- **WOMEN FARMERS' PERCEPTION TO CLIMATE CHANGE/VARIABILITY AND THEIR ADAPTATION STRATEGY**

THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MPHIL ENVIRONMENTAL SCIENCE DEGREE

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July, 2017

DECLARATION

ABSTRACT

Increasing emission of greenhouse gases into the atmosphere through sweltering fossil fuels for energy, industrial air emission and the destruction of carbon sinks in the past years is increasing global temperatures, resulting in changing climatic conditions. The negative impacts of climate variability are becoming gradually obvious nowadays, which includes long-term average temperature and precipitation variations; differences in the amount, timing, and geographical supply of precipitation; a rise in the occurrence of dangerous climatic happenings such as drought, flood; and rising ocean level. In order to increase the capacity and capability of women in agriculture to adjust to ongoing and future variability in the climate, we need improved understanding of the risk they are facing concerning agriculture and climate change/variability. It is therefore essential to identify the magnitude and effects of climate change/variability as well as to know how women in farming perceive climatic changes and the adaptations strategy they practise. This research, therefore, examined women farmers' perception to climate variability and their adaptation strategies in the Lawra District of the Upper West Region of Ghana. Discussion on perception and adaptation options in this research concentrated on evidence perceived in the three communities in the Lawra District. Effecting a qualitative technique, three focus group discussions were arranged in these three communities so as to know the respondents perception to climate variability and the adaptation strategies practised within these communities in the District. Based on the discussion, the research recommends the need to help women farmers' train themselves with measures to combat the adverse effects of climate change/variability, by forming farm base associations in order to support and authorise themselves. They should be provided with irrigation facilities to help them practice all year round farming.

DEDICATION

AKNOWLEDGEMENT

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATION

CHAPTER ONE

INTRODUCTION

1.0 Background

Increasing greenhouse gases emission into the atmosphere through sweltering of fossil fuels for energy, industrial air emission and the destruction of carbon sinks in the past years is increasing global temperatures, resulting in changing climatic conditions (IPCC, 2007). Currently, there is public talk about this phenomenon, which has a threat on global food security with unbearable consequences for the susceptible people, particularly poor women farmers. IPCC (2007) defined climate change as statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Intergovernmental Panel on Climate Change (IPCC, 2007) Fourth Assessment Report indicated that Africa is fast warming up, all year round, than the global average temperature; a trend that is expected to continue by 2100, it was anticipated temperature change will decrease from about 1.4 degree Celsius (^{o}C) to nearly 5.8 degree Celsius (^{o}C), rise in the mean surface temperature compared to 1990 mean surface temperature, and the mean sea level will rise between 10cm to 90cm (AMCEN, 2011). At mid-high latitudes, production of crops might rise slightly whilst local temperature would increase between 1^{o}C–3^{o}C, which would lead to decline crop production as local temperature would rise between 1^{o}C–2^{o}C (IPCC, 2007).

Negative impacts of climate change is increasingly becoming obvious nowadays, which includes variations in temperature and precipitation; extremely increase in climatic happenings such as, drought, flood and rising ocean are becoming more severe nowadays (IPCC, 2007; Verner, 2011). These extreme climate threats will have negative impacts on agronomic production, biodiversity and ecosystem services.

Agricultural production can possibly increase in the mid-high latitudes in the case where temperature increases modestly. Conversely, adverse effects will be at greater rates as temperature increases. Developing regions are anticipated to get hit very hard by the climate variability/change. In the tropics and the sub-tropics minor increases in temperature can severely have a negative impact on soil fertility and crop yields? Projections are that general influences of climate variability on agrarian would negatively be affected, whilst worldwide food security would feel threatening (Nelson et al., 2009, 2010; Keane et al., 2009).

Furthermore, there will be variations in the occurrence and cruelty of extreme climate happenings, this would negatively have impacts on natural resources, agricultural production and on human livelihoods. Rises in the frequency of heat, drought and flood events are also anticipated to have adverse effects on crop and livestock production (IPCC, 2007).

Occurrence of rainfall deficiencies and dry spells are expected to be more, rainfall will be more unpredictable, and the downpour of torrential rains will be heavier than before. Most of these phenomena are those that will decrease soil nutrient via runoff. High temperatures will intensify soil moisture evaporation. Climate variability will worsen water stress, which most regions are currently experiencing; majority of women farmers will be in danger of water stress (Boko et al., 2007).

The negative effects associated with changing climate differ from one state to the other, one district to the other, and within communities as a magnitude of production and frequency of threats. Nations that are poor are more susceptible to impacts of climate variability. Several of these states are at present subject to warmth, rainfall deficiencies, desertification,

deforestation, flooding, diseases and regular tragedies, and lack of structures (Economic Associates and Report, 2012).

Africa is amongst the Continent's most susceptible to climate variability/change. Socio-economic growths aggravate the effects of climatic change/variability on ecosystem and humans. The economy of several Africa countries is at the mercy of sectors susceptible to climatic situations, such as farming. Agronomy and natural resources offer the human livelihoods seventy percent to eighty percent of the total populace and account for thirty percent of the Gross Domestic Product and forty percent of export income in Sub-Saharan Africa (Huq, 2006). Within these poor countries, are the most susceptible and marginalised groups, expected to experience serious impacts of climate change/variability (IPCC, 2007).

Generally, males and females are impacted differently by climate variability due to social factors specifics of work and uneven access to natural resources, and contribution in decision-making (Rohr, 2007; Lambrou and Piana, 2005). The effects of climate change/variability results in sustenance shortage which subject women to increase their workload, by attempting to find sustenance for their household (Swai et al., 2012). Lambrou and Piana (2005) reported that while men are able in managing irrigation, they prefer mechanised agriculture methods, whilst women are mostly involved in labour-intensive and small-holder farming, which normally increases women susceptibility to climate stress. According to McCright (2010) women are able to express their understanding of climate change/variability more than their male partners, although men tend to undermine women knowledge. In the area of agronomy, females feature prominently, as they are believed to produce more than half of all the crops that are grown, exactly, up to 80 percent in Africa (Mehra and Rojas, 2008). It is presumed that if women income is increased, women can have more access to natural resources which

they can invest in their children's education, health care and nutrition. Nevertheless, women are constrained by poor access to natural resources, taking new chances, which includes new markets, limited educational background, poor networks and movement limitations. Rural women in agriculture are predominately engaged in crop farming and petty trading, whilst their male partners are into sustenance and cash crop farming mainly which comparatively are on a higher scale (Duncan, 2004). Women account for about 70% of total food production in Ghana. Under the current macroeconomic framework of the government, agriculture was expected to play a lead role in achieving the target of 5% GDP growth rate in 2005. In more specific terms, growth in the sector was expected to rise from 4.1% per annum in 2002 to 4.8% in 2005 (Giarracca and Teubal, 2008). In 2010, the Social Watch Coalition reported that women are responsible for 87% of food crop production in Ghana (SWC, 2010).

Talking about the challenges of global warming and climate change/variability, the focus for a while has been on reducing greenhouse emissions. There has been little progress on reducing greenhouse emissions and the climate has continued to change affecting the agricultural sector negatively in many developing countries including Ghana (Guthiga and Newsham, 2011). Lately, the focus has shifted to adaptation strategies to reduce susceptibility to climate change impacts (Guthiga and Newsham, 2011).

Agronomic is the key basis of revenue for majority of farming communities, adaptation strategy is important to improve the resilience of the agricultural zones, protect human livelihood, and ensure food security (Bryan et al., 2013). Adaptation strategy involves investment in drought-resistant crop varieties, irrigation systems, tragedy assistance, assurance and social defence courses, and integrate policies to lessen livelihood dangers at the national level as well as at the native level (Howden et al., 2007; Schlenker and Lobell,

2010). Climate change adaptation at the farm level comprises of several possible answers, which includes, change in crop management practices, land choice, planting and harvesting time, planting densities and crop varieties (Ayivor et al., 2015). Livestock management practices such as choice of livestock, feeding and animal health practices. Land use/land cover management such as, ploughing, tree planting to reduce evaporation of soil moisture as well as prevention of soil nutrient as a result of soil erosion, irrigation and water harvesting, soil and water conservation measures, tillage practices, soil fertility management and livelihood strategies are all considered climate change adaptation strategies (Brklacich et al., 1997; Bryant et al., 2000; Smit and Skinner, 2002; Kabubo-Mariara, 2008).

1.1 Problem Statement

Prediction models of climate change/variability indicated the Sudan and Guinea Savanna zones of Ghana will continue to experience temperature increase and rainfall decrease. 2030 and 2039 is expected that rains might start in June or late in the Northern region of Ghana (Ndamani and Watanabe, 2015). Projections show standard deviation for the onset of the rainy season will increase, which proposes not only will the timing of the rains change but also rains will become even more unpredictable. The Northern region of Ghana will witness more dangerous climatic events such as deficiencies in rainfall, dry spells, and floods. These effects will eventually have an influence on agronomy production, the environment, and human livelihoods. Nonetheless, prediction also has it that the negative impacts on the agrarian zones will aggravate poverty (Ndamani and Watanabe, 2015).

Poor agriculture practices and overgrazing have caused land surface to change, this has resulted in desertification and deforestation. Removal of vegetation cover has resulted in the increase of albedo and decrease soil moisture. These have had a negative impact on the

climate, making it difficult for farmers to predict the weather and heavy storm rainfall has become more likely (Opoku-Ankomah, 1998). Surface moisture decrease in semi-arid regions such as the Upper West Region has led to increased surface temperatures resulting in incredible rain formation and increased drought (Kendale and Ann, 2005). Variability in the climate has resulted in increased temperatures with high intensity rainfall within short periods, severe downpours which sometimes cause flooding. These effects are very extensive along the Black Volta in the Lawra district. Recent disastrous floods occurred in October 2010 which basically affected 141,100 individuals, leading those homeless, which also led to the destruction of farm produce and lands (NADMO-USAID, 2011). Future Temperature increase has been predicted by IPCC (2012) Fourth Assessment Report, will, therefore, lead to increasing occurrences of flash floods in communities along the Black Volta.

The scenario on climate change represents an important threat to the environment, communities and the economy which is now known by most policymakers and researchers as a subject of dangerous fear. Climate change is ascribed to anthropogenic activities and is generally perceived over a period of time (Mings, 2008). Occurrence nowadays is the utmost severe worries to sustainable growth in the urban and rural locations. The expected negative impacts are attributed equally to natural events, human wellbeing, sustenance safety, finances, regular resources, organisations and on agronomy, these are measured the greatest exposed (Lang et al., 2007). Lately, subjects of changing climate have been the talk all over the universe. Nevertheless, there is a deficit in perception of climate change/variability particularly in areas where propagation of information is a challenge.

Perception is amongst the causes that influence women agrarian's choice to either adapt or not adapt to climate change/variability, this will decide the choices to be taken by women

farmers thereby managing their agricultural practices. Revelation on climate change/variability shows more agriculturalists nowadays perceive the existences of climate change/variability (Maddison, 2006; Gbetibouo, 2009; Swai, et al., 2012; Kashaigili et al., 2014). Several research show farmers now perceive the weather has become hotter and the rains unpredictable whilst the timing has become shorter. Evidence on agrarians' perception to climate change/variability is more obvious, but there is limited information existing about women farmers' awareness with diverse characteristics on climate change/variability (Sipho, 2016).

Climate change/variability existence and food security relationship show how the perception of climate change/variability influence adaptation responses resulting in food security. Diverse issues have been identified that women farmers' perception to climate change/variability and therefore, how these factors further influence their adaptation responses, crop production and food security. Amongst the major factors identified to influence perception and adaptation includes age, education, access to extension services, access to climate materials, household size, access to funds, marital status among others (Sipho, 2016).

Older women farmers may perceive climate variability more precisely compared to the younger women farmers, as a result of their many years of farming experience and the in-depth indigenous knowledge that they have acquired. They may also have a better understanding of weather pattern such as the beginning of the rainy season on an annual basis. Similarly, exposure to education or training is also influential in improving the perception of climate variables. (Sipho, 2016).

Educated women farmers or those who might have benefited from skill training programmes may also perceive climate variables better than uneducated or untrained women farmers. This may be as a result of their better understanding of the climate scheme and capability in the understanding of climate data. Nevertheless, information on weather and extension services exposure meaningfully influence perception to climate change/variability, since it is based on such exposure and clarification of this information that women farmers can perceive better climate variables, where again their understanding of the information becomes significant (Sipho, 2016).

Women in farming and food production, established in developing countries play a significant role, thus, the role of gender in perception cannot be underrated. Farming in most male-controlled societies in the developing countries is left in the hands of women (female farmers) as men travel in search for career opportunities. Due to increased exposure, female farmers, then tend to perceive climate variables better such as rainfall. This is as a result of their farming experience, mainly in regions where agriculture depends completely on rains (Sipho, 2016).

Nonetheless, there are existing discussions on adaptation strategies at the farming level. These emphasis on practical responses at the highest level and largely do not deliberate on the details why certain choices are or are not selected by these deprived rural women farmers (Ruijs and Bel, 2011). The risk of focusing too much on technical measures are that inadequate reflection is specified to inexpensive adaptation methods which women farmers can adopt themselves (OECD, 2008).

Nevertheless, women farmers have adopted inexpensive farming practises which have lessen their sensitivity to extreme rainfall variable, although the exact methods adopted differ from one country to another. There is a lesser interest on the physical methods to lessen exposure and increase adaptation, due to income, marketplace and awareness (Tabbo et al., 2016). Climate change/variability does not only affects farm production, food security, health and biodiversity but also quickens desertification. In other to solve these problems, numerous measures such as an adaptation such as a decrease in agricultural inputs, the shortage of rainfall and lack of pasture and the lessening of greenhouse gas emission (carbon sequestration) have been anticipated. Other strategies such as resource trading like straws, woods, wild fruits, and socio-economic activities such as trade and various handicraft making have been introduced in short term to help women in farming to adapt (Tabbo et al., 2016). Temporarily, an additional broadening of economic activities targets at compensating losses and declines of harvests, developing better-quality seeds more resilient to drought and assimilating water resource management, are some strategies proposed for intermediate- and long-term adaptation (Tabbo et al., 2016).

According to the community development plan report (2011), the local government of Kaou completely situated between the Sahara and the Sahel zones is been affected by the conjugated effects of desertification, water and wind erosions, high pressure on farm lands and the progressive reduction in the amount of rainfall. This has brought about significances such as natural resource degradation, decrease in farm production and shift in farm line explained by the search for capacity development to enhance resilience through the development of strategies for women farmers. Application of effective change in the climate adaptation strategies will increase the resilience of many people living in developing

countries. Hence, local authorities and community-based institutes in the development of adaptation strategies will be very important and involving (Tabbo et al., 2016).

