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Choice of Climate Change Adaptation Strategies used by Food Crop Farmers in Delta State, Nigeria: The Multinomial Logistic Regression Approach

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A R T I C L E I NFO

Key words:

climate change;

choice;

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multinomial;

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ABSTRACT

This study determined food crop farmer's choice of climate change adaptation strategies used in Delta State Nigeria. The multi-stage random sampling technique was used in selecting 325 farmers adopting the proportionate sampling method. The study data was collected by questionnaires and personal interview schedules. Statistical tools such as table; frequency; percentage; mean and the multinomial logistic regression model were used to examine the data. The results indicate that the mean age of the farmers was 49 years with mean years of schooling at 14. The mean farming experience was 24 years and a mean household size of 8 persons. Empirical result also revealed that age; household size; level of education; sex; farm size; distance; extension contact; access to credit; household income; years of climate change awareness; tenure security and access to weather information are major determinants of the choice of climate change adaptation strategies used by farmers in the study area. Based on the findings it was therefore recommended that there is need for government and non-governmental organizations to invest in climate resilient projects and improving on climate monitoring and reporting stations towards sustainable agricultural and rural development.

Introduction

Climate change according to Intergovernmental Panel on Climate Change (IPCC, 2007) refers to any change in climate over time, whether due to natural variability or as a result of human activity. It also refers to changes in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and or the variability of its properties and that persists for an extended period, typically decades or longer. Literature have shown that for the past decades, anthropogenic factors like urbanization, deforestation, population explosion, industrialization and the release of green house gases (GHGs) are the major contributing factors to global warming and climate change (Buba, 2004; Nigerian Environmental Study Action Team [NEST], 2004; Odjugo, 2007). The increased level of GHGs mainly, Carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) has created a greenhouse effect which subsequently altered precipitation patterns and global temperatures around the world. Impacts have been witnessed in several areas due to change in precipitation and temperature. The areas affected include agriculture, aquaculture, livestock, forestry, water resources, biodiversity, desertification, and human health (Khanal, 2009; Rosegrant *et al*., 2008).

Economic sectors that largely depend on weather conditions – either directly or indirectly – most notably agriculture and fisheries are increasingly subjected to the impacts of climate change (IPCC, 2012). Climate change presents an additional burden on the world's agricultural and natural resources, which are already coping with the growing food demand driven by population growth in developing countries (Wassmann *et al.,* 2013). Climate change has a direct, often adverse influence on the quantity and quality of agricultural production in Nigeria. There is observed decline in crop yield and food crop production due to reduction in rainfall and relative humidity, and increase in temperature in Nigeria. Higher temperatures affect yields of crops, and encourage weed and pest proliferation. Studies by the International Food Policy Research Institute (IFPRI) have shown that increased floods and droughts increases the likelihood of short-term crop failures and long-term production declines in both

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crops and animals (IFPRI, 2009). If left unchecked, climate change is expected to lower global per capita Gross Domestic Product (GDP) by 20% in the year 2200, threatening global food security (Stern, 2006). In all, there are increasing concerns about the rising threats to current income and consumption patterns of households and individuals that earn their livelihoods from these sectors (Foresight, 2011).

The deterioration in agricultural production due to climate change variability has caused many households to look for livelihood choices other than purely crop production and animal production due to uncertainty in earning patterns of these farming operations. Livelihood choices are those employment options that the farm household can engage in order to provide their needs. Household engage in farm and nonfarm (non agricultural) livelihood activities such as crop production, animal rearing, petty trading in order to generate additional income for survival and cope with this difficult and harsh environment (Kalinda and Langyintuo, 2014). Combating climate change can come by way of mitigation and adaptation measures. According to Ngigi (2009) adaptation involves the action that people take in response to, or in anticipation of, projected or actual changes in climate to reduce adverse impacts or take advantage of the opportunities posed by climate change. According to IPCC in Oladipo (2010) adaptation to climate change is defined as an adjustment in natural or human systems to actual or expected climatic stimuli or their effects, which moderates harm and exploit beneficial opportunities. While mitigation is a response strategy to global climate change, and can be explained as measures that reduce the amount of emissions (abatement) or enhance the absorption capacity of greenhouse gases (sequestration). These adaptation measures proffered involve cost on the part of the farmers. These costs are in addition to the existing cost of production borne by the predominantly small-scale farmers whose livelihoods depend on agriculture.

