International Journal of Global Affairs , Research and Development (IJGARD) Vol.2, No.1, 2024, 172-186
ISSN 2992-2488

ASSESSMENT OF CLIMATE CHANGE MITIGATION STRATEGIES ADOPTED BY CROP FARMERS IN NIGER STATE, NIGERIA.

[1]Nandi, J. A., [2]Usman, A., [1]Hamidu, K., [1]Shirama, L., and [3]Ogenyi, M. O

[1]Department of Agricultural Economics and Extension, Federal University of Kashere, Gombe State, Nigeria
[2]Department of Agricultural Economics and Extension, Bayero University, Kano, Nigeria
[3]Central Bank of Nigeria, Abuja, Nigeria
**Corresponding author's email: nandijim@gmail.com*

ABSTRACT

Agriculture is highly dependent on climate. Hence, climate change is expected to have in-depth effect on household economies. This study ascertained farmers' perception on the effect of climate change; identified the mitigation strategies used by the crop farmers; and, determined determinants of adaptation to climate change mitigation strategies in Niger State. A multistage sampling technique was employed in selecting 180 respondents for the study. Data was elicited through primary sources using structured questionnaire. Weighted Average Index (WAI), Kendall coefficient of concordance, descriptive statistics, and logistic regression were used for analyses. The result shows that farmers had different perception on the indicators of climate change. The top most amongst the indicators perceived were unusual timing of onset and cessation of rains/harmattan (4.71),dusty and cloudy atmosphere when it should be clear (4.59), and unstable temperature (4.41) indicating that there is variation in weather condition. The study established that farmers employ some adaptation strategies to manage climatic stimuli. The most used strategies were: planting of improved varieties, change in planting dates, and application of inorganic fertilizer. The Kendall coefficient of concordance was 0.810; implying agreement among the respondents. The determinants of adaptation to climate change mitigation include: gender, age, household size, amount of credit, farm size, extension contact and income level. With proper attention on these variables output could increase to check the effect of climate variation experienced by the crop farming households. It is recommended that: Niger State Ministry charged with the provision of agricultural extension services should be strengthened by creating a unit to handle climate change issues with a view to educating farmers on the effect of climate change and mitigation strategies; and, government should establish sustainable credit scheme which will empower crop farmers financially to be able to implement appropriate adaptation measures.

Keywords: Adaptation, Climate change, Logit regression, Mitigation, Perception,

1.0 INTRODUCTION

Agriculture is one of the most important economic sectors in many developing countries, including Nigeria. Therefore, increasing agricultural production has been one of the essential priorities for agricultural development programs (Hosseini *et al*., 2010). Agriculture is highly dependent on climate, especially in developing countries like Nigeria. Hence, climate change is expected to have far-reaching effects on agricultural production, food security, health and the rural communities in Nigeria. These effects have made climate change a contemporary issue in the media both for international and national policy processes. Climate is the average weather condition of an area over a given period of time, usually thirty (30) years. Over the years, the pattern of these weather conditions can generate some worries in form of rainfall pattern, humidity change, temperature shift and other unstable variables. According to Ajieh and Okoh (2012), this instability in climate variables is what gave rise to the concept of climate change.

Scholars have viewed climate change from different perspectives. For instance, Intergovernmental Panel on Climate Change (IPCC) (2007) viewed climate change as a change in the state of the climate that can be identified (through statistical tests) by changes in the mean and/or the variability of its properties, which persists for an extended period of over decades. Tunde (2011) said climate change is any long term significant change in the "average weather condition" that a given region experience. Climate change and agriculture have tremendous effects on each other, either positively or negatively (Diagi and Nwagbara, 2018).Agriculture affects climate change through the emission of GreenHouse Gases (GHG) from different farming practices while climate change in form of higher temperature, reduced rainfall and increased rainfall variability reducing quantity and quality of crop yield and threatens food security in low income and agricultural-based economies (Ifeanyi-Obi and Issa, 2013). In the words of Goh (2012), these impacts from climate change will have detrimental effects on agricultural productivity, biodiversity and ecosystem services. As climate change is anthropogenic in nature, typically agriculturally, several other constituents of the environment are also affected by these variations (Diagi and Nwagbara, 2018). It was reported by Hansen (2007) that climate change will result in ecological degradation and further threaten the fragility of dry soil, with serious consequences for crop and livestock production vis-a-vis food security. Climate change has brought uncertainty to weather conditions in the northern part of Nigeria which is mostly responsible for major food crops produced in the country (Yakubu and Oladele, 2021).

Malvi (2004) identified the basic causes of climate change to be man's activities such as deforestation and gas flaring related activities which result to accumulation of the greenhouse gases in the atmosphere. Greenhouse gases are gases that cause increase in the earth's temperature by trapping heat from the sun and concentrating it on the lower vapour atmosphere. According to IPCC (2014) since 2000, GHG emissions have been growing in many sectors. The study further substantiated that, Agriculture, Forestry, and Other Land-Used (AFOLU) sector released about 24% of the total emissions of GHG, been the highest GHG emissions from a single sector beside Electricity and Heat production which is a combination of various sub-sectors that indirectly emits Carbon dioxide (CO_2). According to Diagi and Nwagbara (2018), "human activities are however altering the carbon cycle by the addition of more CO_2 to the atmosphere as a result of agricultural and industrial activities embarked upon by man and also by influencing the ability of natural sinks, like forests, to remove CO_2 from the atmosphere". Thus, without additional efforts to reduce GHG emissions beyond those in place today, emissions growth is expected to persevere compelled by growth in global population and demand for food.

