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Determinants of Climate Change Adaptation Strategies among Farmers in Borno State, Nigeria: Multinomial Logit (MNL) Approach

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ABSTRACT

The study assessed climate change adaptation strategies and their determinants among smallholder farmers in Borno State, Nigeria. The study was conducted in Sudan savannah and Guinea savannah Agro-Ecological Zones (AEZ) of the State. Multi-stage sampling procedure was used in selecting 360 smallholder farmers for the study. Both descriptive statistics (percentages; frequencies, means); and inferential statistics (multinomial logit regression) were used to analyze the data. Findings revealed that in both AEZs, farmers adapt to climate change through various farm level practices. These adaptation strategies however, vary slightly among the two AEZs. The adaptation strategies practiced by respondents in Sudan AEZ were multiple cropping (98.9%), early planting (63.9%), mulching/use of cover crops (36.1%) and increased fertilizer application (25.00%). In Guinea AEZ, the most widely used adaptation strategies include multiple cropping (93.30%), use of new crop varieties tolerant to new climate regime (72.20%), increased application of fertilizer (47.20%) and application of chemical (25.00%). Result of marginal effects derived from multinomial logistic regression estimate revealed that variables such as farm experience, household size, farm size, perceived change in temperature, perceived change in rainfall, dry spell experience and access to information on climate change were found as the major factors influencing the choice of adaptation strategies been practiced by respondents. The study concludes that farmers adapt to the menace of climate change using different strategies. It is recommended that adaptation materials such as improved crop varieties, fertilizers and chemicals should be provided to farmers at subsidized rate in order to increase farmer's capacity to adapt.

Keywords: Adaptation Strategies, Climate Change, Borno State, Nigeria: Multinomial Logit Approach

1. INTRODUCTION

The process of producing food requires resources, which could be natural or man-made. Among the natural resources, climate is the predominant factor that influences food crop production (Ifeanyi, 2016). Oyekale *et al*. (2009) described climate as the state of atmosphere, which is created by weather events over a period of time. A slight change in the climate affects agriculture (Adedire, 2010). Intergovernmental Panel on Climate Change (IPCC) (2001) described climate change as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global and/or regional atmosphere and which is in addition to natural climate variability observed over comparable time periods. Climate change poses environmental, social and economic challenges on a global scale (Mendelsohn *et al*., 2006; Scholze *et al*., 2006; Shongwe, 2013). Without gainsaying, climate change is a serious challenge facing the entire world today. The impacts of climate change are being felt by both developed and developing countries. These impacts are been felt more by developing countries because they lack economic, social and political infrastructures to respond adequately to the effects of climate change (Farauta *et al*., 2011).