It is however, necessary to understand how the set of strategies implemented in the field by the farm households (e.g., Irrigation, less fertilizer, soil conservation measures, etc) in response to long term changes in environmental conditions affects farm income from food crop farmers. This is particularly important because most of the discussion on climate change in agriculture has been focusing on the impact of climate change rather than on the role adaptation plays. These changes in the environment and the adaption strategies employed, affect the composition of rural livelihoods through their impact on agricultural production, earning pattern of farms, farmer's income and the implications of both on farmer's earning pattern. Consequently, the study aims at establishing the choices of climate change adaptation strategies among food crop farmers in Delta State, Nigeria.

Objective of the study

The broad objective of this study is to examine the choice of climate change adaptation strategies used by food crop farmers in Delta State Nigeria. The specific objectives are to:

- describe the socio-economic characteristics of the food crop farmers in the study area;
- identify climate change adaptation strategies adopted by food crop farmers in the study area;
- determine the factors that influence the choice of climate change adaptation strategies used by food crop farmers in the study area;

Hypothesis of the study

Based on the research objectives above, this study was guided by the null hypotheses below: There is no significant relationship between selected socio-economic and institutional variables and the choice of climate change adaptation strategies adopted by food crop farmers.

Area of Study

The study was conducted in Delta State of Nigeria. Delta State is located in the South South of Nigeria and one of the 36 States constituting the Nigeria Federation. The State was created in August 27, 1991 out of the formal Bendel State. The State comprises Twenty-five (25) Local Government Areas (LGAs). Delta State is located between longitude $5^0\ 00^1$ and $6^0\ 45^1$ East and latitude $5^0\ 00^1$ and $6^0\ 30^1$ North. It is bounded on the North by Edo State, on the Northwest by Ondo State, Anambra State on the East and Bayelsa State on the South East. On the Southern flank is the Bight of Benin, which covers approximately 160 kilometers of the State's coastline The 2006 population census puts the population of Delta State at 4,098,391 made up of 2,074,306 males and 2,024,085 females, with a land area of 17,011sq kilometres (NPC, 2006).

The State has a tropical climate marked by two distinct seasons: the dry and rainy seasons. The dry season occurs between November and April, while the raining season begins in April and last till October. There exists a brief dry spell in August commonly referred to as 'August break'. The average annual rainfall is about 2667mm in the coastal areas and 1905mm in the Northern areas. Rainfall is heaviest in July. Delta State has a high temperature ranging between 29^0 C and 44 ^{0} C with an average of 30^0 C (Delta State main fact, 2018).

Sampling Procedure; Data Collection and Analysis

To make for a good coverage of respondents in this study, the multi-stage random sampling technique was used to sample a total of three hundred and twenty five (325) farmers. Primary and Secondary data were used in this study. Structured questionnaires were used to elicit information from the respondents. The data collection instrument focused on socio-economic characteristics; institutional characteristics, climate change adaptation strategies used by the food crop farmers, and problems faced by the farmers. Secondary data were sourced from both published and unpublished relevant materials; climate variables were obtained from the Nigeria Meteorological Agency (NIMET) database. The specific objectives were achieved using both descriptive and inferential statistics, such as tables, frequencies, percentages, means, and the multinomial logit regression analysis.

Results and Discussion

Socio-economic and Agricultural Characteristic of Respondents

The socioeconomic and agricultural characteristics of the respondents are reported in Table 1. The result in Table shows that majority of the respondents (34.3%) are between the ages of 41 – 50 years while only 6.7% of the respondents are above 60 years. This implies that most farmers are still in their productive age. These results imply that food crop farmers in the area were above the dependent age i.e. not within the economically active age range, which means that food crop production is tending towards the declining productivity class of greater than 50 years. Majority (62.3%) of the farmers were males while 37.7% were females. This implies that males are more actively involved in farming in the study area. The dominance of the male counterparts may be attributed to the laborious nature of farming in the area whereby most of the farming operations are carried out manually using crude farm implements. In such situation, males may be more able to withstand the stressful and energy dissipating nature of farming. This has implications for gender equality and calls for mainstreaming of women especially in agriculture where they constitute a bulk of the workforce in other clines.