Idowu *et al. (*2011) reported that Nigeria is one of the countries recognized as being susceptible to climate change and its effects. The effects of climatic stimuli in Nigeria, particularly in Niger State had been gargantuan, including noteworthy variations in the rainfall pattern leading to drought and flood. The temperature and rainfall regimes of the study area provide foremost glitches on primary production, which in turn regulates secondary production(Ajayi *et al*., 2020).Mitigation is a human intervention to reduce the sources or enhance the sinks of greenhouse gases (IPCC, 2014). Hence, without adequate mitigation strategies, limiting the effects of climate change in order to achieve sustainable development and equity, or poverty eradication would be grossly impossible. Therefore, effective mitigation will not be achieved if the determinants of adaptation to climate change mitigation strategies are not known. This is because; climate change has the characteristics of a collective action from individuals, communities, companies or countries. Consequently, individuals' activities contribute to the emissions of GHG. There is therefore the need for concerted efforts toward tackling this menace through appropriate knowledge to assess mitigation strategies adopted by crop farmers to curb climate change effect as well as farmers' perception on the mitigation strategies. Obviously, the adverse effect will be grievous in Niger State of Nigeria as a result of the high level of agricultural activities been carried out. Thus, this research aimed to: ascertain farmers' perception on the effect of climate change in the area of study; identify the mitigation strategies used by crop farmers; and, determine the determinants of adaptation to climate change mitigation strategies.

2.0 METHODOLOGY

2.1 Study area

This study was carried out in Niger State. The State is located on latitudes 8º20´ and 11º30´ N and longitudes 3°30´ and 7°20´ E of the Prime Meridian. Niger State has a total land area of 76,470 km^2 comprising of about 10 percent of Nigeria's land cover, out of which about 85% is arable, suitable for agricultural activities (Niger State Bureau of Statistics, 2011). This ranks Niger State the largest State in the country. Niger State population was 3,950,249 (National Population Commission, NPC, 2006). Using 3.2 percent growth rate as adopted by Ajayi *et al*. (2020), in projecting the population of Niger State to 2023, which was 6,328,832 people. The State is bounded in the North by Zamfara State, in the North-West by Kebbi State, in the South by Kogi State, in the South-West by Kwara State and in the North-East and South-East by Kaduna State and the Federal Capital Territory respectively (Yusuf *et al.,* 2015). Furthermore, the State shares a common international boundary with the Republic of Benin (Niger State Bureau of Statistics, 2011).

Niger State, like most parts of Nigeria, experiences two distinct seasons - the dry and wet seasons. The annual rainfall varies from about 1,600mm in the South to 1,200mm in the North (Yusuf *et al*., 2015). The duration of the rainy season ranges from 150 to 210 days (5 to 7 months). Mean maximum temperature remains high throughout the year, hovering at about 32°C (Ajayi *et al*., 2020). According to Yusuf *et al.* (2015) the lowest temperatures occur usually between December and January when most parts of the State come under the influence of the tropical continental air mass which blows from the North with dry season commencing in October. The vegetation consists mainly of short grasses, shrubs and scattered trees. Agriculture (crop farming, livestock and fisheries) is the primary occupation of the inhabitants.

2.2 Sampling Techniques

Data was collected through primary sources using structured questionnaire. A multistage sampling procedure was employed. Firstly, six (6) Local Government Areas (LGAs) were randomly selected - two from each agricultural zone. Secondly, twelve (12) villages were randomly selected, 2 from each selected LGA. Thirdly, fifteen (15) farmers were randomly selected from each village. A total of 180 randomly selected respondents were used for the study.

2.3 Data Analyses

Data collected was subjected to index ranking to obtain Weighted Average Index (WAI),Kendall's coefficient of concordance, descriptive statistics and Logistic regression analyses. The WAI ranking was applied in determining the indicators of climate change by examining the perceived effects of climate change. A five-point scale was used in rating components by scoring 5, 4, 3, 2 and 1 for Strongly Agreed (SA), Agreed (A), Disagreed (D), Strongly Disagreed (SD) and I don't know respectively. Thus, a weighted average index (WAI) analysis was carried out using the formula:

$$\frac{\sum F_i W_i}{\sum F_i} = \frac{WI}{\sum Fi} \text{ ---------------------------- } (1)$$

Where:
F = frequency;
W = weight of each scale;
i = weight;
WI = weighted index
(Falola and Achem, 2017**;** Ndamani and Watanabe, 2016).

