International Research Journal of Natural and Applied Sciences
Vol. 3, Issue 9, September 2016 IF- 3.827 ISSN: (2349-4077)
© Associated Asia Research Foundation (AARF)
Website: www.aarf.asia Email : editor@aarf.asia , editoraarf@gmail.com

VULNERABILTY OF ARABLE CROP FARMERS TO CLIMATE CHANGE IN OGUN STATE, NIGERIA.

Olumba, Chukwudi Charles
Department of Agricultural Economics, Management and Extension,
Ebonyi State University, Abakaliki.

ABSTRACT

Climate change is perhaps the most serious environmental threat facing mankind worldwide. This study examined the vulnerability level of arable crop farmers in Ogun State, Nigeria. A survey of 235 households in Ogun State was used to generate household level data. Principal Component Analysis (PCA) was used to develop vulnerability index for individual household so as to classify households depending on their level of vulnerability to climate change and then logistic regression model was employed to identify the key determinants of vulnerability to climate change. The result of households vulnerability to climate change showed that mean household vulnerability index in the study area was 3.495. The finding further showed that greater fraction (75 %) of the entire sample population was seen to be vulnerable to climate change as most of them are lacking in socio-economic attributes that could make them less vulnerable to climate change and vulnerability level of the female farmers is higher than that of their male counterparts. Access to credit ($p<0.01$), age ($p<0.10$) and sex ($p<0.10$) favoured less vulnerability while climate change awareness ($p<0.05$) was found to increase the likelihood of households being highly vulnerable to climate change. It was recommended among others that government should encourage farming households in the study area to obtain loan from banks and micro-credit institutions by regulating interest rate on loans for farmers as well as removing the severe conditions attached to loans. This will increase farmers' adaptive capacity in alleviating the impacts of climate change thus reducing their vulnerability. Also, there is need for government to implement gender specific policy option that will ensure the transition of women from being vulnerable to being able to adapt effectively to climate change.

Keywords: Vulnerability index, Logit regression model, Climate change, Arable crop farmers

INTRODUCTION

It is accepted today that the temperature of the earth's surface has increased by an average of about 0.3 to 0.6^0C since the end of the 19^{th} century. The 1990s had seven of the ten hottest years of the 20^{th} century. The sea level also rose by an average of 10 to 25 cm during the past one hundred years, and this is, to a large extent, due to increase in the average world temperature. Studies such as Mendelsohn et al., (2000); Paavola (2006); Ozor and Cynthia (2010) indicated that temperature is rising and rainfall frequency and intensity is fluctuating.

Moreover, Climate change impacts vary among regions, generations, age, classes, income groups and gender. Based on the findings of the intergovernmental panel on climate change, it is evident that people who are already most vulnerable and marginalized will also experience the greatest impacts. The poor, primarily in developing countries, are expected to be disproportionately affected by climate change; thus being significantly at higher risk to hazards brought on by climate variability and intensity (ILO, 2008).

Agriculture places substantial burden on the environment in the process of providing humankind with food and shelter, while climate is the principal determining factor of agricultural productivity. Given the ultimate role of agriculture in human wellbeing, anxiety has been articulated by federal agencies and others concerning the possible effects of climate change on agricultural productivity. Interest in this issue has motivated a substantial body of research on climate change and agriculture over the past decade (Fischer et al, 2002; Wolfe et al, 2005; Lobell et al, 2008). It is proven that climate change will have a strong impact on Nigeria-particularly in the areas of agriculture; land use, energy, biodiversity, health and water resources. Nigeria, like all the countries of Sub-Saharan Africa, is highly vulnerable to the impacts of Climate Change (NEST 2004; IPCC 2007).

According to Okunmadewa (2003), vulnerability is the likelihood of a shock causing a significant welfare loss. The implications are that vulnerability of countries and societies to the effects of climate change depends not only on the magnitude of climate stress but also on the sensitivity and capacity of affected societies to adopt to or cope with such stress (NEST, 2004). In the perspective of the global warming problem, evaluating vulnerability is an essential component of any attempt to delineate the magnitude of the threat. Moreover, analysis of vulnerability offers a preliminary point for the determination of

operative means of stimulating corrective action to limit impacts by supporting coping strategies and facilitating adaptation. Thus, the need to analyse the vulnerability of arable crop farmersto climate change based on the assimilated vulnerability valuation approach and to determine the factors influencing households' vulnerability to climate change in Ogun State, Nigeria.

MATERIALS AND METHODS

Study area

The study was carried out in Ogun State of Nigeria. Ogun State is located in the South Western part of Nigeria. It is bounded in the west by the Republic of Benin, in the east by Ondo State, in the south by Lagos State and in the north by Osun and Oyo States. It lies within latitude 6^{o}N and 8^{o}N and longitude 2^{o}E and 5^{o}E. It has a land area of about 16,762 square kilometers and a population of about 3,728,098 (NPC, 2006), which is approximately 2.70 percent of Nigeria's population (NBS, 2007). Farming is the major occupation of the people, particularly those living in the rural areas. The climate favours the production of arable crops such as maize, yam, cassava, rice, cocoyam and tree crops like kola nuts, cashew and oil-palm. Administratively, the state is divided into four divisions which include, Egba, Ijebu, Yewa and Remo. In all there are twenty local government areas in the state.

