at the agricultural level (Jin *et al.*, 2015). Household heads with some higher level of education are noted to have knowledge and

information, which positively affect their perception about changes in climate (Bryan *et al.*, 2009; Deressa *et al.*, 2011; Jin *et al.*, 2015). This help them undertake adaptive strategies suitable for the impact of the changes in climate (Maddison, 2006; Deressa *et al.*, 2011). A study done by Jin *et al.*, (2015) in Yongqiao district, China, illustrated that educated female-headed household farmer's purchase wheat drought weather index insurance and educated male-headed household farmers have a greater likelihood of increasing their investment in farm irrigation.

“Marital status is a non-static social category of social (gender) relations, rights and duties, especially women” (Van Aelst & Holvoet, 2016, p.41). These social structures affect the experience of changing in climatic conditions and decisions in undertaking adaptive strategies of married people (Van Aelst & Holvoet, 2016). Married, single, divorced and widowed men and women have different perception and adaptation to climate change (Van Aelst & Holvoet, 2016). Farmer's marital status also plays an important role in land accessibility which goes a long way to affect climatic perception and adaptation. A study by Englert (2008), on land accessibility among the people of Luguru in the Morogoro Region, shows how women who are single, widowed and divorced have easier access to own land than married women. Also adaptation strategies undertaken by women is normally determined by their marital status compared to men (Van Aelst & Holvoet, 2016).

Wealth is one of the major features that control the choice of adaptation strategies (Holling, 2001). Numerous researchers have found that most female-headed farming households, have lower incomes and fewer assets (experience poverty) than male-headed farming households (Chant, 1997). This goes further to influence their perception of climate change and affect their adaptation strategies undertaken (Buvinic & Gupta, 1997; Deressa *et al.*, 2011; Semenza *et al.*,

2008; Tibesigwa *et al.*, 2015). Farming households with higher earnings are more likely to access knowledge and information which aids in correct perception of changing climatic condition and undertake new or multiple adaptation strategies (Bryan *et al.*, 2009). Again studies show that poor headed farming household adopt adaptive strategies to enhance subsistence while rich headed farming household undertake adaptive strategies to maximize profits (Ziervogel *et al.*, 2006).

The number of members in a household determine the household's perception and choice of adaptation strategies. Studies shows that the larger the household size, the higher the likelihood of the household undertaking various adaptation strategies at the farming stage (Bryan *et al.*, 2009; Deressa *et al.*, 2011 Hassan & Nhemachena, 2008).

Existing literature shows that the agro-ecological zone location of a farmer influences his/her perception to climate change, and this affect the choice of adaptation strategies undertaken. Research done in Ethiopia by Deressa *et al.*, 2011, shows that farmers residing in lowland areas experience more frequent droughts compared to those residing in the highland areas. Again, Diggs (1991) cited in Deressa *et al.*, 2011, revealed that farmers located in wetter areas have less frequent drought compared to farmers located in drier areas, this may be a result of warmer and high temperatures in these drier areas.

2.11 Theoretical Framework

Risk theory is a framework that helps researchers to understand the responses to risk by individuals (Roeser *et al.*, 2013). A vast number of theories have been developed by researchers to explain risk perception. These includes the Social Amplification theory, Rational

Choice theory, Knowledge theory, Social Cognitive theory among others. However, the Rational Choice theory will be described as relevant to this study.

The social amplification theory focuses on the role of the media, institutional structures and social actors as a key feature of risk perception (Kasperson *et al.*, 1988). The theory assumes social status, attitudes, values, cultural identity and education as potential factors that could be used to frame how individuals perceive risk (Renn *et al.*, 1992). It again suggest that individuals could get information of risk from social media, television and newspapers (Zaki, 2011).

The knowledge theory also assumes risk perception about certain situations based on knowledge and information of risks of individuals (Wildavsky & Dake, 1990). It states that different individuals perceive same risks differently. For instance, some individuals might consider the risk of climate change impact as greater than others.

The social cognitive theory states that after assessing a range of possible actions and behavior, individuals select their respective actions (Bandura, 1986).

The Rational Choice Theory (RCT) was adopted for this study (Sorenson 1982). This theory posits that individuals respond to warning or risk as a result of the blend of their feelings, attitudes, emotions and motivation. The theory states that individuals' responses to any stimuli are hardly considered a series of events which can logically be explained or projected collectively. Again, the RCT postulates that in accordance with what individuals perceive as better for them, they are able to rank their diverse preferences based on what they possess. An important concept of RCT is the beliefs people hold with respect to rankings of risk preferences (Bridge, 2009). Also, RCT examines the way individuals respond to risk based on how they

perceive risk. Responses to warning by individuals are different and individuals choose solutions to risk based on their perceptions (Zaki, 2011).

This study adopted the RCT in its analysis. The study presents how perception of individual on climate change risk influences their responsive strategies to the phenomenon.

2.12 Conceptual Framework

Based on the theoretical framework, the study conceptualizes how household heads perceive and response to climate change. Perception of climate change has been categorized into perception of no change, low and high perceptions. And adaptation strategies undertaken by households have been grouped into no, single and multiple adaptations. No adaptation as the name implies undertaking no adaptation strategy, single adaptation refers to only one adaptation strategy and multiple adaptation two or more adaptation strategies. Socio- economic and demographic characteristics which includes age, marital status, gender, wealth categories, household size, level of education and agro-ecological zones of the households are controlled for. This is because these characteristics also influence perception and adaptation.

To begin with, the study assumes that households with heads with no perception to climate change, may not undertake any adaptation strategy. Secondly, households with heads with a low perception of climate change may undertake a single adaptation strategy. Whilst, households with heads with a high perception of climate change may undertake multiple adaptation strategies.

However, ones response to climate change impact is not only dependent on perception, this is because other intervening variables such as age marital status, gender, household size, level

of education, wealth categories and agro-ecological zones influences both perception and adaptation choices. This information is shown in Figure 2.1.