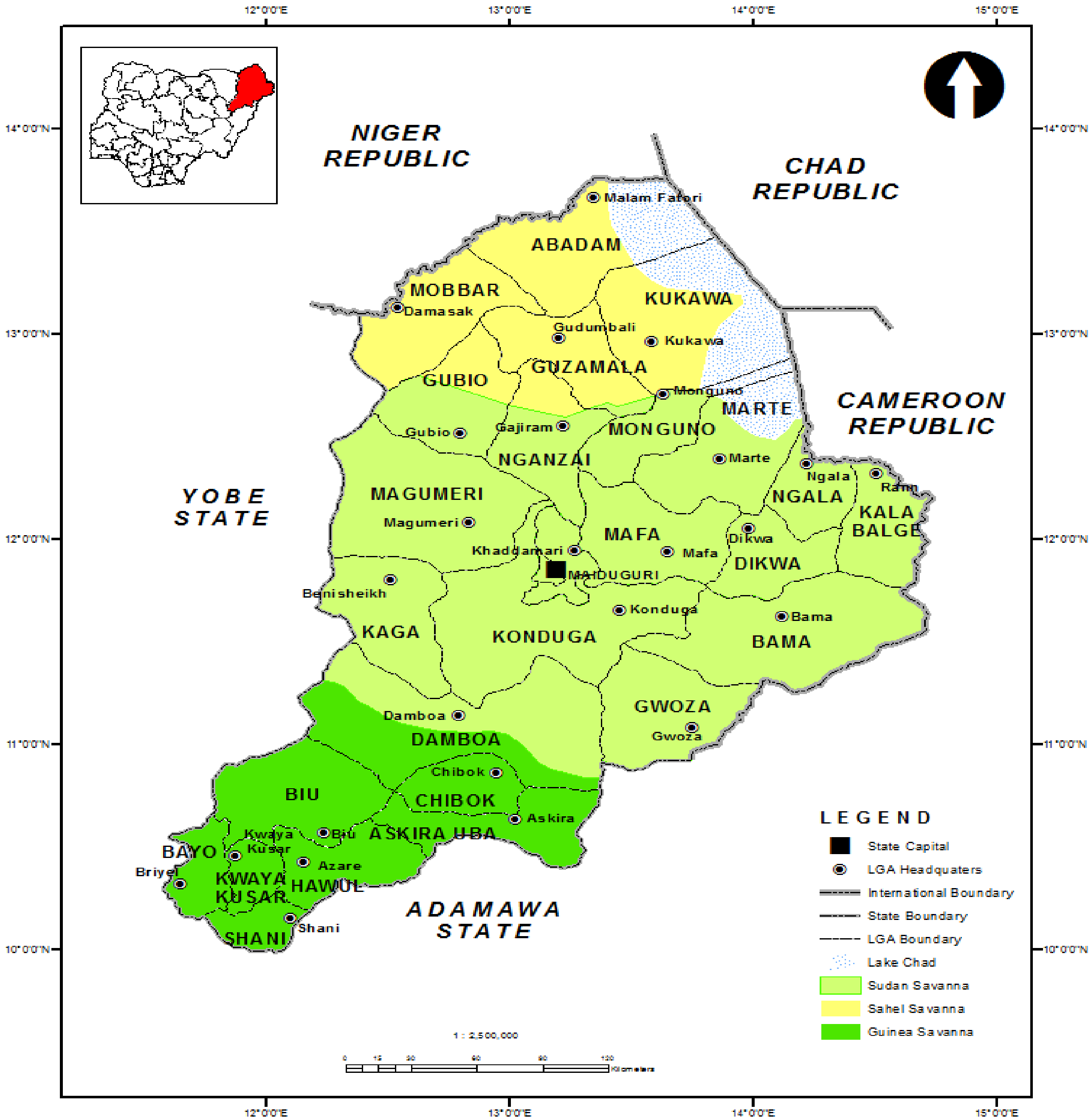
Adaptation to climate change is the adjustment of practices, processes and structures to reduce the negative effects particularly, the unavoidable ones, and takes advantage of any opportunities associated with climate change (IPCC, 2007). Although, African farmers have a low capacity to adapt to changing climate, however, have survived and coped in various ways over time. Better understanding of how they have done it and factors influencing the adoption of a particular strategy are essential for designing incentives to enhance private adaptation. Deressa (2008) posited that farmers adapt to climate change in order to maximize profit by changing crop mix, planting and harvesting dates, and a host of agronomic practices. The coping strategies adopted by crop farmers, which are mainly initiated at the farm and village-level, are expected to enhance their farm productivity, and improve their profit as a producing unit. Many studies have been conducted on the determinants of adaptation to climate change in Nigeria (Apata *et al.,* 2009; Oyerinde and Osanyede 2010; Nzeadibe *et al*., 2011; WEP, 2011; Idrisa *et al*., 2012; Adebayo *et al*., 2012; Adebayo *et al*., 2013) using logit regression and multiple regression models. Limited knowledge however, exists on the use of multinomial regression model in analyzing the determinants of adaptation strategies to climate change particularly in the study area, where farmers require incentives in tackling the multidimensional effects of climate change worsen by the menace of *Boko Haram* insurgency. This study aims to address this research gap by analyzing crop farmers' adaptation to climate change in Borno State, Nigeria. Specifically the study sought to examine farm level climate change adaptation strategies practiced by farmers and factors influencing the choice of climate change adaptation strategies.

