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# Assessing farmers livelihood adaptation strategies due to climate change in Upper West Region of Ghana

Abdul-Moomin Ansong Salifu *

*Centre for Sustainable Communities and Climate Change, Kumasi, Ghana*

## Abstract

The upsurge in severe weather conditions such as increased in temperature, drought, erratic rainfall, and floods as a result of climate change has a profound effect on the livelihoods of rural farming households. This study examined farmers livelihood adaptation strategies due to climate change in 4 districts of the Upper West Region of Ghana. The sustainable livelihood approach was used as the theoretical foundation to examine farmers adaptation strategies. Using a mixed method approach (survey and focus group discussion), 120 farm households were interviewed. Results showed that farmers practice 18 different adaptation strategies to cope with climate change. Farm households face both climatic and non-climatic challenges in adopting adaptation strategies. The study concludes by highlighting the need for stakeholders in the agriculture industry to promote more mitigating measures as this have the propensity to restore the environmental conditions in the long run. It is also significant that policy makers and other stakeholders work to harmonize these adaptation strategies into a uniform national adaptation strategy.

***Keywords:*** Adaptation; Climate Change; Households; Livelihoods; Sustainability



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* Corresponding author. *E-mail address:* salmoomin@yahoo.com

## 1. Introduction

Climate change poses a greater challenge to humanity and has gone beyond rise in global temperatures to adverse weather conditions that affect agriculture productivity and increases the risk of global food shortage (Xie et al., 2015; Tai et al., 2014). It is therefore seen as the number one threat to development and sustainability in Africa (Zubairu et al., 2021).

The effect of climate change on agriculture has become a global concern to farmers, especially farmers in the tropical region of Africa (IPCC, 2014; Schlenker and Lobell, 2010). The United Nations Climate Change (2020) asserts that, climate change is a significant threat to Africa due to the continent's over reliance on mainly climate sensitive areas like rain fed agriculture with a corresponding weaker adaption capability. Changes in rainfall patterns are among the long-term impacts of climate change that causes reduction in agriculture productivity, affects food security, increases poverty, and affects livelihoods. The climate change effects in Ghana are similar to those witnessed all over the globe. Evidence in Ghana shows that, the levels and patterns of rainfall are increasingly becoming erratic and generally reducing across all the ecological zones (Lawson et al., 2020).

The magnitude of climate change on global livelihoods remains unclear. However, when agriculture productivity is adversely affected due to climate change, it automatically affects food security as well as households' livelihoods especially in rural communities who are predominantly farmers. The United Nations Economic Commission for Africa (2011) projects that, climate change-induced events such as increased rainfall magnitude, severe droughts, and floods would affect agriculture, livestock, and fisheries production and hence, worsens the food security situation in Africa. The adverse effects of climate change on agriculture and livelihoods requires appropriate adaptation and mitigation measures to cope with the situation. According to Barnett (2010), adaptation involves the need to minimize susceptibility and risk associated with climate change. In view of this, the national adaptation plan ((NAP) was formed under the Cancun Adaptation Framework (CAF), that allows countries to develop and implement strategies addressing climate change (United Nations Climate Change, 2020).

Agriculture is vital to the socio-economic development of many countries and serves as the primary source of employment and livelihood for most of the rural population (Nyamekye et al., 2021). The agriculture sector of Ghana contributes 19.25% to Gross Domestic Product (GDP) in 2020 (O'Niel, 2022) and employs about 45.38% of the population according to Ghana Statistical Services (2019). The sector also provides food and raw materials for industries. Due to the significant role agriculture plays in national economies, research studies have found that agriculture growth can have a negative or positive effect on economic growth (Sertoglu et al., 2017).

The focus of this study on the Upper West Region of Ghana is germane as agriculture production is the main source of livelihood in the northern sector of Ghana. About 97.9 percent of households in the Northern part of Ghana are engaged in crop and livestock farming which is mainly seasonal and mostly on subsistence basis (Bawa, 2019). While Ghana tries to meet the sustainable development goal (SDG) of ending hunger, promoting sustainable agriculture, and achieving food security (Government of Ghana, 2019), this is however, threatened by climate change in recent years. Although the agriculture sector is among the least contributors to climate change, the sector is adversely affected by climate change due to increase in severe weather conditions (Adeleye et al., 2021). The livelihoods of most rural populations in developing countries which are mostly