Projects, nongovernmental organisations and development partners have financially and technically sustained the local government authority to develop women farmers' adaptation strategies, thereby strengthen their resilience in contradiction to the negative effects of climate variability. Conversely, the assessment of farmers' adaptation strategies in contradiction to climate change/variability has not been managed, where most projects have been introduced thereby given little attention to women farmers' opinions (Tabbo et al., 2016).

1.2 Significance of the Study

In Ghana farming continues to be one vital instrument for sustainable development and reduction of poverty due to the significant agrarian component in Ghana's economy. According to World Development Report on Agriculture (2008) farming is a source of growth for the national economy, it is a benefactor of venture openings for private and public sectors, a prime driver for agriculture-related industries and rural off-farm economy. In Ghana, agriculture, however, depend on rains and farmers generally use simple tools and equipment in their farming activities. Due to the nature of agriculture in the country, it is highly affected by changes in the climate.

Since anthropogenic effects on variability in the climate are not gender-neutral, it is essential for a study to be conducted to establish reasons why climate variability have adverse impacts

on the most marginalised people in the farming industry. Similarly, WEDO (2007) reported that majority of women form the world's poorest people and are susceptible to the impacts of climate change/variability. The government of Ghana recognised that the impact climate change can have on it citizens made government signed the United Nations Framework Convention on Climate Change (UNFCCC) in June 1992 in Rio de Janeiro. The Convention entered into force globally on March 21, 1994, and specifically for Ghana on December 5, 1995, three months after Ghana ratified the Convention. In 2002, Ghana's Parliament passed a resolution to ratify the Kyoto Protocol (KP) and the Kyoto Protocol entered into force globally on February 16, 2005 (Agyeman-Bonsu and William, 2007). These interventions made by the government of Ghana were to provide farmers with the essential infrastructure as contained in the various conventions and policies to increase their adaptive capacity against climate change impacts. Ministry of Food and Agriculture (MOFA) also established women in Agrarian Development Directorate in 1989 as a way of improving strategy and execution of gender methods to help females' agrarian production undertakings. This research seeks to bring to fore the impact of climate change/variability on women agrarians' perception and adaptation strategies in the Lawra district in the Upper West Region of Ghana.

In order to increase the abilities and capabilities of women farmers to adjust to ongoing and forthcoming climate change/variability, we need improved understanding of the risk they are facing concerning farming and climate change/variability. Therefore empirical research is important to identifying the magnitude and effects of climate variability in order to see women farmers' perception and their adaptation strategies. This study was aimed to establish the status of climate variability, to study the effect along with the adaptation strategies of women farmers, in order to provide a meaningful insight and contribute to efforts aimed at ensuring sustainable adaptation strategies. It provides realistic information to formulate

policies and develop intervention mechanisms that are tailored to the specific need of the study area. Furthermore, this study can be used as a source material for further studies.

1.3 Research Questions

Major question: what are the effects of climate change/variability on women in farming?

1.4 Specific questions:

Which group of women are into farming in the district?

What are the adaptation strategies women farmers in the district adopt to?

What are the factors accounting for women farmers' inability to adapt to climate variability in the district?

How do the women perceive climate change/variability in the district?

1.5 Research Objectives

Major Objective: The research seeks to examine women farmers' perception of climate change/variability and their adaptation strategies.

1.6 Specific objectives:

I. To establish from existing records whether or not the district is experiencing climate change/variability
II. To identify different category of women farmers in the Lawra district.
III. To examine women farmers' perception on climate change/variability,

IV. To identify women farmers' adaptation strategy in response to climate change/variability,

V. To assess barriers to climate adaptation for women farmers

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

There is Literature on climate change, which have stated a potential impending situation of carbon dioxide releases and have provided such significant initial fact for this research. Here are likewise extensive debates on components of climate change with possible effects. Some experimental confirmations are existing which shows the impacts of current changing climate on agriculture and on women farmers especially. The literature review has been classified under the following subheadings; Concept and terms of climate variability/change, Agriculture and climatic changes, Climate variability/change and Ghana's agriculture, Category of women farmers, Climate variability/change in Lawra district, Women farmers' perception to climate change/variability, Climate variability and adaptation strategies, finally, Barriers to climate change adaptation.

2.1 Concepts or terms in climate variability/change

Climate and weather are often used interchangeably, definition of ''weather'' by World Meteorological Organization (WMO) is the atmospheric conditions of a place at a given time and ''climate'' is the day-to-day variations which are often based on statistical average of a 30-year record of weather observations (Barry and Chorley, 1992).

Climate variability is used to indicate the disparities of climate on all historical in mean state and spatial scales (Fu¨ssel, 2010). Nonetheless, for some meteorologists and climatologists, defined climate variability as short-term variations above or below long-term average values (Terungwa and Torkwase, 2013). Climate change as continues variation in the typical meteorological conditions was defined by the World Meteorological Organization (WMO)

(Barry and Chorley, 1992). Solomon (2007), also defined changing climate as the state of the climate in variation that can be recognised (example using statistical test) the mean persisting for an extended period in the changes, generally years or extensive time span. Definition of climate change by The United Nations Framework Convention on Climate Change is a change in climate that is recognised right or incidentally by anthropogenic action that changes the composition of the universal atmosphere and, natural climate variability, being witnessed over subsequent times (IPCC, 2007). Splitting climate change and climate variability may be needless from the view of vulnerability and aiding adaptation (Adger, 2006). This is because, climate change and climate variability impacts may not be significantly different from each other (Adger, 2006). Consequently, the term is used to refer to perceived and predictable increases in average global temperature, increases in extreme weather conditions, variations in the timing and the total precipitation associated with their impacts.

2.2 Agriculture and climate changes

One important area for human sustainability is agriculture because, it produces food for human and also the main source of employment which consists 36% of the entire labour force in the world (World Bank Group, 2012). International Labour Organization (2007) stated that "the share of agriculture in severely populated countries such as Asia and Pacific ranges from 40% to 50%, and in Sub-Saharan Africa, two-thirds (2/3s) of the working population make their living from agriculture" (ILO, 2007).

The changes in climate would have impacts on agriculture but it is not clear whether the average global agricultural potential will increase or decrease because of climate change (Adams et al., 1998). Notwithstanding, regions and crops have covered several studies on a wider range showing the adverse effects of changing climate on agriculture yields which have been more public than affirmative (Parry et al., 2013). Research have revealed that positive

impacts of changing climate relate to regions with high latitude, although it balance of impacts is either negative or positive in these areas (Edenhofer et al., 2014).

Furthermore, two degrees (2^oC) temperature increase or more beyond the late 20th era is anticipated to negatively influence agricultural production and decrease subsistence crops such as sorghum, maize, millet, and groundnut (Edenhofer et al., 2014). IPCC (2007), reported that crop produces from agriculture depending on rains could be halved (1/2) in 2020, several regions and net incomes from crops productions will also drop by 90% in 2100 (Fischer and Edmeades, 2010). Moreover, increase in the occurrence of floods and droughts are projected to adversely impacts crop production locally, especially low latitude regions, due to pests and changes in ground water levels related to climate change/variability (Selvaraju et al., 2001).

2.3 Climate change and Ghana's agriculture

Agriculture, including forestry and fishery, remains the largest industrial sector in Ghana employing about 41.5% (44.9% males and 37.7% females nationwide) of the energetic populace aged 15 years and older according to Ghana Statistical Service (2012). In 2006, agriculture alone generated about 75% of the export earnings of the country (Sagoe, 2006). Therefore, the overall economic progress of Ghana to a large extent depend on the growth of the agricultural area.

An agricultural household is one in which at least one member is engaged in one or the other agricultural activity (GSS, 2012). In all, 45.8% of all households in Ghana are agricultural households and approximately 95.1% of these households are engaged in crop farming as well as 40.5% are also engaged in livestock rearing and 1.1% engaged in tree planting (Caulum et al., 2012). 58.3% of agricultural households practice monocropping i.e. having a

single crop on a field of plot, while 22.8% of households practice mixed cropping i.e. planting two or more crop on a field and more than three-fifth of households practice mixed farming i.e. cultivating of crops and rearing of animals at the same time (GSS, 2012).

Nunoo and Acheampong (2014), argued that in Ghana, crop and livestock farming is extremely dependent on climate, making it vulnerable to rain and weather patterns. This is because, of all the elements of climate required for agriculture, it is the variability in rainfall and temperature that directly impact soil moisture. International climate models project increases in rainfall variability for Ghana's agro-ecological zones (Stanturf et al., 2011). For example, in some areas of the savannah and transitional zones, rainfall is projected to increase while for both Savannah and transitional zones, delays in the rainy season and extended drought may result in reduced harvest, especially for maize (Stanturf et al., 2011). With respect to excess rainfall, flooding may affect maize and lowland rice farming while higher temperature may cause evaporation in dams and dug-out wells (Barry et al., 2005). The agriculture system in Ghana remains sensitive because, the nature of production is still rudimentary, rainfall dependent uses old methods and techniques (GSS, 2012). Therefore, climate change and variability may not only affect Ghana's agricultural productivity in terms of yields and subsequently food security, but may also pose threats to the farmers' income as agriculture may become even uncertain and risky for rain-fed agriculture (Dietz and Veldhuizen, 2004)

2.4 Category of women farmers

Women in farming are extremely well-organized and use extensive political power due to their successful association. As it may be, cultivating associations are completely male. Women in cultivating associations and the presence of women's cultivating associations fortify gender orientation divisions within agriculture do not in any capacity question the comprehension of men as agriculturists, or the political power they hold. To consider how women are dealt within cultivating association. Weber proposed that within a bureaucratic association, roles are occupied on the premise of legitimacy and expertise rather than acquired status. Nevertheless, when taking a gender at women in cultivating organisations, the women's activist scrutinise of Weber's hypothesis is more suitable. Farming organisations are not gender-bias, and collaboration with the occupants of roles is vigorously influenced by the gender of the occupant (Shortall and Shortall, 2001).

Nevertheless, women in farming comprise over 40 percent (%) of agrarian labour force in the developing world, and ranges from about 20 percent (%) in America to almost 50 percent (%) in Africa (Team and Doss, 2011). Woman farmer chances to a farm are influenced by her specific societal and life course. Women’s lives across structural move moulding, existing patterns in sustainable cultivating, land access including legitimate rights, social dispositions toward women, increase educational level of women and economic power will give women the opportunity to improve agricultural sectors. Furthermore, increasing the number of women in the agriculture field will help more women to get access to land directly as compared to their male accomplice. From numerous point of view, the structural and cultural discrimination against women as landowners and cultivators are challenges originate from a long history. Generally, women are deprived of the legal right to own land. Women in farming constitute, educated, non-educated, divorce, young, old, widow, physically

challenged, just to mention but a few. (Pilgeram and Amos, 2015).

2.5 Climate variability/change in Lawra district

The world's climatic change is no longer subject to discuss as numerous studies conducted by researchers confirm the phenomenon (Parry, 2007; Hinzman et al., 2005; Kaser et al., 2004; Walther et al., 2002). Changing climate has, then, become a clear phenomenon in all parts of the world as research has shown its signs in both the pure and applied sciences (IPCC, 2012). Truthfully, climate change has been established by its various signs and associated effects and impacts on human activities. On the larger scale, growing irregularities of various weather events have revealed signs of climate change/variability (Abdulai et al., 2017). This consist of changes in rainfall, temperature, humidity and other consequential happenings like rising sea levels, melting ice and glaciers, flooding, droughts, the disappearance of plant and animal species and many others (Parmesan, 2006; Jones et al., 2007). Nevertheless, studies have noted all these several pieces of evidence of climate change, the need for context-specific signs is still essential considering the diversity of this contemporary phenomenon (Abdulai et al., 2017).

The location of Lawra District makes it experiences tropical mainland kind of climate with it mean annual temperature between 27°C-36°C (Abdulai et al., 2017). This, however, makes the months of February and April the hottest periods in the area. According to Ghana Statistical Service (2014), there has been evidence of climate change in the area of late, affecting meteorological conditions which makes the Tropical Maritime air blows over the area between April and October, which gives the only wet season in the year (Abdulai et al., 2017).

2.6 Women Farmers' Perception to climate variability

Climate change/variability is a major problem that impacts the world's ecological zones in this present era. Vital evidence concerning women farmers' awareness of changing climate especially in the deprived communities are lacking. Surveillance shows there is conversely, little knowledge of women farmers' awareness to climate change/variability particularly amongst rural women (Egbe et al., 2014).

Perception, knowledge, experience of life-threatening climatic events and effects influence women farmers' to follow precautions (Siegrist & Gutscher, 2006, 2008; Grothmann & Reusswig, 2006; Thieken et al., 2007) which encouraged women to whether follow or not to follow the adaptation options (Berkes and Jolly, 2001; Alessa et al., 2008). Moreover, indigenous perceptions on climate change/variability can reflect local concerns to women farmers (Danielsen et al., 2005), whilst the real effects of changing climate will insight women the next steps to be taken (Laidler, 2006). Additionally, women farmers' experiences and opinions on the past climatic happenings can assist women to foresee likely effects in the future (Lorenzoni and Pidgeon, 2006). Consequently, local perception could be considered in the situation of climatic changes for an effective implementation of climate change/variability resourcefulness (Byg and Salick, 2009).

Women farmers perceive climate variables as vital for rain-fed agriculture as it stimulus investment decision in relation to the amount of input used. Women Farmers invest sufficiently or suitably when they perceive rainfall to be plenty and abandon investment when they perceive rainfall to below. Similarly, even in good years where rainfall is satisfactory, women farmers abandon making the proper investment in inputs resulting to poor crop yield amongst adequate rainfall due to a poor or wrong perception of climatic variables such as

rains in the onset of the farming season. The importance of proper perception, therefore, cannot be exaggerated (Sipho, 2016).

The agricultural sector in Swaziland, like in many developing countries highly depend on rain for crop production. Maize is the primary essential crop and is widely grown by smallholder farmers throughout the country, with a dual sorghum-maize regime found in the Lowveld region and fewer parts of the Middleveld of Swaziland. Amongst the smallholder farmers," almost agricultural production is rain-fed with very few farmers using mechanised irrigation. Moreover, a significant decline of agricultural production and aggravated poverty in the kingdom is as result of climate change/variability (Sipho, 2016).

Seasonal variation, such as drought and rainfall variability has been a major risk to food security, with huge failures in maize yield constantly occurring in seasons with below normal rainfall. Several research have been revealed in Swaziland to quantify the effect of climate change/variability on crop production, and how farmers are reacting to such changes. Among the existing climatic change, discussions in the country show women farmers perceive climate change/variability otherwise and that women farmers' perception can influence investment decisions, crop yield and food security (Sipho, 2016).

