



Research Article

## Determinants of Adaptation Strategies to Climate Change among Farming Communities along River Benue in Adamawa State, Nigeria

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### ABSTRACT

This research work examines the determinants of adaptation strategies to climate change among rural communities along River Benue in Adamawa State, Nigeria. The specific objectives of the study are to assess the determinants of adaptation strategies to climate change and examine the impacts of climate change on the farmers' livelihood activities. A multistage sampling procedure was employed in selecting 463 respondents. Data were collected from primary sources. Secondary information was also used. The data sourced were analysed using descriptive and inferential statistical tools such as mean, percentages and multinomial logit regression models. It was found that climate change has a serious impact on the agricultural activities of respondents. The result of multinomial regression analysis revealed that different factors were responsible for the selection of adaptation strategies used by farmers. Generally, variables such as being male, age, income level, farming experience, and education levels among others were found to influence the selection of different adaptation strategies used by farmers in the study area. For example, variable issue as gender, marital status, age and farming experience were positive (P and significant in influencing respondents to practice 2 and 3 adaptation categories. The study therefore, recommends among others that government should provide adaptation incentives to farmers to reduce the impact of climate change on agricultural activities in the study area and diversification of livelihood activities to be encouraged among farming communities along river Benue so that farmers can get more income to adapt to the menace of climate change

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## INTRODUCTION

Climate change is the latest challenge to sustainable human development. The scientific evidence shows unequivocal warming of the climate system, and the rate of change is accelerating. Melting glaciers and ice caps, and more extreme weather events in many areas such as droughts, bigger tropical cyclones, heavier rainfall, and more wildfires have been recorded since the 1970s. For example, the 2010 floods in Pakistan were described as the worst in the country's history, affecting 20 million people. In the same year, floods in Colombia displaced over 400,000 people (Building Nigerian Response to Climate Change, BNRCC, 2011). Nigeria now experiences warmer conditions compared to the period thirty years ago. Evidence of climate variability and climate change in the country is indicated by increasing surface air temperature, increasing heat waves which enhance disease vectors, communicable diseases epidemics, sea level rise and associated coastal erosion, flooding, saltwater intrusion and mangrove degradation, increased evaporation that lead to drying up of streams and river, loss of forest vegetation which promotes soil degradation and desertification, as well as changes in seasonal patterns of climatic variables leading to reduced agricultural productivity (NEST, 2003). In Adamawa State, evidence of climate change includes delayed onset date of rains, an increase in the number of dry days during the rainy season and an increase in maximum temperature (Adebayo, 2010).

Climate Change affects human health, livelihoods, safety and society in general. The human impact is still difficult to assess with great accuracy because it results from a complex interplay of factors such as; natural variability, population growth, land use and governance. Climate Change affects all agricultural sectors in various ways, affecting

regions differently. For example, it lessens the predictability of seasonal weather patterns and increases the frequency and intensity of severe weather events such as floods, cyclones and hurricanes. Some regions face prolonged drought and water shortages. Changing temperatures are leading to changes in the location and incidence of pest and disease outbreaks (FAO, 2009a). Approximately 20-30% of plant and animal species will be at risk of extinction if the global average temperature increases more than 1.5-2.5°C (IPCC, 2007a). There is a growing agreement in the scientific literature that in the coming decades the world will witness higher temperatures and changing precipitation levels. The effects of this will lead to low poor agricultural products; evidence has shown that climate change has already affected crop yields in many countries (IPCC, 2007, Deressa *et al.*, 2008, BNRCC, 2008), particularly in developing countries, where the climate is the primary determinant of agricultural productivity (SPORE, 2008, Apata *et al.*, 2009). Vulnerable communities living in fragile environments, such as drylands, mountainous areas, riverine areas and coastal zones, will be particularly affected. Climate change will significantly increase the production risk of farmers, livestock keepers, fisherfolks and forest-dependant people, particularly, in regions that already suffer from chronic soil and water scarcity, high exposure to climatic extremes including floods, droughts, poverty and hunger (FAO, 2008b).