dependent on agriculture are highly affected due to the frequent exposure to adverse climate change induced events such as drought, floods, pests' outbreak, and diseases (Hoque et al., 2019). Farmers in the Upper West Region of Ghana depend heavily on rain fed agriculture. The region has two distinct seasons, the rainy season that usually start from April to October and a dry season for the rest of the year. Meanwhile, problems with frequent drought have been experienced in recent years and are expected to increase in the future because of climate change. For this reason, Bunce et al. (2010) suggested the need to address climate change at the local level to prevent Africa from becoming a major global food crisis spot. Although it has been argued that climate change adaptation and mitigation vary from place to place even within the same country (Mushore et al., 2021), it is better to understand the actual dynamics of climate change adaptation and mitigating strategies at the lower level of populations such as households, communities, and districts in order to bring the needed responsive interventions (Nath and Behera, 2011). Despite the significance of adaptation and mitigation against climate change-induced effects in the region, a lot remains unknown with respect to the different adaptation or mitigating strategies employed by farm households to cope with climate change over time in different parts of the region. This gap in knowledge affects the ability to harmonize key adaptations strategies valuable in mitigating climate change as well as evaluating progress of adaptation strategies in the region and the country as a whole. Hence, the purpose of this study was to assess current adaptation and mitigating strategies employed by farmers as a response to climate change and the challenges they face in implementing these strategies. Identifying and understanding the adaptation and mitigating strategies adopted by farm households will assist in policy decision-making and responsive intervention.

## 2. Theoretical-conceptual framework

### 2.1. The sustainable livelihood framework

The sustainable livelihood (SL) framework helps researchers to conceptualize the complexity of rural livelihoods and the different variables that shape their activities, objectives, and outcomes in a simplified way. The sustainable livelihood approach was formulated purposely for development with the main focused on poverty reduction or eliminating poverty (Ashley and Carney, 1999). The framework is also used as an analytical tool that provides a way of understanding the factors that influence the ability of people to achieve sustainable livelihoods under a particular circumstance, for instance, climate change-induced extreme events, and addresses various components in relations to sustainable livelihoods. The present study examines what adaptation strategies are being employed by rural farm households in the Upper West Region as mechanisms of comping with climate change to meet their livelihood needs.

In the sustainable livelihood framework, seasonality, shocks, and trends are addressed under vulnerability which clearly depicts the nature of rural farm households in the study area, and thus establishes the appropriateness of using the SL framework for this study. The framework outlines how institutions and policies should help in affecting rural people livelihoods positively. To this end, governmental institutions such as the Ministry of Food and Agriculture (MoFA) and Council for Scientific and Industrial Research (CSIR) can work with rural farm households to harmonize their adaptation strategies and introduce mitigating measures. This will help to reduce their vulnerability and build their resilience against climate change thus bringing positive social change.

Though the seasonality nature of agriculture makes most rural livelihood strategies result in income fluctuations, the situation is greatly impacted by climate change which could be dramatic and profoundly affect rural livelihood security (Devereux et al., 2011). Hence, fluctuations in income resulting from climate change could be minimized using adaptation strategies (e.g., crop diversification, crop rotation, irrigation, and income diversification). Since livelihood involves capabilities, assets, and activities required for a means of living (Chambers and Conway, 1992), it is important that households adapt strategies that will enable them to cope with the stress and shocks caused by climate change both now and in the future thus making their livelihoods sustainable (Chambers and Conway, 1992). In view of this, tackling the problem of climate change requires a holistic approach that must involve adaptation strategies and mitigation measures.

## 3. Methodology

### 3.1. The study area

The Upper West Region is located in the North-Western part of Ghana with 11 administrative Districts/Municipalities and Wa as the regional capital. The region shares border with the Northern Region to the South. To the East it shares borders with Upper East Region and the Northern Region, and to the North and West it shares border with the Republic of Burkina Faso.