In Nigeria, traditional and cultural frequently controls women faith. These faiths decide women perception that influences their dealings about the environment. Consequently, situations of changing climate are regularly observed by these women farmers as naturally happenings that would not have any negative impacts on the environment in the forthcoming. Reason been that there is limited information on current climatic trends as well as reasonable corrective actions or policies (Egbe et al., 2014).

2.7 Climate variability and women farmers' adaptation strategies

Climate change adaptation is the alteration in natural or anthropogenic systems in reaction to actual or anticipated climatic stimuli or their effects, which lessens damage or exploits advantageous chances (IPCC, 2001). The easy approaches of adaptation strategies in farming includes; using new crop varieties, irrigation, drought-resistant crop variations , mixed cropping, mixed farming, livestock agriculture techniques, and changing sowing and harvesting time (Kurukulasuriya and Mendelsohn, 2008; Bradshaw et al., 2004; Nhemachena and Hassan, 2007).

Climate change impacts on worldwide agriculture productivity are certain (IPCC, 2007; IAASTD, 2008; Godfray et al., 2010; Mercer et al., 2012). Despite the fact that evaluations for various geographical regions and crops differ, the knowledge of climatic variables stays narrow, therefore horticultural production in numerous regions are required to decrease (Lobell and Field, 2007; Lobell et al., 2008). Lobell et al. (2011) stated that the world's maize production is estimated to decrease, says the anticipated worldwide production is ~3.8 percent because of climate variability impacts between the years of 1980 and 2010. Few agronomists who grow extensive varieties of traditional crops serve as superiors of these differing crop qualities that make their susceptibilities have effects on the in situ conservation of varied traditional crops (Bellon and Hellin, 2011; Brush, 2004). According to Ortiz (2011, p. 190) reviewed that, "agrobiodiversity remains the key raw material for agroecosystems to adapt to climatic changes since it can give qualities to plant breeders and farmers to choose resilient, climate-ready crop germplasm.

There are numerous adaptation strategies on climate variability which have been proposed to address production of crop? One of these strategies, stress on changing social practices. For

example, numerous agriculturalists are changing planning of sowing and modifying irrigation system (Cutforth et al., 2007; Conde et al., 1997). Mercer et al. (2012) stated that in receiving strategies to expand the resilience of agroecosystems to ecological variability, the advantage is that climate variability leads to susceptibility, so expanding the structure's capacity to climate is important. Huge variations to agroecosystem might bring challenges on women farmers to cope, especially when their assets are stressed. Another strategy includes enhancing varieties of seed to grow new crops, for example, dry spell resistant crop varieties (Edmeades, 2008; Pray et al., 2011; Grover et al., 2003). It is generally known that well-spoken on adaptation strategies would lessen the adverse impacts of climate variability on farming and biodiversity (IPCC, 2007; Hatfield et al., 2008; Mawdsley, 2009). Adaptation in agriculture can take many measures, on numerous scales, and include different performers (Mercer et al., 2012). Smit and Skinner (2002, p. 95) recognised four (4) mean groups of adaptation: "technological development, governmental programmes and assurance, farm generational practices and farm finance management''.

Nonetheless, particular social gathering and regions receive distinctive strategies to help them adjust to climate change in other to improve yields (Mercer et al., 2012). Given the multifaceted nature of making a decision at the farming level, specific agriculturalists inclined towards coordinating a particular adaptation strategy, regardless of possibilities that are not viewed as the best, due to different variables women farmers can consider (Smit and Skinner, 2002; Rosenzweig and Tubiello, 2007). The requirements of women agriculturalists make it unnecessary to centre on adaptation strategies that are simply suggested as "choices between products" (Smit and Skinner, 2002, p. 107). Additionally, the clashing requirements amongst women farmers limit them in choosing the adaptation strategies to adopt (Smithers and Blay-Palmer, 2001).

Agricultural sectors, however, are active, they have the ability to cope with climate variability via natural events. The genetic differing quantities inside and among traditional crops react to natural and farmer intervened procedures (Brush, 2000), for example, new pests or change in seed. Introduce of new biotic and abiotic conditions due to climate change/variability will consistently bring about proceeds with an alteration to traditional crops preserved in situ.

In Ghana, few studies have given reports on adaptation strategies in farming which includes, crop variety, changing of sowing and harvesting time, hybrid varieties, and soil moisture preservation practises. In Uganda, revenue changing, construction of drainage systems, and utilisation of drought-resistant crop varieties have all been accounted for. To add to, mixed farming, mixed cropping, tree planting, utilization of crop varieties, changing harvesting and sowing time, and improved use of irrigation, have been improved, these activities have been reported in Nigeria and South Africa (Ndamani and Watanabe, 2015).

In Asia, numerous indigenous agricultural practices which however adapt to climate change includes; mixed farming, mixed cropping, agroforestry, livestock production and using variation of crops. In addition, adaptation options such as irrigation techniques, and varieties of crops in agronomy are to combat climatic event, mainly drought (UNFCCC, 2007). Precise farming and agricultural growth are certainly essential to meet the sustenance supply in Asia since both techniques increase crop production per resources use (IPCC, 2007). Additionally, adaptation strategies for farming can be technological adaptation approach which includes, transplantation methods in order to adapt to flooding (UNFCCC, 2007).

2.8 Barriers to climate change adaptation

Barriers to climate adaptation has received increasing care in current times, particularly in the United Nations Framework Convention on Climate Change, amongst improvement and adversity experts (van Aalst et al., 2008). Early ways to deal with adaptation took a ‘‘top-down’’ perspective, moving from universal climate model situations to sectoral impact studies and after that to evaluations of adaptation alternatives (van Aalst et al., 2008). Barrier to climate adaptation is progressively underscored and significant (Pielke et al., 2007). Adaptation has gotten to be a piece of talk on dangerous atmospheric deviation and is currently broadly perceived as a principal and essential reaction to the risk postured by the climatic changes that will happen, or are now happening, due to significant time span of carbon dioxide emissions (IPCC, 2007; UNFCCC, 2007). Anthropogenic adaption to climate change is not another marvel. Feeling desperation has come in the scene and scientists, government, and the public have involved in competition in contrast time to appreciate how adaptation can be assisted, sustained, and eventually continue, in countries in danger to climate change/variability impacts (Coulthard, 2008).

The significance of rain-fed agriculture on women livelihoods, on how women have reacted to climatic events, includes, factors that hinder agriculture, all been attempted crosswise over sub-Saharan African. Barriers from the point of revenues required for variation to factors persuading are the causes behind not utilising specific adaptation strategies thus not reacting to changing climate signs, are reasons some group or women farmers adapt and others do not (Shackleton et al., 2015). Most studies have disclosed that only few women farmers can react to perceive changing climate, while others are limited by a suite of local and higher level barriers. A considerable lot of these barriers reveal the ones that are easily recognized, such as., financial, biophysical, technological, informational, and governance, with the absence of

satisfactory resources such as financial resources for agricultural inputs and the adoption of new technologies (example, irrigation) and lack of information with regards to choose from option or adapted agricultural practices being the most often cited barriers across all cases (Shackleton et al., 2015). Few studies inquire as to why these barriers develop, and most give careful consideration to the fundamental political–economic and structural factors which make essential specifications also making agriculturalists susceptible in the first place (Shackleton et al., 2015).

Furthermore, less than half of the women farmers in Ghana, have tried to react to experienced changes with regards to climate, as the core barriers to climate adaptation that limit information on adaptation strategies, agricultural practices and the climate, infrastructural such as poor transportation links to seed markets, financial aspect is poverty and access to funds or credit, as well as biophysical and institutional influences, such as low soil fertility and tenure insecurity. Kenya, also found out that shaky property rights, poverty, low self-organization, insufficient climate data, restricted reactions to market flow, livestock diseases, decreased mobility, insufficient skills, and poor infrastructure all postured barriers to sustainable and resilient adaptation to climate change/variability (Shackleton et al., 2015). With respect to social barriers, women found that agro-pastoralists' cultural attachment to livestock deterred livestock disinvestment during drought periods, brings about detrimental deals that affect farmers' capacity to reconstruct their crowds afterwards. (Shackleton et al., 2015).

Negative impacts of climate change/variability have been reported to have influences on rural women farmers in particular, because of their susceptible nature to climatic change (Goh, 2012; Kakota, et al., 2011; Nellemann, et al., 2011). Women domestic responsibilities such as

taken care of their children, firewood collection and fetching H_2O could make them mainly sensitive to climate, this is for the reason that women take on most farming works as males travel to look for new jobs. Women have limited right to agrarian resources which includes, plots of land, extension facilities and farm input, these hinder them to adapt to climate variability, gendered social norms and rules preventing women's adaptive capacity (Nelson and Stathers, 2009; Peterman et al., 2010; Kakota et al., 2011; Doss, 2011; FAO, 2011; Wright and Chandani, 2014).

2.9 Conceptual Framework

This study looks at sustainable rural adaptation strategies of women farmers, which has been used to organise the search for indicators, concepts and components of climate change/variability and how it influences women farmers' and the consequences thereafter to know how women farmers perceive climate change/variability.

Adaptive capacity signifies the ability of a system to recover/cope, change/modify if the environment where it exists is changing and actions of reasonable potential future damage, take possible advantage of chances and to cope with the significances of external stresses and shocks (Brooks, 2005). Adaptive capacity of a system can have an effect on the perception of climate change/variability by moderating exposure/sensitivity (Gallopin, 2006; Fellmann, 2012). There is no single approach in assessing adaptive capacity of a system, as its components extremely depend on a system at stake, although, there have been several efforts to structure the ingredients of adaptive capacity to introduce standard indicators to assessments (Asante et al., 2012). According to Asante et al., (2012), the factors of adaptive capacity are neither independent of one another, nor can forever replace one another, hence, adaptive capacity results from the combination of the determinants as well as differences

between economic units and their location over a period of time. Consequently, fostering the adaptive capacity of agriculture in Africa means, women farmers have to gain access to food, formal/informal education, practical skills, alternative source of revenue, health care, infrastructure and access to markets (Fu¨ssel, 2010).

Exposure, related concept to susceptibility is exposure and the degree, duration/extent to which a system is in direct contact with climatic threats or subjected to external stresses or nature and degree to which a system experiences environmental or socio-political stresses (Adger et al., 2008). Typical exposure factors are temperature, rainfall, and evapotranspiration as well as extreme events such as heavy rains (Field, 2012). Parameter changes can utilise major additional stresses on systems such as heavy rains, a shift of peak rain, and increase in temperature. People living in arid/semi-arid regions like Ghana are likely to experience increased exposure to drought, floods, and storms than those in the humid regions of Ghana. To evaluate exposure, we need to deliberate on how individuals and resources can be impacted via climatic changes/variability, therefore, precipitation and temperature change (IPCC, 2001; UNDP, 2012).

Sensitivity is an amount to which a system is affected or modified, either adversely or beneficially, by climate-related stimuli (IPCC, 2001). Sensitivity effect can be direct that is a change in crop production in response to a change in the variability of temperature, and indirect, been damages caused by an increase in the frequency of floods due to increased rainfall (Hinkel, 2011). Communities which depend on rains for agriculture are more sensitive to changing climate than communities where the means of livelihood is mining. Adger (2006) stresses that social factors such as population growth can only be regarded as sensitivities if they contribute directly to specific climate change impacts. Thornton et al.

(2011) explain that sensitivity to climate change/variability in most parts of Sub-Saharan Africa is extraordinary, because of the high reliance on the environment for livelihoods. Field (2012) concluded that exposure and sensitivity determine the possible impact of climate change/variability on agriculture. Thus, heavy rains in combination with steep slopes and bare soils may result in erosion. Gallopin (2006) stated that though a system may be considered as being highly exposed/sensitive to climate change/variability, it does not necessarily mean it is susceptible. This is because neither exposure nor sensitivity accounts for the adaptive capacity of a system to adapt to climate change/variability, whereas perception is the net impact that remains after adaptation is taken into account (Fellmann, 2012).

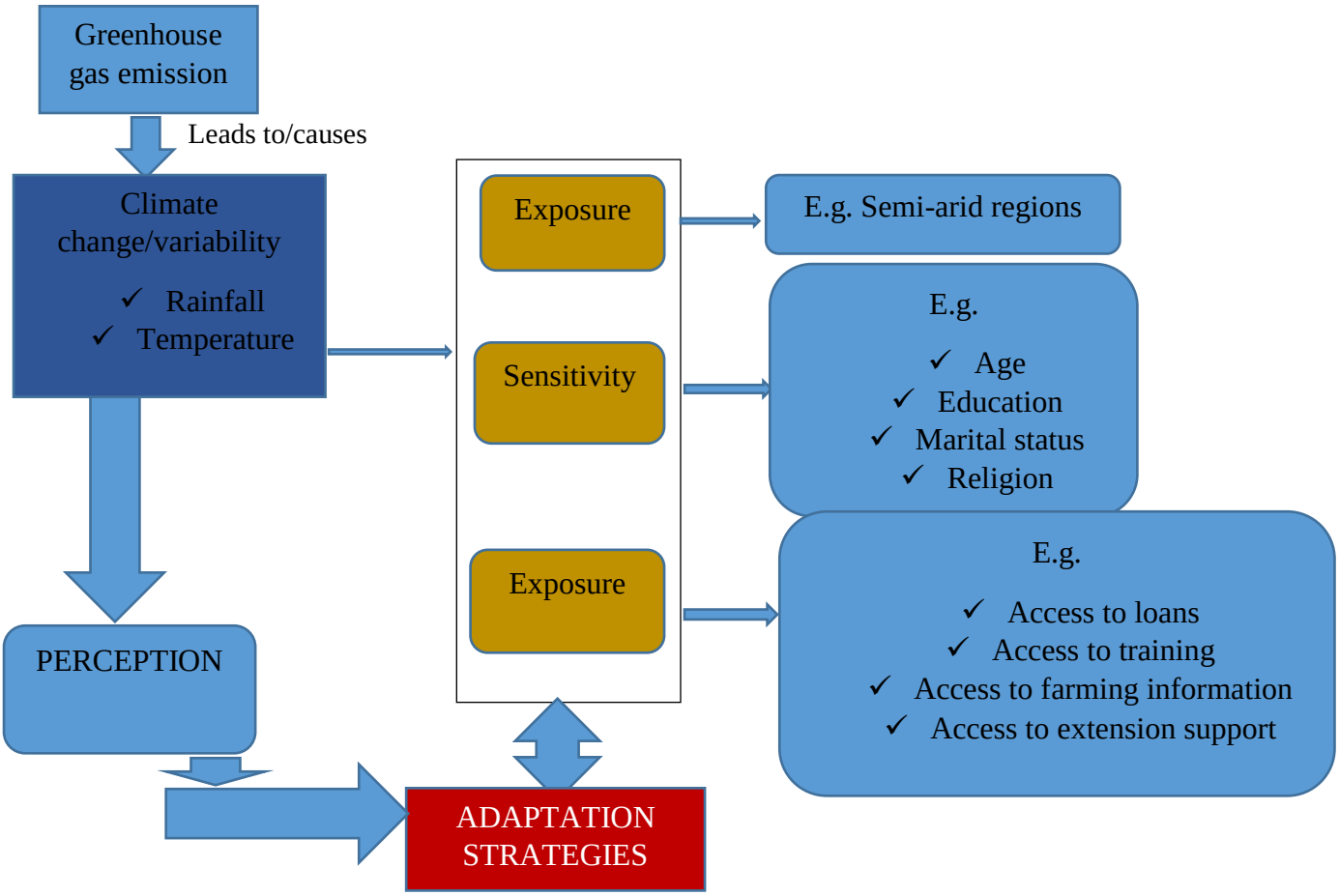

Figure 2.1 Schematic presentation of climate change/variability of women farmers' Adaptation strategies.