There are problems regarding the disappearance of many valuable plant and fish species, loss of wildlife species and reduction of biodiversity as a result of climate change effects on the farming communities of the riverine areas. This is a result of the absence of relevant data on the effective adaptation strategies to cope with climate change menace

in the affected areas. Although several studies have been carried out on adaptation to climate change in developing countries (Adetoye, 2009; Badi, 2010; Nhemachena, 2007; Selvarajuet *al*, 2006), none of these studies looked at the determinants of adjustment plans to climate change along the river Benue in Adamawa State, hence the study.

Small-scale farmers despite constraints struggle to adapt to the menace of climate change. A recent study by the United Nations Environmental protection UNEP on the adaptation and development perspective from Bangladesh has highlighted key elements of local adaptation. These include stakeholder engagement, participatory planning; production in risk and vulnerability; new knowledge generation and dissemination of awareness about Climate Change and its impact, livelihood protection and resilience building; better adaptive capacity, poverty reduction and enhancement of social safety (Haider, 2012).

Hassan and Nhemachena (2008) analysed the determinants of farm-level climate adaptation measures in 11 African countries and observed that the adjustment plans farmers perceive as appropriate include crop diversification, using different crop varieties, varying the planting and harvesting days, increasing the use of irrigation, increasing the use of water and soil conservation techniques, shading and shelter, shortening the length of the growing season and diversifying from farming to non-farming activities. Some plans that serve as an important form of insurance against rainfall variability include increasing crop diversification by planting crops that are drought tolerant and/or resistant to temperature stresses, taking full advantage of the available water and making efficient use of it. So much research was carried out on adaptation strategies to climate change, however, no study was carried out on the

determinants of adaptation particularly, at the flood plain of River Benue Basin to the knowledge of the researchers. The study is significant considering the huge impact of climate change on agricultural activities and the diverse socio-economic status of farmers.

The main characteristics of communities or regions that seem to determine their adaptive capacity are wealth, technology, information and skills, infrastructure, institutions and equity (Smit, *et al* 2001). Similarly, there are many factors responsible for taking up adaptation strategies for farmers. These range from socio-economic, institutional and environmental factors. Therefore, this study assessed the determinants of adaptation strategies among farmers by the length of the River Benue in Adamawa State, Nigeria. The study was designed to provide answers to the following research questions:

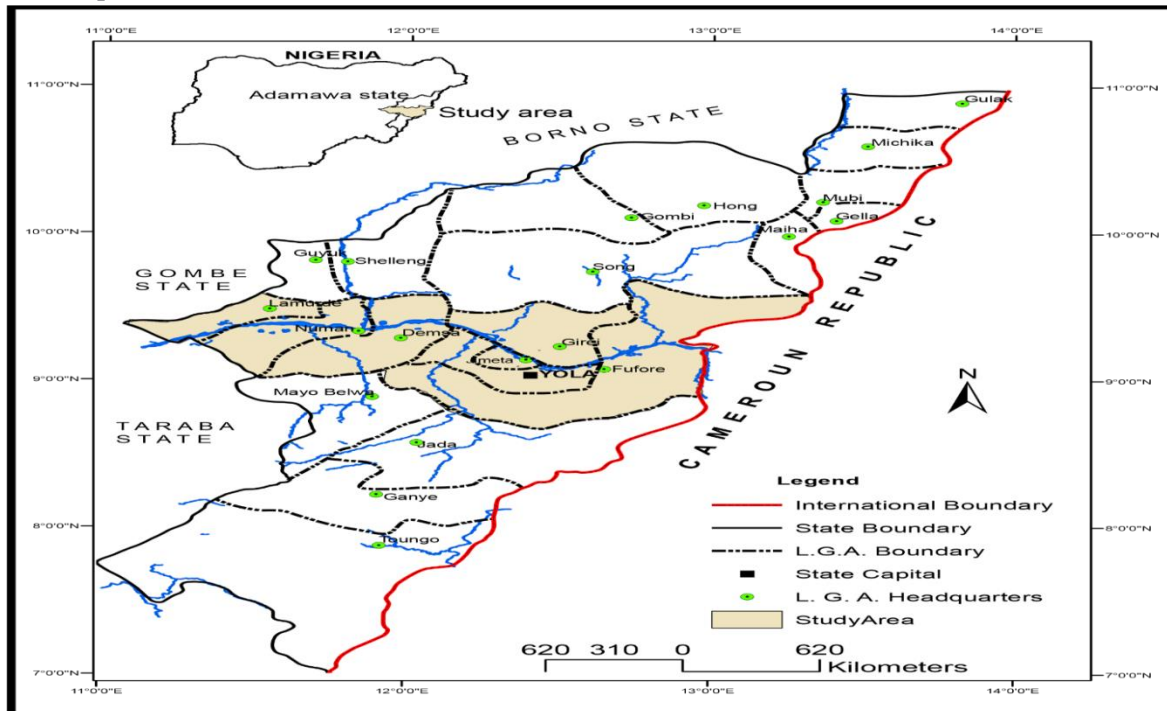
1. What are the impacts of climate change on agricultural activities in the study?
2. What are the determinants of adaptation strategies to climate change among the respondents in the study area?