Kendall's coefficient of concordance (W) is a measure of the agreement among several judges who are assessing a given set of objects (Kendall and Babington, 1938). S or S^I is computed first from the row-marginal sums of ranks Ri received by the objects. Kendall's coefficient of concordance (W) is express as follows:

$$S = \sum_{i=1}^{n}(R_i - R)^2 \ or \ S^I = \sum_{i=1}^{n}(R_i^2) = SSR \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where:
S = is the sum of square statistic
R_i = the row sum of rank
R = is the mean of the R_i value

$$W = \frac{12S}{P2(n3 - n) - PT} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

and;

$$T = \sum_{k-i}^{g}(tk3 - tk) \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where;
W = Kendell statistics
n = is the number of objects
P = is the number of Judges (species)
T = is a correctional factor for tied ranks
t_k= number of tied ranks
g = group of ties
Note; T = 0 when there is no tied value, and T = 1 when there is tied or perfect concordance

In rating component, the frequency of the farmers who responded to the multiple-response questions on diverse mitigation strategies they used was obtained. The components were rated into; High (70 percent and above), Moderate (40 to 69 percent), and Low (Less than 40 percent).

Determinants of adaptation to use of climate change mitigation strategies by crop farmers in Niger State were determined by using logistic regression model. The dependent variable is adaptation (whether a farmer adapted or not). Therefore, the dependent variable was taken as a dummy, taking a value of 1 if a farmer had adopted minimum of four (4) of the mitigation strategies and 0 if otherwise.

The independent variables include:

X_1 = Gender (Male = 1, Female = 2)

X_2 = Age of the farmer (Years),

X_3 = Educational status (Number of years spent in school),

X_4 = Household size (Number of persons),

X_5 = Farming experience (Years),

X_6 = Amount of credit (Amount in Naira),

X_7 = Farm size (Hectares),

X_8 = Access to agricultural extension services (Dummy: 1 if yes and 0 if otherwise).

X_9 = Membership of Association (Dummy: Member = 1, Otherwise 0),

X_{10} = Level of income (Amount in Naira)

X_{11} = Marital status (Dummy: Married = 1; Otherwise 0)

Studies have shown that logit models are appropriate econometric models in evaluating qualitative dependent variables with dichotomous variables ('1' or '0') while the independent variables could be either categorical, continuous or dummy (Falola and Achem, 2017; Uddin *et al.*, 2014). This study used the functional form of the logistic regression model, as used by Falola and Achem, (2017). In this model, dependent variable becomes the natural logarithm of the odds when a positive choice is made. It is expressed as:

$ln\{Px/(1- Px)\} = b_0 + b_1X_1i + b_2X_2i + \ldots + bk\, X_ki + e_i$......................................(5)

Where:

Px = Probability of adaption;

$(1-Px)$ = Probability of non-adaption;

i = ith observation in the sample;

$b_1, b_2 \ldots b_k$ = Regression coefficients of the explanatory variables;

$X_1, X_2 \ldots\ldots X_k$ = explanatory variables;

b_0= constant term

e_i =error term.

According to Nandi *et al*. (2012), the logit model, which is based on cumulative logistic probability functions, is easier to use than other types of models and it also has the advantage to predict the probability of farmers adopting any technology. In this case, it is adaptation to climate change mitigation strategy. Thus, the Binary Logit Regression Model (BLRM) is considered appropriate in such a situation, because, it requires far fewer assumptions than other models. The probability estimate will always be between 0 and 1, regardless of the value of the error term.

3.0 RESULTS AND DISCUSSION

3.1 Farmers' perception on the effect of climate change

The result shows that farmers had different perception on the indicators of climate change in the area of study. From the analysis, the highest effect noticed was on unusual timing of onset and cessation of rains/harmattan (Table 1). This effect recorded WAI of 4.71 in agreement that there is a fluctuation in onset of rain and harmattan. This conforms to IPCC reports (IPCC, 2007 and 2013) and the current widely accepted view that there is variability in climatic conditions. This result agrees with that of Diagi and Nwagbara (2018) where 79% of swamp rice farmers noticed changes in the sizes of their swamp rice farm, attributable to climatic changeability. Falola and Achem (2017) observed a similar result and stated that, delay in the onset of rains, fluctuations in rainfall pattern, early end to the rainy season, are the indicators of climate change. Based on the index ranking, it was found that dusty and cloudy atmosphere when it should be clear, unstable temperature, change in rainfall pattern and increase in sunshine intensity recorded WAI of 4.59, 4.41, 4.32 and 4.18 respectively. The findings from this research corroborates that of Nmadu *et al*. (2017),who found the most important indicators of respondents' perception of climate change to be increased/high temperature, increased sunshine hours, low rainfall, soil erosion and soil infertility. Hence, the farmers perceived that there are changes in these climatic factors.

Other indicators perceived by the farmers include, increase in pest and diseases, prolonged drought, increased period of dry season, change in duration of harmattan, low output, higher incidence of flood, very high unusual temperature (heat) and late appearance of harmattan. Meanwhile, the sampled farmers disagreed that the area has experienced; increase in rainfall amount, stabled temperature, and, incessant and elongated non-stop rainfall when it should be less. This is because these indicators recorded 2.90, 2.74 and 2.53 respectively. These weighted indexes are lower than the weighted mean of 3.00. This findings supports the report by Diagi and Nwagbara (2018) where the respondents observed changes in temperature in Ebonyi State.