2. METHODOLOGY

The study area was Borno State, Nigeria. The State has a land area of 69, 435 square km (Amaza *et al*., 2007). The area lies between latitudes 12^{o} - 00N and 14^{0}, 00N and Longitude 10^{o} - 00E and 14^{0}- 00E of north eastern Nigeria (Fig. 1). There are 27 Local Government Areas (LGAs) in the state spread over three agro-ecological zones viz, the Sahel (S), Guinea Savanna (GS) and the Sudan Savanna (SS) (Amaza *et al*., 2007).

The State has population of 4,151,193 (NPC, 2006) with a projected 2017 estimates of 6,001,901 based on 3.2 population growth rate. It has climatic peculiarities characterized by erratic and un-reliable rainfall patterns. The rains are of short duration followed by a long dry spell. Temperatures are high all year round, with hot season mean temperatures ranging between 39^{o} and 40^{o}C in the northern part of the State and the annual precipitation ranges from less than 600 mm in the north to 1500 mm in the south (Amaza *et al*., 2007). Rainfall, however, varies from year to year but has tended to decrease over the last two decades. Droughts are endemic; the State is one of the eleven desert front line States of Nigeria (WEP, 2011). The main livelihood activity of the people is agriculture producing variety of crops, livestock and fish.

Data for the study were mainly from primary source, obtained through household survey. Multi-stage random sampling technique was used in selecting respondents in the two AEZs selected for the study. In the first stage, three (3) LGAs were purposively selected from each AEZ based on the intensity of agricultural production practices and accessibility to communities. The second stage involved random selection of three (3) communities from each LGA, giving a total of eighteen (18) communities. Lastly, from the lists of registered farmers obtained from Borno State Agricultural Development Programme (BOSADP), farmers associations and community leaders, farmers were proportionately selected from each community, making a total of 360 respondents for the study. Both descriptive (mean, frequency and percentages) and inferential statistics (multinomial logit regression) were used in analyzing data obtained.



Source :Department of Geography,University of Maiduguri (2019)

Figure 1 : Map of Borno State showing Ecological Zones.

Multinomial Logit (MNL) Regression Model

The determinants of the choice of adaptation to climate change by crop farmers were analyzed using MNL regression. The application of the model in explaining socio-economic phenomenon has been shown to be more appropriate particularly in analyzing the relationship involving multiple dependent variables and a set of independent variables (Greene, 2003).

The household decision of whether or not to adopt climate change adaptive strategies could be considered under the general framework of utility or profit maximization (Deressa, 2008). In this context, the utility or the net benefit of the economic agents is not observable, but the actions of the economic agents could be observed through the preference the farmers make. Supposing that U_j and U_k represent household's utility for two preferences; β_j and β_k respectively, the linear random utility/net benefit model could then be specified as follows:

$Uj = \beta jXi + \varepsilon j$ and $Uk = \beta jXi + \varepsilon k$ ---(1)

Where;
Uj and Uk are perceived utilities of adaptation strategies *j* and *k*, respectively,
Xi is the vector of explanatory variables which influenced the perceived desirability of each strategy,
βj and βk are the estimated, and εj and εk are error terms assumed to be independently and identically distributed (Greene, 2003).
To describe the MNL model implicitly, consider a rational household that seeks to maximize the present value of the expected benefits of production over a specified time horizon, and must prefer among a set of climate change adaptation strategies. The household i decide to choose j climate change adaptation strategy, if the perceived benefit from j is greater than that from other climate change adaptation strategies (say k) depicted as:

$U_{ij}(\beta j; Xi + \varepsilon j) > U_{ik}(\beta k;Xi+ \varepsilon k), k \neq j$ --(2)

Where:
U_{ij} and U_{ik} = Perceived choice of household to climate change adaptive strategies j and k, respectively.
Xi = Vector of explanatory variables that influence the preference for climate change adaptive strategies.
β_j and β_k = Estimated parameters.
εj and εk = Error terms.