#### **METHODOLOGY OF THE STUDY**

The Study area is located between latitude 9<sup>0</sup> 09' and 09<sup>0</sup> 33'N and longitude 12<sup>0</sup> 21' and 12<sup>0</sup> 54' E. (Fig. 1). The study area consists of the settlements along the River Benue, it cuts across seven local government areas (LGAs), namely, Fufore, Girei, Yola North, Yola South, Demsa, Numan and Lamurde. The area represents about one-fourth of Adamawa State, it is bounded to the north by Shelleng, Guyuk, Song and Maiha LGAs, to the South by Mayo Belwa and Ganye LGAs, to the west by Gombe State and to the East by the Cameroon republic. River Benue is the major River in Adamawa State. The river is replenished by flows from the Adamawa plateau of northern Cameroon, flowing west

across Nigeria to join River Niger at Lokoja. The river is about 1,400km long and its width varies from about 488 – 976m. The floodplain of River Benue has been a favorite site for a wide range of human activities which may have a profound effect on land use; the river

was also impounded at Lagdo in the Cameroon republic (Bashir, 2013). The River is almost navigable during the summer months. As a result, it is an important transportation route in the regions through which it flows.



**Figure 1:** Adamawa State Showing Study Area

**Source:** Cartographic Unit, Department of Geography, University of Maiduguri

The climate of the study area is characterised to a large extent by the seasonal movement of the inter-tropical convergence zone (ITCZ) which oscillates between 15oN and 15oS. The ITCZ moves northwards in April reaching its northernmost position in July to August and starts its southward movement in September. However, two strong air masses greatly influence the climate of the study area, these are a dry continental air mass and a humid, maritime air mass which oftentimes collide creating unexpected weather patterns. Precipitation usually occurs when a great depth of humid air mass gathers. In general, the depth of the air mass varies greatly from day to day and year to year causing unpredictable weather conditions altogether.

However, by the end of the dry season, the dry air mass becomes dominant and evaporation occurs. The dry season is a period when there is hardly any rain that is from the months of November to April while the months of May to October constitute the rainy season when the cultivation of crops becomes intensive within the flood plain.

The annual rainfall is roughly 759 mm (Bashir, 2013). It is common for the river to overflow its banks which are at the peak of the rainy season August to September. Most of the communities along the river channel experience flooding of different scales. The average temperature during the rainy season is approximately 32°C, however, during October and November, the temperature often rises

high. Throughout December and January, average temperatures can be around 80°C during the evening which is considered quite low for most African climates. The hottest month of the year is March when temperatures can reach well over 43°C.

The study has sub-Saharan vegetation and Guinea savannah vegetation, the northern part of Adamawa State has the sub-Saharan vegetation zone marked by short grasses interspersed with short trees, while in its southern part, the northern Guinea savannah vegetation exists. The Guinea savannah vegetation type is a by-product of centuries of tree devastation by Man and fire, and continuous attempts by the plants to adapt themselves to the climatic environment. The true vegetation of the area has for years been modified by human activities, and hence, traces of the climatic climax are difficult to come by.

Within the corridor of the River Benue floodplain, the vegetation is largely dominated by an extension of grassland and a few scattered trees which are mainly used as rangelands (Bashir, 2013). The woody vegetation that has existed, has been cleared by intensive human activities going on within the flood plain, it is now being replaced by grasses which increasingly attract large stocks of livestock thereby causing overgrazing in the area. The major occupation of the people in the study area is farming, the Communities that live on the bank of the river engaged in fishing while the Fulani are cattle herders. More than 1000 fishermen are found around the shores of the River.