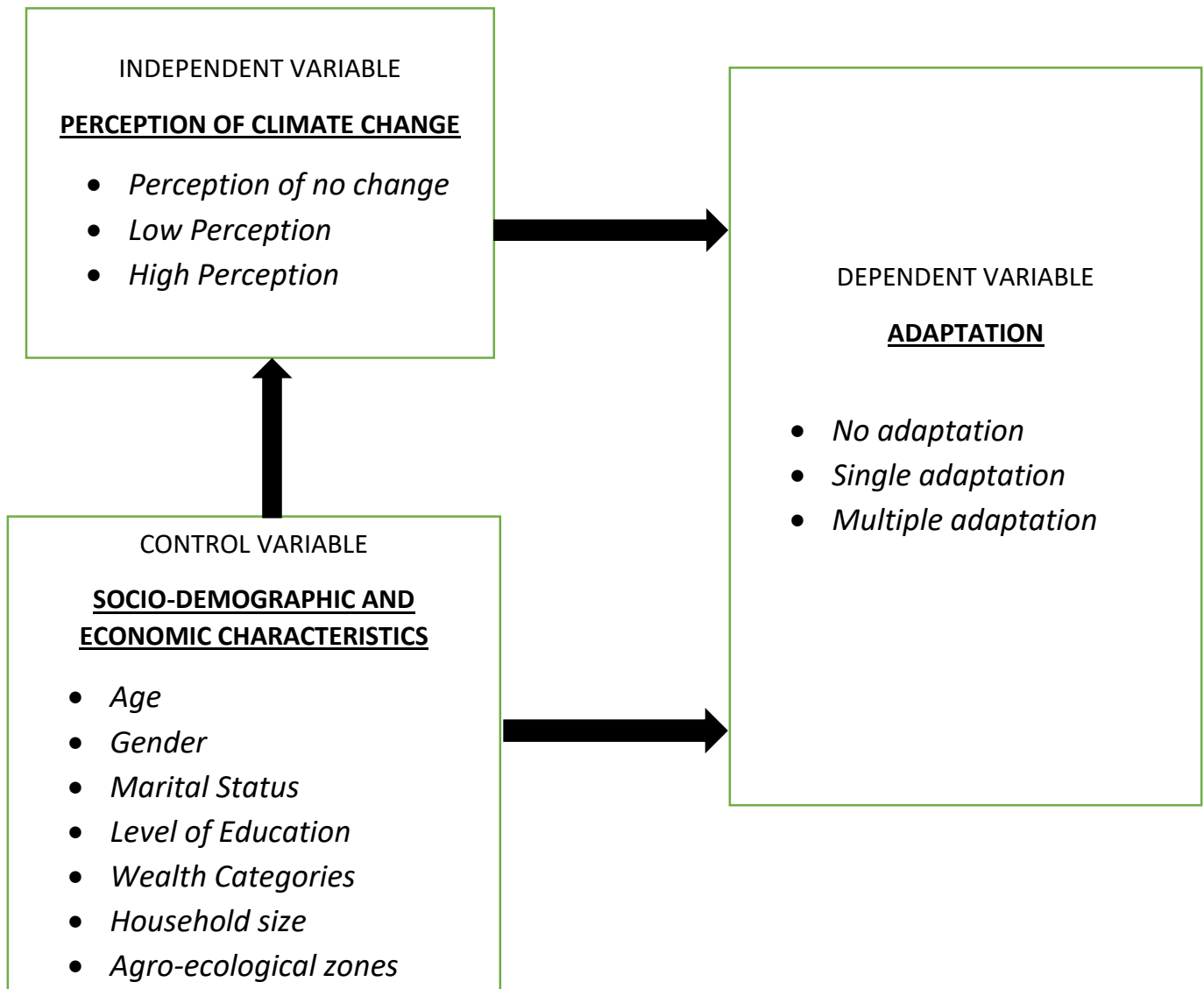


Figure 2.1: Conceptual framework showing perception of climate change as an environmental hazard, socio-demographic and economic characteristics of household heads and adaptation strategies undertaken

Source: Author's construct (2018)

2.13 Hypotheses

From the observation made in available literatures and the conceptual framework, it is hypothesized that:

1. Households with heads with a high perception of changes in climate are more likely to undertake multiple adaptation compared to households with heads with no perception of climate change.
2. Male-headed households are more likely to undertake multiple adaptation compared to female-headed households.
3. Households in the Guinea Savannah agro-ecological zone are more likely to undertake multiple adaptation compared to households in the Coastal Savannah agro-ecological zone.
4. Households with married heads are more likely to undertake multiple adaptation compared to households with unmarried heads.
5. The higher the household size, the more likely multiple adaptation will be undertaken.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter describes the source of data and the analytical methods based on the selection of variables for the study. The chapter further explains the dependent and independent variables and how they are measured. It explains the research design, sample design, data analysis methods and limitations of the study.

3.2 Source of Data

This study uses secondary data from the 2016 Climate Change, Women in Agriculture and Food Security Project in Ghana conducted by the Regional Institute for Population Studies and sponsored by the University of Ghana's Office for Research, Innovation and Development (ORID). The 2016 Climate Change, Women in Agriculture and Food Security survey data covers four agro-ecological zones (rainforest, forest-savannah transition, coastal and guinea savannah). Four districts (Amansie West, Techiman, Mfantseman, and Tolon) were selected from the rainforest, forest-savannah transition, coastal and guinea savannah respectively for the survey. These districts were selected because they are classified as agricultural districts based on the 2010 Population and Housing Census report by the Ghana Statistical Service (GSS, 2012). The survey was designed to collect, analyze and disseminate information on socio-demographic and economic characteristics and housing conditions of households, fishing, land tenure and livelihood sources, food security (availability, consumption, accessibility and stability of food), awareness of climate change or variability, key adaptation strategies, climate timelines and mitigation strategies.

3.3 Sampling Design

The 2016 Climate Change, Women in Agriculture and Food Security survey is a household survey which sampled four communities in the four agro-ecological zones. The objective of the Climate Change, Women in Agriculture and Food Security survey was to assess the climate change and food security among women in rural Ghana. Communities in the four agro-ecological zones were selected on the bases of the number of residents in crop farming and the availability of food market in the community or a nearby community (approximately 5 kilometers walking distance). The communities were also zoned using the 2010 enumeration area maps from the Ghana Statistical Service, randomly sampled and followed by a household listing in all selected enumeration areas.

A simple random sampling technique was employed in selecting communities since all are agricultural communities. A total of 560 households were selected from the 16 communities, 35 household each in the four districts, of the four agro-ecological zones, out of the 560 household, 559 household were interviewed. For the purpose of the study, information collected from household heads who are farmers on their perception of climate change or variability and key adaptation strategies were used. The sample size used for this study was 529 and the unit of analysis is household.

3.4 Categorization and Measurement of Variables

The independent and dependent variables of the study are perception of climate change and adaptation, respectively.

3.4.1 Independent variable

The independent variable (perception of climate change) was measured by no, low and high perceptions. Perception of climate change was measured by three questions from the survey.

1. Have you noticed a decrease in the total rainfall patterns in recent years compared to childhood (or when you first moved into this community)?
2. “Have temperatures of the growing seasons increased compared to childhood (or when you first moved into this community)?
3. Has flooding increased compared to childhood (or when you first moved into this community)?

If a respondent answers “No or Don’t Know” to all the three questions, it was coded as a “Perception of no change in climate”. If a respondent answers a “Yes” to any one of the three questions, it was coded as a “Low Perception of change in climate”. Finally, if a respondent answers “Yes” to two or all the three questions, it was coded as a “High Perception of change in climate”.

3.4.2 Dependent variable

The dependent variable (adaptation) was measured by no, single and multiple adaptations.

Adaptation was measured using ten adaptation strategies:

1. planting drought tolerant varieties
2. extensification of agriculture
3. intensification of agriculture (increased use of farm inputs)
4. planting of early maturing varieties of crops

5. using irrigation
6. changing planting time (planting early/late)
7. crop diversification (planting of various crops at different times)
8. tree planting (agroforestry system)
9. growing of major and minor season crops
10. drainage on farms (construction of channel on farm to prevent flooding)

These options were derived from the following question. “Please indicate the key adaptation strategies that are used by you or members of your household to reduce the impact of climate change?” With respect to the question, a “Yes” response indicates the usage while a “No” response indicate no usage.

Out of the ten adaptation strategies, a “No” response to all ten adaptation strategies was coded as a “No Adaptation”. a “ Yes “ response to one of the ten adaptation strategies was coded as “Single Adaptation” and two or more “ Yes” responses was coded as “Multiple Adaptation”.

3.4.3 Control variables

The control variables considered in the study are the socio-demographic and economic characteristics of household heads. These are age, gender, marital status, level of education, wealth categories, household size and agro-ecological zones

The age of households heads was measured continuous and in single years,

The gender of the respondent was measured as male=1, female=2

Marital status was categorized as Married=1 and Not married=2

The level of education of respondents was categorized as No schooling=0, Pre-school/Primary=1, Middle/Junior secondary/Junior high=2, Senior secondary /Senior high=3 and Higher=4

Wealth quintile was classified into five categories; Poorest=1, Poorer=2, Middle=3, Richer=4 and Richest=5. This variable was used as a measure of respondent's economic status. 12 items were used to compute the wealth quintile of household heads, these are whether a household have any of the following items, a radio, mobile phones, television, sewing machine, motor bike, bicycle, canoe, tractor, irrigation facilities , land, livestock and farming holdings.

Household size was measured as continuous and in single numbers.

Agro-ecological zone was measured as Rainforest=1, Forest-savannah transition=2, Coastal savannah=3 and Guinea savannah=4

3.5 Method of analysis

The study employed descriptive and analytic statistics to examine the relationship between levels of perception of climate change as an environmental hazards and its associate adaptation strategies adopted by farming household heads. The IBM's Statistical Package for Social Science (SPSS) for Windows Version 23.0 was used for the analyses. The study used the univariate, bivariate and multivariate methods of analysis.

At the univariate level, frequency tables, bar charts and pie charts showing distributions in percentages, were used to describe the background characteristics of respondents used for the study.

The bivariate analysis entailed the use of cross-tabulations to test the association between each of the control variables and the dependent variable. The cross-tabulation was also used to compare the relationship between the independent variable and the dependent variable. A Pearson's chi square test of independence was also used to test for the correlation or significance between the independent, control and dependent variables at 95% significance level.

For the multivariate analysis, since the dependent variable is nominal and made up of more than two categories a multinomial logistic regression model was run. The multinomial logistic regression model was undertaken to determine the relationship or association of independent variable and control variables with the dependent variable.