The probability that farmer i choose adaptation strategy j among a set of climate change adaptive strategies is defined as:

$P (y = 1/x) = P (U_{ij}>U_{ik})/X$ ---(3)

$= P [(\beta^1Xi + \varepsilon i – \beta^1kXi – \beta_k) > 0/X]$
$= P [(\beta^1_j – \beta^1_K) Xi + (\varepsilon j – \varepsilon k) > 0/X]$
$= P [(\beta^*X_i + \varepsilon^*> 0/X) = F (\beta^*X_i)$

Where;
P = probability function;
U_{ij} , U_{ik} and X_i are as defined above;
U_{ij} , U_{ik} and X_i are as defined above;
$\varepsilon^* = \varepsilon j – \varepsilon k$ is a random disturbance term;
$\beta^*= \beta^1j – \beta^1_K$ is a vector of unknown parameters influencing preference of a strategy
$F (\beta^*Xi)$ is a cumulative distribution function of ε^* evaluated at β^*Xi
The probability that a household would choose climate change adaptation strategy j among the set of adaptation strategies was then be implicitly expressed as:

$Yi = \beta o + (\beta_{lj} + \beta_{jk}) X_1 + (\beta_{2j} + \beta_{2k}) X_2 +----+ (\beta nj+ \beta nk) Xn +e$ ---------------------(4)

Where:
Yi = Preferred choice of climate change adaptive strategies
β_0 = Intercept
βj(i-n) and βk(i-n) = Estimated parameters
Xi-n = Independent variables
j= Preferred climate change adaptive strategy

k = Other climate change adaptive strategies
i = 1, 2, 3------- n number of adaptive strategies
e = Error term

The choice of explanatory variables in the model was based on literature. It was assumed that each farmer faced with a set of discrete, mutually exclusive choices of adaptation strategies. These measures were assumed to be dependent on a number of climate variables, household characteristics and institutional factors.

The explanatory variables included in the model were:
X_1 = Sex (Male= 1, Female = 0)
X_2 = Primary Occupation (Farming= 1, Otherwise= 0)
X_3 = Education Level (Yrs)
X_4 = Farming Experience (Yrs)
X_5 = Marital Status (Married= 1, Otherwise= 0)
X_6 = Household Size (No.)
X_7 = Farm Size (hectare)
X_8 = Access to Credit (Access= 1, Otherwise= 0)
X_9 = Change in Temperature (Noticed= 1, Otherwise= 0)
X_{10} = Perceived Change in timing of Rain (Noticed= 1, Otherwise= 0)
X_{11} = Perceived Intensity of Rain (Noticed= 1, Otherwise= 0)
X_{12} = Numbers of dry spell experience last cropping season (No.)
X_{13} = Access to information on Climate Change (Accessed 1, 0 Otherwise)
U = error term

3. RESULTS AND DISCUSSION

Adaptation Strategies Practiced by Farmers

To respond to the perceived changes in climate, farmers are employing adaptation strategies in order to reduce the negative impacts on crops. Majority of the farmers reported to have being using multiple adaptation option. The farm level adaptation strategies practiced by respondents in the two agro-ecological zones are presented in Table 1.

Table 1: Distribution of Respondents based on Adaptation Strategies

	Sudan Savannah (n= 180)		**Guinea Savannah (n=180)**	
Adaptation Strategy	**Frequency***	**Percentage**	**Frequency***	**Percentage**
Multiple Cropping	178	98.9	168	93.3
Application of Chemicals	12	6.7	45	25
Early Planting	115	63.9	33	18.3
Increased Application of Fertilizer	45	25	85	47.2
Mulching/use of Cover Crops	65	36.1	25	13.9
Use of New Crop variety tolerant to new climate regime	16	8.9	130	72.2
Increased Cultivated Land	25	13.9	21	11.7
Application of Organic Manure	32	17.8	18	10
Irrigation Supplementation	5	2.8	14	7.8

Source: Field Survey, 2018 * Frequency based on Multiple Responses

In Sudan savannah agro ecological zone, the result revealed that 98.9% of the respondents adopted multiple cropping as adaptation strategy, 63.7% practiced early planting and 36.1% of the respondents employed mulching and use of cover crops as adaptation strategy. In guinea savannah zone the result revealed that 93.3% of the respondents practiced multiple cropping, 72.2% of the respondents employed new crop varieties tolerant to new climate regime, 25% of the respondents practiced increased use of chemical. The use of multiple cropping or crop diversification is considered as a tradition for smallholder farmers as reported by many authors (Enete *et al*., 2008; Mohammed, *et al*., 2014). The practice however, has been intensified as a result of climate change. Multiple cropping is aimed at spreading climate risk over two or more crop enterprises as climate factors affect crop enterprises differently. This is because different crops have different level of resilience to climate variability; hence planting many crops could ensure that farmers get some output in the face of extreme climate situation.