The result also indicates that 56.3% of the respondents were married, 19.0% were single, 10.0% widowed and 14.7% divorced. This implies that majority of the respondents are married and involved in farming in the study area. Household size ranges from 1 -5 (5.3%), 6 – 10 (50.7%), 11–15 (28.3%) and above 15 (15.7%) and 29-35 Higher family size is an indication that there are enough hands to carry out the farming activities. Hence, household size as a proxy to labour availability reduces labour constraint. It should however be noted that large household size may increase the probability of poverty if majority of the members are not involved in income generating activities but are merely dependants.

Table 1: Socio – economic characteristics of respondents

Age	Frequency	Percentage
21- 30	22	7.3
31-40	87	29.0
41-50	103	34.3
51-60	68	22.7
Above 60	20	6.7
Mean	49	
Sex		
Male	187	62.3
Female	113	37.7
Marital Status		
Single	57	19.0
Married	158	52.7
Divorced	44	14.7
Widowed	30	10.0
Separated	11	3.7
Household size		
1-5	16	5.3
5-10	152	50.7
11-15	85	28.3
Above 15	47	15.7
Mean	8	
Educational Level (Years of Schooling)		
No Formal Education	23	7.7
Primary (6 years)	56	18.7
Secondary (12 years)	121	40.3
OND/NCE (14/15 years)	63	21.0
HND/BSc (16 years)	37	12.3
Occupation (Primary		
Farming	231	77.0
Civil Servant	22	7.3
Trading/Business	39	13.0
Schooling	8	2.7
Experience (in years)		
1-10	29	9.7
11-20	86	28.7
21-30	145	48.3
Above 30	40	13.3
Mean	24	
Farming System		
Sole Cropping	27	9.0
Mixed Cropping	273	91.0
Farm Size (in hectares)		
Less than 1	54	18.0
1-5	191	63.7
6-10	42	14.0
Above 10	13	4.3
Total Mean	4.2	
Total	**300**	**100.0**

Source: computation from field survey data; 2018.

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Table 1 also reports the educational status of the sampled farmers. The result shows that 7.7% of the farmers had no formal education, 18.7% had primary education, 40.3% had secondary education, 21.0% had OND and NCE education while 12.3% had university education. This shows that the farmers have some level of education and would therefore be able to comprehend the complexities of farming and climate change better. This implies that majority of them only attempted secondary schools or its equivalents.

Based on the main occupation of the farmers, majority of the farmers were into full time farming 77%, civil servants were 7.3%, schooling 2.7% and trading and business is 13%. Majority of the farmers have been farming for the past 21 to 30 years with a mean farming experience of about 19 years. Based on the Types of farming system majority of the respondents 91% practiced mixed cropping and 9% of them practiced mono cropping on some food crop farm plots. Farm size in hectares indicate that majority of the respondent farmers 63.7% possess 1-5 hectares of usable land while 18% of the farmers have less than 1 hectare of land and about 14% of the respondent farmers possess between 6 -10 hectares of land and only 4.3% of the farmers have above 10 hectares of land. The mean average land available to the respondent farmers was 4.2 hectares. the result indicated that majority of the respondent farmers have less farm land to practice some of the climate change adaptation strategies such as shifting cultivation and bush fallowing.

Climate change Adaptation strategies used by food crop farmers.

Table 2. Adaptation strategies used by farmers

Adaptation strategies	Frequency	Percentage
Crop rotation	283	94.3
Intercropping	273	91.3
Irrigation	201	66.9
Use of resistant varieties	186	61.9
Plant cover crops	143	47.7
Mixed cropping	269	89.7
Mulching	197	65.7
Minimum tillage	183	60.9
Planting trees	45	15
Water conservation	127	42.3
Early planting	210	70.1
Crop diversification	193	64.3
Late planting	225	74.9
Application of farm yard manure	173	57.7
Fertilizer application	294	97.9
Soil conservation	182	60.7
Livestock diversification	127	42.3
Off- farm employment	190	63.3
No adaptation	6	2
Total	**300**	**100**

Multiple choice responses recorded.
Source: Computation from field survey data; 2018.