3.6 Limitations of study

The data for the study had limitations, it revealed some missing cases. Also the data did not have enough variables to be used to compute for the wealth quintile. This made the computation of the wealth quintile a little difficult.

CHAPTER FOUR

BACKGROUND CHARACTERISTICS OF RESPONDENTS

4.1 Introduction

This chapter presents the results of the univariate analyses for the study variables. The univariate analysis describes the levels of perception of climate change, choice of adaptation strategies, the socio-demographic and economic profiles and other background characteristics of the 529 respondents. The background characteristics of respondents for the study includes the gender, age, level of education, marital status, wealth categories, household size and agro-ecological zones. Frequencies distribution, pie charts and bar charts are used to show the characteristics of respondents of the study.

4.2 Perception of climate change

Perception of climate change by farmers influences their choice of adaptation strategies undertaken. From Table 4.1 below, out of 529 household heads in the survey, 2.8 % had perception of no change in climate, 51.6 % of the respondents had a low perception of change in climate, representing the largest percentage of the farmers. Households' heads high perception of change in climate were 45.6 %.

Table 4.1: Percentage distribution of household heads by their perception of climate change

Perception of climate change	Frequency	Percentage
Perception of no change in climate	15	2.8
Low Perception of change in climate	273	51.6
High Perception of change in climate	241	45.6
Total	529	100

Source: Generated from WIA (RIPS) data, 2016

4.3 Adaptation

Looking at the distribution of adaptation strategies in Table 4.2, we can note that a greater percentage of household heads undertook multiple adaptation strategies which accounted for 66.5%, followed by no adaptation strategy which is 18.3%. Only few farmers, thus 15.1%, undertook single adaptation strategy.

Table 4.2: Percentage distribution of household heads by adaptation

Adaptation	Frequency	Percentage
No Adaptation	97	18.3
Single Adaptation	80	15.1
Multiple Adaptation	352	66.5
Total	529	100

Source: Generated from WIA (RIPS) data, 2016

4.4 Age of household heads

Age is a key variable to any demographic analysis. Some studies found that the age of household heads determines their experience and their probability of perceiving climate change and undertaking multiple adaptive strategies (Ishaya & Abaje, 2008; Deressa *et al.*, 2011). Respondents' ages were analyzed in single years (continuous). From, Table 4.3 the minimum age of household heads is 23 years and the maximum age is 90 years. The mean age of household heads is 50.13, thus 50 years and the standard deviation for the years is 13.711.

Table 4.3: Distribution of household heads by age

	N	Minimum	Maximum	Mean	Std. Deviation
Age of Household Head	529	23	90	50.13	13.711

Source: Generated from WIA (RIPS) data, 2016

4.5 Gender of household heads

Male-headed households made up of more than half of the total sample of respondents (62.8%) and female-headed households constituted of 37.2 % of the sample in Figure 4.1.

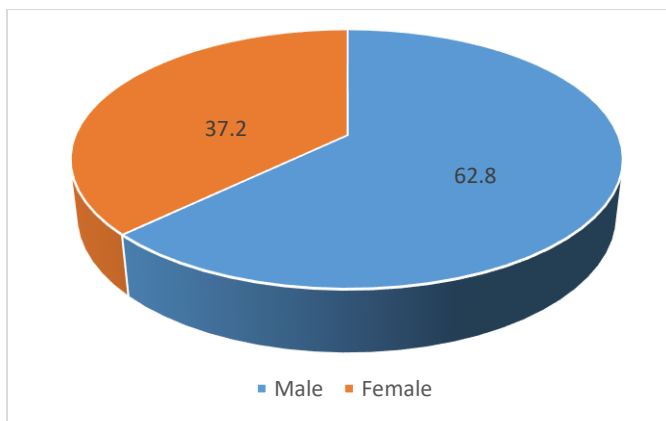


Figure 4.1: Percentage distribution of household heads by gender

Source: Generated from WIA (RIPS) data, 2016

4.6 Marital Status

The marital status of an individual influences his/her behaviour towards responsibilities pertaining to marriage in the society. From Figure 4.2, it is indicated that a larger proportion of the respondents (67.3%) were married, while 32.7% were not married. Respondents who were not married included those who have never married, in consensual union, divorced, separated and widowed.

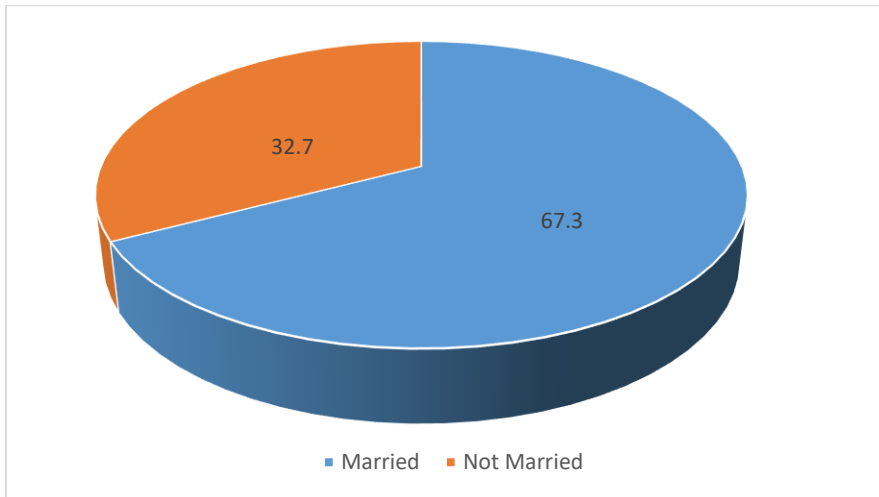


Figure 4.2: Percentage distribution of household heads by marital status

Source: Generated from WIA (RIPS) data, 2016

4.7 Level of Education

Education is a vital variable that influences the behavior of a respondent positively or negatively. As expected of rural households, Figure 4.3 below indicates that a larger percentage (53.9%) of household heads had no schooling, followed by 16.1% of household heads with preschool/primary education. Those with higher education had the lowest percentage of 1.9, preceded by respondents with senior secondary/senior high with (13.6%) and middle/junior secondary/junior high with (14.6%). This shows that household heads with no schooling and preschool/primary is the larger percentage (70%) of the total sample compared to the other levels of education.

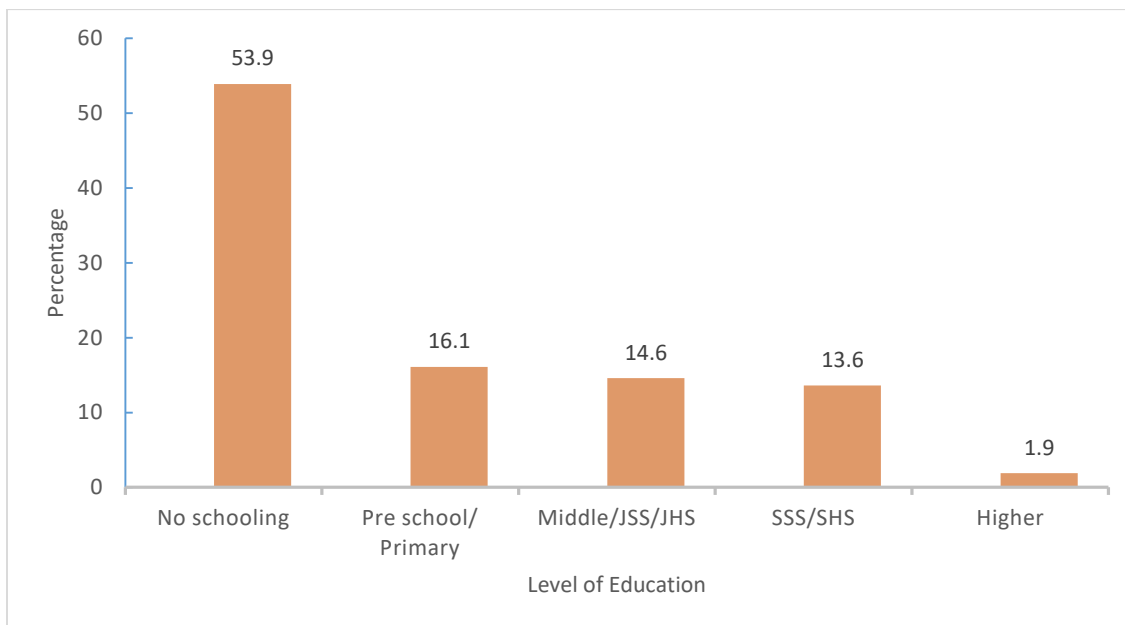


Figure 4.3: Percentage distribution of household heads by level of education

Source: Generated from WIA (RIPS) data, 2016

4.8 Wealth Categories

Wealth status is an important proxy for determining the socio-economic or income status of the heads at the household level. This can be a factor that influences their perception and adaptation strategies undertaken. Figure 4.4 below shows the wealth quintile to which respondents belong. From the distribution, larger proportion of households are in the richest (21%) and poorer wealth categories (20.5%). Households in the richer and poorest wealth categories carried equal percentage of 19.5. Households in the middle wealth category consist of 19.8 percent of the total percentage of the sample of respondents.