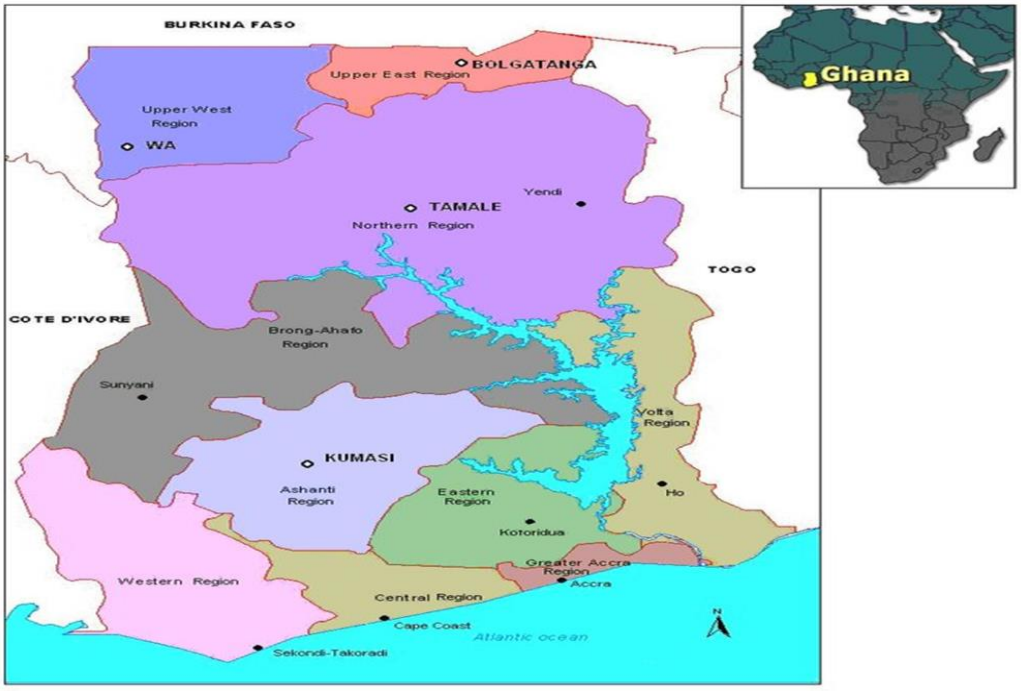


**Figure 1.** Map of Ghana showing the Study Areas (Credit: Divine Kwaku Ahadzie, 2010)

The region falls within the guinea savannah zone of the Northern part of Ghana and experiences a single rainfall season (April-October) with an intensity of 800 - 1100mm/annum. The region has a minimum and maximum temperatures of 22.60c and 39.10c respectively, and relative humidity of 70%-90% which falls to 20% in the dry season (Ghana Meteorological Service Department, Wa, 2019). Due to the unfavorable weather conditions, the region usually face water stress for both domestic and agriculture activities for 7 months (November-May). This exacerbates the poverty situation in the region which has the highest poverty rate of 70.9% in the country (GLSS, 2018). Various climate change-induced events have been observed in northern Ghana in recent times which includes floods, persistent drought, increasing temperatures, episodes of late rains during planting season, and continuous decline in precipitation (Yengoh et al., 2010; Stanturf et al., 2011). The study was undertaken in four districts in the region namely Sissala West, Jirapa, Daffiama-Isa-Bussie, and Wa West. A significant portion of the natural vegetation in the region has been disturbed over the years by anthropogenic activities in search of livelihood and housing. Farmers in the region grow crops such as maize, millet, rice, sorghum, yam, groundnuts, beans, and cassava. Vegetables like tomatoes, okra, cabbage, pepper, and garden eggs are cultivated by some farmer in the dry season for supplementary income.

## 3.2. Research design and sample

A mixed method research approach was used which involved the combination of a quantitative (survey) and qualitative (focus group discussion) methods for data collection between October 2021 - January 2022 to assess the indicators of farmers adapted livelihood strategies due to climate change in the study area. A semi-structured questionnaire was used to examine farmers perceptions and understanding of climate change and how climate change induced events such as drought, poor rainfall increased temperature, and floods affect their agriculture activities and livelihoods. The identification of households' current adaptation strategies and the challenges were achieved using semi-structured survey and focus group discussion.

## 3.3. Household surveys

Household surveys were conducted to assess farmers perceptions of climate change and its effects on agriculture productivity, their livelihoods, adaptation strategies and adaptation challenges. After randomly selecting the 4 districts/municipals, 5 villages from each district were purposefully sampled based on information about their intensive agriculture activities from the District Agriculture offices, and 6 households were surveyed from each of the villages. The sample size was determined using Kathari (2004) sample size formular. This formula was chosen over other sample size formulae because it addresses the number of households variable in the equation which is the unit of analysis of this study. For example, I considered the qualitative sample size calculation formula suggested by Taherdoost (2017), but the formula does not address the number of households in the equation which makes it inappropriate for this study.

$$n = \frac{Z^2 pqN}{e^2(N-1) + Z^2 pq}$$

where:

n is sample size

N is total number of households in 4 districts (56,081)

p is 0.5 (sample proportion)

q is o.5 (1-p)

z is 1.96

e is 0.1 (10% margin of error)

Using the above equation, the estimated sample size for the 4 districts was 96 households. However, 120 households were surveyed from the 4 randomly selected districts, thus 30 households were surveyed from each district.