The most common crops grown include Maize, Ground nut; Rice, Guinea corn, Yam, Cassava and Vegetables (Mohammed, 2013). Communities have shifted from relying entirely on fishing to farming as water recedes. Increased economic activities, which led to an increase in population and standard

of living, have resulted in over-fishing, overgrazing, poor farming practices and deforestation in the River Benue valley.

#### **METHODOLOGY**

A multistage sampling procedure was used to select the respondents for this study. The first stage was the purposive selection of three (3) riparian communities from each of the 7 LGAs, based on the proximity to the river, making a total of twenty-one sampled communities. In the second stage, a sampling frame of registered farmers was obtained from Adamawa Agricultural Development Programme (AADP), and a proportionate selection of 463 farmers was made to give the sample size of the study.

Data were obtained from the primary source. Secondary information was equally used. The primary data were obtained from the selected respondents through interview schedules. The Secondary information, particularly climatic data was obtained from published and unpublished materials. The data generated for this study were analysed using both descriptive and inferential statistics. The descriptive statistics included frequency counts and percentages while inferential statistics included, the multinomial logit (MNL)

The study adopted the MNL logit model to analyse the determinants of farmers' decision to adopt, the main limitation of the model is the independence of irrelevant alternatives (IIA) property, which states that the ratio of the probabilities of choosing any two alternatives is independent of the attributes of any other alternative in the choice set (Hausman and Mc Fadden, 1984; Tse, 1987).

Let  $A_i$  be a random variable representing the adaptation measure chosen by any farming household. We assumed that each farmer faces a set of discrete, mutually exclusive choices of adaptation measures. These measures are assumed to depend on several climate attributes, socioeconomic characteristics and other factors  $x$ . The MNL model for adaptation choice specifies the following

relationship between the probability of choosing option  $A_i$  and the set of explanatory variables  $X$  as (Greene, 2003).

$$\text{Prob}(A_i = j) = \frac{e^{\beta_j x_i}}{\sum_{k=0}^j e^{\beta_k x_i}}, j = 0, 1 \dots J \dots \dots \dots (1)$$

Where  $\beta_j$  is a vector of coefficients on each of the independent variables  $x$ . equation (1) can be normalised to remove indeterminacy in the model by assuming that  $\beta_0 = 0$  and the probabilities can be estimated as:

$$\text{Prob}(A_i = j/x_i) = \frac{e^{\beta_j x_i}}{e^{\beta_0 x_i} + \sum_{k=1}^j e^{\beta_k x_i}}, j = 0, 2 \dots J, \beta_0 = 0 \dots \dots \dots (2)$$

Estimating equation (2) yields the  $J$  log-odds ratios

$$\ln \left( \frac{P_{ij}}{P_{ik}} \right) = x_i' (\beta_j - \beta_k), \text{ if } k = 0 \dots \dots \dots (3)$$

The dependent variable is therefore the log of one alternative relative to the base alternative. The MNL coefficient to interpret, and associating the  $\beta_j$  with the  $j$ th outcome is

$$\delta_j = \frac{\partial \ln P_i}{\partial x_j} = P_i^{-1} \sum_{k=0}^j P_k (\beta_j - \beta_k) \dots \dots \dots (4)$$

$$\left( \beta_j - \sum_{k=0}^j P_k \beta_k \right)$$

The marginal effects show how a dependent variable changes in probability of a particular choice being made with respect to a unit change in an explanatory variable (Long 1997: Greene, 2000). The signs of the marginal effects and respective coefficients may be different, as the former depend on the sign and magnitude of all other coefficients.

tempting and misleading. To interpret the effects of explanatory variables on the probabilities, marginal effects are usually derived as (Greene, 2003):

To describe the MNL model implicitly, consider a rational household that seeks to maximize the present value of expected benefits of production over a specific time, and must choose among a set of adaptation strategies. The household  $i$  decide to choose  $j$  adaptation strategy if the perceived benefit from  $j$  is greater than the choice from other strategies say  $k$  depicted as:

$$\mu(\beta_j) = X_i + \epsilon_j > U_{ik} (\beta_k x_j + \epsilon_k), k \neq j \dots \dots \dots (5)$$