In response to the risks on agricultural productivity from the increasing temperature and unpredicted rainfall, farmers in the study area adopted various adaptation strategies. As revealed in table 4, the major actions that have been taken by farmers in response to the negative effect of climate change were: adoption of crop rotation (94.3%), intercropping (91.3%), and increasing use of irrigation (66.9%), use of resistant varieties (61.9%), planting of cover crops (47.7%), use of mixed cropping (89.7%), mulching (65.7%), minimum tillage (60.9%),planting of trees (15%),water conservation(42.3%), early planting (70.1%), crop diversification (64.3%), late planting (74.9%), application of farm yard manure(57.7%), fertilizer application (97.9%), soil conservation (60.7%), livestock diversification(42.3%) and off farm employment (63.3%). As observed in table 5, majority of the farmers who implemented adaptation measure have a propensity of implementing multiple adaptation strategies in combination and only 2% of the respondents did not used any adaptation methods.

Factors that influence the choice of climate change adaptation strategies used by crop farmers in Delta State

The estimation of the multinomial logit (MNL) model for this study was undertaken by normalizing one category which is referred to as the 'reference state' or the ''base category'' in this analysis, the base category is no adaptation. The result of the multinomial logit model indicates that different socio-economic, farm specific and institutional factors (age, household size, years of education of household head, sex of household head, farm size, average distance, access to credit, years of climate change awareness, household income, marital status and tenure security) affects the farmers choice of the main farm level climate change adaptation strategies of food crop production in Delta State. Results of the parameter estimates from the multinomial logit model are presented in table 3 below.

The likelihood ratio statistics as indicated by X^2 statistics were highly significant ($P< 0.000$), suggesting the model has a strong explanatory power. Also, the pseudo (Negalkerke) R^2 was 89.9 % thus confirming households' choice decision making process was highly attributed to fitted covariates. In terms of consistency with *a priori* expectations on the relationship between the dependent and the independent variables, the model appeared to have performed well.

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Table 3: Multivariate analysis of the influence of socio-economic; farm specific and institutional factors on the choice of climate change adaptation strategies used by farmers.

Variables	Soil Multiple Conservation operations	Crop Off-farm Planting operations	Portfolio Diversification operations	Employment operations	Diversification operations
Age	.169(7.458) .082^{x}	0.745(7.193) .007^{xxx}	-.439(5.992) .042^{xx}	-.729(6.722) .014^{xx}	.1.000 (6.681) .081^{x}
House hold size	.097 (.823) .006^{xxx}	.101(.772) .005^{xxx}	.120(.661) .056^{x}	.144(.742) .046^{xx}	.083 (.009) .009^{xxx}
Educational status	.004 (1.679) .098^{x}	.014(1.439) .092^{x}	235(1.287) .005^{xxx}	.196(1.569) .001^{xxx}	168 (1.529) .012^{xxx}
Sex	.124 (1.953) .049^{xx}	212(1.761) .004^{xxx}	.269(1.612) .067^{xx}	.350(1.832) .049^{xx}	-144 (1.760) .03^{xx}
Farm size	.136 (1.625) .003^{xxx}	-.219(1.404) .076^{x}	.009(1.252) .004^{xxx}	.026(1.442) .085^{x}	.035 (1.433) .004^{xxx}
Average distance	-.030 (1.519) .004^{xx}	-.254(1.438) 0.86	-.156(1.301) .005^{xxx}	-.278(1.505) .053^{xx}	-.180 (1.451) .001^{xxx}
Access to extension	.184 (.897) .037^{xx}	.192(.823) .016^{xx}	213(.737) .073^{x}	.169(.902) .051^{xx}	.198 (.804) .005^{xxx}
Access to credit	2.441(11.813) .036^{xx}	3.744(11.373) .042^{xx}	3.932(8.832) .056^{x}	1.511(11.325) .094^{x}	2.325(10.725) .028^{xx}
Marital status	.000 (.000) 0.91	.000 (.000) 0.876	.000 (.000) 0.883	.000 (.000) 0.919	.000 (.000) 0.919
House hold income	.123 (.931) .095^{x}	.214 (827) .006^{xxx}	303(.707) .068^{x}	.113(.888) .009^{xxx}	.265(790) .038^{xx}
Years of awareness	2.636 (14.857) .059^{xx}	2.956 (13.933) .032^{xx}	1.651 (12.576) .006^{xxx}	2.696 (12.714) .033^{xx}	1.620 (12.171) .094^{x}
Tenure security	.157 (13.107) .090^{x}	.955 (12.497) .039^{xx}	.580 (11.393) .059^{x}	.774 (11.487) .046^{xx}	1.594 (10.887) .084^{x}
Access to weather information	.026 (.737) .071^{x}	.132 (.726) .005^{xxx}	.014 (.588) .001^{xxx}	.063 (.696) .028^{xx}	.048 (.646) .040^{xx}
Constant	5.908 (82.978) .043^{xx}	-6.558 (82.709) .037^{xx}	-2.356 (71.298) .004^{xxx}	-4.863 (82.465) .003^{xxx}	.913 (82.103) .001^{xxx}