Early planting is an age long adaptation strategy practiced by crop farmers. The main trust of the strategy is to ensure that critical growth stages do not coincide with the harsh climate condition usually experienced at the end of the wet season. Farmers reported that as soon as the wet season starts, they plan their crop. However, the strategy requires replanting as not all the seeds germinate as a result of moisture deficiency in the soil at the beginning of the raining season. Mulching/use of cover crops is aimed at conserving moisture content of the soil. Couple with soil characteristics, the rainfall regime in the Sudan savannah is scanty, therefore, farmers resort to adopt the strategy in order to conserve the little moisture in the soil by covering the soil either with cover crops (cowpea, groundnut) or some non- crops materials (thatch, farm waste). This will ensure the soil surface is not directly exposed to the sun radiation thereby minimizing the rate of evaporation.

The use of new crop varieties tolerant to new climate regime has been practiced by farmers in guinea savanna agro-ecological zone of Borno State. New crop varieties such as maize, cowpea and soybean are promoted by IITA, IFAD and government agencies in the zone. This paved way for farmers to adopt it as an adaptation strategy to climate change. The main trust of using new crop varieties as an adaptation strategy could be twofold: grow fast to meet up the shortened wet season and yield high to ensure that farmer get income in the face of climate change. The use of chemical as an adaptation strategy is gaining ground among farmers in Guinea savannah zone evidenced from the result of the study. Chemical such as herbicides application is a substitute for labour in farm business. Considering the cost of labour in farm business and the adverse effects of climate change on crop production, farmers lessen the cost of labour by adopting the strategy hence reduced cost of crop production leading to increased profitability of farm business.

Factors Affecting the Choice of Adaptation Strategies to Climate change

Before conducting econometric estimation for the multinomial regression, different tests which are very necessary for multinomial logit model were undertaken. These include model specification test and test for the assumption of independence of irrelevant alternatives (IIA). Initially the model runs sixteen variables. From the first model (Model 1) chi square 162.83 and Prob > LR 0.000 indicate the overall significance of the explanatory variables in explaining the model. Variance inflation factors and correlation matrix in the first model shows that, age, awareness to climate change and non-farm income show high multicollinearity problem. Therefore, the second model is fitted after dropping one highly insignificant variable and the variables which show multicollinearity problem, i.e., age, awareness of climate change and non-farm income respectively. The second model, the chi-square was 153.19 and Prob > LR 0.000. MNL model requires the fulfillment of the assumption of the Independence of Irrelevant Alternatives (IIA), otherwise the model would be inappropriate. Moreover, Multinomial logit models work well when the alternatives are dissimilar. Result of Hausman-McFadden (HM) test of assumption shows that the alternatives were dissimilar. In this model, six categorical outcome tests of IIA were reported.

The parameter estimates, however, did not represent actual magnitude of change or probabilities. Thus, the marginal effects, which measure the expected change in probability of a particular climate change adaptation strategy choice being made with respect to a unit change in an independent variable, are presented in Table 2.

Gender:

Gender of respondent’s household head had a significant and positive effect on application of organic manure as an adaptation strategy to climate change relative to multiple cropping. This result implies that being male respondent increased the probability of choosing application of organic manure by 1.31% at $P \leq 0.01$. The finding agrees with that of Ogada *et al*. (2010) who found that male headed households had a positive relationship with the adoption of manure and fertilizer as farm technology in Kenya.