CHAPTER THREE

STUDY AREA AND RESEARCH METHODOLOGY

3.0 Introduction

This chapter will focus on the detailed description of the Lawra district, research design, population and sample size, sampling technique, data analysis and other beneficial evidence which have an influence on this subject matter either directly or indirectly.

3.1 Description of Lawra district

3.1.1 Natural and Physical Environment

One of the eleven districts that make up the Upper West Region is Lawra district which derives its lawful existence from Legislative Instrument (L.I) 1434 of 1988 (PNDCL 207, Act 462). The north-western part of the Upper West Region of Ghana is Lawra. Lawra is bounded to the north by Nandom district, to the east by Lambussie-Karni district, to the south-west and west by the Republic of Burkina Faso. Lawra lies between Latitude 10^{o}C 35-10^{o}C 40 North and 2^{o}C 50-2^{o}C 53 West. The total area of Lawra District is 527.3 kilometres square. This is about 2.8% of the Region's entire area land. The Lawra District has over eighty percent of the populace living in the rural zones (GSS, 2014). The population density of Lawra district is 104.1 per square kilometres (GSS, 2010). 65km is the longest distance across the area (that is the length). There are three (3) major towns and 138 villages. The prime natural resources in the district are the Black Volta, Brutu Forest Reserves and Mushroom rocks at Babile.

Lawra District has forest reserves with a total of 3,152.2 hectares; nevertheless, the natural environment of the district has been perceived by all kinds of degradation over the years to the extent that vegetative cover has declined which has led to low soil fertility. Extensive forest fires are annual formalities in most communities in the district. Conversely, few communities in the district, such as Goziri is adopting non-burning culture. Tree cutting for

firewood is done indiscriminately which is their principal source of energy in the district. Unsuitable agricultural practices, soil erosion, livestock overgrazing, sand, gravel and stone winning are another doings of environmental degradation in the district (GSS, 2014).

The nature of the land in the area is flat and low-lying. Land in the district rises to between 180 and 30 meters above sea level with isolated round hills dotting the landscape. This is a unique feature related with the Lawra Tumu high Plains. The area is filled with Birimian rocks high in minerals deposits. Along the flood plains of the Black Volta are strips of alluvial soils. Sandy soils, and loamy soils are also along some of its tributaries. The main river in the district drains the Black Volta, with Kambaa, Dangbal, Nawer and Kokoligu, Baa rivers, as its tributaries.

The formation of rock in the Lawra district is principally birimian with spotted outcrops of granite. The district's potential mineral is unknown. Various exploration specifies the existence of insignificant amounts of manganese, traces of gold, diamond, Iron ore and clay in the district. Because of a well-developed fracture pattern in the rocks, the possibility of obtaining ground water in the district is very high. In the early 1980s, borehole drilling activities established the occurrence of the granite and birimian rocks in the district (GSS, 2014). The district soils contain typical laterite. These soils are formed from the birimian and granite rocks which underlie in the area. The type of rainfall, and the general nature of soils, combined with the local land use practices, tend to have a negative impact on the production of crops. This has forced the younger ones to look for a job elsewhere at the expense of their lives and health.

Lawra District lies within the Guinea-Savannah, which is characterised by it short grasses and few woody plants. The common drought and fire resistant trees found in the District consist of Baobab, Dawadawa, Shea trees and Acacia.

Vegetation in the District is very pleasant for livestock production, and it contributes ominously to household's incomes in the area. The highest effect on vegetation is the long dry season which makes grasses become dry, and subsequent bush burning leaving the area patchy and mostly bare of vegetation during this period. Thus, heavy early rains lead to excessive soil erosion. Bush burning decreases the vegetative cover and transpiration; this eventually affects the average annual rainfall total causing low agricultural production as farmers mostly depend on rains for agriculture (GSS, 2014).

Furthermore, the district experiences two (2) seasons, which are the dry and wet seasons. The district's climate is the tropical continental type with the mean annual temperature ranging between 27^{o}C and 36^{o}C. The hottest months are between February and April. The late Climatic changes, however, affect the weather pattern. The only wet season in the year is between the months of April and October which is as a result of the Tropical Maritime air mass which blows over the district. Moreover, the major factor for youth to migrate is therefore associated with the underdevelopment of the human resource which is based on the rainfall pattern (GSS, 2014).

3.1.2 Economic activity

The population of Lawra district, per the 2010 Population and Housing Census, is 54,889 signifying 7.8% of the region's total population. Men constitute 26,347 representing 48.0% and females constitute 28,542 representing 52.0 percent. About 88.2 percent of the inhabitants live in rural vicinities. The sex ratio the district has is 92.3. The populace of the

area is youthful under 15 years representing 41.0% depicting a large base population pyramid which matches with a small number of elderly persons 60 years and above representing 10.1%. The dependency ratio of total age for the District is 93.6, the dependency ratio for males is higher (103.8) than that of the dependency ratio for females which is (85.1) (GSS, 2014).

The primary economic activity in the district is agriculture, which employs about 78.0 percent of the working people. Farmers who are into subsistence farming consist about 80.0 percent, producing mainly maize, millet, groundnuts, soya bean, and cowpea. Animal production is a significant agricultural activity undertaken by the people to increase their incomes from crop farming.

The local agricultural sector is threatened with depleting soil fertility, undependable rainfall pattern, low investment capital and skills, pests and diseases, inadequate access to extension service and poor access to the market. These challenges have resulted in microscopic agricultural productivity in the district, thereby making farming unappealing. Several of the active population, therefore, travel to other parts of the country to search for other opportunities (GSS, 2014).

The district industrial activities are closely connected to the agricultural sector which largely involves the processing of agricultural products such as Shea butter extraction. Most of the industries in the district are agro-based and small. Local industrial activities include Pito brewing, Shea butter extraction, smock making, basket weaving, etc. Increased access to financial capital and markets could improve the operations of some of the local industries (GSS, 2014). These small scaled industries rest on raw materials from the agricultural sector.

Furthermore, they absorb extra workforce in the district, which helps farm-based households to spread threats, offer more remunerative activities to replace agricultural income, offer income potential during the agricultural off-season and provides a mean to adapt or endure when farming fails. The Lawra district brags of some institutions that provide sustenance and training to warrant increased output from the industrial sector due to a substantial role played by this area.

Among the educational training establishments in the district are Eremon Technical Senior High School, the Boo Vocational School, and the Tanchara Vocational Institute. These institutes have over the years provided the skilled human resource. Other vocational training centres that are presently making progress are the Baare Xylophone Training Center and Binne Basket Making Center, all located in the Lawra Township (GSS, 2014).

Figure 3.1.1 below shows a map of Lawra District.

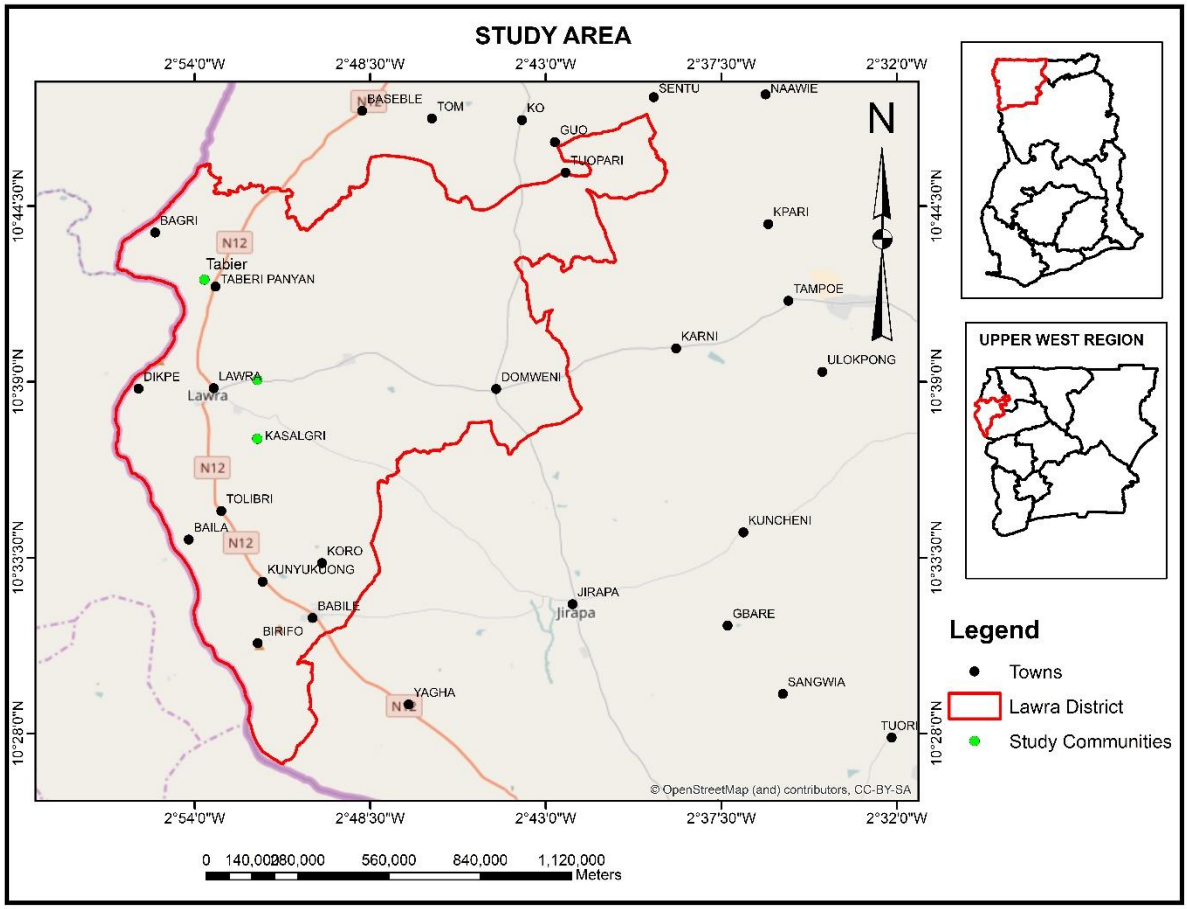

Figure 3.1 Map of Lawra district

3.2 Research design

Considering the nature of the study objectives, the research used a mixed-method approach for the data collection, therefore, integrating qualitative and quantitative data. Climate variability is multifaceted issue relating to diverse procedures, and a mixed-method approach allows a complete considerate of several dimensions of the problem (Adger et al., 2008). A mixed-method is more than simply collecting and analysing both data. It comprises the use of both approaches in a cycle so that the overall strength of the study is better than quantitative or qualitative research (Creswell, 2009).

Advantages of mixed-methods are numerous for the study of climate variability on perception and adaptation strategies of farmers. This approach allows both qualitative and quantitative data to be put together into one database and the outcomes used side by side to strengthen each other (Creswell, 2009). On the other hand, mixed-methods can serve a greater, transformative purpose to support marginalised groups such as women farmers, who rest on rains for farming. Consequently, the mixed-method approach allows for an in-depth analysis of women farmers' perception concerning climate variability, and adaptation strategies in response to threats in the agricultural sector (Antwi-Agyei et al., 2012).

Numerous researchers have undertaken mixed-method approach on adaptation studies. Example, Gyasi *et al*. (2006) followed the same analysis in their study, titled; climate change and adaptation assessment: a study of selected agro-ecological zones of Ghana. Jonge (2010) used the same analysis to assess farmers' perceptions on adaptation to climate change in Southern Australia.

Steps and procedures were followed to collect information to ensure the credibility of the data as well as the outcome of the study.

Information was collected from two main sources: secondary and primary. Open-ended and closed-ended questionnaires were used for the collection of household data. The study was conducted from February 15, 2017, to March 3, 2017, which is usually off-farm season in the study area. This timeframe was chosen because this is the best time to meet women farmers in their homes when farm activities were less. Also, women farmers are believed to be less reluctant in offering their time to answer the question during the dry season period compared to the major farming season.

Within the Lawra District, three communities were purposively selected to allow appraisals to be made without forfeiting the opportunity for in-depth qualitative and quantitative analysis: one community near the Black Volta and two communities farther away from the Black Volta. Community near the Black Volta was Tabier (a rural community) and farther away from the Black Volta were the Lawra township (urban community) and Kalsagri (semi-urban community) respectively.

The literature search on climate change/variability and its effects on agronomy production were done to provide a rough sign of various effect to anticipate, and methods of analysis expected to be most efficient and the scope of the study were defined. To generate past trends and variability in the climate concerning agriculture, secondary data on climate were obtained from Meteorological Service, Headquarters Accra.

Key informant interview, focus group discussions, administration of household questionnaires and field survey was implemented. Methodological triangulation like obtaining data from different sources, such as observation, documents and consultations, assist in connecting to different concepts about the similar issue and helping in validating outcomes, and therefore assist in increasing validity, and consistency in the results while easing data analysis (Olsson, 2009). Ikehi et al. (2014) showed that the use of questionnaires creates quantifiable data while interviews permit respondents to express their views on each detail as well as to state the nature of observed impacts of climatic events on their production level and livelihoods.

To understand the historical trends of rainfall and temperature variability in the past years, data on annual rains and temperature were taken from the meteorological service headquarters Accra. An in-depth key informant interview.