Chisquare=680.273; -2 loglikelihood =1204.960; NagelkertkeR-square=.898; Coxand Snell=.896; Mcfadden= .361; No. of Observations= 300.

$^{xxx;\ xx;\ x}$ **means significant at 1, 5 and 10% probability level, respectively; while first figures are the betas; the bracket are the standard errors and the last figures shows the level of significance.**

Source: computation from field survey data; 2018.

Age of the household head: Age is significantly and positively related to the probability of choosing and using soil conservation, multiple planting dates and portfolio diversification and negatively related to the probability of choosing and using crop diversification and off farm operations as adaptation strategies to climate change in Delta State compare to no adaptation methods used. This implies that as the age of the farmers increase, they are likely to adopt soil conservation, multiple planting date and portfolio diversification and as younger farmers are not likely going to use crop diversification and off farm operations. A unit change in the age of the farmer has a direct effect on the farmers ability to adopt climate change adaptation strategies the marginal effects or magnitude of change are captured in the results as shown in appendix. This results agrees with the findings of Temesgen; Yehualashet and Rajan (2015) which found that GM corn adaption increased with age for younger farmers as they gain experience and increase their stock of human capital but declines with age for those farmers closer to retirement and also the work of Hassan and Nhemachena (2008) which found that age is directly related to the probability of choosing and using mono crops-livestock under irrigation. Similar result was discovered by Maddison (2008) that the age of farmers has a positive influence on adoption of rock walls as soil management practice in Fort- Jacques in Haiti and on adoption rbST in Connecticut dairy farms.

Household size: The results shows that there is a positive and significant relationship between household size and the probability of choosing soil conservation, multiple planting date, crop diversification; off-farm employment and portfolio diversification as adaptation strategies among food crop farmers in Delta state compare to the base category of no adaptation measure used. This implies that the larger food crop families are the higher the likelihood that they may be able to choose these main climate change adaptation strategies than smaller families. Based on the result of the marginal effect, a unit increases in the number of economically active household increases the likelihood of adopting the above adaptation categories except multiple planting dates. The result agrees with findings of Gbetibouo (2009) which indicated that a large household are more willing to choose labour intensive adaptation measures. According to his findings, household size positively and significantly leads to an increase in the likelihood of adapting to climate change. The fact that increasing household size is normally associated with a higher endowment, which would enable a household to accomplish various agricultural task during peak seasons (Deressa *et. al.*, 2010). This results was also confirm by Okon and Enete (2009) , Hassan and Nhemachena (2008) and Nhemachena (2009).

Educational status: Education of the household head has a significant and positive correlation with all the adaptation measures. Education increases the likelihood of the use of soil conservation measures, use of multiple planting date, portfolio diversification, crop diversification and off-farm employment at different significant levels. This implies that an increase in the years of schooling education of the household head will have a marginal increase in the likelihood of the household head adopting all the climate change adaptation strategies enumerated compared with no adaptation. Education is expected to impact positively on farmers decision makings since educated household are expected to be more informed and knowledgeable on the best livelihood choices to make in combating the effect of climate variability. This finding is in line with that of, Birkann and Fernando (2008), who noted that education and skills up grading are powerful adaptive strategies for individual families and communities. In addition, Temesgen, Yehualashet and Rajan (2015) reported a strong association between education status of the household head and the probability of adopting multiple adaptation measures in combination like irrigation with agricultural inputs, agronomic practices with agricultural input and irrigation with collection of agronomic practices at less than 5% probability level.