It can be inferred that there is a logical relationship among the effects observed by the farmers. For instance, a reduction in the amount of rainfall will definitely bring about prolong drought, resulting in higher intensity of sunshine which will culminate into higher and unsteady temperature favourable for pest and diseases infestation thereby resulting to lower yield. Pest and diseases reduces harvestable produce from the field through losses, consequently, bringing about food insecurity and poverty in the area.

Table 1: Perceived climate change indicators

Climatic Statements	SA (5)	A (4)	D (3)	SD (2)	I don't know (1)	WI	WAI	Perception
Unusual timing of onset and cessation of rains/harmattan	140	21	13	1	0	825	4.71	Agreement
Dusty and cloudy atmosphere when it should be clear.	124	33	15	3	0	803	4.59	”
Temperature is unstable in the area	108	38	22	7	0	772	4.41	”
Rainfall pattern has changed in the area	92	59	14	8	2	756	4.32	”
Sunshine intensity has increased	90	44	25	14	2	731	4.18	”
Increase in pest and diseases	43	69	57	6	0	674	3.85	
Prolonged drought in the area in the last few years	64	51	32	25	3	673	3.85	”
Period of dry season has increased	48	61	55	11	0	671	3.83	”
Duration of harmattan has changed	45	72	33	18	7	655	3.74	”
Low output/yield	66	42	35	20	12	655	3.74	”
There is higher incidence of flood	32	84	42	14	3	653	3.73	”
Very high temperature when it should be mild (heat)	55	37	51	32	0	640	3.66	”
Late appearance of harmattan	23	63	14	61	14	545	3.11	”
Rainfall amount is on increase	6	18	105	45	1	508	2.90	Disagreement
Temperature is stable in the area	5	12	104	41	13	480	2.74	”
Incessant and elongated non-stop rainfall when it should be less.	5	22	40	101	7	442	2.53	”

Note: SA = Strongly Agreed; A = Agreed; D = Disagreement; SD = Strongly Disagreed; WI = Weighted Index; WAI = Weighted Average Index

Source: Field survey, 2023

3.2 Kendall W Coefficient of Concordance on perceived climate change indicators

The result on the Kendal coefficient of concordance presented in Table 2, indicate that most of the respondents were in agreement with each other as the coefficient was positive, lies between 0 and 1, with a significant Chi-Square value and a significant general model. This implies that the data conform to the use of the Kendall coefficient of concordance. The result shows a high coefficient of concordance of 0.81 which imply that the respondents highly agreed with each other on the indicators of climate change in the study area. This conforms to the result in Table 1 where the Weighted Average Index (WAI) was observed to be mostly in agreement.

Table 2: Kendall coefficient of concordance on sources of information

Test	Indicator
Kendall's W	0.810
Chi-Square	36.68**
Sig.	.000**

*** Significant at 1%*

Source: Print-out from field survey

3.3 Mitigation strategies practiced by crop farmers

Table 3 shows adaptation strategies employed by farmers in mitigating the effects of climate change. Farmers used one adaptation strategy or the other in managing the effects of climate change on their farming operations. In decreasing order of ranking, strategies categorized as high were: planting of improved varieties, change in planting dates, application of inorganic fertilizer, and planting of drought-tolerant crop varieties as well as crop rotation practices. This result conforms to the findings of Falola and Achem (2017) where change in planting dates was ranked 1st. Among the mitigation strategies considered to be practiced moderately were: planting of early maturing varieties (6th), crop diversification (7th), use of agrochemicals (8th), and off-farm income activities (9th). This findings is in tandem with the study of Onyeneke and Madukwe (2010) where respondents adopted planting early/late maturing varieties, crop diversification as major climate change adaptation strategies.In the study by Yakubu and Oladele (2021), the adjustment of calendar (dates) was noticed, 97% used early planting; while 95% used early harvesting.In the result, the least practiced strategies were categorized as Low: Afforestation (17Th), planting of pest-resistant crop variety (18th), soil conservation (19th) and use of weather forecasting (20th). In the research conducted by Ajayi *et al.* (2020) to cushion the effect of climatic variation, groundnut farmers in Suleja Local Government Area of Niger State adopted mixed cropping, new cropping pattern and crop diversification as topmost mitigation strategies for effective production while soil conservation and planting of cover crops/afforestation were the least. Similarly, Nmadu *et al*. (2017), reported changing planting dates (early/late) as one of the most adopted strategies in mitigating climate change among yam farmers in Niger State.