Primary Occupation:

The result on primary occupation of respondents indicated significant and positive effect on the choice of increased fertilizer application and application of organic manure as adaptation strategies to climate change. The result implies that being full time farmer increased the likelihood of taking up increased application of fertilizer and application of organic manure as adaptation strategies by 57.02% and 5.36% at $P \leq 0.01$ and $P \leq 0.05$ respectively. Being full time farmer enables respondents take up measures that reduce the menace of climate change on crop production in order not to risk the only source of livelihood.

Table 2. Marginal Effects from the Multinomial Logit Model of the Determinants of Choice of Adaptation Strategies to Climate Change

Explanatory Variable	AC	UICV	IFA	EP	AOM	MUCC
Gender	1.5679	1,0534	0.6853	0.0131	0.0131	1.4175
	(0.60)	(0.70)	(0.22)	(0.56)	(1.72)*	(0.46)
Pry Occupation.	0.1039	0.3706	0.5702	0.1927	0.0536	0.3999
	(0.06)	(0.44)	(1.69)*	(1.44)	(2.24)**	(-0.29)
Education Level	0.3984	0.2617	0.1778	0.1862	0.1080	0.2538
	(0.99)	(1.49)	(3.47)***	(3.60) ***	(1.97) **	(0.87)
Farm Experience	0.1819	0.1784	0.1079	0.5403	0.2250	0.1798
	(0.17)	(3.46) ***	(3.27) ***	(5.81) ***	(3.62) ***	(3.49) ***
Marital Status	0.9969	0.3332	3.8594	0.0094	0.9444	0.9242
	(0.46)	(2.04) **	(1.37)	(0.10)	(0.73)	(0.27)
Household Size	0.4790	0.0740	0.5343	0.9172	0.0178	1.1990
	(4.93)***	(0.14)	(5.88) ***	(2.94)**	(2.45)**	(1.27)
Farm Size	0.9802	0.8983	2.8846	0.0124	0.5124	0.8972
	(0.67)	(5.32)***	(2.17)**	(1.32)	(4.20) ***	(4.86) ***
Access to Credit	0.9368	0.9451	0.4905	0.4465	0.0205	0.3559
	(0.72)	(2.88)**	(0.30)	(0.34)	(2.09) **	(0.28)
Perceived	1.2259	0.4772	0.0967	0.0278	0.2243	0.1641
Change in Tempt.	(0.86)	(4.92) ***	(3.12) ***	(1.84) **	(3.23) ***	(3.61) ***
Perceived	0.1066	0.8485	3.3228	0.0298	0.5811	0.4192
Change in Rain	(3.23)***	(4.60) ***	(1.91) **	(1.85) **	(14.91) ***	(3.83) ***
Farm Income	0.1983	0.2666	0.3299	0.8230	0.3600	25.6787
	(0.11)	(1.99) **	(1.15)	(18.20) ***	(0.35)	(0.00)
Dry Spell Exp.	0.3704	0.1595	0.1862	0.1113	0.0598	0.6984
	(0.22)	(0.17)	(3.60) ***	(6.17) ***	(3.32) ***	(0.55)
Acc to info on	0.9281	0.9457	0.9655	0.0915	0.2737	0.5309
Climate Change	(0.88)	(2.09) **	(6.61) ***	(2.94) ***	(1.97) **	(0.66)

Source: Computed from Regression Extract, 2018

*, **, ***: Significant at P≤ 0.01, P≤ 0.05 and P≤ 0.10 levels respectively.

Note: AC = Application of Chemical, UICV = Use of Improved Crop Varieties tolerant to new Climate Regime, IFA= Increased Fertilizer Application, EP = Early Planting, AOM = Application of Organic Manure and MUCC = Mulching and Use of Cover Crops.

Education Level:

The result on the effect of education level on the choice of adaptation strategies revealed significant and positive relationship on increased fertilizer application, early planting and application of organic manure as adaptation strategies. This result implies that a year increase in education level of respondents increased the probability of using increased fertilizer application, early planting and application of organic manure by 17.78%, 18.62% and 10.80% at P≤ 0.10, P≤ 0.10, and P≤ 0.05 respectively. Education improves awareness on the effects of climate change and adaptation options to be employed. The result was in line with the findings of Haji and Keleme (2012) who reported that education level increases the probability of choosing combination of bundles of adaptation strategies to climate change in East Hareerghe Zone of Oromia region of Ethiopia.