### 3.4. Focus group discussion

Focus group discussion was conducted to identify and better understand farmers adaptation strategies resulting from climate change. 3 focus group discussions were conducted in each district, and each of the focus group discussion consisted of 12-16 persons, mostly made up of people who take farming as their full-time occupation, teachers, healthcare, and agriculture workers who do part time farming, and NGO officials.

### 3.5. Data analysis strategies

The data analysis included descriptive statistics such as average, frequency, tabulation and percentages were used to analyze farmers socio-economic characteristics, adaptation strategies, perception of climate change on agriculture, and adaptation challenges. Tabulation was used for systematic and logical representation of numerical field data to facilitate comparison and statistical analysis. The average number of years of experience in farming of the different age groups was arrived using averages. Farmers perceptions of the variation in rainfall and drought patterns each year because of climate change was analyzed using the frequency these events occur in each rainy season. Expressing numbers as proportions of 100 makes it easier to understand than using decimals. Hence, the numbers recorded during the survey were expressed in percentages. Percentage also facilitates comparison of the various parameters measured in the study.

## 4. Results

### 4.1. Characteristics of respondents

The survey results showed that 87.5% of the respondents were males and 12.5% were females. In terms of age, 64.2% of the responds belonged to the age group of 35-55 and have an average farming experience of 19 years and 35.8% belonged to the age group of 46-70 and have an average farming experience of 28 years. Farming is the primary occupation of most of the respondents (81.7%). Of this number, about 62% of the respondents are full time farmers. The findings corroborate records of the Ministry of Food and Agriculture (2022) that 80% of the economically active population in the region are directly or indirectly engaged in agriculture. In term of education, 40.8% (n=49) of the respondents have no formal education, 28.3% (n=34) had basic education, 24.2% (n=29) and 6.7% (n=8) had high school and college degrees respectively. The

average household size was found to be 6.5. The level of education of the respondents could have partially contributed to their level of awareness of climate change.

## 4.2. Farmers perceptions on climate change and its effects on agriculture

Farm households who took part in this survey demonstrated their understanding of climate change-induced events and the effects on their agriculture activities. Results of the study showed that more than three quarters of the respondents (79%) are aware of climate change and its attendant effects on agriculture and livelihoods. Although some farmers are not aware of the main causes of climate change, more than half of the respondents (53%), indicated deforestation (e.g., charcoal burning in most communities) as a major cause.

The survey further showed that, farmers perceived increased in temperatures (76%), decreased in amount of rainfall (84%), increased drought (84%), rainfall variability (78%), and floods (76%) over the past 10 years as direct cause of climate change (Figure 2). In terms of adaptability to the climate change-induced events, 51%, 74%, 68, 72%, and 66% of respondents said they could adapt to increase in temperature, rainfall variability, rainfall amount, drought, and flooding conditions respectively (Figure 3). The number of respondents who cannot adapt to increase temperature, rainfall variability, rainfall amount, drought, and floods were 18%, 4%, 6%, 16%, 10% respectively. Those who have no idea about their adaption ability ranges from 1% to 4%.