Sex of household head: Male household head have a high probability of choosing, using and intensifying soil conservation multiple planting dates; off-farm employment and crop diversification than their female counterparts among the sampled food crop farmers in Delta State and possess negative correlation with portfolio diversification when compared with no adaptation measures adopted. An additional unit of a male headed household would lead to an increase in probability of choosing and using the aforementioned adaptation strategies except for portfolio diversification. While female household heads have a higher probability of choosing, using and intensifying portfolio diversification than their male counterparts this implies that that an additional unit of a female headed household would lead to an increase in the likelihood of choosing and using portfolio diversification as adaptation strategy in the study area as compared with the based category. Correspondingly, the following previous studies found that male household heads have a positive relationship in adoption of manure and intensity of its use and fertilizer adoption and intensify of use of farm technology adaptation in Kenya (Senait, 2002), on multiple crops under irrigation and multiple crop- livestock under irrigation as farmers strategies for adapting to climate change (Deressa *et. al.*, 2008).

Farm size: The model results showed that farm size has a positive and statistically significant association with soil conservation, portfolio diversification, crop diversification and off- farm employment adaptation categories but negatively related to multiple planting operations as compared to no adaptation measure used. This implies that famers with more farm land tend to use all the other adaptation measures except multiple planting operations when compared to the based category. Whereas farmers with larger size of farm land has better probability of increasing land under cultivation practicing shifting cultivation and planting of fodder trees as an adaptation measure in reducing the negative effect of climate change. Gbetibouo (2009) showed that farm size positively and significantly leads to an increase in the likelihood of adapting to climate change. In agreement to this finding, the coefficient on farm size is significant and positively correlated with the probability of choosing irrigation as an adaptation measure.

Average distance: Average distance of the farms to the residents of the farm households is negatively related and statistically significant. This implies that a one unit increase in average distance would lead to a decrease in the probability of the food crop farmers of choosing and using soil conservation practices, multiple planting dates, crop diversification, off –

farm employment and portfolio diversification as climate change adaptation strategies compared to the based category. It means that long distance i.e remoteness of the food crop farmer's residents to their farms discourages the use of climate change adaptation strategies among food crop farmers in the study area thereby promoting no adaptation. This result was in agreement with the study of Maddison (2008) which found out that distance from plot to farmers residence had negative relationship with adoption of climate change adaptation strategies. They further stress that distance encourages the use of more cultural practices such as bush fallowing, shifting cultivation, use of inorganic fertilizer and terracing as land management practices in Uganda. This result is also confirm by findings by Deressa *et al.*, (2008), Yehualashet and Rajan (2014) and Nhemachena (2009).

Extension contact: Extension contact/services significantly and positively correlated with soil conservation, multiple planting dates, off-farm employment; portfolio diversification and crop diversification as compared with the based category. This means that a one unit increase in extension contact services would increases the probability of choosing the above adaptation strategies in the study area. This result supports the innovation theory and also suggests that the food crop farmers in Delta State have made use of these climate adaptation strategies categories probably because of their personal conviction as a result of advice received from extension personnel. Previous studies have found positive influence of extension contact/ services on adoption of agricultural and farm technologies; among them are Maddison (2008) that found positive relationship between agricultural extension and adoption of inorganic fertilizer as land management technology in Uganda, Hassan and Nhemachena (2008) found out that extension contact had positive influence on adoption of multiple crop under irrigation; mono crop- livestock under dry land as adaptation strategies employed by African farmers. Senait (2002) also found positive relationship between fertilizer intensity and extension contact in farm technology adoption in rain fed semi arid lands of Kenya.

Access to credit: As hypothesized access to credit has a positive and significant effect on the probability of a household head to choose soil conservational practices; multiple planting dates; crop diversification; portfolio diversification and off-farm employment as adaptation strategies among food crop farmers in Delta State compared to the based category. This implies that the more access food crop farmers have to useable credit the more likelihood of the farmers adopting adaptation strategies to combat climate change variability. Based on the result of the marginal effect a unit increase in the amount of farm credit available to the food crop farmers increases the probability of adopting the above climate change adaptation strategies compared with no adaptation. The advantage of credit provision in solving the financial constraints of farmers to invest on agricultural technologies was clearly expressed from this result; farmers having better access to credit will have the probability of using different adaptation strategies. Other studies (Deressa *et al.*, 2008; Gbetibouo, 2009; Nhemachena, 2009) reported similar results with regard to the effect of credit access in adaptation decision. Gbetibouo 2009 reported that access to credit increase the likelihood that farmers will take up portfolio diversification and buy feed supplements for their livestock. Having access to credit indeed increases the likelihood of choosing portfolio diversification by 3%.