Sampling Techniques

A multi-stage random sampling technique was used to select a sample size of 250 respondents for the study. The first stage involved the random selection of five (5) Local Government Areas. In each selected local Government Area, five (5) communities/villages were randomly selected.Lastly, ten (10) arable crop farmers were randomly selected from each farming community, giving a sample size of 250 arable crop farmers. Out of 250 questionnaires served to the selected farmers, a total of 235 questionnaires were retrieved and useful for analysis.

Methods of data analysis

The study makes use ofvulnerability index to analyse the vulnerability of arable crop farmers to climatechange and logistic regression model to examine the determinants of vulnerability to climate change among respondents.

Household vulnerability analysis

In order to analyse the vulnerability of arable crop farmers to climatechange, vulnerability index was employed. FollowingMadu, (2012) and Gutu (2013), the data were

analysed in stages. The first stage of analysis was the descriptive analysis that described the adaptive capacity, sensitivity, and exposure of the arable crop farmers to climate change. Second, the vulnerability indices were obtained by applying Principal Component Analysis (PCA) on the adaptive, sensitivity, and exposure variables.

Vulnerability = (adaptive capacity)–(sensitivity/exposure).

The vulnerability index of each household was obtained as follows:

$$V_i = \begin{pmatrix} W_1 \\ W_2 \\ . \\ . \\ W_{n+n} \end{pmatrix} \times \begin{pmatrix} (X_{11}+ \ldots + X_{1n}) - (K_{11}+ \ldots + K_{1n}) \\ \vdots \\ \vdots \\ (X_{m1}+ \ldots + X_{mn}) - (K_{m1}+ \cdots + K_{mn}) \end{pmatrix} \ldots\ldots\ldots\ldots (1)$$

The values of X and K were obtained by normalization. In the equation 1 above, the Ws, are the first component score of each variable computed using Principal Component Analysis.

Vulnerability indicators that were used for adaptive capacity (Xs) include; primary and secondary school, literacy rate, non-farm income, fertilizer supply,ownership of radio, ownership of livestock, insecticide and pesticide supply, improved seeds supply, access to large farm size, access to farm credit, access to electricity, access to health services, secured land tenure, access to food market, mobile phone services, veterinary services and household size. The indicators for sensitivity/exposure (Ks) included;frequent flooding deforestation, drought,rainfall variability, temperature variability, biodiversity loss, soil erosion, sloppy farmland and desertification.

Logistic regression model

Logit regression model was used to examine the determinants of vulnerability to climate change among respondents, as used by Apata et al (2009) examining the characteristics that best explain variation in the measures of attitudes of the indigent perception and adaptation level to climate change and factors that influences such decisions. The advantage of the logistic regression model is that it allows for a differential response from different respondents. This equates to having a different coefficient for each individual or group of individuals in the model which can allow policy makers to tailor their polies at the individual or small group level.

The structural form of the logistic regression is expressed as;

$\text{Log}(y_i) = b_0 + b_1X_1 + b_2X_2 + \ldots + b_{k-1}X_{k-1,i} + e_i$ ---------- equation 2

Where;

Y_i = dependent variable (household vulnerability to climate change)

b_o = intercept

b_i = regression coefficients

X_i = explanatory variables (socio-economic characteristics / climate change variables). They include;

X_1 = farmers' age (years), X_2 = years of educational attainment, X_3 = number of household size, X_4 = non-farm income (₦), X_5 = farm income (₦), X_6 = access to credit (access = 1, 0 otherwise),X_7 = sex of a household head (male =1, female = 0), X_8 = climate change awareness (aware = 1, 0 otherwise), X_9 = adaptation to climate change (adapt = 1, 0 otherwise), e_i = error term.

Let $p(y_i= 1)$ be the probability that the event did occur and $p(yi = 0)$ be the probability that the event did not occur, the probability model for yi is thus represented as,

$$\frac{p(yi=1)}{1-p(yi=1)} = \frac{p(yi=1)}{p(yi=0)}$$

RESULTS AND DISCUSSION

Farmers' Vulnerability Level to Climate Change

In order to analyze the vulnerability level of each and every arable crop farmers in the study area, household level variables were used to measure the differences between the adaptive capacity and the exposure/sensitivity as in Madu (2012) and Gutu (2013).

Using the Principal Component Analysis (PCA), Vulnerability index was generated for each household. The Principal Component Analysis of the data set on vulnerability indicators revealed two components with eigen values greater than 1. These two components explain 100 percent of the total variation in the data set. The first principal component explained most of the variation with about 57.979 percent and the second principal component explained 42.021 percent. Asearlier stated for the use of PCA, in constructing indicies, the first principal, which explained most of the majority of the variation in the data set was chosen. It was observed from the factor scores that the first PCA (the vulnerability index, in this case) was positively associated with majority of the indicators under adaptive

capacity and negatively associated with the indicator for sensitivity. The component scores were shown in table 1.