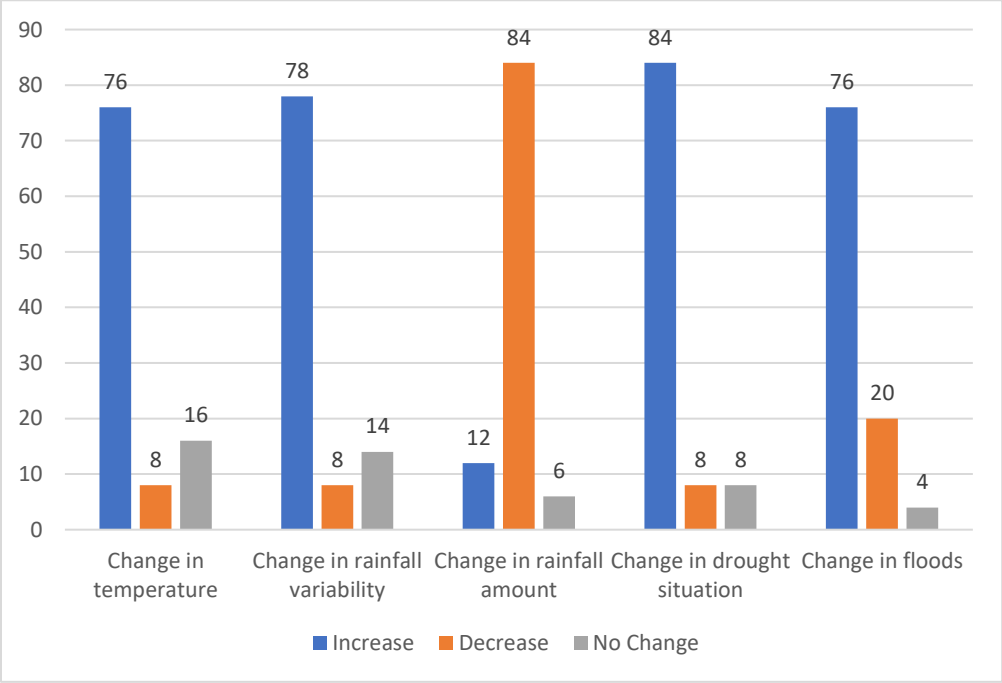


**Figure 2.** Farmers perceptions of climate change-induced events

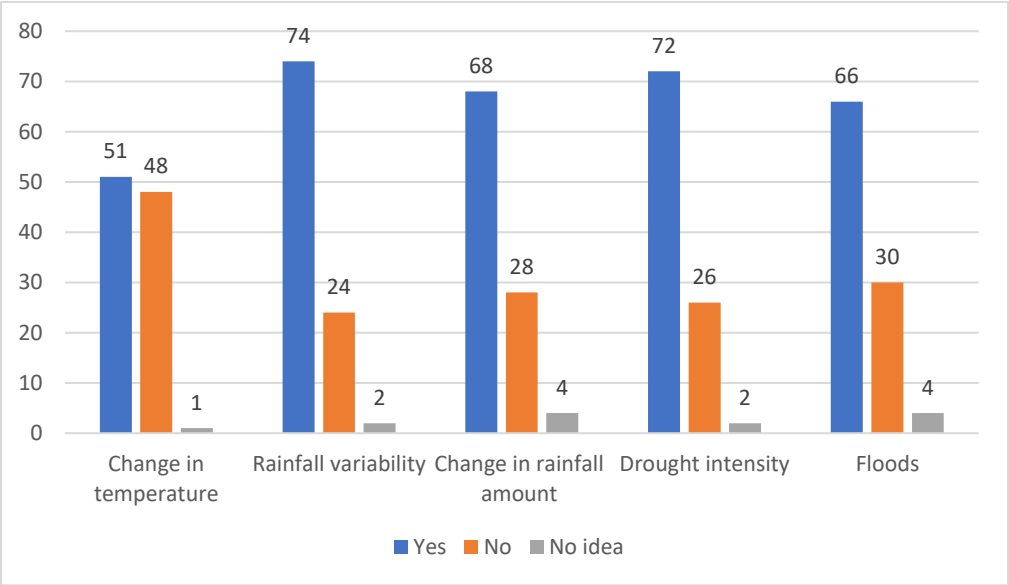


**Figure 3.** Farmers perceptions of adaptability to climate change-induced events

Investigation on the effects of climate change-induced events such as poor rainfall, increased temperature, and floods on agriculture productivity revealed that, between 54% and 78% of respondents perceived increased in crop yield (54%), pests infestation (58%) (e.g army worms), weed infestation (68%), disease outbreak (74%), and pesticides and weedicides usage (78%) in the last 10 years due to climate change. On the contrary, 40%, 34%, 27%, 24%, and 16% of respondents reported decreased in crops yield, pest infestation, weed infestation, disease outbreak and pesticides and weedicides usage in the past 10 years respectively (Figure 4).