Where  $\mu_{ij}$  and  $\mu_{ik}$  = perceive choice by household of adaptation strategy  $j$  and  $k$  respectively.  
 $X_i$  = vector of explanatory variables that influenced the choice of adaptation strategies.  
 $\beta_j$  and  $\beta_k$  parameters to be estimated  
 $\epsilon_j$  and  $\epsilon_k$  = error terms

Data collected were analyzed to ascertain variables influencing farmers' adaptation strategies. Therefore, it is explicitly express as:

$$Y = \beta_0 + b_1 x_1 + b_2 x_2 + \dots \dots \dots + b x + e \dots \dots \dots (6)$$

- $Y_i$  = Adaptation strategies (1,2,3,4)  
 $\beta_0$  = Intercept  
 $b_1$ - $b_7$  = Coefficient  
 $X_1$  Changing planting date  
 $X_2$  = Switching to other crops  
 $X_3$  = Irrigation supplementation  
 $X_4$  = Using improved crop varieties  
 $X_5$  = Fertilizer and pesticide application  
 $X_6$  = Zero tillage  
 $X_7$  = Mixed cropping  
 $e$  = Error term

## RESULTS AND DISCUSSION

### Impact of Climate Change on agricultural activities

The effects of climate change on farming activities are presented in Table 1. The result shows that about 45.5% of the farmers had their crop yield reduced as a result of climate change, while about 20.5% noticed wilting of crops on their farms and 14.9% had their income reduced, 5.6% reported to have complete crop failure. The study further reveals that 1.1% reported having encountered reduced grass and biomass, and another 10.2%

of the respondents complained of reduced water for animals. Finally, 2.2% of the respondents claimed to have been faced with other effects of Climate Change. This implies that the respondents in the study area are being challenged by serious problems imposed on them by Climate Change. The study supports the findings of Mohua (2008) who reported that the performance of the agricultural sector depends largely on the returns of good rains, and the timely and adequate provision of agricultural inputs.

**Table 1:** Effects of Climate Change on Farming Activities

Effects	Frequency	Percent
Reduce crop yield	211	45.5
Reduce water for animals	47	10.2
Reduce grass and biomass	5	1.1
Wilting of crops	95	20.5
Reduce farm income	69	14.9
Complete crop failure	26	5.6
Others	10	2.2
<b>Total</b>	<b>463</b>	<b>100.0</b>

**Source:** Field Survey, 2021

The result on the sensitivity of the impact of climate change on agricultural activities is presented in Table 2. The result revealed that about 42.8% of the respondents stated that they are sensitive to the impact of climate change, while 32.8% of the respondents claimed to be very sensitive to the climate

change impact. The finding further reveals that 19.7% of the respondents maintained that the impact is slightly sensitive to them. However, about 4.8% of the respondents claimed to be not sensitive to the impact of climate change, in another word climate change does not make any difference in their livelihood activities.

But generally, the frequency shows that about 95.2% of the respondents were sensitive and were affected by the impact of climate change, and only about 4.8% of the farmers were not sensitive to the impact in the study area. This

implies that the impact of climate change has the tendency of affecting the performance of the individual farmers on their farms and subsequently affects their outputs.

**Table 2:** Sensitivity to the Impact of Climate Change on Agricultural Activities

<b>Sensitivity to Climate Change</b>	<b>Frequency</b>	<b>Percent</b>
Very sensitive	152	32.8
Sensitive	198	42.8
Slightly sensitive	91	19.7
Not sensitive	22	4.8
<b>Total</b>	<b>463</b>	<b>100.0</b>

Source: Field Survey, 2021

### **Determinants of Adaptation Strategies to Climate Change**

The analysis used changing planting date as a reference base category or “reference state” and assesses the others as an alternative to this option. It was observed that all the respondents adopted changing planting dates as an adaptation strategy to Climate Change, which was the reason for categorizing it as a reference category. Respondents practised multiple adaptations of 2, 3,4,5,6 and 7 options: (2= Switching to other crops; 3= Irrigation supplementation; 4= Using improved crop varieties; 5= Fertilizers and pesticide application; 6= Zero tillage; and 7= Mixed cropping). For this analysis, data for

those respondents that practised 2 and 3 adaptation options were collapsed and denoted as 2, so also those respondents that practised 4 and 5 adaptation options were assigned 3, and 4 for those that practised option 6 and 7 adaptation strategies Table 3.