Household income: the sign from the result for this variable is consistent with *a priori* expectation which is statistically significant at different probability levels on adoption of soil conservation practices; multiple planting dates, crop diversification; portfolio diversification and off-farm employment. As depicted in the model result, household income was found to have positive and strong association with all categories adaptation measures as compared with the based category. The likelihood of adopting soil conservation, multiple planting dates, portfolio diversification, crop diversification and off- farm employment will increase with a unit increase in household's income. This implies that a unit increase in the amount of house hold income will directly result in the likelihood of increasing climate change adaptation strategies by the farmers in the study area and a decrease in household income will increase no adaptation; the implication is that the availability of more funds will mean additional incentive for combating the menace of climate variability. Deressa *et al.*, (2008) also reported a positive relationship between farm income and adoption of soil conservation practices, use of different crop varieties and adjustment in planting dates. Temesgen, Yehualeshet and Rajan (2014) reported that income from non-farm activities increases the financial base of the household which in turn contribute positively for adaptation at farm level.

Years of climate change awareness: Years of climate change awareness has a positive relationship and was statistically significant with the probability of choosing among the different climate change adaptation strategies compared with the based category. This implies that a unit increase in the years of climate change awareness has directly increased the likelihood of the food crop farmers in the study area to choose any of the various adaptation strategies thereby reducing no adaptation. The result is in conformity with Senait (2002) who reported that years of climate change awareness has a positive relationship with the probability of choosing and using multiple crop varieties and multiple planting dates among African farmers.

Tenure security; Tenure security has positive relationship and statistically significant with the probability of choosing and using soil conservation, multiple planting dates, off-farm employment; portfolio diversification and crop diversification in the study area compared to the based category. This means that food crop households that own their own plots or lands have higher probability of choosing and using the above adaptation measures as climate change adaptation strategies. Tenants can be assumed less likely than land owners to use new or emerging climate change adaptation strategies as the benefits may not necessarily flow to them, while land ownership influences the farmer's decision. An additional unit of land secured food crops farmer would increase the likelihood of choosing and using the various climate change adaptation strategies. This finding agrees with the study of Maddison (2008) that found that secure land tenure has a positive influence on the probability of adopting terrace as a farm technology in the rain-fed semi-arid lands of Kenya.

Access to weather information; in conformity with *a priori* expectations; access to weather information appears to have positive and significant relationship with the likelihood of using the above climate change adaptation measures there by reducing the based category (no adaptation). A marginal increase in the amount of weather information received by the farmers in the study area will directly increase the response to climate change. Farmers with better access to information of the changing climate have more probability of using several adaptation measures. This study conforms to work by Nhemachena and Hassan 2007 who reported that access to weather information positively and significantly affects the decision to take up climate change adaptation measures.

Conclusion and Recommendations

Global climate change is a threat that is already having initial tangible impacts upon humankind and nature today. Reports have shown that the impacts of climate change on livelihoods and agriculture in countries of the world including Nigeria are inversely proportional to the nation's responsibility for the problems. The observable impacts include: low agricultural productivity, food insecurity, water stress, low income due to changes in earning patterns of various farm assets, poverty, unemployment, resource conflicts, environmentally induced mitigation, hunger and starvation, health problems, violence and the ultimate price- death. All these conditions impact negatively on national development. Based on the findings of this result; it was recommended therefore that:

- ➢ Farmers should be granted incentives such as farm inputs; credit facilities and innovative technologies that will place them in an advantage position.
- ➢ There is need for government and non-governmental organizations to invest in climate resilient projects and improving on climate monitoring and reporting stations.
- ➢ The level of education of farmers should be improved in order to increase their ability to adjust to the effects of climate variability.
- ➢ The determinants which influence farmer's likelihood of adopting climate change adaptation strategies should be harnessed and properly utilized.

REFERENCES

Birkmann J. and Fernando N. (2008); measuring revealed and emergent vulnerability of coastal communities to Tsunami in Srilanka. Disaster. 32(1): 82-105.