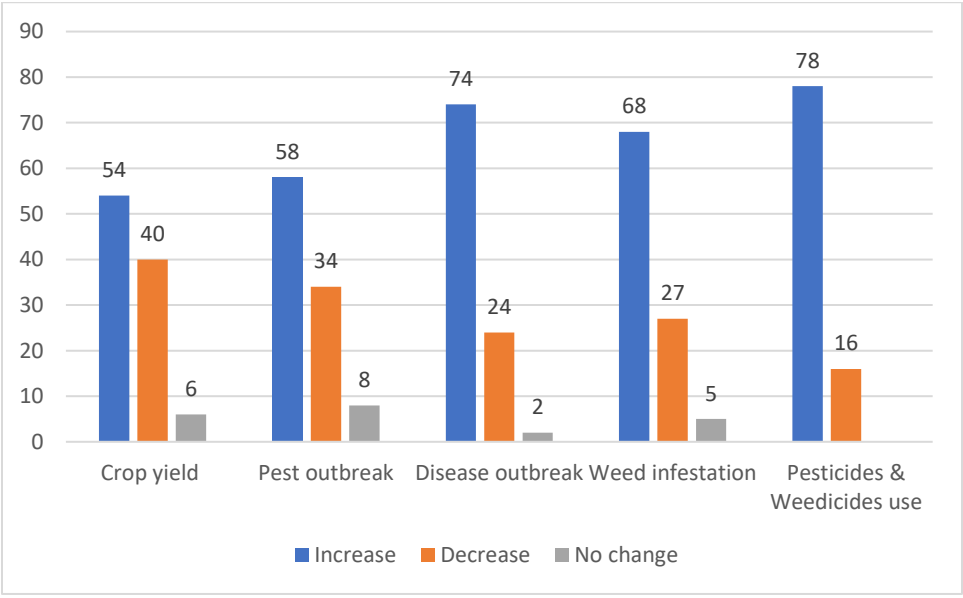


**Figure 4.** Farmers perceptions of the effects of climate change-induced events on agriculture

## 4.3. Farmers adaptation strategies

Rural farm households embark on diverse strategies as adaptation to climate change-induced events and to meet their livelihood needs. In all, 18 adaptation strategies were uncovered from the survey and focus group discussions which were divided into 3 categories namely, crop management, income diversification, and environmental management (Figure 5).

The study revealed that 79% of farmers introduced new crops as a mechanism to cope with the effects of climate change-induced events such as change in rainfall pattern and increased temperatures. Among this category are farmers who introduced disease resistant varieties (46%) and drought tolerant varieties (47%). Another mechanism adapted by farmers against climate-induce events is changing the planting and harvesting dates of crops. More than three quarters (96%) of farmers stated that they have changed their planting and harvesting dates due to changes in rainfall variability. Farmers who use improved seed varieties constitute 54% while 46% of these farmers still use their own seeds for planting. Almost half (48%) of respondents have introduced and increased animal production to supplement their crop production activities. While more than three quarters of respondents (77%) stated that crop production is still their major agricultural activity though they keep a few animals. Similar findings are also reported in the work of Gani et al. (2019) where they noted that majority of the rural households in Nigeria diversify their income from cropping, fishing, livestock, and poultry production. The use of chemical fertilizer has increased more than that of organic manure across the study area. The study shows that 62% and 17% of farmers use chemical fertilizer and organic manure respectively. Crop rotation- a practice of plating different crops in the same area year after year has increased. More than three quarters (77%) of farmers now practice crop rotation as an adaptation mechanism. Similarly, almost half of the respondents (46%) stated that they now practice intercropping especially mixing cashew with legumes. Furthermore, some farmers practice contract farming (38%) as a way of coping with climate change because they cannot afford farm inputs. Crops such as soya beans, sorghum, and maize have been grown as out growers' scheme in recent times in the region.

With respect to income diversification, some household men (18%) migrate to other big cities in the dry season as farm and other forms of laborers to earn extra income for the family. The study further revealed that climate change has forced women in some parts of the region to migrate to other parts of the region where farming is intensive especially in the Sissala East and West districts. Instead of collecting cash, they are given a percentage of the crops they harvest (e.g., maize). In the same vein, petty trading has increased (42%) in the area as a mechanism of coping with climate change. Though a contributor to climate change, some farmers engage in charcoal burning and chainsaw lumbering (15%) to make extra income as a way of coping with declining crops yield. Again, the gathering and processing of sheanuts for additional income have increased. More than three quarters of respondents (82%) stated that they assist their women to gather sheanuts to increase cash inflow into the family. Also, less than a quarter of the respondents (15%) purchase or drive motor king or "pragyia" on full time or part time basis to earn extra income to compensate for declining crop yield.