The result on factors that influence the second category (2) shows that gender, marital status, age and farming experience were positive (P and significant in influencing respondents to practice 2 and 3 adaptation strategies. Also, income level, education level, farm size and access to credit were found to be positive (P and significantly influencing respondents to practice 2 and 3 adaptation strategies in the study area.



**Table 3:** Multinomial logistic regression estimates of Determinants of adaptation strategies to Climate Change

No. of adaptation strategies practice	Variable	Coefficient	P> z
1	(base outcome) Changing planting date		
2			
Switching to other crops	Gender	1.809317	2.41**
	Marital	.6845405	2.04**
	H/H size	.009175	0.09
Irrigation supplementation	Age	.110958	2.50**
	Income	.849742	4.73***
	Farming exp	.311908	2.58**
	Education	.0223497	9.44***
	Farm size	.9999422	16.27***
	Sec. Occupation	.0548718	0.72
	Credit	2.223439	5.60***
	Ext. service	.0236084	0.23
Awareness	2.496759	2.24**	
3			
Using improved varieties	Gender	1.031861	2.61***
	Marital	.3135284	0.64
	H/H size	.2131453	1.25
	Age	2.553762	5.36***
Fertilizers and pesticide application	Income	1.466475	2.51**
	Farming exp	.3119089	2.58**
	Education	1.015823	3.02***
	Farm size	.0360224	2.80***
	Sec. Occupation	.2530081	2.22**
	Credit	.1093228	4.37***
	Ext. service	.0476302	2.42**
Awareness	.4584279	4.26***	
4			
Zero tillage	Gender	.3664163	0.62
	Marital	.689815	1.26
	H/H size	.4541009	2.28**
	Age	1.198342	2.13**
	Income	.8497429	4.73***
Mixed cropping	Farming exp	1.359399	6.46***
	Education	.8122785	3.28***
	Farm size	.6862085	3.14***
	Sec. Occupation	.0628358	0.48
	Credit	.8646457	3.05***
	Ext. service	.1601211	0.99
	Awareness	5.634574	2.97**

Note: \*\*, \*\*\* are significant at 5% and 1% respectively

Source: Field Survey, 2021

The results suggest that male respondents tend to adopt this category of adaptation more than

their female counterparts; it is obvious that men have access to information and

technology more than female farmers. Therefore, male respondents could adjust as a result of Climate Change due to their experience and exposure. Married respondents also practice this category of adaptation over shifting planting dates alone. This could be a result of anticipated returns due to the practice of multiple adaptations. Adaptation strategies occasioned by marital obligations. Age was also found to be significant. This implies that older farmers adopt this category of adaptation option. This could be a result of an experience in agricultural production. This result concurred with that of Bayard *et al* (2007) who found that age is positively related to the adaptation of soil conservation measures. Farmers with higher years of farming experience tend to adapt to Climate Change with 2 or 3 practices rather than one (changing planting date).

The income level of respondents was also significant, this suggests that the more the income of the farmer, the higher the tendency to adapting 2 and 3 options practised rather than one. With higher income, farmers procure adaptation materials that will enable them to practice multiple adaptation strategies. The result on education level shows that, farmers with a higher level of education practice 2 and 3 adaptation options rather than one (reference category). This could be a result of awareness of the dangers of climate change and the perceived returns of farm enterprise as a result of practising multiple adaptation options (2 and 3). Educated and experienced farmers are more likely to have more knowledge and information about Climate Change and agronomic practices that they can use in response (Maddison, 2006). Farm size was reported to have a significant influence on adopting this category of adaptation option. This implies that farmers with larger farm sizes practice multiple adaptation strategies of 2 and 3 rather than one. This could be a result

of the huge investment made by farmers with larger farm sizes. With larger farms, farmers have more land to allocate for the practice or trial of adaptation options.

The result on access to credit revealed that farmers who had access to credit during the 2020/2021 cropping season tended to adopt 2 and 3 adaptation materials (seeds, irrigation facilities, chemicals and fertilizers). These technologies could enable them to adapt multiple responses rather than one. The coefficient of gender, age, education level, farm size and access to credit were found to be positive (P and significantly influenced farmers to adopt practice 4 and 5 adaptation strategies rather than taking up one adaptation option (reference category). In the same manner, the coefficient of income level, farming experience, primary occupation and access to extension services were found to be positive (P and significantly linked to the adoption of multiple adaptation strategies of 4 and 5 rather than the reference category. Nhemachena and Hassan (2007) found a positive effect of free extension services on the probability of adoption of different crops, different varieties, crop diversification, increase irrigation and increase water conservation in the hills of Nepal.