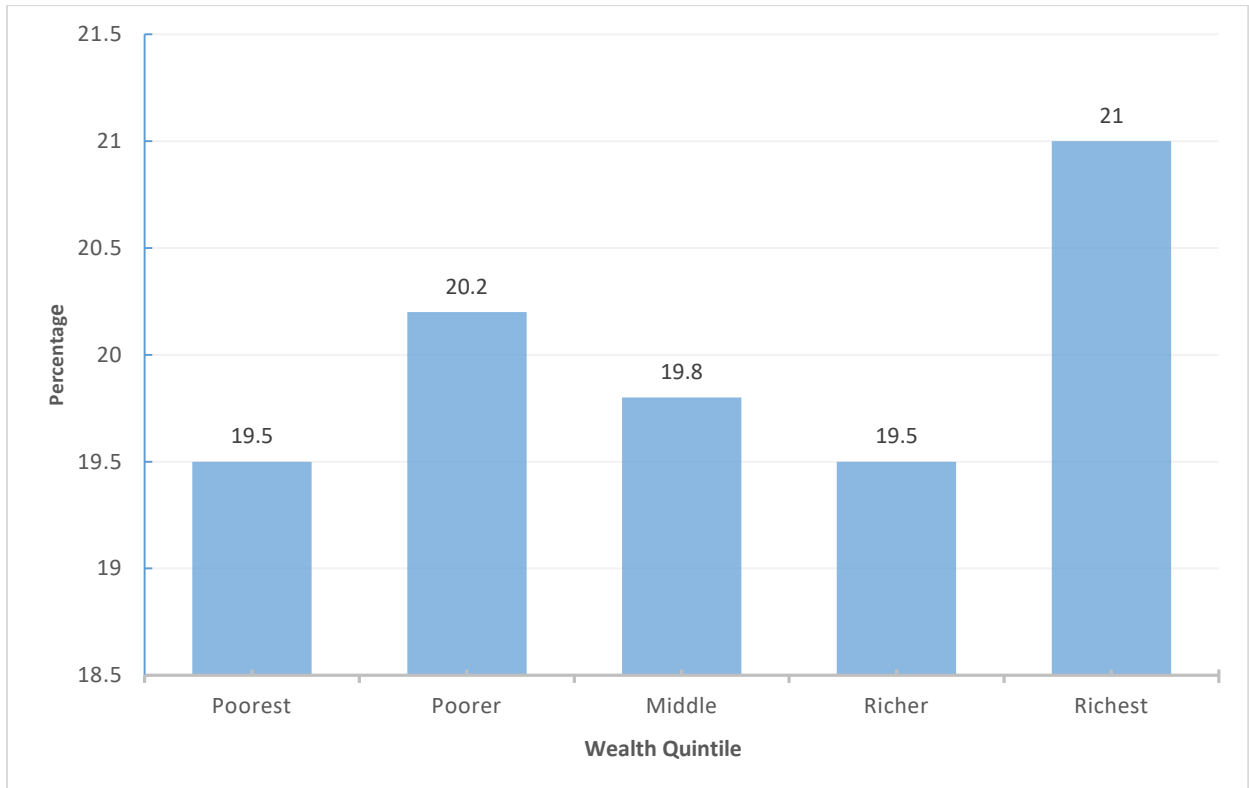


Figure 4.4: Percentage distribution of households by wealth categories

Source: Generated from WIA (RIPS) data, 2016

4.9 Household size

Table 4.3 shows the minimum, maximum, mean and standard deviation of household size of household heads. The minimum household size is 1 member and the maximum household size is 29 members. The mean household size is 4.9338, thus equivalent to 5 members and the standard deviation is 2.76637.

Table 4.4: distribution of household heads by household size

	N	Minimum	Maximum	Mean	Std. Deviation
number of people in household	529	1.00	29.00	4.9338	2.76637

Source: Generated from WIA (RIPS) data, 2016

4.10 Agro-ecological zones

The agro-ecological setting of a farmer also influences his/her behaviour toward responding to certain situations, such as perception and adaptation to changes in climate. From Figure 4.5, out of the 529 household heads sampled, 26.5% of the households were located in the guinea savannah zone, followed by 26.1% of households in the rain forest zone. Households with heads located in the forest-savannah transition zone accounted for 24.6% while the least sampled households were located in the coastal savannah zone (22.9%).

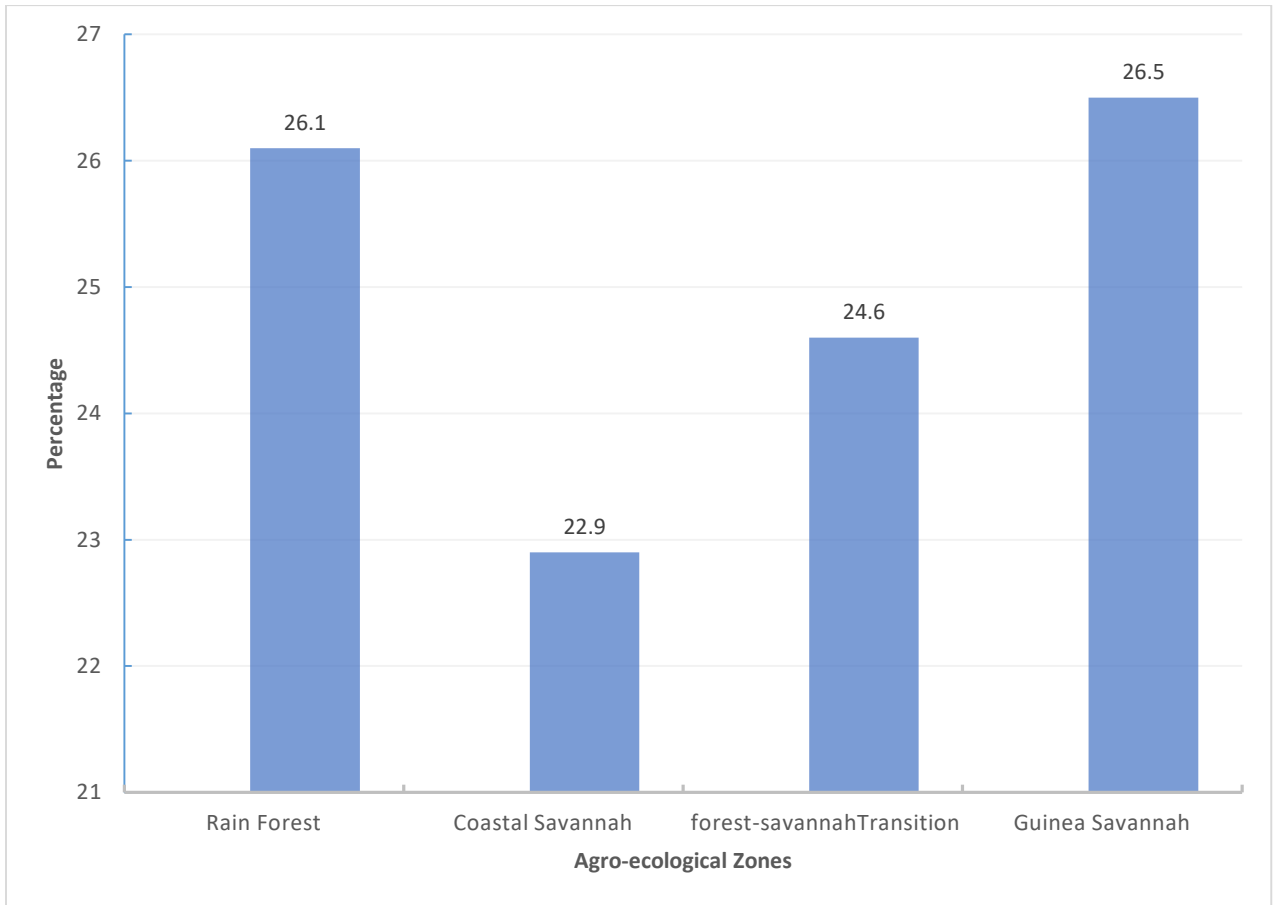


Figure 4.5: percentage distribution of households by agro-ecological zones

Source: Generated from WIA (RIPS) data, 2016

CHAPTER FIVE

ASSOCIATION BETWEEN PERCEPTION OF CLIMATE CHANGE AND ADAPTATION STRATEGIES.