The used of the household question helped to accumulate both qualitative and quantitative information. Households were chosen as the key unit of study for the reason that, critical choices on adaptation to changing climate and livelihoods procedures are taken at the domestic side (Thomas et al., 2007). The household is defined as a collection of persons who possess the similar useful resources, stay together and eat in the same pot (Yaro, 2006). Households are linked to a broader community that can significantly control the policymaking process concerning the use of productive resources, therefore, it is essential to ascertain perception and adaptation strategies at the domestic level (Thomas et al., 2007). About 95% of the questions were closed-ended. The benefit of using closed-ended questionnaires was that it makes the analysis of the data easier. Also, closed-ended questions were less time consuming for the reason that, it took few minutes to tick boxes than writing full answers as connected with open-ended questions. The closed-ended question also allowed the researcher to tick the answers, since a majority of the respondents were illiterate.

The questionnaires were administered to only women farmers of the household and the community age 25 years and above. This was because according to Gyasi et al. (2006) respondents falling within this period may have information of climate change/variability patterns as compared to respondents below this range.

Organised focus group discussions were conducted with female farmers in each of the three communities, consisted of 10 female farmers. The aim of the focus group discussion was to understand women farmers' perception of climate change/variability, its sources and its major impacts on agriculture at the community level and the adaptation strategies women farmers engaged themselves in. Focus group discussions create evidence on the understanding of women farmers to climate change/variability; it's associated with dangers, how women perceived climate change/variability, and existing adaptation strategies women farmers practised (Mengistu, 2011). To understand different female roles and how they contribute to perception and local adaptation strategies, young women were separated from older women farmers to form groups to identify how different climate factors impacts on them.

Field surveys were done to validate the results of the initial literature review, develop more detailed perception assessments and to validate information gathered throughout the household surveys and focus group discussions. It also gave the researcher the opportunity to identify the nature of the soil, and the level of land degradation were also identified by the field surveys.

3.3 Population and sample size

Care should be taken to make the sample size of the study to be as descriptive as possible in agreement with the time and budget assigned. The population is an aggregate or totality of all the objects, subjects or members that conform to a set of specifications Polit and Hungler (1999). In this research, the population here was women farmers in the Lawra District. Women farmers of all age group, educational status, religious background, marital status, physically challenged and socio-economic status who fit the criteria for the population to be included in this study selection were considered. The process of selecting a portion of the population to represent the entire population is known as sampling (LoBiondo-Wood and Haber 1998; Polit and Hungler 1999).

The population of Lawra district, according to 2010 Population and Housing Census, is 54,889 signifying 7.8% of the region's total population. Males constitute approximately 26,346 representing 48.0 percent and females constitute 26,543 represent 52.0 percent. (GSS, 2014).

3.4 Sampling technique

Information collection is important in research, as the information is meant to add to a well understanding of a theoretical framework (Bernard, 2002). The purposive sampling procedure is the deliberate choice of an informant due to the qualities the informant possesses (Tongco, 2007). Simple random sampling is a sampling in which every member of the target population have a similar chance of being involved in the sample (Kitchenham and Pfleeger, 2002). The researcher selects what needs to be acknowledged and sets out to discover individuals who will be able to and are ready to make available information by virtue of experience/knowledge (Bernard, 2002; Lewis and Sheppard, 2006). Robbins et al. (1969) used the questionnaire as an effective approach to discover informants in a research about acculturation.

The study involved a cross-sectional survey, multistage, random and purposive sampling.

Stage one; communities were chosen purposively on a fair geographical spread.

Stage two; houses were systematically sampled in the communities with respondents randomly chosen, such that for every household been interviewed the third house from the first house was chosen to be interviewed to avoid bias answers. Also, where a road divides a community, homes were selected from both sides with the same systematic approach.

Stage three; women farmers were purposively sampled on the basis that women were the target group for the research.

3.5 Data analysis

Data were processed and analysed using Statistical Package for the Social Science (SPSS) version 22 software. Using this software, data was entered and organised on a scale either as parametric (numeric, example; age, and household size) or non-parametric (ordinal or coded, example; marital status, gender, adaptation strategies, and perception) for each one of the respondents. With various modelling options of this software, it is possible to process, obtain and display accurate information such as frequency tables, and graphs. To carry out this test, items in the questionnaire which were ungrouped for descriptive analysis were transformed or re-coded. For instance, questions like the age of respondents were coded as 1 if the respondents are between the ages 16-24, 2 for respondents between the ages of 25-34, and so on. Family sizes were also re-coded to 1 for 2-5 members, 2 for 6-9 members, and so on.

A Chi-Squared test was used to analyse the association between several variables. Chi-Square test is used for testing goodness of fit to decide whether there is any change between the observed value and the expected value. A P-value ≤ 0.05 means the measure of association is statistically significant. For instance, a measure of association was established between awareness of climate change/variability and the various demographic characteristics. A study

of variance (ANOVA) was used to determine whether there was a significant difference in the average recorded temperature and rainfall in the in the district. The adaptation strategies of agrarians in response to climate change/variability were analysed and presented with simple descriptive statistics and multivariate logistic.

The exceptional benefit of this model is that it allows researchers to do decision analysis and to determine the associated possibilities for perception and adaptation strategies variables. Logistic models can analyse the elements of perception characteristics and adaptation strategies individually unlike the use of multinomial Logistic model. This is to eradicate the impacts of the choice of one adaptation strategy on another. Acquah (2011) indicates the effect of X on the response likelihoods and Y can be assessed using binary logistic model.

Prob (Y) = $\beta o + \beta X$ (X1, X2, X3,X4,X5,…….) + e, where Y is the binary response assuming only two values 1 or 0 per a farmers' association with an ith adaptation strategy X. The Y variables considered are use of improved varieties, and use of short maturing crops. The X variables are X1 = Age (1 Older Females, 2 =Younger Females), X2 = Marital status (1 =Married, 2 =Unmarried), X3 = Educational level (1 =Illiterate, 2 = primary, 3 =Jhs, 4= Shs/Middle school, and 5 = Tertiary), X4 = Residence status (1 = indigene, 2 = migrants), X5 = Religious background (1 = Christian 2 = Muslim, 3 = African Traditional), (Bryan et al., 2011).

CHAPTER FOUR

RESULTS AND ANALYSIS

4.0 Introduction

This chapter comprises of five sections which include the introduction; existing data for annual temperature and rainfall trend in the Lawra district, category of women farmers; respondents' perception of temperature and rainfall trends in Lawra district and the adaptation strategies adopted by the respondents and finally, the strategies for addressing the barriers to climate change.

4.1 Existing data for annual rainfall and temperature trend in the Lawra district

4.1.1 Rainfall trend in the Lawra district

Figure 4.1 gives the annual rainfall trends in the study area over the last three decades. The highest (1274.1mm) and the lowest (565.5mm) annual rainfall trends were recorded from 1984 to 2014. Although, the annual rainfall trends did vary significantly from year to year (t =, 31.39 p>0.000), there was an indication of annual rainfall decline of 565.5mm in 2004. There has been rainfall variations in the study area. P-value >0.05, which indicates statistical significant difference in the annual recorded rainfall pattern from 1984 to 2014 (Table 4.1).

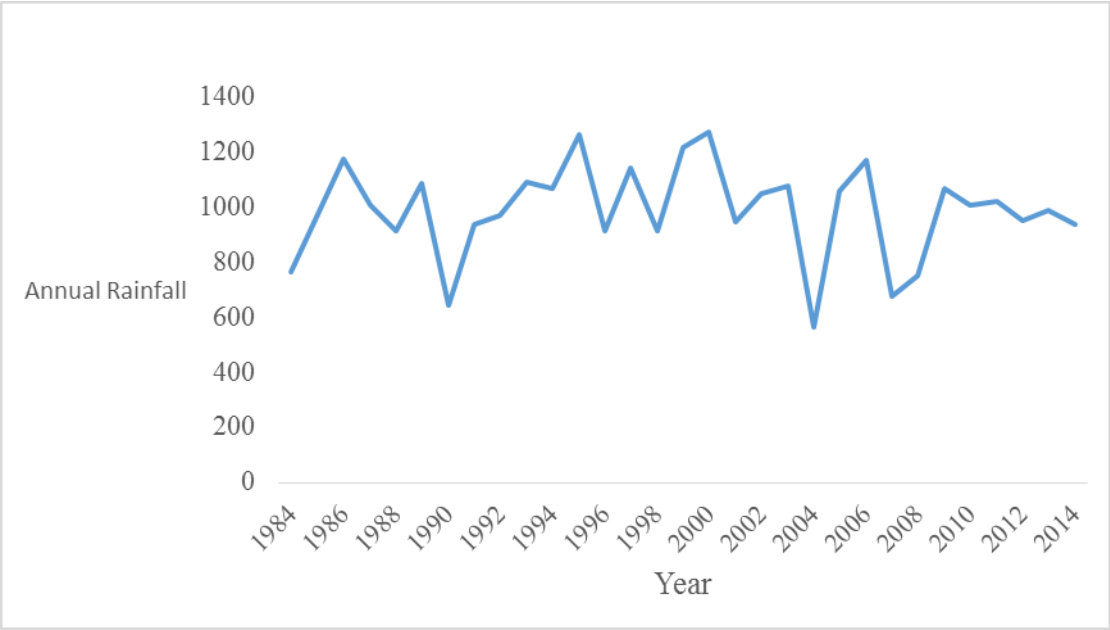

Figure 4.1 Annual rainfall (mm) trend in the Lawra district

Ho: There is no significant difference in the annual recorded rainfall trend in the study area

H1: There is significant difference in the annual recorded rainfall trend in the study area

Table 4.1 Minimum and maximum rainfall range for the first 10 and last 20 years

Years	**Mean**	**Standard deviation**	**95% CI for Mean**		**Min**	**Max**	**X^2**	**t-value**
			lower	**upper**				
First 10 years	955.93	157.50	843.26	1068.60	642.0	1175.60	0.000	31.139
Last 20 years	1005.62	183.24	919.86	1091.38	565.50	1274.10		
Total	989.06	173.97	924.09	1054.02	565.50	1274.10		

***Significant (P≤0.05)**

4.1.2 Temperature trend in the Lawra district

Figure 4.2 shows that, the annual minimum and maximum temperatures in the past three decades in study area. There was an indication of annual mean minimum temperature for the first 10 and the last 20 years are 22.29^{o}C and 22.30^{o}C respectively. For mean maximum

temperature for the first 10 and the last 20 years are 34.57ºC and 34.76ºC respectively (Table 4.2).

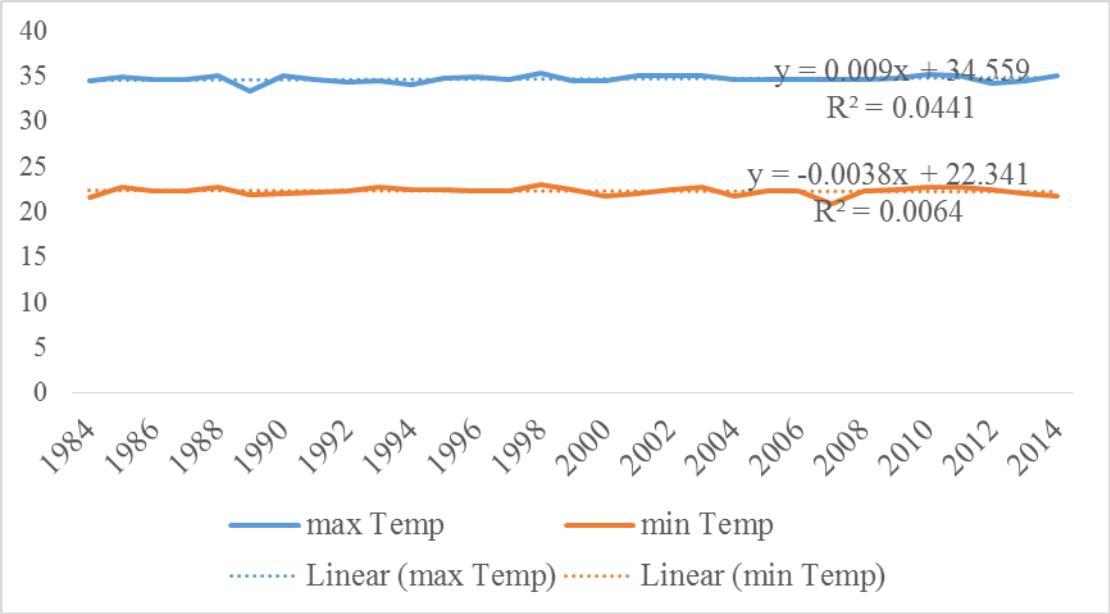

Figure 4.2 Annual temperature (ºC) trend in the Lawra district

Table 4.2 Minimum and maximum temperature range for the first 10 and the last 20 years

Years	Mean	Standard deviation	95% CI for Mean		Min	Max
			Lower	upper		
First 10 years	22.29	0.40	22.01	22.57	21.60	22.80
Last 20 years	22.30	0.46	22.09	20.90	20.90	23.00
Total	22.30	0.43	22.46	20.90	20.90	23.00
Years	**Mean**	**Standard deviation**	**95% CI for Mean**		**Min**	**Max**
			Lower	**upper**		
First 10 years	34.57	0.50	34.21	34.93	33.30	35.10
Last 20 years	34.76	0.32	34.60	34.91	34.00	35.30
Total	34.69	0.39	34.55	34.84	33.30	35.30

4.2 Demographic Characteristics of Respondents

A total of 240 women farmers were interviewed from three communities in the Lawra district namely; Tabier (16.7%); Kalsagri (33.3%) and Lawra Township (50%). Majority of the respondents were between the ages of 35-64 (50.8%) and the least age group were 65 years and above (8.3%). Seventy eight point three percent (78.3%) were indigene whilst the remaining 21.7% were immigrants. Most of the respondents were of Christian faith representing 71.7%. Majority of the respondents were farmers with which those involved in mixed cropping form the majority (80.8%). Majority (52.5%) of respondents didn't have a large household size. Most respondents (76.5%) depend on rains for farming with few respondents used traditional hand watering can for irrigation. (Table 4.3).

Table 4.3: Category of women farmers

Variable	Frequency	Percent (%)
Age		
25-34	98	40.8
35-64	122	50.8
65 and above	20	8.3
Total	240	100
Educational level		
None and Primary	201	83.7
JHS and above	39	16.2
Total	240	100
Residence Status		
Indigene	188	78.3
Migrant	52	21.7
Total	240	100
Marital status		
Single	14	5.8
Married	183	76.3
Widowed	39	15.4
Separated	4	1.7
Total	240	100
Religious Background		
Christian	172	73.9
Muslim	47	17.6
African Traditional	21	8.4
Total	240	100

4.3 Perception to climate change /variability

The analysis indicated 99.2% of the respondents were aware of climate variability/change and have noticed changes in the weather pattern. These indicate a high level of awareness among respondents. Also (92.1%) of respondents mentioned that temperature in the last 10 years had increased whilst 7.9% reported that temperature had decreased in the last 10 years.