Buba, A. D. (2004). Climate change and water problems in Chad Republic. *Journal of Arid Environment,* 3(2): 24-27.

Delta State (2018) Main Fact. http:/www.deltastate.gov.ng.

Deressa T.; Hassan R.; and Ringler C. (2010). Perception of and adaptation to climate change by farmers in the Nile Basin of Ethiopia. *J. Agric. Sci*. 149: 23-31.

Deressa T; Hassan C; Ringler T.A. and Yusuf M. (2008); Analysis of the determinants of farmers' choice of adaptation methods and perceptions of climate change in the Nile Basin of Ethiopia. IFPRI: Washington DC.

Foresight. (2011). The future of food and farming. Final Project Report. London, The Government Office for Science.

ISSN 2536-6084 (Print) & ISSN 2545-5745 (Online)

Gbetibouo G. (2009); Understanding farmer's perceptions and adaptations to climate change and variability: The case of the Limpopo Basin; South Africa; IFPRI. Washington DC.

Hassan R. and Nhemachena C. (2008); Determinants of Africa farmer's strategies for adapting to climate change: multinomial choice analysis. *AFJARE* 2(1):85-104.

Intergovernmental Panel on Climate Change (IPCC) (2007), *Impact, adaptation and vulnerability, contribution of Working 1 of the Intergovernmental Panel on Climate Change to the Third Assessment Report of IPPC*, London: Cambridge University Press.

Intergovernmental Panel on Climate Change (IPCC) (2012). *Managing the risks of extreme events and disasters to advance climate change adaptation (SREX)*. Special Report of the Intergovernmental Panel on Climate Change (IPCC). Geneva, IPCC Secretariat, 32 (1): 35-48.

Kalinda T, and Langyintuo A (2014). Livelihood strategies, shocks and coping mechanisms among rural households in Southern Zambia. *Curr. Res. J. Soc. Sci*. 6(4):120-133.

Khanal, R.C. (2009). Climate change and organic agriculture. *The Journal of Agriculture and Environment* 10: 100-109 , Review paper.

Maddison D. (2008); The perception of adaptation to climate change in Africa. University of Pretoria; Johannesburg. PMcid; PMC1698947.

National Population Commission (2006); 2006 National population census of federal republic of Nigeria. provisional results. Abuja.

Ngigi, S.N. (2009), *Climate change adaptation strategies: Water resource management options for small holder farming systems in Sub-Saharan Africa*, the MDG Centre for East and Southern Africa, The Earth Institute at Columbia University, New York.

Nhemachena C. (2009); Agriculture and future climate dynamics in Africa: Impacts and adaptation options. Ph.D Thesis presented to department of agricultural economics; extension and rural development; University of Pretoria. 150.

Nhemachena, C. and Hassan, R. (2007). *Micro-level analysis of farmers' adaptations to climate change in Southern Africa.* IFPRI, Environment and Production Technology Division. Washington, DC: International Food Policy Research Institute.

Nigerian Environmental Study Team (NEST), (2004). Regional climate modelling and climate scenarios development in support of vulnerability and adaptation studies: Outcome of regional climate modelling efforts over Nigeria, NEST, Ibadan, Nigeria.

Odjugo, P.A.O. (2007). The impact of climate change on water resources; global and regional analysis. *The Indonesian Journal of Geography*, 39: 23-41.

Okon U.E and Enete A.A. (2009); Resource use efficiency among urban vegetable farmer's in Akwa-Ibom State Nigeria. *Tropicultura* 27(4): 211-217.

Oladipo, E. (2010), *Towards Enhancing the Adaptive Capacity of Nigeria: A Review of the Country's State of Preparedness for Climate Change Adaptation*, Ilorin, Nigeria.

Rosegrant, M.W., Ewing, M., Yohe, G., Burton, I., Huq, S. and Valmonte-Santos, R. (2008). Deutsche Gesellschaft fur 177

Senait R. (2002); The economics of emerging land resources towards sustainability in the highlands of Ethiopia. Ph.D Dissertation presented to the University of Hohenheim.

Temesgen D; Yehualashet H. and Rajan D.S. (2014); Climate change adaptations of smallholder farmers in South Eastern Ethiopia. *Journal of Agric. Ext. and Rural Dev*. 6(11):354-366.