5.1 Introduction

This chapter employs the bivariate method of analysis. In this analysis, the independent and control variables are cross tabulated against the dependent variable. Pearson's Chi-square test and Spearman's rho were employed to determine the significant association between the variables and the dependent variable at 95 percent significance level.

5.2 Perception of climate change and adaptation

Table 5.1, shows that there is no statistically significant association between perception of climate change by household heads and their adaptation strategies undertaken, with a Chi-square of 8.217 and a p-value of 0.084. Also, as expected, the highest proportion of household heads that did not undertake any adaptation (40%) are also those with perception of no change in climate. The highest proportions of household heads who undertook some adaptation thus, single and multiple are those with low and high perception of change in climate, 82.4% and 82.2% respectively. This was not expected, and may probably be the reason that household heads with low perception of change in climate rather had better knowledge to undertake multiple adaptation strategies compared to those with high perception of change in climate and those with perception of no change in climate. Also, it maybe because household heads have a public perception of climate change impact as stipulated by Taylor *et al.*, (2014).

Table 5.1: Percent distribution of adaptation types by household heads' perception of climate change

Perception of climate change	Percent Adaptation			Total
	No Adaptation	Single Adaptation	Multiple Adaptation	
Perception of no change in climate	40	6.7	53.3	15
Low Perception	17.6	12.8	69.6	273
High Perception	17.8	18.3	63.9	241
Total	97	80	352	529

Chi-square= 8.217

P-value= 0.084

Source: Generated from WIA (RIPS) data, 2016

5.3 Age of household heads and adaptation

Table 5.2, depicts no significant association between age of household head and adaptation strategies undertaken. The coefficient on age of household heads shows that there is a negative association between adaptation and age of household heads. The probable reason for the negative association could be due to the fact that adaptation to climate change is not determined by the age of a household head, but the experience and perception that dictates the need for a specific type of adaptation strategy (Hassan & Nhemachena, 2008). Studies done by Shiferaw and Holden (1998) also shown a negative relationship between age and adaptation strategy (adoption of improve soil conservation practices).

Table 5.2: Distribution of adaptation by age of household head

			Adaptation strategies	Age of Household Head
Spearman's rho	Adaptation strategies	Correlation Coefficient	1.000	-.056
		Sig. (2-tailed)		.199
		N	529	529
	Age of Household Head	Correlation Coefficient	-.056	1.000
		Sig. (2-tailed)	.199	
		N	529	529

Correlation Coefficient= -0.056

P-value= 0.199

Source: Generated from WIA (RIPS) data, 2016

5.4 Gender of household heads and adaptation

Table 5.3 portrays a significant association between gender of household heads and their adaptation strategies at a 99 % significant level. Here it can be observed that female-headed households were the highest proportion that did not undertake any adaptation (26.9%) and also undertake single adaptation (21.8%) compared to male-headed households. Households with male heads undertook more multiple adaptation strategies (75.6%) compared with those with female heads (51.3%). This result is expected because it corroborates research done by Deressa *et al.*, (2011), Hassan & Nhemachena (2008) and Jost *et al.*, (2016), which showed that households with male heads are more likely to undertake more adaptation strategies in order to adapt to the effect of climate change. Again male-headed households often have a higher

chances of adopting better agricultural technologies compared to female-headed households (Buyinza & Wambede, 2008). Also, it was assert by Steady (1998), women a lot of times than men are confronted with cultural and socioeconomic problems that can affect their adaptive capacity which may result in female household heads undertaking no or single adaptation. Furthermore, it can be the reason that male-headed households receive more agricultural support compared to female-headed households which enable them undertake more adaptation as revealed in a study by Hart and Aliber, (2012), on South Africa’s black farmers.

Table 5.3: Percent distribution of adaptation types by gender of household head

Gender of household head	Percent Adaptation			Total
	No Adaptation	Single Adaptation	Multiple Adaptation	
Male	13.3	11.1	75.6	332
Female	26.9	21.8	51.3	197
Total	97	80	352	529

Chi-square= 32.896

P-value= 0.000

Source: Generated from WIA (RIPS) data, 2016

5.5 Marital status and adaptation

The chi-square test shows a significant correlation between marital status and adaptation strategies with a significance level of 99 percent (p-value of 0.000), as shown in Table 5.4, As noted, households with married heads (14%) were the smallest proportion to undertake no adaptation. However single adaptation households with unmarried heads (22.5%) were the

highest proportion. Married heads households undertook more of multiple adaptation strategies (74.4%) compared to unmarried household heads (50.3%). This may

Table 5.4: Percent distribution of adaptation types by marital status of household head

Marital Status	Percent Adaptation			Total
	No Adaptation	Single Adaptation	Multiple Adaptation	
Married	14	11.5	74.4	356
Not Married	27.2	22.5	50.3	173
Total	97	80	352	529

Chi-square= 30.498

P-value= 0.000

Source: Generated from WIA (RIPS) data, 2016

5.6 Level of education and adaptation

A higher proportion of household heads who did not undertake any adaptation were those with preschool/primary level of education (35.3%) whereas the least proportion of household heads had did no adaptation were those with higher level of education (10%). Single adaptation was highest among household heads with higher (20%) and middle/ junior secondary/junior high (18.2%) levels of education. In Table 5.5, household heads with senior secondary/senior high level of education are the highest (79.2) who undertook multiple adaptation strategies while the smallest proportion of household heads who undertook multiple adaptation strategies were among household heads with preschool/primary education (51.8%). However, household heads with higher level of education also undertook multiple adaptation strategies (70.0%),

followed by those with no schooling (67.7%), and household heads with middle/junior secondary/junior high (66.2%). Moreover, Table 5.5, depicts that the level of education of household heads is significantly associated with their adaptation strategies undertaken at 99% significance level (p-value of 0.002). This observation is in line with studies done which indicate that household heads with higher educational level (secondary and higher) are expected to use multiple adaptation strategies (Deressa *et al.*, 2011; Jin *et al.*, 2015).

Table 5.5: Percent distribution of adaptation types by level of education of household head

Level of education	Percent Adaptation			Total
	No Adaptation	Single Adaptation	Multiple Adaptation	
No schooling	15.8	16.5	67.7	285
Preschool/ Primary	35.3	12.9	51.8	85
Middle/JSS/JHS	15.6	18.2	66.2	77
SSS/SHS	12.5	8.3	79.2	72
Higher	10	20	70	10
Total	97	80	352	529

Chi-square= 24.414

P-value= 0.002

Source: Generated from WIA (RIPS) data, 2016

5.7 Wealth categories and adaptation

From Table 5.6, there is a significant association between wealth categories and adaptation strategies undertaken at the household level. It was noted in the distribution that the higher the wealth category, the higher the proportion of the households undertaking multiple adaptation.

Table 5.6, indicates that, the highest proportion of household heads who did not undertake any

adaptation were in the poorest wealth category (23.3%). However, households in the richer wealth category (5.8) were the least to undertake single adaptation, whereas households in the middle wealth category (21.9%) did more of single adaptation. Households in the richer wealth category (78.6%) undertook multiple adaptation, followed by those in the richest wealth category (71.2%). Households in the poorest wealth category are the smallest proportion (56.3%) who undertook multiple adaptation in the sample. The findings is in congruent with Bryan *et al.*, (2009) study in Ethiopia and South Africa, which indicate that farming households with higher incomes have a higher likelihood of using new or multiple adaptive strategies to adapt to perceived climate changes. Findings from Ziervogel *et al.*, (2006) support the results, which found that households in the wealthier category are able to respond better to climatic changes compare to poorer households. This can also be the reason that richer household own larger acres of land and other agricultural equipment which enable them adapt better to perceived climate changes (Bryan *et al.*, 2009).