With regards to the rainfall pattern; 97.5% reported that rainfall had decreased. All respondents reported that the timing of rains had changed. (Table 4.4).

Table 4.4 Respondents' views on rainfall and temperature changes for the past 10 years

Variable	**Increasing**		**Decreasing**	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Temperature changes	221	92.1	19	7.9
Rainfall changes	6	2.5	234	97.5

The general perception was that the rainy season now starts late and ends early. This view was held by 76.3% of the respondents as against 22.9% who asserted that rains normally starts early and ends early.

The study also sought to analyse respondent's perception on the origins of climate change. Most were of the view that human activities were the main cause of climate change with 1.1 % citing natural phenomenon; 1.3% were of the view that climate change was a punishment from God because of our sins. To confirm the human actions that cause climate change, 49.7% respondents cited cutting down as a significant whilst the remaining 39.6% of the respondents mentioned bush burning (Figure 4.3).

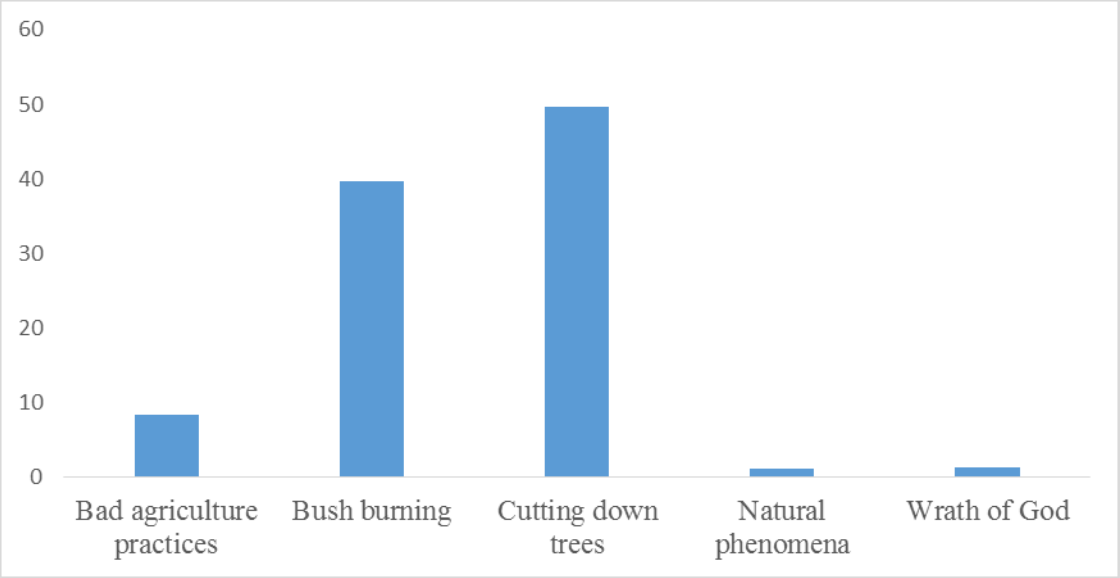

Figure 4.3 Respondents perception on causes of climate change

The study sought to ascertain if demographic factors played a role in awareness of climate change. With regards to age, 50.4% between the ages 35-64 years were aware of climate change/variability and those 65 years and above showed the least level of awareness (7.7%). Married individuals showed the highest level of climate change awareness (76.5%) as compared to respondents who were not married (6%).

Respondents with no formal and primary education but are aware of climate variability represent 84.2%. With regards to residential status; 77.8% respondents who were indigenes were more aware of climate change/variability than immigrants representing 22.2%. The results further showed that Christians (70.9%) were aware the weather is changing while 9% of African traditional answered in the affirmative to changes in climate. Statistical analysis using the Chi-square showed that age, education, marital status and residential status are

significantly associated with climate change awareness (P≤0.05). Religious affiliation however were not significant (P≥0.05) (Table 4.5).

Table 4.5 Cross tabulation of demographic characteristics of women farmers' associated with awareness of climate change/variability

	Awareness of Climate Change/variability					
	Yes		No			
	N	%	N	%	$\chi 2$	p-value
Age						
25-34	98	41.9	0	0.0	21.735	0.001*
35-64	118	50.4	0	0.0		
65 and above	18	7.7	2	100		
Total	234	100	2	100		
Marital Status						
Single	14	6.0	0	0.0	116.991	0.000*
Married	179	76.5	0	0.0		
Widowed	39	16.7	0	0.0		
Separated	2	0.9	2	100		
Total	234	100	2	100		
Educational Level						
None and Primary	197	84.2	2	100	1.983	0.024*
JHS and above	37	15.8	0	0.0		
Total	234	100	2	100		
Residence Status						
Indigene	182	77.8	2	100	0.258	0.028*
Migrant	52	22.2	0	0.0		
Total	234	100	2	100		
Religious Background						
Christian	166	70.9	2	100	0.364	0.834
Muslim	47	20.1	0	0.0		
African Traditional	21	9.0	0	0.0		
Total	234	100	2	100		

***Significant (P≤0.05)**

The sources of information on climate changes, were also assessed. The analysis showed that the most reported information from Tabier community were; NGO's (87.5%), fellow farmers (70%) and Government agencies (25%). The least reported were on radio and television and these accounted for 7.5% and 0% respectively. Majority of respondents from Kalsagri also receive climate change information from NGO's (82.5%), family and friends (75%), fellow

farmers (62.5%) and Radio (58.8%). Government agencies and television were also reported to be least source of information on climate change for the respondents at Kalsagri community. Similarly respondents at Lawra Township receive much of their climate change/variability information from NGO's (87.5%), family and friends (79.2%), fellow farmers (73.3%), Radio (66.7%) and Government Agencies (33.3%) whilst the least reported was on television (3.3%) (Table 4.6).

Table 4.6 Cross tabulation of sources of information about climate change

Information source	**Name of community**				
	Kalsagri (N=80)	**Tabier** (N=40)	**Lawra township** (N=120)	$\chi 2$	P-value
Television	0(0%)	0(0%)	4(3.3%)	2.03	0.36
Radio	47(58.8%)	3(7.5%)	80(66.7%)	1.90	0.38
Family and friends	60(75%)	8(27.6%)	95(79.2%)	3.02	0.22
Fellow farmers	50(62.5%)	28(70%)	88(73.3%)	1.02	0.50
Government agencies	28(35%)	10(25%)	40(33.3%)	0.59	0.74
NGO's	66(82.5%)	35(87.5%)	105(87.5%)	4.19	0.12

When the respondents' views were ascertained as to whether they have access to information on farming activities, majority representing 88.3% answered in the affirmative. Majority representing 88.3% of respondents confirmed that they received weather warning information mainly from the Ministry of Food and Agriculture (MOFA) and NGO's.

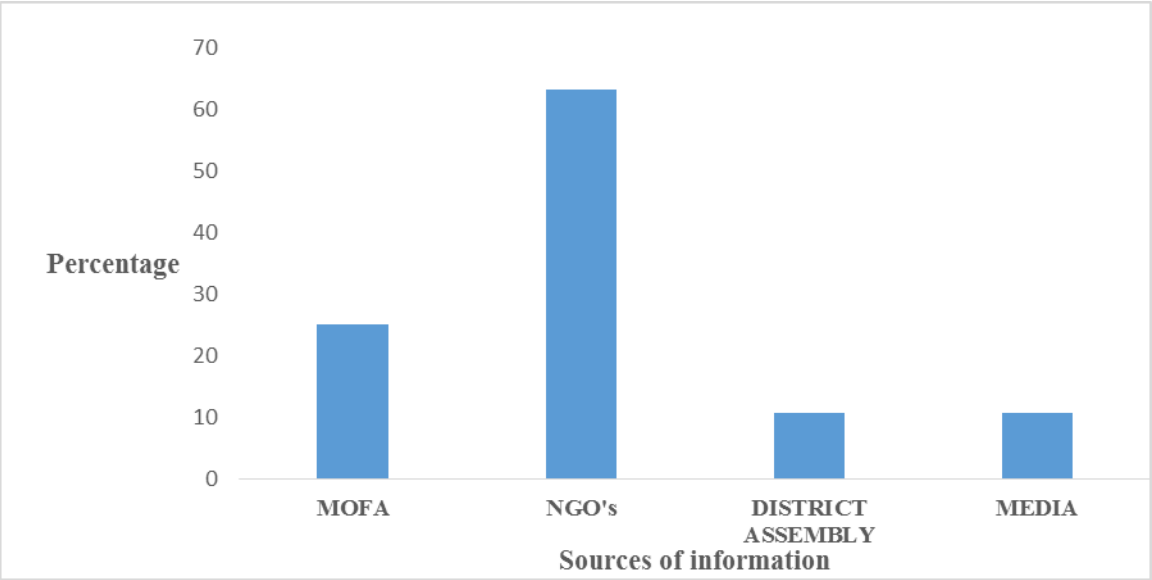

Figure 4.4 Respondents' sources of farming information

The 35-64 age group received the highest amount of information on farming 50.9% whilst those 65 years and above received the least (7.1%). Considering communities, Lawra Township showed the highest level of respondents who receive information on farming activities (50.9%). Respondents with none and primary education also received information on farming activities represent 81.1%. In addition, the indigenes received more information compared to the migrants (27.4%). Statistical analysis using the chi-square showed that age, education and residential status are significantly associated with farming information ($p \leq 0.05$). Communities however were not significant ($p \geq 0.05$) (Table 4.7).

Table 4.7 Cross tabulation of demographic characteristic and access to information on farming activities

Demographic information	Frequency	Percentage (%)	$\chi 2$	P-value
Age			1.160	0.325*
25-34	89	42		
35-64	108	50.9		
65 and above	15	7.1		
Total	212	100		
Communit*y*			1.801	0.406
Tabier	37	17.5		
Lawra Town	108	50.9		
Kalsagri	67	31.6		
Total	212	100		
Educational Level			7.590	0.003*
None and Primary	172	81.1		
JHS and above	40	18.8		
Total	212	100		
Residence Status			3.687	0.002*
Indigene	154	72.6		
Migrant	58	27.4		
Total	212	100		

***Significant (P≤0.05)**

4.4 Women Farmers' adaptation Strategies

Women farmers' are unable to produce and store enough food for home consumption throughout the year. The question is, how are they able to survive? This section presents the adaptation strategies of respondents in response to climate variability/change and the extent to which socio-demographic characteristics and perception of respondents influence the adoption of strategies.

Adaptation strategies practiced by respondents were on-farm and off-farm. The off-farm strategies adopted by respondents included food aid, sale of livestock, petty trading, daily labour, and remittance. On-farm adaptation strategies adopted by respondents were switching to short maturing crop varieties, the use of stored grains, the use of improved varieties,

growing drought resistance crop varieties, soil conservation, use of fertilizer, growing new crops, dry season gardening, changing sowing and harvesting time of crops.

Again the adoption of adaptation strategies was influenced by the demographic characteristics of respondents.

For example most respondents between the age 35-64 years were the more likely to use at least more than one adaptation strategy such as use of stored grain (70%), switching to short maturing varieties (66.7%), soil conservation (57.1%), changing of sowing and harvesting time(62.6%), Growing new crops (55.5%), use of fertilizer (69.3%) and use of improved crop varieties (71.4%), growing drought resistance crops (100%) as an adaptation method (Table 4.8).

With regards to the educational level of respondents and its association with adaptation strategies, respondents with none and primary education were the majority in using more than one adaptation strategies including; use of stored grain (80%), switching to short maturing varieties (90.4%), soil conservation (71.4%), changing of sowing and harvesting time(91.7%), growing new crops (45.5%), use of fertilizer (84.6%) and use of improved crop varieties (85.7%), growing drought resistance crops (100%) as an adaptation method. (Table 4.8).

Concerning residential status, the indigenes were the majority in the use of at least one adaptation methods compared to the migrants. These are; use of stored grain (100%), switching to short maturing varieties (71.4%), soil conservation (100%), changing of sowing

and harvesting time(79.2%), growing new crops (88.9 %), use of fertilizer (92.3%) and use of improved crop varieties (100%), growing drought resistance crops (100%) as an adaptation method (Table 4.8)

The analysis also revealed that married individuals were the majority in the use of most adaptation strategies. The strategies used are; use of stored grain (80%), switching to short maturing varieties (90.5%), soil conservation (85.7%), changing of sowing and harvesting time(83.3%), growing new crops (100 %), use of fertilizer (76.9%) and use of improved crop varieties (85.7%), growing drought resistance crops (75%) as an adaptation method (Table 4.8).

With respect to association between religion and adaptation method, the analysis showed that respondents of Christian faith were the majority in the use of most adaptation strategies. The strategies used are; use of stored grain (70%), switching to short maturing varieties (76.2%), soil conservation (85.7%), changing of sowing and harvesting time(70.8%), growing new crops (85.2%), use of fertilizer (61.5%) and use of improved crop varieties (100%), growing drought resistance crops (100%) as an adaptation method (Table 4.8).

Table 4.8: Cross tabulation between on farm adaptation strategies and demographic characteristics

	Use of stored grains		Switching to short maturing crop varieties		Soil conservation		Use of improved crop varieties		Changing of sowing and harvesting time		Growing drought resistance crop varieties		Use of fertilizer		Growing new crops	
	F	%	F	%	F	%	F	%	F	%	F	%	F	%	F	%
Age																
25-34	3	30.0	7	33.3	2	28.6	2	28.6	8	42.3	0	0.0	4	30.8	12	44.4
35-64	7	70.0	14	66.7	4	57.1	7	71.4	15	62.6	4	100	9	69.3	15	55.5
65≥	0	0.0	0	0.0	1	14.3	0	0.0	1	4.2	0	0.0	0	0.0	0	0.0
Education level																
None and Primary	8	80.0	19	90.4	5	71.4	6	85.7	22	91.7	4	100	11	84.6	23	45.5
Jhs and above	2	20.0	2	9.5	2	28.6	1	14.3	2	8.3	0	0.0	2	15.4	4	14.8
Residence status																
Indigene	10	100	15	71.4	7	100	7	100	19	79.2	4	100	12	92.3	24	88.9
Migrant	0	0.0	6	28.6	0	0.0	0	0.0	5	20.8	0	0.0	1	7.7	3	11.1
Marital status																
Married	8	80.0	19	90.5	6	85.7	6	85.7	20	83.3	3	75.0	10	76.9	27	100
Widowed	2	20.0	2	9.5	1	14.3	1	14.3	4	16.7	1	25.0	3	23.1	0	0.0
Religious Background																
Christian	7	70.0	16	76.2	6	85.7	7	100	17	70.8	4	100	8	61.5	23	85.2
Muslim	0	0.0	3	14.3	0	0.0	0	0.0	3	12.5	0	0.0	2	15.4	2	7.4
African Traditional	3	30.0	2	9.5	1	14.3	0	0.0	4	16.7	0	0.0	3	23.1	2	7.4

Concerning the adoption of the adaptation strategies by respondents, majority of respondents (62.9%) use dry season gardening as an adaptation strategy and it was found that 91.5% grow vegetables and legumes in place of crops such as maize, sorghum, millet, beans and groundnut. Most respondents (62.8%) grow new crops as on farm adaptation strategy. All

respondents (69.8%) from Tabier do dry season gardening as an adaptation strategies as compared to Lawra town (30.2) and Kalsagri (0.0%) respectively.