Male respondents adopt this category of adaptation perhaps men have more access to resources, education, technology and information than female farmers. Resources endowments enable respondents to adopt multiple adaptation options. Farmers believe that practising multiple adaptation strategies could enable them to cope well with the menace of Climate Change. This is because different adaptation strategies could take care of different climatic variables. The result on age revealed that respondents that have higher age were involved in 4 and 5 adaptation options instead of one. This could be because of the farming experience of farmers that are

associated with age. Farmers who have much experience could adopt multiple adaptation options because of the experience of climate change over the years.

The educational awareness of farmers improves awareness of the climate change menace, thereby enabling them to practice 4 and 6 adaptation options if they have better educational qualifications. Farmers with large farm sizes do adapt to climate change by adopting 4 and 5 adaptation options. This is perhaps because huge farm investment that is associated with large farm size. Farmers that invested heavily will do everything (adaptation) to secure his/her investment. Access to credit and income level influence farmers to adopt 4 and 5 adaptation options. This could be better explained by the ability to secure adaptation inputs with access to credit and increased farm income. Different adaptation methods require different inputs. With access to credit, respondents could be able to purchase these inputs to deal with the climate change menace. Likewise, with large farm incomes, farmers could buy such inputs with ease.

The primary occupation of the respondents influenced them to practice 4 and 5 adaptation options. This implies that farmers who take farming as a primary occupation practice 4 and 5 adaptation strategies. Perhaps farmers who practice farming as their main occupation might have taken it with utmost serosity to secure their farms from all odds by adopting multiple responses to Climate Change. Access to extension service implies that farmers who had extension contacts during the last farming season (2021) do adopt these category 4 and 5 adaptation options. This is because of the informed decision and awareness brought about by access to extension services.

The coefficients of household size and age were found to be positive (P and significantly influenced farmers to practice the 6 and 7

adaptation categories. The coefficient of income level, farming experience, education level, farm size, and access to credit were found to be positive (P significant influencing respondents to practice 6 and 7 adaptation options instead of one. Household size implies that some adaptation strategies require much labour that can be better taken up by households with large household sizes, in addition to other adaptation options. Age and farming experience influence farmers' ability to practice 6 and 7 adaptation options instead of the reference category alone. This is because of the experience over the years brought by age and farming experience.

Access to credit and income levels enable farmers to procure adaptation materials/inputs for the different adaptation methods. With credit and much farm income, in addition to other adaptation strategies practised by farmers, the latter could procure such materials. Education level creates awareness of the dangers of Climate Change and perceived adaptation options. Farmers with higher qualifications do adopt this category of adaptation option (6 and 7) rather than one because of the awareness and access to technologies that could enable them to adapt by using different strategies. The implication of farm size is that; a large farm size could be translated to a huge farm investment that can be secured by adopting different adaptation options available. Farmers with large farm sizes practice these category 6 and 7 adaptation options to deal with the effects of Climate Change.

#### **CONCLUSION**

The study concluded that huge impacts of climate change exist on the agricultural activities of farmers along River Benue settlements in Adamawa State. As a result of these impacts, farmers do adapt to the changing climate in different ways suited to the resources available and cultural practices.

Many factors were responsible for the selection of adaptation practices used by farmers. Generally, variables such as being male, age, income level, farming experience, and education level among others were found to influence the selection of different stratagem used by farmers in the area.

### RECOMMENDATIONS

The study, therefore, recommends the following:

1. As a result of the huge impact of climate change on farming activities, the government should provide adaptation inputs such as improved seeds to farmers to reduce the impact of climate change on agricultural activities in the study area;

2. Diversification of livelihood activities to be encouraged among farmers on the river bank of the river Benue, so that farmers can get more income to deal with the menace of the changing climate
3. Formal and informal education to be encouraged among farmers to enlighten them on the dangers pose by climate change and serve as an incentive to adopt technology for adaptation to climate change; and,
4. Extension service programmes should be enhanced so that farmers would be advised appropriately on measures to be taken to cushion the effect of climate change.

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