Farming Experience:

Farming experience showed significant and positive effect on the choice of use of improved crop varieties, increased fertilizer application, early planting, application of organic manure and mulching/use of cover crops as adaptation strategies to climate change. This implies that a year increase in farming experience of respondents increase the likelihood of choosing the adaptation options by 17.84%, 10.79%, 54.03%, 22.50% and 17.98% at P≤ 0.10 respectively. Farming experience improved awareness about climate change and hence the right decision on the adaptation strategies to be employed in reducing the menace of climate change.

Marital Status:

The result marital status showed significance and positive effect on the choice of improved crop variety adaptation strategy. This implies that married respondents had increased probability of taking up the use improved crop variety as an adaptation strategy by 33.32% at $P \leq 0.05$.

Household Size:

Household size was found to have significant and positive effect on application of chemicals, increased fertilizer application, early planting, and application of organic manure as adaptation strategies. This result implies that an increase in household size by one unit, the probability of taking up application of chemicals, increased fertilizer application, early planting, and application of organic manure as adaptation strategies increase by 47.9%, 53.43%, 91.72% and 1.78% at $P \leq 0.10$, $P \leq 0.10$, $P \leq 0.05$ and $P \leq 0.05$ levels of significance respectively. Family labour is an important source of labour in African subsistence agriculture, which is determined by household size. Early planting and application of manure are labour intensive strategies and are being practiced since household members were used in providing the labour. This finding agrees with Aymore (2009); Ifeanyi (2016) who reported that large households are more willing to choose soil conservation techniques, chemical treatment, mulching, increased cultivation of farm land as adaptation strategies that are labour intensive in Limpopo, south Africa and Enugu State, Nigeria.

Farm Size:

The result of farm size revealed significant and positive effect of the choice of adaptation strategies such as use of improved crop varieties, increased fertilizer application, application of organic manure and mulching/use of cover crops. This implies that a unit increase in farm size increase the tendency of taking up use of improved crop varieties, increased fertilizer application, application of organic manure and mulching/use of cover crops increase by 89.83%, 88.46%, 51.24% and 89.72% at $P \leq 0.10$, $P \leq 0.05$, $P \leq 0.10$, $P \leq 0.10$. Farm size could be associated with greater wealth and it is hypothesized to increase adaptation to climate change. This is because farm size is always associated with greater wealth, more capital and resources, the larger the farmer's farm size, the more likely to adapt to climate change in various ways. This finding was in line with that of Tefsay (2014) and Tesso *et al*. (2012).

Access to Credit:

Access to credit was found to have significant and positive effects on the choice of use of improved crop varieties and application of organic manure as adaptation strategies to climate change. This result implies that with increase access to credit by farmers, there is an increased probability of using the aforementioned adaptation strategies by 94.51% and 2.05% at $P \leq 0.05$ respectively. Access to credit could enable respondents to have access to resources such as inputs necessary for taking up adaptation strategies to climate change.

Perceived Change in Temperature:

Perceived change in temperature was found to have significant and positive effects on the choice of adaptation strategies such as use of improved crop varieties, increased fertilizer application, early planting, application of organic manure and mulching/use of cover crops instead of multiple cropping. This result implies that an increase in the perception of farmers on the change in temperature increase the probability of taking the use of improved crop varieties, increased fertilizer application, early planting, application of organic manure and mulching/use of cover crops by 47.72%, 9.67%, 2.78%, 22.43% and 16.41% at $P \leq 0.01$, $P \leq 0.01$, $P \leq 0.05$, $P \leq 0.01$ and $P \leq 0.01$ significance level respectively. Increase in temperature is one of the manifestations of climate change that affect crop production. Framers adjust their farm practices in order to reduce the menace. The finding of the study is consistent with that of (Mustapha *et al*. (2017) who found significant and positive relationship between perceived change in temperature and the choice of adaptation strategies.