This result on the practices used by the crop farmers in checkmating the effects of climate change could have intertwined implications, for example, planting of improved crop varieties while changing planting dates may prove unreliable in the long-run, because some of these improved varieties are time bound, hence, applying it at wrong time may bring about low output. Another consideration could be when there is uncertainty of onset/amount of rainfall, sunshine, leading to incessant drought or flood, even when inorganic fertilizer is applied and planting dates are altered; the yield may still be low because of wrong farm management techniques. In the same vein, crop rotation may not be a dependable alternative at when there is competition for land between crop farming and other uses due to population increase, urbanization and industrialization, leading to frequent conflicts. Also, the poor practice of soil conservation techniques in guarding against the effects of climate change poses serious concern on ecosystem sustainability. This is because protecting key ecosystems through management of resources such as soil confers resilience to the ecosystems (Baron *et al.*, 2008). If farmers do not give attention to such pertinent aspect of climate change and its mitigation measures, finding solutions to the effects of climate change may be difficult to achieve.

Table 3: Mitigation strategies practiced in the area

Mitigation strategy	*Frequency	Percentage (%)	Remark	Rank
Planting of improved varieties	142	86.86	High	1st
Change in planting date	107	84.57	High	2nd
Application of inorganic fertilizer	136	79.43	High	3rd
Planting of drought-tolerant crop varieties	128	73.14	High	4th
Crop rotation practices	103	71.43	High	5th
Planting of early maturing varieties	117	66.86	Moderate	6th
Crop diversification	125	65.71	Moderate	7th
Use of agrochemicals	114	65.14	Moderate	8th
Off-farm income activities	83	58.86	Moderate	9th
Mixed farming	97	52.00	Moderate	10th
Use of irrigation	86	50.86	Moderate	11th
Intercropping of crops	64	44.00	Moderate	12th
Application of organic fertilizers (Manure / compost)	71	40.57	Moderate	13th
Planting of late maturing varieties	66	32.00	Low	14th
Reduced crop cultivated area	55	31.43	Low	15th
Mulching	49	28.00	Low	16th
Afforestation	56	25.14	Low	17th
Planting of pest-resistant crop variety	63	24.57	Low	18th
Soil conservation	42	24.00	Low	19th
Use of weather forecasting	35	20.00	Low	20th

Source: Field survey (2023); *multiple response

3.3 Determinants to Farmers Adaptation Decision

The result in Table 4 shows determinants of adaptation to climate change mitigation strategies amongst crop farmers in Niger State. The result obtained revealed a deviance (–2 log likelihood) of 32.60. This value measures how much variation is left having fitted the model (that is, how much is left unexplained by the model). The deviance follows a Chi-square distribution, explaining how well the model explains variations in the outcome of interest, in this case, adaptation of climate change. In this result, a Chi-square value of 91.59 which is greater than the conventional significance level of 0.01 was obtained. Hence, it can be said that the addition of these variables to the model is statistically significant. In other words, the included variables explain variation in adaptation to climate change mitigation strategies in the study area. Therefore, the results indicate fitness of the data to the model. The Nagelkerke R-Square explains the level of variation in the model attributable to the explanatory variables. It shows that 80.20 percent of the variation is explained by the included independent variables in the model.

Some of the variables of the Logit regression model were in conformity with the *a priori* expectations. Gender (X_1), had a positive and statistically significant relationship with adaptation of climate change mitigation strategies. The Exp(B) value (70.21) of gender shows the relative odds (odds ratio) and indicates that male are 70.21 times as likely to adopt the climate change mitigation strategies than females. This contradicts the findings of Ndambiri *et al.* (2012) which posited that in most rural communities, most of the agricultural work is carried out by women because men are more often based in towns in search of white collar jobs. Age (X_2) of the household head had a significant effect on adaptation to climate change. Age was negatively signed, though, statistically significant at 5 percent ($p<0.05$) level of significance; indicating a negative relationship with the probability of a farmer adapting to the mitigation strategies. This implies that older farmers are less likely to adapt measures to guard against the effects of climate change than their younger counterparts. This could be because young individuals, *citerus parabus*, are more innovative to relevant agricultural practices than their older colleagues (Omotesho *et al.*, 2012). Also, studies have revealed that young farmers have more risk-bearing ability to adapt measures against effects of climate change than the elderly ones (Uddin *et al.*, 2014) because the elderly are more conservative to change. This study is in agreement with the study of Falola and Achem (2017) but disagreed with the reports of Gbetibouo (2009), Ndambiri *et al.* (2012) and Onubuogu and Esiobu (2014) where they observed in their respective studies, that there was a positive relationship between age of the household head and the adoption of improved agricultural technologies.

Household size (X_4) was positively signed and the coefficient is significant to the dependent variable. Large household size increases the likelihood of a farmer adapting climate change mitigation strategies introduced in the study area. The Exp(B) for household size is 3.35, which means for each person added to the household size, the household is 3.35 times more likely to adapt new strategy that will cushion the effect of climate variation experienced in their farming activities. The plausible reason for this relationship cannot be unconnected with large household size been associated with higher labour endowment for easy and quick accomplishment of various farm production tasks. As noted by Onubuogu *et al.* (2014), household size is a proxy to labor availability. Amount of credit(X_6) obtained had a positive and significant coefficient with the likelihood of adapting the climate change mitigation strategies to ameliorate the effect of climate change in the study area. Researches (Deressa *et al*., 2008; Nandi *et al.,* 2012; Onubuogu and Esiobu, 2014) have demonstrated that inadequate fund is one of the main impediments to acceptance of new innovations. Hence, the larger the amount of credit obtained to purchase the necessary inputs and other associated equipment for adaptation of climate change, the more likelihood of adopting the mitigation strategies.