Table 4.9 Respondents into dry season gardening

	Are you into dry season gardening					
	Yes		No			
	N	%	N	%	$\chi 2$	p-value
Community						
Tabier	40	69.8	0	0.0	73.209	0.00*
Lawra Township	57	30.2	83	58.9		
Kalsagri	0	0.0	80	41.1		
Total	43	100	73	100		

***Significant (P≤0.05)**

Spearman's Correlation was used to establish a possible association between awareness of climate change/variability with adaptation strategies: the results revealed a very weak positive correlation between awareness of climate change and the various on farm adaptation strategies (Table 4.10).

Table 4.10 Correlation between awareness of climate change and on farm adaptation strategies

		Food Aid	Sale of livestock	Petty trading	Labour	Remittance
Awareness of climate change/variability	Spearman Correlation	0.012	0.021	0.132	0.252	0.015
	P-value	0.896	0.818	0.156	0.004*	0.872

***Significant (P≤0.05)**

The results showed that the most reported on farm adaptation strategies used by respondents were; growing new crops(62.8%), change of sowing and harvesting time(55.8%),switching to short maturing crops(48.8%) and the use of fertilizer(30.2%).The least reported however

were; use of stored grains(23.3%),soil conservation(16.3%), use of improved crop variety(16.3%) and growing drought resistance crop variety(9.3%)(Figure 4.5).

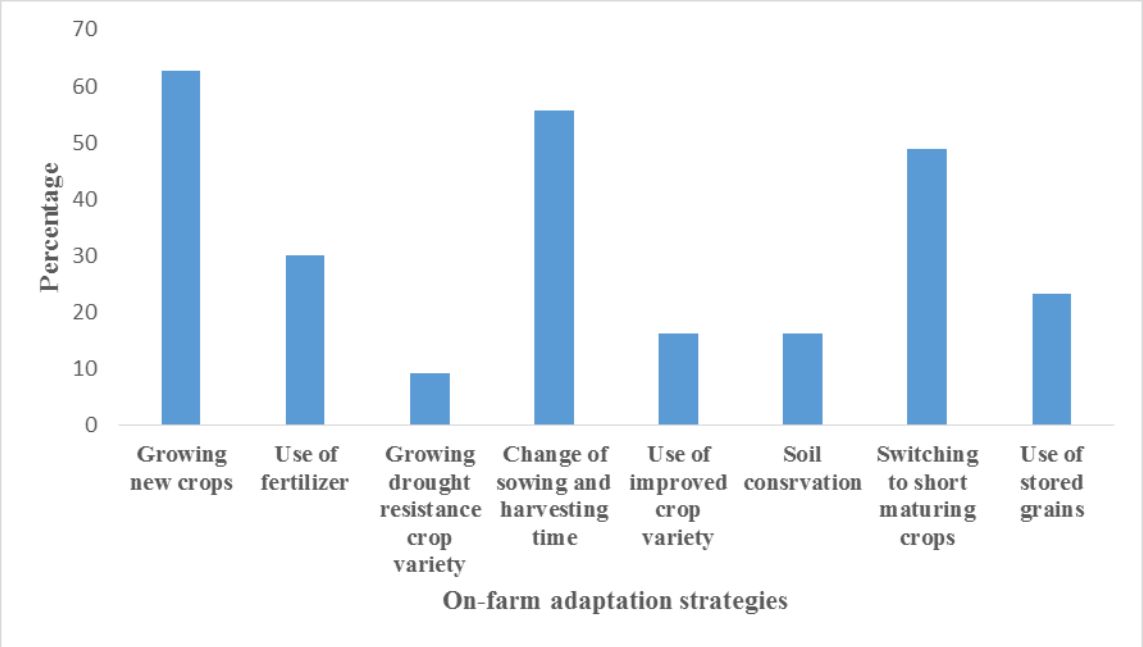

Figure 4.5 Adaptation strategies reported by respondents

In order to establish the association between farmers adaptation response to climate change and which adaptation strategies to adopt, multiple logistic regressions analysis was conducted. The results revealed that, switching to short maturing crops, use of improved crop varieties, changing of sowing and harvesting time, growing drought resistance crop varieties and growing new crops were the climate change adaptation strategies that were significantly associated with adaptation response to climate change in the multivariate analysis ($P \leq 0.05$). Climate change adaptation strategies such as use of stored grains, soil conservation, and use of fertilizer were however not statistically significant at 95% confidence level ($P \geq 0.05$). The analysis shows that, the odds of farmers growing new crops as an adaptation measure to climate change was higher, farmers were about 4.5 times more likely to adopt growing new crops as an adaptation strategies compared to other adaptations(Adjusted OR, 4.530 [95 % CI, 1.652-8.670], $p = 0.014$). The odds of changing of sowing and harvesting time as an

adaptation strategy are about 3.3 times higher compared to other adaptations (Adjusted OR, 3.320 [95 % CI, 0.420-5.430], p = 0.024). Similarly farmers are about 2.8 times more likely to adopt growing drought resistance crop varieties as an adaptation strategy compared to other adaptations (Adjusted OR, 2.870 [95 % CI, 0.051-3.210], p = 0.035). Use of improved crop varieties (Adjusted OR, 2.800 [95 % CI, 0.051-5.250], p = 0.342). Soil conservation (Adjusted OR, 1.771 [95 % CI, 0.105-2.400], p = 0.069) and use of stored grains (Adjusted OR, 0.040 [95 % CI, 0.001-1.100], p = 0.998) had low odds. This is an indication that women farmers were less likely to use these adaptation strategies as climate change mitigation measures (Table 4.9). This is an indication that on farm adaptation strategies contributes 83% of the total variation in the adaptation strategies to climate change. The variations unaccounted for is therefore 17% indicating that there are other adaptation strategies which influences farmers decision not to adapt to climate change (Table 4.12).

Table 4.12 Regression results of on farm adaptation strategies

Variable	Regression coefficient	p-value	Odds ratio	95% C.I. for OR	
				Lower bound	Upper bound
Use of stored grains	20.892	0.998	0.040	0.001	1.100
Switching to short maturing crops	4.079	0.034*	1.92	1.200	6.750
Soil conservation	0.572	0.069	1.771	0.105	2.400
Use of improved crop varieties	-0.043	0.019*	2.800	0.059	5.250
Changing of sowing and harvesting time	2.376	0.028*	3.320	0.420	5.430
Growing drought resistance crop varieties	1.054	0.035*	2.870	0.051	3.210
Use of fertilizer	0.782	0.791	0.140	0.007	0.450
Growing new crops	2.493	0.014*	4.530	1.652	8.670

***Significant (P≤0.05)**

Concerning the various off farm adaptation strategies, the most reported was petty trading (88.8%) and labour (16.9%). The least reported were food aid (2.2%), sale of livestock (7.9%) and remittance (3.4%) (Figure 4.6).

Figure 4.6 Off farm adaptation strategies

The results revealed that, food aid, petty trading, and labour were the off farm climate change adaptation strategies that were significantly associated with adaptation response to climate change in the multivariate analysis ($p \leq 0.05$). Climate change adaptation strategies such as sale of livestock, migration, and remittance were however not statistically significant at 95% confidence level ($p \geq 0.05$). the analysis shows that, the odds of farmers into petty trading as an adaptation measure to climate change was higher, farmers are about 3.891 times more likely to adopt growing new crops as an adaptation strategies compared to other adaptations (adjusted or, 3,891 [95 % ci, 0.921-5.222], $p = 0.024$). The odds of labour are about 2.880 times higher among farmers compared to other adaptations (adjusted or, 2.880 [95 % ci, 0.453-4.671], $p = 0.031$). Similarly farmers are about 1.254 times more likely to adopt food aid as an adaptation strategy compared to other adaptations (adjusted or, 1.254 [95 % ci, 0.740-2.980], $p = 0.049$). Sale of livestock (adjusted or, 0.709 [95 % ci, 0.050-1.626],

p = 0.071). Remittance (adjusted or, 0.576 [95 % ci, 0.164-2.388], p = 0.084) and migration (adjusted or, 0.020 [95 % ci, 0.005-1.527], p = 0.988) had low odds. This is an indication that women farmers were less likely to use those adaptation strategies as climate change mitigation measures. This is an indication that off farm adaptation strategies contributes 80% of the total variation in the adaptation strategies to climate change. The variations unaccounted for is therefore 20% indicating that there are other adaptation strategies which influences farmers decision not to adapt to climate change (Table 4.13).

Table 4.13 Regression results of off farm adaptation strategies

Variables	Regression coefficient	P-value	Odds Ratio	95% C.I.for OR Lower bound	Upper bound
Food Aid	21.504	0.049*	1.254	0.740	2.980
Sale of livestock	21.681	0.071	0.709	0.050	1.626
Petty trading	4.193	0.024*	3.891	0.921	5.222
Labour	-0.101	0.031*	2.880	0.453	4.671
Migration	21.407	0.988	0.020	0.005	1.527
Remittance	20.325	0.084	0.576	0.164	2.388

***Significant (P≤0.05)**

The reasons for which some farmers do not adapt to climate change was ascertained, majority representing 54.5 of the respondents cited adaptation to climate variability is both costly and labour intensive as reasons for non-adaptation to climate change variability whilst the remaining 45.5% cited lack of information as reasons.

4.5 Barriers to climate change adaptation

In order to ascertain the barriers to climate change, the results showed that 91.0% of the respondents mentioned they have encountered challenges in adapting to climate change. Majority (81.5%) of respondents cited financial constraint as the major factor preventing the women from adapting to weather changes. 40.8% cited inadequate storage facility as a barrier and 15% cited health challenges.

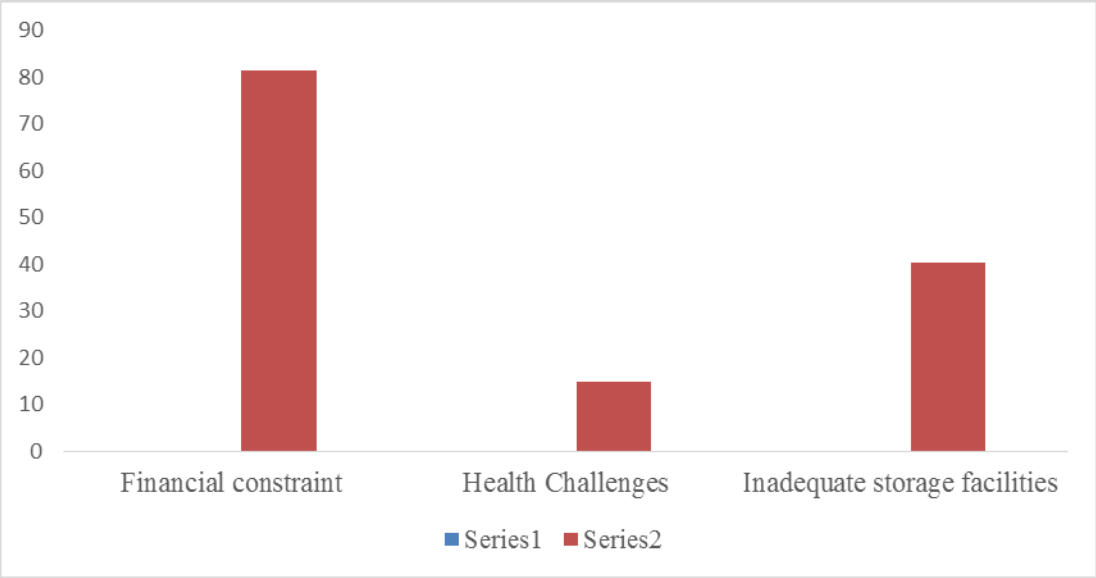

Figure 4.7 Factors that prevent women from adaptation strategies

The regression analysis revealed that financial constraint was the only barrier that significantly influenced climate change adaptation ($P \leq 0.05$) (Table 4.8). Health challenges and inadequate storage facility were however not statistically significant ($P \geq 0.05$).

From the regression results, the coefficient of determination thus an R2 value of 0.48 which is approximately 48% was obtained. This is an indication that financial constraint, health challenges and inadequate storage facility contributes 48% of the total variation in the barriers to climate change. The variations unaccounted for is therefore 52% indicating that there are other barriers which influences farmers decision not to adopt climate change (Table 4.14).

Table 4.14 Barriers influencing climate change adaptation

Variable	Adjusted β	S.E	P-value	95% CI for β	
				Lower Bound	Upper Bound
Financial constraint	1.03	0.469	0.029*	0.109	1.960
Health challenge	0.02	0.001	0.345	-0.197	0.200
Inadequate storage facility	0.05	0.001	0.654	-0.213	0.213

***Significant (P≤0.05)**

CHAPTER FIVE

DISCUSSION

5.0 Socio-demographic characteristics of respondents

It is vital to know the socio-demographic characteristics of respondents, before assessing their perception and adaptation strategies. This is for the reason that certain socio-demographic characteristics of these individual women farmers' may impact on how they effectively manage and respond to climatic threats (Adger et al., 2008).

The age distribution of respondents revealed that those actively engaged in farming were the 35-64 year group, implying that respondents have many years of farming experience and use indigenous knowledge in their farming activities. This was not surprising, considering the experience and level of knowledge respondents have on farming as stated by Defang et al. (2014). The majority (80.0%) of respondents were indigenes signifying how familiar they are with the weather in the area than the immigrants. The farming practices the respondents are involved in was mixed farming and mixed cropping with a majority of respondents depend on rains for agriculture activity.