Table 5.6: Percent distribution of adaptation types by wealth categories of households

Wealth Quintile	Percent Adaptation			Total
	No Adaptation	Single Adaptation	Multiple Adaptation	
Poorest	23.3	20.4	56.3	103
Poorer	21.5	15	63.6	107
Middle	15.2	21.9	62.9	105
Richer	15.5	5.8	78.6	103
Richest	16.2	12.6	71.2	111
Total	97	80	352	529

Chi-square= 19.266

P-value= 0.014

Source: Generated from WIA (RIPS) data, 2016

5.8 Household size and adaptation

Table 5.7, depicts that the household size is significantly associated with the adaptation strategies undertaken at 99% significance level (p-value=0.00). The coefficient on household size shows that household heads adaptation is greatly influenced by the size of their household. Larger household sizes have a higher likelihood of undertaking adaptation to perceived climate change. As household size increase by one member (a mean of 5 household members) there is a probability that adaptation increases by 1 percent. The observed positive association between household size and adaptation strategies support finding from previous studies, that the larger the household size, the higher likelihood of undertaking various agricultural adaptation strategies (Bryan *et al.*, 2009; Deressa *et al.*, 2011; Hassan & Nhemachena, 2008). This can probably be the reason that larger household size is mostly associated with higher labour endowment, which would enable a household to undertake more adaptation strategies (Desersa *et al.*, 2011).

Table 5.7: Distribution of adaptation by household size

			Adaptation strategies	Household size
Spearman's rho	Adaptation strategies	Correlation Coefficient	1.000	.229**
		Sig. (2-tailed)		.000
		N	529	529
	Household size	Correlation Coefficient	.229**	1.000
		Sig. (2-tailed)	.000	
		N	529	529

Correlation Coefficient = 0.229

P-value= 0.000

Source: Generated from WIA (RIPS) data, 2016

5.9 Agro-ecological zones and adaptation

The location of a farmer in an agro-ecological zone influences his/her adaptation strategies undertaken to withstand the negative implications of climate change. The distribution in Table 5.8, indicates that there is a significant association between location in agro-ecological zones and adaptation strategies at the 99% significance level (p-value= 0.000). Table 5.8, shows that households located in the Guinea Savannah zone undertook multiple adaptation strategies (94.3%) and also the same zone had the least household heads (2.1%) who did not undertake any adaptation compared to the other agro-ecological zones. Households located in the coastal savannah were highest proportion (34.7%) who did not undertake any adaptation, but did more of single adaptation (28.1%) compared to the other zones. The results for the Guinea Savannah zone can be as a result of the areas having more frequent droughts and increase in temperature, as revealed in a study done by Diggs (1991).

Table 5.8: Percent distribution of adaptation types by agro-ecological zone location of household

Agro-ecological Zones	Percent Adaptation			Total
	No Adaptation	Single Adaptation	Multiple Adaptation	
Rain Forest	15.9	14.5	69.6	138
Coastal Savannah	34.7	28.1	37.2	121
Forest-savannah Transition	23.1	16.2	60.8	130
Guinea Savannah	2.1	3.6	94.3	140
Total	97	80	352	529

Chi-square= 98.394 P-value= 0.000

Source: Generated from WIA (RIPS) data, 2016

CHAPTER SIX

**MULTINOMIAL REGRESSION ANALYSIS OF THE PERCEPTION OF CLIMATE
CHANGE AND ADAPTATION STRATEGIES**

6.1 Introduction

This chapter presents the results of the multinomial logistic regression analysis conducted to examine the perception of climate change and adaptation strategies undertaken by smallholder farmers in rural Ghana. The dependent variable which is adaptation strategy was measured in three categories, they are no, single and multiple adaptations. However, no adaptation was used as the reference category for the model. Again, the independent variable was perception of climate change and the control variables were age, marital status, gender, level of education, wealth categories, agro-ecological zones and household size.

Results presented in Table 6.1 show the overall association between the independent, control variables and the dependent variable. The model was significant ($p= 0.000$), showing that the model fit the data.

Table 6.1: Overall Associations between the Independent, Control Variables and Dependent Variable

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2Log Likelihood	Chi-Square	df	Sig.
Intercept Only	916.705			
Final	742.588	174.117	34	0.000

Source: Generated from WIA (RIPS) data, 2016

Table 6.2 also shows the association of the independent and some control variables and the dependent variable. The independent variable and two control variables namely level of education and agro-ecological zones have a significant association with the dependent variable. The Nagelkerke R-Square for this model is 0.340, indicating that 34.0% of the variation in the dependent variable was as a result of the combination of the independent and control variables in the model.

Table 6.2: Association of the Independent and individual Control Variables to Dependent Variable (Adaptation)

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	742.588a	0.000	0	.
Perception of climate change	759.689	17.101	4	0.002
Age	743.946	1.358	2	0.507
Gender	742.793	0.205	2	0.903
Marital Status	743.688	1.100	2	0.577
Level of Education	766.199	23.531	8	0.003
Wealth Categories	757.401	14.813	8	0.063
Household size	744.589	2.001	2	0.368
Agro-ecological zones	824.541	81.953	6	0.000

Nagelkerke R-Square=0.340

Source: Generated from WIA (RIPS) data, 2016

6.2 Single Adaptation

6.2.1 Independent Variable

Perception of climate change influences the choice of adaptation strategies used at the household level. From table 6.3, households with heads with perception of no change in climate are 89.8 percent less likely than those with high perception of change in climate to undertake single adaptation relative to no adaptation. Again, households with heads with low perception of change in climate are 31.5 percent less likely than those with high perception of change in climate to undertake single adaptation relative to no adaptation. This was expected because the result conforms to findings from studies such Elum et al (2017) which found that perceptions of individuals are normally based on their experience of the effects of climate change. Thus, people undertake adaptation strategies based on how they perceive climate change impacts.

6.2.2 Control Variables

Age of household heads had no significant association with single adaptation. This result supports a study by Hassan & Nhemachena (2008). That adaptation to climate change is not determined by the age of a household head but rather their experience with the implications of climate change.

The gender of household heads also had no significant association with single adaptation. However, the studies done by Deressa *et al.*, (2011) and Jost *et al.*, (2016) found that gender has an influence on adaptation strategies undertaken by household heads, as male-headed households are more likely to undertake adaptation strategies than those with female heads and this is contrary to this study findings.

Table 6.3: A Multinomial Regression of Perception of climate change, socio-demographic and economic characteristic and adaptation strategies undertaken by smallholder farmers in rural Ghana

		Single Adaptation					Multiple Adaptation				
		B	Std. Error	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	B	Std. Error	Sig.	Exp(B)	95% Confidence Interval for Exp(B)
Intercept		1.486	1.738	0.393			4.469	1.471	0.002		
Variables											
Perception of climate change	Perception no change in climate	-2.283	1.140	0.045*	0.102	(0.011, 0.952)	-1.737	0.706	0.014*	0.176	(0.044, 0.702)
	Low Perception of change in climate	-0.378	0.328	0.249	0.685	(0.360, 1.302)	0.422	0.274	0.124	1.525	(0.891, 2.611)
	High Perception of change in climate(R C)	0	.	.	1.000	.	0	.	.	1.000	.
Age	Age	-0.10	0.013	0.467	0.990	(0.964, 1.017)	-0.004	0.011	0.708	1.004	(0.983, 1.026)
Gender	Male	-0.097	0.540	0.857	0.901	(0.315, 2.641)	-0.198	0.446	0.657	0.820	(0.342, 1.967)
	Female (R C)	0	.	.	1.000	.	0	.	.	1.000	.
Marital Status	Married	-0.72	0.532	0.892	0.930	(0.328, 2.641)	0.347	0.443	0.434	1.415	(0.593, 3.373)
	Not married (R C)	0	.	.	1.000	.	0	.	.	1.000	.
Level of Education	No Schooling	-0.395	1.307	0.762	0.674	(0.052, 8.721)	-1.024	1.140	0.369	0.359	(0.038, 3.351)
	Preschool/Primary	-1.789	1.317	0.174	0.167	(0.013, 2.209)	-1.606	1.140	0.159	0.201	(0.022, 1.874)
	Middle/JSS/JHS	-0.407	1.322	0.758	0.666	(0.050, 8.879)	-0.433	1.156	0.708	0.649	(0.067, 6.253)
	SSS/SHS	-0.908	1.375	0.509	0.403	(0.027, 5.970)	-0.187	1.170	0.873	0.829	(0.084, 8.210)
	Higher (R C)	0	.	.	1.000	.	0	.	.	1.000	.
	Poorest	-0.085	0.529	0.873	0.919	(0.326, 2.590)	-0.407	0.427	0.340	0.665	(0.288, 1.536)