Farm size(X_7) had negative statistically significant relationship with the probability of adopting the introduced mitigation strategies to revolutionize the consequence of climate change. The negative relationship between farmers' adaptation measure and farm size is in consonance with the results obtained by Onubuogu and Esiobu (2014) and Deressa*et al*. (2008) but contradict reports of Gbetibouo (2009) and Ndambiri *et al*. (2012). According to Fatuase and Ajibefun, (2013) increase in farm size increases the tendency of farmers' easy adaptation to climate change.The result which agrees with the study byYakubu and Oladele (2021) where farm size was statistically significant with a positive coefficient, implying a strong influence of farm size on use of climate change adaptation practices. From the value of Exp(B) of 0.04, it indicates that the larger the farmers' farm size, the less likelihood that the farmer will adopt the mitigation strategies by 0.04. This might be attributed to the fact that climate change adaptation measures are plot-specific, hence not affected by the farm size.

Extension contact (X_8) had a negative sign but statistically significant coefficient, implying a negative relationship with the likelihood of adopting the climate change mitigation strategies in the area. A similar result of negative influence of extension contact was reported by Van *et al.* (2015). This is against the *a priori* expectation, but it shows that farmers who had contact with Extension agents are less likely to adopt the introduced technologies. Also, Yakubu and Oladele

(2021); Fatuase *et al.* (2015) found access to extension agent to be significant in influencing the rate of utilizing adaptation measures. It is against this background that Opara (2008) noted that communication of agricultural information is a vital factor in the change process of the farming community. Access to the right information at the right time and from the right source, may shift the balance between success and failure of farmer; hence, farmers must have access to information about new technologies before they can consider adopting them (Gunn and Nandi, 2013).Income level (X_{10}), of the farmer had a positive significant coefficient. This shows that with higher income level, a farmer will be willing to adopt a new technology that will improve the effect of climate change in the area. This is because adaptation options are most times expensive to be implemented. This observation is similar to that of Deressa *et al*. (2008), Ndambiri *et al.* (2012), Onubuogu and Esiobu (2014) who noted that farmers' incomes level have a positive relationship with the adoption of agricultural technologies since the latter requires sufficient financial wellbeing to be undertaken. This result is in consonance with that of Ajayi *et al*. (2020) where age, household size and income level were found to statistically affect adaptation to climate change by groundnut farmers in their study area.

Table 4: Logit regression result of determinants of farmers' adaptation decision

Variables	Coefficient	SE	Wald	Sig	Exp(B)
Gender	4.251*	2.306	3.400	0.065	70.208
Age	-0.300**	0.138	4.731	0.030	0.741
Educational attainment	-0.213	0.151	1.979	0.160	0.809
Household size	1.210***	0.430	7.906	0.005	3.354
Farming experience	0.032	0.057	0.310	0.578	1.032
Amount of Credit	0.000**	0.000	4.073	0.044	1.000
Farm size	-3.269***	1.193	7.508	0.006	0.038
Extension contact	-6.751*	3.672	3.380	0.066	0.001
Membership of Association	1.379	1.484	0.864	0.353	3.971
Income level	0.000***	0.000	8.491	0.004	1.000
Marital status	2.347	3.413	0.473	492	10.452
Constant	7.001	5.473	1.636	0.201	1097.510
-2 Log likelihood	**32.597**				
Cox & Snell R Square	**0.408**				
Nagelkerke R Square	**0.802**				
Chi-square	**91.787**				

Source: Print-out from field survey, 2016
***, **, and * significant at 1, 5 and 10 percent respectively.

4.0 CONCLUSION AND RECOMMENDATIONS

4.0 Conclusion

Increasing agricultural production is one of the priorities of most governments like that of Nigeria, due to the high poverty incidence and food insecurity experienced by households. Meanwhile, agricultural production mostly depends on climate, especially in Nigeria where rain-fed agriculture is widely practiced. Thus, a change in climate is expected to have remarkable effect on food production. This research established that crop farmers have noticed some climate change indicators in the area. The highest effects noticed by the respondents were: unusual timing of onset and cessation of rains/harmattan, dusty and cloudy atmosphere when it should be clear, unstable temperature, change in rainfall pattern and increase in sunshine intensity. The area of study has experienced decrease in rainfall amount, unstable temperature, increase in flood, and drought leading to pest and diseases infestation culminating into low output from fields. As a result of the effects of climates change on agricultural activities, the farmers adopted some strategies such as change in planting dates, planting of improved crop varieties, application of inorganic fertilizers, and planting of drought-pest tolerant varieties of crops to cope these menace.

Determinants of adaptation to climate change mitigation strategies amongst farmers were gender, age, household size, amount of credit obtained, farm size, extension contact and income level. This imply that male younger farmers with moderate household sizes, large amount of credit, but farming on medium sizes of farms, increased income level, without extension contact will adopt the mitigation strategies to ameliorate the effects of climate change on farm productivity. With proper attention on these variables, output will increase to check the effect of climate change experienced by the farming households.