5.1 Rainfall and temperature pattern in the Lawra district

5.1.1 Rainfall trends in the Lawra district

The annual rainfall range for the minimum and the maximum depicted the actual variable nature of rainfall in the Lawra district. The amounts of rainfall during the rainy season had decreased over the first 10 years and the last 20 years in the district, since from 1984 to 2014. The availability of soil moisture has implication on crop production as crops are sensitive to moisture/water for growth and optimal yield (Assan and Obeng, 2009). The average annual rainfall for the district ranges between 900-1,200mm, thus amount less than this figure present danger circumstances for the district. Using the average annual rainfall as the source

for determining dangerous years in the district, the analysis revealed that the last thirty years had been risky for crop production. The inconsistent pattern of rainfall and declines in average annual rainfall could therefore poorly affect crop cultivation. Decline in the number of rainy days and temperature increase in the district, the district could be susceptible to drought (Assan and Obeng, 2009).

5.1.2 Temperature trends in the Lawra district

In the Lawra district, it was discovered that temperature had been increasing annually for the past three decades. The consequence of temperature increase on farming is huge. Increasing temperature can lead to massive evaporation increase and evapotranspiration rate, these together decrease moisture content in the soil, which creates heat stress and reduce the quality and quantity of farm produce, consequently temperature changes caused by climate change/variability, is anticipated to have great threats on crops and livestock production (Assan and Obeng, 2009). The focus group participants mentioned that increasing temperature patterns had created favourable conditions for the existence of pest and infections which destroyed their farm produce and decreased yields. Temperature increase was likely to create favourable conditions for the emergence of new pests and diseases (Ringer, 2008). The increased annual temperature had already led to decreased agricultural production in Sub-Saharan Africa and cereals are anticipated to decrease by 12 percent under moderate temperature decrease (Ringer, 2008).

5.2 Women farmers' perception to climate change/variability

One of the many reasons in adapting to changes happening in the climate system is a realization of the change taking place. Women farmers' perception about climate change/variability have also become very important about climate variability and adaptation strategies (Maddison, 2007). This is because the way women farmers' perceive climate disparities in their surroundings can have an impact on the type of adaptation strategies to use

as a reaction to climate difficulties, women are expected to adapt only if women can perceive the variations in the climate (Antwi-Agyei et al., 2012). In the study, most respondents observed variations in the climate and they were aware climate has changed totally. Antwi-Agyei et al. (2012) witnessed similar occurrence among households in Bongo and Ejura Sekyeredumase districts of Ghana. Most respondents mentioned that temperature had increased tremendously and that sunshine was hotter now compared to 10 years ago. Previous studies had also reported similar situation among respondents (Gbetibouo, 2009; Deressa et al., 2011). Temperature increase was likely to cause crop failure, hence, leaving farmers in severe indebtedness (Deressa et al., 2011). During focus group discussions, participants used their experience about the extremely high temperatures and low rainfall pattern during the dry and wet seasons to describe climate change/variability. According to participants, in the past years, the major and minor rainy seasons started in May and ends in September, while dry season starts from October to April. Participants indicated that rainy seasons time has changed, the time they expect the rains do not happen like that anymore with the temperature been increased severely. In addition, 97.5 percent of respondents' perceived decreased rainfall. A large number of respondents perceive decreased trends in rainfall total in the Ashanti and Upper West regions of Ghana (Antwi-Agyei et al., 2012). Understanding the fundamental problems and sources of climate change/variability by respondents varied a lot, with some respondents taking a scientific approach and the others religious course. Some respondents perception are mainly unscientific because, fewer respondents who have no formal education, resorted to superstitious belief to describe the natural happenings and that was their only source of information as speculated (Kemausuor et al., 2011).

The high response on bush burning and felling of trees as main causes of climate change/variability demonstrated the high knowledge the respondents have about climate

change. Gyasi et al. (2006) stated anthropogenic causes of climate change/variability are not a new thing on the Northern regions of Ghana because widespread bushfires have caused major damage to the ecology in these regions. The authors emphasized that although bush fires could be aggravated by dry spells, the nature of vegetation cover, and storm, human activities, such as hunting, cigarettes leftovers, cutting down trees and bush burning by farmers in order to hasten growth of new grass are supposed to be the main cause of the wild and indiscriminate bush fire in the north (Gyasi et al., 2006).

The attribution of climate change/variability as a punishment from God/gods demonstrated the superstitious nature of respondents in attaching all phenomenon as because of human sins that are the reason God/gods are punishing us with this kind of weather. Simon and Aasoglenang (2013) stated that respondents believed God Almighty, the gods and their ancestors were responsible for the natural disaster. The main source of information on climate change was from friends /family possibly because most women farmers learnt about new innovations from their neighbours' experimentation as reported by Conley and Udry (2001). Radio and television were also reported to be the least source of information on climate change for the respondents' in the study area.

5.3 Adaptation strategies used by respondents and the influence of socio-demographic characteristics on the adoption of these strategies

Women farmers responded to the difficulties caused by seasonal-irregular rainfall and temperature patterns in numerous ways. The used of stored grains, changing sowing and harvesting time, dry season gardening, soil conservation and growing new crop were through individual experience or from relatives/friends. According to Cudjoe et al. (2013), local knowledge is gained via familiarities of the indigenous individuals which give useful information about variations in the seasons and the weather.

Women farmers also adopted scientific methods which were presented to them by agricultural extension officers and non-governmental organisations (Adjei-Nsiah and Kemah, 2012). The scientific measures adopted included the use of fertilisers, switching to short maturing crop varieties and improved crop varieties. Adger et al. (2013) reported that the use of modern agrarian technologies to improve production of crop and livestock has a better practise and a key adaptation strategy to climate change/variability. Modern agricultural technologies are very important because they can improve crop yields and livestock production which would make access to markets easier (Egyir et al., 2015). Another adaptation strategies adopted by the respondents were engagement in off-farm jobs, like food aid, the sale of livestock, petty trading, labour and remittance. Respondents who are into mixed farming reported that mixed farming has been the most profitable adaptation strategy because in hard times, livestock was sold out and the income spent on foodstuff to sustain the domestic sustenance secured after they have run out of foods from their individual farm production in terms of buying farm inputs. Hesselberg and Yaro (2006) and Apata (2011) reported that most agriculture dependents in African households, mixed farming signifies prosperity and serves as an essential assurance mechanism because families can trade their animals to purchase grains.

Few respondents stated they did not adopt any adaptation techniques in reaction to long-term alterations in temperature and rainfall trends. Participants who took no adaptation techniques indicated the absence of information and that adaptation to climate variability is both expensive and labour intensive being the reasons for not adopting. Deressa et al. (2009) reported that the primary reason of agriculturalists choosing not to adapt was absence of information on climate change impacts and adaptation choices, lack of fiscal resources, workforce limitations, and unavailability of acreage. Lack of financial resources keeps farmers from securing the required knowledge that will help them adapt. The similar response

has been reported in different parts of Ghana (Etwire et al., 2013; Mabe et al., 2014; Lolig et al., 2014).

In the focus group discussions, it was realised, that there were differences in the way women responded to the crisis. The rich households, characterised by ownership of livestock such as goat, sheep etc., responded to climate change/variability by selling livestock than respondents with no livestock, also respondents do petty trading by selling fuel wood, Pito (local alcohol) and uses modern agricultural inputs while the poor households responded by using stored grains, growing new crop varieties and sort to food aid from friends/family.

The choice by woman farmer to use an adaptation strategy to alleviate the impact of climate variability is an influence of certain socio-demographic factors. Factors that affect women farmers' adaptation choices are appropriate in planning strategies that will inspire effective adaptation in the agricultural sectors (Mabe et al., 2014). Some women farmers have the ability to change and adapt well than women depending on farm management practices, land management practices, farm characteristics, livelihood strategies and women farmers' socio-demographic characteristics (Deressa et al., 2009). Women farmers involve themselves in alternative livelihoods such as trading and processing. Women engaged in these activities to get income to support themselves and to support the house (Lolig et al., 2014).

Women were 4.5 and 3.9 more likely to grow new crops and do petty trading as on farm and off farm adaptation strategies respectively. Marital status had an influence on the engagement in switching to short maturing crop varieties and growing new crops compared to respondents who are unmarried. This was perhaps women who are married unlike single women, shared

farm information they receive from radio, television, friends/family and non-governmental organisations with themselves which enhanced their adoption to these adaptation strategies.

Attainment of formal education to senior high and tertiary influenced adaptation options. This supports the findings of Fatuase and Ajibefun (2013) and Defang et a*l*. (2014) that better and higher education improves consciousness of potential benefits and readiness to partake in adaptation options. Illiteracy also positively influenced the adaptation options. Extension education is an important factor inspiring improved intensity of use of adaptation options (Di Falco et al., 2011; Fatuase and Ajibefun, 2013). It was hence not surprising that respondents who gained access to information on farming issues engaged in adaptation strategies. Anley et al. (2007) found that in Haiti, farmers who have good access to extension services were expected more to adopt to better technologies. On the other hand, some adaptation studies have been discovered that extension services were not an important factor affecting the adoption of adaptation practices (Davis et al., 2012). The information helped farmers to choose among alternative crop management practices, the choice to adapt better to climate change/variability lied in the decision of the woman farmer (Lolig et al., 2014).

Age had influence in the adaptation option. Age groups 35-64 influenced adaptation practices in the sense that respondents have many years of farming experience and use indigenous knowledge in their farming activities. This was not surprising, considering the experience and vigorous nature of farming as reported by Defang et al. (2014). Thus, age played a significant importance in the adaptation options.

Residences status influenced adaptation options. This is because the indigenes have knowledge about their environment and know the climatic condition in the area much more than the migrant, for that reason they are able to adapt to adaptation strategies better than the migrants will adopt to. Women farmers who are the native of the land, however, appear to have adapted better to recent manifestations of weather extremes than those have migrated to the area.

5.4 Barriers to climate change adaptation

To know what restricts women agriculturalists from adapting to climate change, respondents were requested to classify the key barriers to climate adaptation in the cause of the interview. Interviewers reported financial constraint as one of the many challenges preventing them from adapting to climate change. Bryan et al. (2009) and Kithiia (2011) reported that financial barriers are key barriers that limit execution in adapting to climate variability. Majority (81.5%) respondents cited financial constraint as a severe barrier to climate change adaptation. According to respondents, financial constraint comprises of inadequate capitals, the absence of credit services, finances and grants. Respondents demanded that financial barriers stopped them from accessing fertilisers and upgraded crop variations and drought resistant crop varieties that can well adapt to climate change/variability as well as reduce labour cost.

Physical strength is an essential factor when it comes to climate change adaptation. Physical strength determines whether or not one would be able to adapt to climate change/variability. In this context respondents interviewed reported that they were weak, which mostly came from respondents with the age 65 and above, which for the respondents was an obstacle, making them not to adapt to climate variability. Respondents mentioned sickness was another

hindrance when it comes to adapting to climate change, they sometimes fall sick and for that matter, they are not able to adapt to climate change.

Nevertheless, agriculturally related growths were very wide. The absence of infrastructural development comprising of readily vacant markets and storage facilities were also identified as barrier to climate change adaptation. Although it recorded the second option respondents mentioned, a factor which was identified by respondents in the communities visited. It constituted the second major barrier to the successful approach in adapting to climate change.

Lack of ready market was associated to lack of storage amenities by the respondents for storing harvested crops in these communities. Lack of storage amenities weakened the negotiating strength of the women farmers when it came to bargaining fees of their harvested crops. Lack of market a barrier to climate change adaptation is, maybe, valued entirely when it is linked to the responsibility of families to achieve their repayments of funds (Antwi-Agyei et al., 2017). Women farmers are unable to get better prices for their farm produce, so most of them are unable to refund their credits and this has serious effects on them which made them unable to contract future loans to help them adapt to climate variability. There was an indication that financial constraint, health challenges and inadequate storage facility contribute 48% of the total variation in the barriers in adaptation to climate. The variations unaccounted for is therefore 52% indicating that there are other barriers which influence farmers decision not to adopt climate change.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.0 Conclusion

The socio-demographic characteristics revealed that majority of the respondents were between the ages of 35-64 years. The majority of respondents were Farmers, which was their main occupation in the in the study area. The respondents are mostly engaged in mixed cropping.

The study revealed that for the first 10 years and the last 20 years range for temperature had increased as compared to literature, respondents' perception and recorded minimum and maximum temperature for the district been 23^{o}C and 33^{o}C respectively. For minimum and maximum range for the first 10 and the last 20 years rainfall was indicated to have decreased, which was in line with respondents' perception, literature and recorded maximum and minimum rainfall range for the district been 1200mm and 900mm respectively.

The general perception of the respondents was that temperature had decreased while rainfall had increased. Most of the respondents mentioned human activities were the main cause of climate change/variability which tree cutting and bush burning were mentioned while climate information was mostly received from NGOs such as ESOKO, Care International etc.

Adaptation strategies practiced by the respondents to curtail the impacts of climate change/variability were the use of stored grains, switching to short maturing crops such as maize, beans, vegetables, soil conservation, use of improved crop varieties, change of sowing

and harvesting time, growing resistance crop variety, respondents also engage in off-farm adaptation strategies, such as petty trading, sale of livestock, food aid, daily labour and remittance among others.

The majority of the respondents had encountered challenges in adapting to climate change. Financial constraint, health challenges, inadequate storage facility are factors preventing respondents from adapting to climate change and variability.

6.1 Recommendation

Women are important providers to the food basket and as such the problems they face in their field of work must be successfully addressed. It can be concluded from this research that most of the women crop farmers in the Lawra district are well prepared in emerging adaptation strategies and other impacts of climatic changes present to them.

- ✓ In order to help women farmers' train themselves with approaches to combat the negative impacts of climate change/variability, women farmers' should be fortified to form farm based associations to support and authorize them to be able to save funds and even micro assurance from monetary organizations to enhance their resilience to improve upon their adaptation strategies against climate change/variability impacts.

- ✓ Women farmers' should be provided with irrigation facilities to help them practice all year round farming. Dams and reservoirs should also be built to store and retain water when it rains to be used on the farms when the rain ceases.

- ✓ Storage facilities should also be built for the women farmers' to help them store grains after they have been harvested in order to reduce postharvest losses and also increase their earnings.

- ✓ The government must find ways of managing climate change stresses such as droughts and floods to ensure food security through the construction of dams in order to collect surface runoff in times of floods and also as a water source in times of drought.

- ✓ It would be essential for the government to ensure upgrading through extension services in the mass education for women farmers to educate them on technologies employed in farming and the new crop varieties that are resistant either to floods or droughts.

- ✓ Extension officers should be trained on climate change/variability science to permit them to pass suitable information to women farmers on proper adaptation strategies.

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