Wealth Categories	Poorer	-0.348	0.529	0.510	0.706	(0.250, 1.991)	-0.945	0.422	0.025*	0.389	(0.170, 0.889)
	Middle	0.616	0.517	0.234	1.852	(0.672, 5.106)	-0.203	0.430	0.636	0.816	(0.352, 1.895)
	Richer	-0.965	.628	0.124	0.381	(0.111, 1.305)	-0.477	0.436	0.274	0.621	(0.264, 1.459)
	Richest (R C)	0	.	.	1.000	.	0	.	.	1.000	.
Household size	Household size	0.111	0.089	0.210	1.118	(0.939, 1.330)	0.094	0.074	0.205	1.099	(0.950, 1.271)
Agro-ecological zones	Rainforest	-0.486	0.881	0.581	0.615	(0.109, 3.456)	-2.646	0.707	0.000***	0.071	(0.018, 0.283)
	Forest-savannah transition	-0.409	0.851	0.631	0.664	(0.125, 3.522)	-3.883	0.698	0.000***	0.021	(0.005, 0.081)
	Coastal savannah	-0.676	0.859	0.431	0.509	(0.094, 2.737)	-3.133	0.684	0.000***	0.044	(0.011, 0.167)
	Guinea savannah (R C)	0	.	.	1.000	.	0	.	.	1.000	.
The reference category: No Adaptation. ***=P<0.05											

Source: Generated from WIA (RIPS) data, 2016

With regard to marital status, the results depict that marital status of household heads had no significant association with single adaptation. This was unexpected because a study by Van Aelst & Holvoet (2016) found that marital status plays a key role in adaptation. Also households with married heads have a higher probability to undertake adaptation strategies than those than with unmarried heads.

The level of education of household heads had no significant association with single adaptation. However, findings from the study is contrary to studies done. Deressa *et al.* (2011) and Jin *et al.* (2015) in their studies found out that the level of education influences the choice of adaptation at the household level. Also, heads of households with higher educational level are more likely to undertake adaptation

Wealth was found to have an insignificant association with single adaptation. However, a study by Bryan *et al.* (2009) indicates that households with higher incomes have a higher possibility of undertaking adaptation strategies and this is the opposite of this study's findings.

Household size was noted to have an insignificant association with single adaptation. This was not expected because studies done show that the number of members influence the use of adaptation strategies at the household level. And households with large or more members had the higher likelihood of undertaking an adaptation strategy compared with smaller sized households (Bryan *et al.*, 2009; Deressa *et al.*, 2011; Hassan & Nhemachena, 2008).

Lastly, agro-ecological zone had an insignificant relationship with single adaptation. This finding is contrary to studies done. It was expected that households in the Guinea savannah agro-ecological zones will undertake single adaptation than those in the other three agro-ecological zones. This is because Deressa *et al.* (2011) found that drier lands, including the

Guinea Savannah zone, are more prone to frequent droughts and households located there are more likely to undertake adaptation strategies.

6.3 Multiple Adaptation

6.3.1 Independent Variable

It was found in Table 6.3 that, households with heads with no perception have a significant association with multiple adaptation undertaken. Households with heads with perception of no change in climate are 82.4 percent less likely than those with high perception of change in climate to undertake multiple adaptation relative to no adaptation. Also households with heads with low perception of change in climate were 0.525 times more likely than households with heads with high perception of change in climate to undertake multiple adaptation relative to no adaptation. This was not expected especially with household with heads with low perception of change in climate, undertaking more multiple adaptation than households with heads with high perception of change in climate. This may probably be because households with heads with low perception of change in climate also had some level of experience together with some public perception which enable them undertook more multiple adaptation than those with high perception of change in climate. Furthermore, Elum *et al.*, (2017) found in his study that people perceive impact of climatic changes based on the experience they have with respects to the negative implications associated with the changes in climate. However this findings also confirms the hypothesis stated for the study that households with heads with a high perception of changes in climate are more likely to undertake multiple adaptation compared to households with heads with perception of no change in climate.

6.3.2 Control Variables

The age of household heads had no significant association with multiple adaptation. Studies shows that age of a household head has a negative relationship with adaptation. However this findings conform to the study done by Hassan & Nhemachena, (2008) which indicated that age does not determine whether an individual adapt to the effect of climatic change but experience of the individual is what matters.

Gender of household heads was found to have no significant association with multiple adaptation. However, according to studies conducted, gender was found to have an influence on adaptation strategies undertaken by heads at the household level and this is the opposite of the study findings. Also research found that households with male heads are more likely to undertake multiple adaptation strategies compared to households with female heads (Deressa *et al.*, 2011; Jost *et al.*, 2017; Hassan & Nhemachena, 2008).

The marital status of household heads had no significant association with multiple adaptation. This was contrary to a study done by Van Aelst & Holvoet, (2016), which found that marital status had an influence on adaptation. And households with married heads have a higher likelihood of undertake multiple adaptation strategies than those with unmarried heads.

Furthermore, the level of education of household heads was not significantly associated with multiple adaptation. This was not expected because literature have shown that the choice of adaptation at the household levels are influence by the level of education of the head. Again, Deressa *et al.*, (2011) and Jin *et al.*, (2015) found that heads of households with higher educational level were more likely to undertake adaptation. The negative relationship between

adaptation and level of education could be a reason that majority (53.9%) of the household heads in the study had no formal education (no schooling).

With regard to wealth categories, households in the poorest category of the wealth quintile were 33.5 percent less likely than those in the richest wealth category to undertake multiple adaptation relative to no adaptation. Again from the findings, households in the poorer wealth category were 61.1 less likely than those in the richest wealth category to undertake multiple adaptation relative to no adaptation. Furthermore, households in the middle wealth category were 18.4 percent less likely than households in the richest wealth category to undertake multiple adaptation relative to no adaptation. Households in the richer wealth category were 37.9 percent less likely than those in the richest wealth category to undertake multiple adaptation relative to no adaptation. The result indicated that households in the poorer wealth category were significantly less likely than the richest to undertake multiple adaptation. It is observed that wealth categories was significant with multiple adaptation. This finding confirms the finding by Bryan *et al.*, (2009) that households with higher incomes have a higher possibility of undertaking multiple adaptation strategies compare with households with lower incomes.

Household size had an insignificant association with multiple adaptation. However, studies done have shown a positive relationship of household size with adaptation. Again, household size influence the use of adaptation strategies at the household level. It was also found that households with larger or more members had the higher likelihood of undertaking multiple adaptation strategy compared with smaller size households (Bryan *et al.*, 2009; Deressa *et al.*, 2011; Hassan & Nhemachena, 2008).

Finally, agro-ecological zones have a significant association with multiple adaptation. From the result, households situated in the Rainforest agro-ecological zone were 92.9 percent less likely than households situated in the Guinea savannah agro-ecological zone to undertake multiple adaptation relative to no adaptation. Again, households located in the Forest-savannah transition agro-ecological zone were 97.9 percent less likely than households situated in the Guinea savannah agro-ecological zone to undertake multiple adaptation relative to no adaptation. Households situated in the Coastal savannah agro-ecological zone were 95.6 percent less likely than households situated in the Guinea savannah agro-ecological zone to undertake multiple adaptation relative to no adaptation. These findings confirm the hypothesis of this study that households in the Guinea Savannah agro-ecological zone are more likely to undertake multiple adaptation compared to households in the Coastal Savannah agro-ecological zone. In relation to these findings, other studies have shown that Guinea Savannah zone (which the northern part of Ghana falls within) is mostly dry and associated with high temperature and frequent droughts, therefore farming households located in these areas will have to undertake multiple adaptation to fight the adverse impact of climate change (Deressa *et al.*, 2011; Yaro, 2013).