4.2 Recommendations

The study recommends that:

i. The Niger State Ministry charged with the provision of agricultural extension services should be strengthened by creating a unit to handle climate change issues with a view of educating farmers on the effect of climate change and mitigation strategies;
ii. The coping mechanisms embarked upon by the respondents have short term effect. Therefore, there is a need to improve on access to income generating activities by the farmers that are more sustainable to increase their ability to purchase the mitigation strategies which may be expensive; and,
iii. Perhaps government can provide incentives by establishing a sustainable credit scheme which will empower crop farmers financially to be able to implement appropriate adaptation measures.

REFERENCES

Ajayi, O.J., Muhammed, Y., Yusuf, L.T. and Ajijola, R.T. (2020). Climate Change Adaptation Strategies among Groundnut Farmers in Suleja Local Government Area of Niger State, Nigeria. *Ethiopian Journal of Environmental Studies and Management,* 13(4): 414 – 424.

Ajieh, P.C. and Okoh, R.N. (2012). Constraints to the Implementation of Climate Change Adaptation Measures by Farmers in Delta State, Nigeria. *Global Journal of Science Frontier Research Agriculture and Veterinary Sciences*, 12(8): 8-16

Baron, J.S., Julius, S.H., West, J.M., Joyce, L.A., Blate, G., Peterson, C.H., Palmer, M., Keller, B.D., Kareiva, P., Scott, J.M. and Griffith, B. (2008). Some Guidelines for Helping Natural Resources Adapt to Climate Change. *http://www.fs.fed.us/psw/cirmount/publications/pdf/IHDP2008_Baron_etal.pdf,* (Retrieved 10th February 2016).

Deressa, T.T, Hassan, R.M., Alemu, T., Yesuf, M. and Ringler, C. (2008). Analyzing the Determinants of Farmers' Choice of Adaptation Methods and Perceptions of Climate Change in the Nile. *Scholarly Journal of Agricultural Science*, 4(7):370-385.

Deressa, T.T., Hassan, R.M., Ringler, C., Alemu, T. and Yesuf, M. (2009). Determinants of Farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Global Environmental Change,* 19:248-255.

Diagi, B.E. and Nwagbara, M.O. (2018). Perceived Impact of Climate Change on Swamp Rice Cultivation by Farmers in Ebonyi State, Southeastern Nigeria. *Archives of Current Research International 14(2): 1-10, Article no.ACRI.41176*

Falola, A and Achem, B.A. (2017). Perceptions on climate change and adaptation strategies among sweet potato farming households in Kwara State, NorthCentral Nigeria. *Ceylon Journal of Science, 46(3): 55-63*

Fatuase, A.I. and Ajibefun, I. (2013). Adaptation Strategies: A case study of rural farminghouseholds in Ekiti State, Nigeria. *Proceedings of the Impacts World 2013, International Conference on Climate Change Effects,* Potsdam, May 27-30. Germany.

Fatuase, A.I., Aborisade, A.S. and Omisope, E.T. (2015). Determinants of Adaptation Measures to Climate Change by Arable Crop Farmers in Owo Local Government Area of Ondo State, Nigeria. *World Rural Observations,* 7(1): 23-34. Available at: http://www.sciencepub.net/rural.

Gbetibouo, G.A. (2009). Understanding Farmers' Perceptions and Adaptations to Climate Change and Variability: The Case of the Limpopo Basin, South Africa. IFPRI Discussion Paper No. 00849.

Goh, A.H.X. (2012). A literature review of the gender-differentiated impacts of climate change on women's and men's assets and well-being in developing countries. CAPRi Working Paper No. 106. Washington, D.C.: IFPRI. http://dx.doi.org/10.2499/CAPRiWP106.

Gunn, P. and Nandi, J.A. (2013). The Role of Information on Adoption of Improved Palm Oil Processing Technologies in Delta State, Nigeria. *International Journal of Agricultural Sciences and Veterinary Medicine,* 1(4):81-86,

Hansen, J.W., Baethgen, I., Osgood, D., Ceccato, P. and Ngugi, R.K. (2007). Innovations in Climate Risk Management: Protecting and Building Rural Livelihoods in a Variable and Changing Climate. *Journal of Semi-Arid Tropical Agricultural Research,* 4(1):1-38

Hosseini, S., Mohammadi, F., Mirdamadi, S.M. and Hosseini, S.M. (2010). The perception of greenhouse owners about environmental, economic and social aspects of sustainable agriculture in Iran. *International Journal of Agricultural Science Research*, 1, 1–10.

Idowu, A.A., Ayoola, S.O., Opele, A.I. and Ikenweiwe, N.B. (2011). Impact of climate change in Nigeria. *Iranica Journal of Energy and Environment,* 2(2): 145 – 152.