While a lot of farmers are practicing adaptation measures to cope with climate change, some of these adaptation measures are mitigating against climate change. About 12% of the respondents are practicing "farmer manage natural regeneration" adaptation process where they combine cashew planting with legumes. Dry season farming (irrigation) has also been undertaken by some of the respondents (18%), who practice vegetable production as a means of earning additional income.

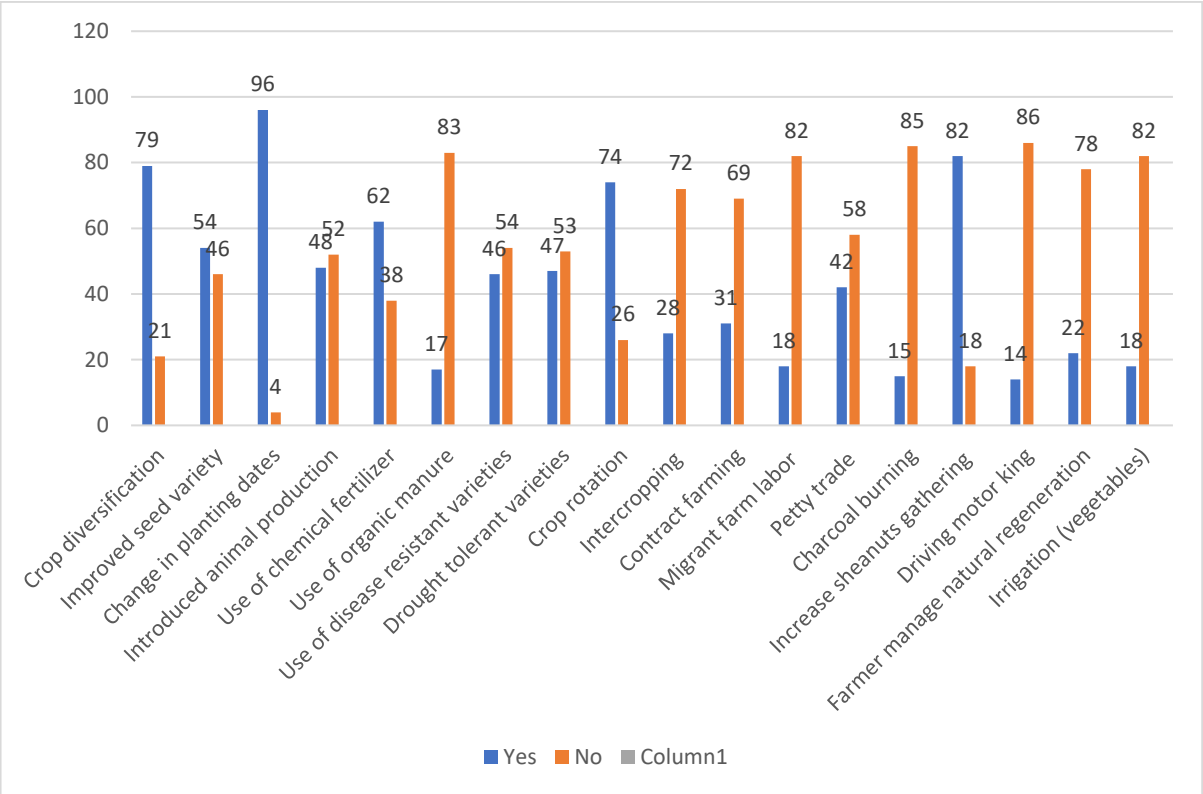


**Figure 5.** Farmers adaptation strategies

### *4.3.1. Challenges in adaptation to climate change*

The findings of this study shows that each of the respondents adopt a minimum of 4 adaptation strategies to protect their agriculture activities against climate change induced events such as erratic rainfall, drought, and floods. According to the respondents, the challenges they encounter in adopting these adaptation strategies have to do with factors relating to climate change such as rainfall uncertainty, floods, high temperatures, floods, and drought. Also, the availability and affordability of farm inputs (e.g., fertilizer, improved seeds, pesticides and weedicides) are things they are grappling with on yearly basis. The respondents complained about high cost of farm inputs (e.g., fertilizer) due to the lack of subsidies from government. Respondents also mentioned the lack of irrigation facilities in the region as one of the most significant challenges in coping with climate change. Lack of proper storage facilities, lack of ready market for farm produce, and the lack of sufficient knowledge in adopting adaptation strategies are some of the challenges farmers face in coping with climate change.