Perceived Change in Rainfall:

The study found significant and positive effect of perceived change in rainfall and all the main adaptation strategies practiced by farmers in the study area at varying level of significance. The result implies that increase in the perception of framers towards change in rainfall could lead to the increase in the probability of choosing application of chemicals, use of new crop varieties, increase fertilizer application, early planting, application of organic manure and mulching/use of cover crops relative to multiple cropping by 10.66%, 84.85%, 32.28%, 2.98%, 58.11% and 41.92% at $P \leq 0.01$, $P \leq 0.01$, $P \leq 0.05$, $P \leq 0.05$, $P \leq 0.01$ and $P \leq 0.01$ significance level respectively. Change in rainfall in terms of duration, intensity and frequency again are manifestation of climate change that directly affect crop production. Farmers do adjust farm practices in order to suit the new rainfall regime. This finding was in line with that of Nhemachena and Hassan (2008) who observed that decreasing rainfall increases the probability of smallholder farmers to efficiently utilize water resources for crop production.

Farm Income:
Farm income was found to be significant and positive related to the choice of climate change adaptation strategies such as the use of improved crop varieties and early planting instead of multiple cropping. This implies that an increase in the farm income of respondents increase the chance of using improved crop varieties and early planting as adaptation strategies by 26.66% and 82.30% at $P \leq 0.05$ and $P \leq 0.01$ significance level respectively. Increased farm income enables respondents procure improved seed varieties used in formers adaptation strategy. Increased farm income also enables respondent pay for labour in sowing in case of germination failure experienced in latter adaptation strategy. This finding was in line with that of Tefsay (2014) who found significant and positive relationship between farm income and probability of choosing adaptation strategies among farmers.

Dry Spell Experience:
The study found significant and positive relationship between dry spell experience and the choice of adaptation strategies such as increased fertilizer application, early planting, and application of organic manure relative to multiple cropping. The result implies that an increase in the dry spell experience of respondents, the likelihood of using increased fertilizer application, early planting, and application of organic manure relative to multiple cropping increased by 18.62%, 11.13% and 5.98% at $P \leq 0.01$ significance level respectively. Dry spells do affect crops particularly during crop establishment and when crops are yielding.

Access to Information on Climate Change:
The study found significant and positive relationship between access to climate information and the choice of adaptation strategies among farmers in the study area. These adaptation strategies include use of improved crop varieties, increase fertilizer application, early planting and application of organic manure instead of multiple cropping. This result implies that an increase in the access to information on climate change increase the probability of employing use of improved crop varieties, increase fertilizer application, early planting and application of organic manure by 94.57%, 96.55%, 9.15% and 27.37% at $P \leq 0.05$, $P \leq 0.01$, $P \leq 0.01$ and $P \leq 0.05$ respectively. Climate forecast information are important in creating awareness among farmers on the likely climatic situation in the future. This could enable farmers plan a head the promising adaptation measures to be employed. The result was in line with the findings of Mustapha *et al.* (2017) who found that access to information on climate change has increased the probability of preferring early maturing crop varieties as adaptation strategies in Borno State, Nigeria.

4. CONCLUSION AND RECOMMENDATIONS

Climate change constitutes a serious threat to agricultural development particularly in arid and semi-arid environments of the world. These zones are vulnerable to the menace of climate change due to the nature of their biodiversity and livelihoods. Adaptation is the key to sustainable agricultural production. The study concludes that farmers adapt to the menace of climate change using different strategies. These strategies were influenced by many socio-economic and environmental factors. It is recommended among others that:

1. Adaptation materials should be provided to farmers at subsidized rate. These include improved crop varieties, fertilizers and chemicals. This will increase farmers' capacity to adapt.
2. The on-going efforts of IFAD-CASP/FGN in providing public adaptation through climate change adaptation and agribusiness support programme is commendable. Communities' identified adaptation strategy interventions however, should be given priority.

Conflict of Interest
We, write to attest that the article submitted to *Climate Change* Journal for consideration has not been published previously. The authors declare that there is no conflict of interest.

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Peer-review

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Data and materials availability

All data associated with this study are present in the paper.

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