Ifeanyi-Obi, C.C and Issa, F.O. (2013). Barriers Faced By Cassava Farmers in Adapting To Climate Change in Oron Agricultural Zone of Akwa Ibom State. *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS), 4(6):19-26*

Intergovernmental Panel on Climate Change (IPCC) (2007). Climate change: Impacts, adaptation and vulnerability: An assessment report of the Intergovernmental Panel on Climate Change; Cambridge University Press: Cambridge, UK.

Intergovernmental Panel on Climate Change (IPCC) (2013). Climate change: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change; Cambridge University Press: Cambridge, UK.

Intergovernmental Panel on Climate Change (IPCC) (2014). Summary for Policymakers, In: Climate Change 2014, Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlomer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Kendall, M. G. and Babington Smith, B. (1938). Randomness and Random Sampling Numbers.*Journal of the Royal Statistical Society*, 101(1)147-166

Malvi, G. (2004). *Agrometerogy in the tropics*. Longman Printing press, London.

Nandi, J.A., Haruna, S.K. and Abudu, S. (2012). Analysis of Socio-economic factors Influencing Farmers' Adoption of Rice varieties with High Yielding and Weed Suppressing Abilities in Kano River Irrigation Project (KRIP). *Journal of Agriculture, Forestry, and Social Science*, 10(1):32-46.

National Population Commission (NPC) (2006). http://www.population.gov.ng/state/crossriverfinal.pdf. Accessed 10th December, 2010.

Ndamani, F. and Watanabe, T. (2016). Determinants of farmers' adaptation to climate change: A micro level analysis in Ghana. *Scientia Agricola*, 73(3):201-208.

Ndambiri, H.K., Ritho, C., Nganga, S.I., Kubowon, P.C., Mairura, F.C., Nyangweso, P.M., Muiruri, E.M. and Cherotwo, F.H. (2012). Determinants of Economic Growth in Sub-Saharan Africa: A Panel Data Approach. *International Journal of Economics and Management Sciences*, 2(2): 18-24

Niger State Bureau of Statistics (2012). Facts and Figures about Niger State. 2012 edition. Accessed date July 1, 2018. Retrieved at http://www. nigerstats.ni.gov.ng/.../NIGER%20STATE%20%20STATISTICAL%20YEARBOOK%2

Nmadu, J.N., Coker, A.A.A. and Adams, E. (2017). Determinants of climate change adaptation strategies of Yam producers in Niger State, Nigeria. *Conference Proceedings of The 18" Annual National Conference of The Nigerian Association of Agricultural Economists Held at Federal University o/Agricu/ture, Abeokuta, Nigeria I6th - I 9th October.*

Omotesho, O.A., Falola, A. and Agbonpolor, G. (2012). Analysis of sweet potato production in Offa and Oyun Local Government Areas of Kwara State, Nigeria. *Benin International Journal of Agricultural Economics and Extension Services*, 2(1):67-75.

Onyeneke, R.U. and Madukwe, D.K. (2010). Adaptation measures by crop farmers in the Southeast Rainforest zone of Nigeria to climate change. *Science World Journal*, 5(1): 32 – 34.

Onubuogu, G.C. and Esiobu, N.S. (2014). Trends, Perceptions and Adaptation Options of Arable Crop Farmers to Climate Change in Imo State, Nigeria; Multinomial Logit Model Approach. *Scholarly Journal of Agricultural Science*, 4(7):370-385

Onubuogu, G.C., Esiobu, N.S., Nwosu, C.S. and Okereke, C.N. (2014). Resource use efficiency of smallholder cassava farmers in Owerri Agricultural zone, Imo State, Nigeria; *Scholarly Journal of Agricultural Science*. 4(6):306-318.

Opara, U.N. (2008). *Agricultural Information Sources Used by Farmers in Imo State, Nigeria*, 24(4): 289-295, SAGE Publications.

Tunde, A.M. (2011). Perception of Climate Variability on Agriculture and Food Security by Men and Women Farmers in Idanre L.G.A, Ondo State, Nigeria. *Ethiopian Journal of Environmental Studies and Management, 4(2): 19 – 32*

Uddin, M.N., Bokelmann, W. and Entsminger, J.S. (2014). Factors affecting farmers' adaptation strategies to environmental degradation and climate change effects: A farm level study in Bangladesh. *Climate*, 2:223-241.

Van, S.T., Boyd, W., Slavich, P. and Van, T. M. (2015). Perception of Climate Change and Farmers' Adaptation: A Case Study of Poor and Non-Poor Farmers in Northern Central Coast of Vietnam. *Journal of Basic and Applied Sciences, 11,* 323-342.

Yakubu, D.H and Oladele, O.I. (2021). Determinants of Use of Climate Change Adaptation Practices by Rice Farmers in Kebbi State, North-West Nigeria. *Scientific Journal Warsaw University of Life Sciences – SGGW, Problems of World Agriculture, 21 (XXXVI)*, 1: 52–69. DOI: 10.22630/PRS.2021.21.1.4

Yusuf, O., Williams, N. and Abubakar, U.Z. (2015). Measurement of technical efficiency and its determinants in sampea-11 variety of cowpea production in Niger State, Nigeria. *International Research Journal of Agricultural Science and Soil Science*, 5(4):112-119.