## 5. Discussions

Climate change is adversely affecting agriculture activities in the Upper West Region of Ghana especially in the rural population where agriculture is their main source of livelihood. This study aimed at examining the current adaptation strategies employed by farmers as a mechanism of coping with climate change. The findings

paint a gloomy picture about the increasing trend of climate change -induced events (e.g. increased temperatures, rainfall variability, drought, and floods). Results of the survey showed that more than three quarters of the respondents (79%) are aware of climate change and its attendant effects on agriculture productivity and general livelihoods. Similarly, more than half of the respondent (53%) mentioned deforestation as the main cause of climate change. The level of awareness of climate change-induced effects is an indication that the climate change subject is gaining much-needed attention at the local levels in the region. The findings thus support the results of other studies that farmers in Ghana and Nigeria show high level of awareness of climate change (Korir, 2019; Oruonye, 2011). Hence, the level of awareness is a positive step towards practicing adaptation and mitigating strategies. Respondents indicated that climate change-induced severe weather conditions have caused increased in pests, weeds, and diseases infestation and reduced crop yield. This is consistent with the findings of Mwinkom et al. (2020) that farmers in the Northern part of Ghana and some parts of the Bono, Ahafo, and Oti regions will be most affected by severe weather conditions caused by climate change. Contrarily, some farmers indicated that their yields have increased over the years. This category of farmers could be among those who embrace technology such as using improved seed varieties and chemical fertilizer to cope with climate change. Other studies have shown that farmers in the Northern part of Ghana use improved seed varieties and fertilizer to boost production as their main aim of reducing the impact of climate change on agriculture (Schlenker and Lobell, 2010).

The study further revealed that most respondents indicated their ability to adapt to climate change-induce events. This category of farmers could belong to farmer-based organizations (FBOs) who embrace technology and can afford to buy inputs such as chemical fertilize, pesticides, improved varieties, and weedicides to boost their agriculture production. Farmers who belong to FBOs are usually incentivized and may not be predisposed to climate change-induced events thus reducing their vulnerability against climate change. On the contrary, those farmers who indicated their inability to adapt to climate change are the poor in society and can hardly afford any farm inputs including using tractor to plough their lands. This scenario worsens the food security situation in the region since most farmers fall within the poverty bracket.

The study identified a total of 18 adaptation strategies being practiced by farmers in the region. Most farm households engage in crop diversification as an adaptation strategy to climate change. This is necessary because growing many different crops serve as safety net for the farmers. This guarantees food security and reduces households' vulnerability. In the same vein, some farm households have turned to using improved seed, disease, and drought tolerant crop varieties as is usually done to curb issues of unreliable weather. Farmers who use such early maturing crop varieties are usually the ones who have good farm income and can afford. This is consistent with the findings of Mwinkom et al. (2021) that farm income determines the purchasing power of farming households' ability to purchase improved seeds and early maturing crops.

The change in planting and harvesting times across the region is something almost all the farmers are grappling with for the past 10 years. According to the study their planting times have shifted from mid-May to June and July in recent times due to the erratic nature of the rains. These experiences of the farmers corroborate the findings of Haile (2019) that climate change has reduced the length of traditional planting seasons in some parts of East Africa and eventually compelled farmers to stop farming. In the same vein, farmers in the Sekyedumase district of the Ashanti Region observed shift in planting dates over the years (Fosu-Mensah et al., 2012). This scenario also highlights the perceptions by the farmers that rainfall pattern in the region has changed drastically and even varies across the various districts in the region.

## 6. Conclusion

The effects of climate change on agriculture and its negative impact on rural farm households' livelihoods cannot be understated. The present study revealed that households in the upper west region are struggling to ensure food security due to climate change. In view of this, farm households have adapted different strategies as a way of coping with climate change. Although some households claimed to be resilient against climate change, these households belong to farmer-based organization who embrace technology and help their members with farm inputs to boost production as already indicated the discussion section. Most farm households in the region however are highly vulnerable to climate change. But farmers can reduce their vulnerability to climate change by learning from their counterparts who belong to these farmer-based organization by joining such organization to also benefit from their services from time to time. Also, the adaptation strategies employed by households vary from farmer to farmer and from community to community. Hence, it is significant that policy makers and other stakeholders work to harmonize these strategies into a uniform national adaptation strategy. Farmers should be trained to not only engage in adaptation but mitigating strategies, since that have the propensity to restore the environmental conditions in the long run and reduce the effects of climate change. More research should be conducted on the sustainability of these adaptation strategies over time.

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