CHAPTER SEVEN

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

This chapter discusses summary of the results of this study. Especially, it presents the findings on the relationship between perception of climate change, as well as adaptation strategies undertaken by smallholder farmers in rural Ghana. The final part of this chapter provides some recommendations for policy-making and interventions in the area of adaptation in agriculture in Ghana.

7.2 Summary

The main objective for the study was to examine the relationship between how farmers perceive climate change and adaptation strategies undertaken in the four agro-ecological zones in Ghana. The specific objectives were to examine how farmers perceive climate change, to identify how socio-demographic and economic characteristics influence the choice of adaptation strategies and lastly to examine how perception of climate change influence the choice of adaptation strategies undertaken. The background characteristics examined in the study were gender, age of household head, marital status, wealth categories, level of education, agro-ecological zones and household size.

The following hypotheses guided the study. Households with heads with high perception of change in climate are more likely to undertake multiple adaptation compared to households with heads with perception of no change in climate. Male-headed households are more likely to undertake multiple adaptation compared to female-headed households. Households in the

Guinea Savannah agro-ecological zone are more likely to undertake multiple adaptation compared to households in the Coastal Savannah agro-ecological zone. Households with married heads are more likely to undertake multiple adaptation compared to households with unmarried heads. Finally, the higher the household size the more likely multiple adaptation will be undertaken. For the objective of the study to be met and to test the hypotheses, data from the WIA 2016 was used. The study focused on 529 farming household heads in the four agro-ecological zones in Ghana.

The association between the dependent and independent and control variables of the study were analyzed at three different levels. These were the univariate, bivariate and multivariate levels of analyses. Frequencies, percentages, bar and pie charts were used to report the background characteristics of respondents at the univariate level. Again, Chi-square test and correlation coefficient (at 95% confidence level) were employed to test for the association among the variables in the study at the bivariate level. At the multivariate level, multinomial regression analysis was performed to determine the association between perception of climate change, the socio-demographic and economic characteristics and adaptation strategies undertaken.

The univariate analysis was used to examine the distribution of respondent's background characteristics. The analysis of the background characteristics showed that a larger percentage of the household heads were males, confirming that Ghana has most of its household heads being males. Also, the minimum age of household heads was 23 years and the maximum age was 90 years. The mean age of household heads was 50.13, thus 50 years and the standard deviation for the years was 13.711. A larger proportion of the respondents were married. As expected of rural farming communities, the distribution of level of education indicated that

most of respondents had no schooling. It was also observed that the minimum household size was 1 member and the maximum household size was 29 members. The mean household size was 4.9338, thus equivalent to 5 members and the standard deviation was 2.76637. For wealth categories, households in the richest category were the majority. Again, households within the Guinea savannah agro-ecological zone were the majority. Furthermore, it was noted that a higher proportion of respondents had low perception of change in climate while a lower proportion had perception of no change in climate. Lastly for the univariate analysis it was observed that majority of the respondents undertook multiple adaptation.

The bivariate level, crosstabs, Pearson Chi-square test and Spearman's rho correlation coefficient were employed to test for the association between perceptions of climate change, socio-demographic and economic characteristics and adaptation. Among the variables considered, gender of household head, level of education marital status, agro-ecological zones and household size were found to be significantly associated with adaptation at 5% confidence level.

At this level, results showed that households with heads with low perception of climate change were noted to be the largest proportion who did not undertake any adaptation whereas those who did some adaptation were households with heads with perception of no change in climate and heads with high perceptions of climate change.

Also, the coefficient on age of household heads depicted a negative association between adaptation and age of household heads

With regard to gender, the highest proportion who did no adaptation was households with female heads. Female-headed household were again, the highest proportion to undertake single

adaptation compared to male-headed households. Multiple adaptation was higher for households with male heads compared with those with female heads.

For marital status, no adaptation was higher for households with unmarried heads compared to those with married heads. The highest proportion to undertake single adaptation was households with unmarried heads while households with married heads were the least to undertake single adaptation. Households with married heads undertook more multiple adaptation compared to unmarried household heads.

In addition, heads of households with preschool/primary level of education were the highest proportion who did not undertake any adaptation while those with higher level of education were the least proportion to undertake no adaptation. Single adaptation was higher for household heads with higher level of education and lower for those with senior secondary/senior high level of education. The highest proportion of household heads who undertook multiple adaptation was with those with senior secondary/senior high level of education while the least proportion were heads with preschool/primary level of education.

Again, no adaptation was higher for households in the poorest category and lowest for those in the middle wealth category. Households in the middle wealth category did more of single adaptation while those in the richer wealth category did less of single adaptation. A higher proportion of households in the richer and richest wealth categories undertook multiple adaptation compared to the other wealth categories.

Furthermore, as household size increase by one member (a mean of 5 household members) there is a probability that adaptation increases by 1 percent. Therefore larger household sizes

undertook multiple adaptation while smaller household sizes undertake single adaptation or no adaptation.

Finally, for agro-ecological zones, households located in the Coastal Savannah zone were the largest proportion who did not undertake any adaptation whereas, households located in the Guinea Savannah zone were the smallest proportion who did not undertake any adaptation. Single adaptation was undertaken more in the coastal savannah zone and less in the Guinea savannah zone. Households located in the Guinea Savannah zone were the highest proportion to undertake multiple adaptation while the smallest proportion were those located in the Coastal Savannah zone.

Multinomial logistic regression models were fitted at 95% confidence level at the multivariate level. The dependent variable (adaptation) was in three categories, there were no, single and multiple adaptations. No adaptation was made the reference category for the model. The overall model was significant at 0.000 level. The Nagelkerke R-Square for the model was 0.340, indicating that 34.0% the variation of the dependent was as a result of the combination of the independent and control variables in the model. Perception of climate change, level of education and agro-ecological zones were significantly associated with adaptation.

For single adaptation, perception of climate change was found to have significant association with single adaptation, the other variables were insignificantly associated with single adaptation.

At the multiple adaptation, it was also noticed that perception of climate change, wealth categories and agro-ecological zones were found to have a significant association with multiple adaptation.

The following hypotheses of the study: male-headed households are more likely to undertake multiple adaptation compared to female-headed households, households with married heads are more likely to undertake multiple adaptation compared to households with unmarried heads and the higher the household size, the more likely multiple adaptation will be undertaken were not significant determinants of adaptation. However, the hypotheses: household heads with a high perception of climate change are more likely to undertake multiple adaptation compared to household heads with perception of no change in climate, and households in the Guinea Savannah agro-ecological zone are more likely to undertake multiple adaptation compared to households in the Coastal Savannah agro-ecological zone, were statistically significant with adaptation.

From the result obtained, two out of the five hypotheses, thus households with heads with a high perception of climate change are more likely to undertake multiple adaptation compared to households with heads with no perception of climate change, and households in the Guinea Savannah agro-ecological zone are more likely to undertake multiple adaptation compared to households in the Coastal Savannah agro-ecological zone were accepted while the other hypotheses were rejected.

7.3 Conclusion

This study examined the relationship between the perception of farming household heads on climate change and adaptation strategies undertaken in the four agro-ecological zones in Ghana. The study revealed that the perception of household heads influence adaptation strategies undertaken. Other factors that exerted influence on the adaptation strategies

undertaken by household heads included their wealth and agro-ecological zones. The latter however was noted to be the key factor influencing the household head's risk perception levels of climate change and their choice of adaptation strategies undertaken in rural Ghana.

7.4 Recommendations

Findings from the study show that farmers located in the Guinea Savannah zones undertake more adaptation strategies due to the climate nature of the area, it is therefore suggested that government as well as NGOs, support farmers in these areas financially to aid them in undertaking adaptation strategies.

Moreover, the government should improve its support and budget to programmes related to climatic changes in the country. It is suggested that there should be increase in the construction of dams and irrigation systems in agricultural communities, this will provide sufficient water to rural farmers during drought periods to enhance productivity.

Lastly, other findings show that most farmers in the four agro-ecological zones had no formal education, therefore it is suggested that the government and NGOs should train personnel (extension officers) to educate farmers on the appropriate adaptation strategies to undertake to deal with the adverse effects of climate change. This will help the smallholder farmers since most of them depend solely on climate for farming and livelihood.

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