From the result in table 1, it was observed that the result of the principal component analysis for factor score was positively associated with majority of the indicators identified under adaptive capacity and negatively associated with majority of theindicators categorised under exposure and sensitivity. Thus for the construction of the vulnerability indicies, the indicators of adaptive capacity which are positively associated with the first PCA and the indicator of sensitivity which is negatively related were selected. This reduced the indicies remaining to just eighteen**.** Higher values of vulnerability index show less vulnerability and vice versa. Furthermore, households' vulnerability to climate change was profiled against gender and the result is presented in table 3.

Table 1: Factor score of the first principal component analysis

Vulnerability variables	**Factor Scores**
Primary and secondary school	-0.012
Literacy rate	0.065
Non-Farm Income	-0.029
Fertilizer supply	0.052
Household size	0.078
Ownership of livestock	0.037
Insecticide and pesticide supply	0.324
Improved seeds supply	0.117
Access to large farm size	0.683
Access to farm credit	0.331
Access to electricity	-0.053
Access to health services	0.033
Secured land tenure	0.067
Access to food market	0.022
Mobile phone services	-0.084
Veterinary services	0.686
Ownership of radio	0.712
Frequent flooding deforestation	0.254
Drought	-0.037
Temperature variability	0.074

Biodiversity loss	-0.034
Soil erosion	-0.042
Sloppy farmland	0.349
Desertification	0.071
Rainfall variability	-0.050
Eigen value	9.631
Proportion of variance	57.979

Source: Field survey, 2016

Vulnerability Index for Households

The difference between adaptive capacity and exposure/sensitivity was computed for individual household after multiplying each factor score by the variable for each household as shown by equation 1. Table 2 showed the result of vulnerability index of households in Ogun State,Nigeria with mean score of about 3.4948.

Table 2: Mean Vulnerability Index for Households

Index	**Full sample (n= 235)**
Adaptive capacity	6.9720
Sensitivity / exposure	-3.4772
Vulnerability index	3.4948

Source: Field survey data, 2016

Gender and Climate Change Vulnerability

From the results presented in table 3, greater fraction (75 percent) of the entire sample population is seen to be vulnerable to climate change. About 81.25 percent of the female population is vulnerable to climate change while 18.75 percent is shown to be non – vulnerable. Of the male population, 72.26 percent is vulnerable while 27.74 percent is revealed as not vulnerable to climate change. This implies that the level of vulnerability of females to climate change in the study area is very high. This is also consistent with literature, and is further discussed in subsequent sections.

Table 3: Distribution of Gender and Climate Change Vulnerability

Female		**Male**		**Total**
Vulnerable	Non-vulnerable	Vulnerable	Non-vulnerable	
65(81.25)	**15(18.75)**	**112(72.26)**	**43(27.74)**	**235(100)**

Source: Field survey, 2016

Determinants of Households' Vulnerability to Climate Change

The result of the Logit regression analysis in the table 4 shows that age, access to credit, sex and climate change awareness are significant factors affecting households' vulnerability to climate change.The result reveals age of the arable crop farmers (household head) to be significant at 10 %. The marginal effect reveals that a year increase in crop farmers' age translates into a 7 % reduction in the probability of such household being vulnerable to climate change. This stems from the implication that older respondents are likely to have more years of farming experience, is consistent with past studies. Increasing the age of the crop farmersby one unit increases the probability of perceiving change in climate by 0.4 % (Deressa, 2008). In other words, older respondents tend to be less vulnerable to climate change.

Access to credit by arable crop farmers was found to have negative and statistically significant relationship with the level of vulnerability to climate change at 1% level. The marginal effect reveals that arable crop farmers having more access to credit reduces the farming household vulnerability to climate change by 16 %. Credit availability during period of natural shocks leads farmers to access early maturing varieties, drought tolerant varieties and fertilizer. This result was in agreement with the findings of Gutu (2013) who found a positive relationship between access to credit and level of households' vulnerability to climate change in Ethiopia.

Result from the Logitregression shows that the household head being a male implies a 22 % reduction in the probability of the farming household being vulnerable to climate change and is statistically significant at 10 %. This implies that females are more vulnerable to climate change compared to males, thereby showing consistency with past studies like that of Thapa, (2008) who studied "Women's vulnerability and policy framework for climate change adaptation".

Climate change awareness is significant at 1 %. The marginal effect reveals that farmers that are aware of climate change increased their probability of being vulnerable to climate change by 25%. This is however contrary to expectation, due to the fact that beyond awareness, the farmer needs to have high farm income in order to employ adaptation strategies in order to reduce his vulnerability to climate change since adaptation measures are capital intensive.

Table 4:Logit Regression Result forDeterminants of Households' Vulnerability to Climate Change

Vulnerability to Climate change	Coefficient	Standard Error	Marginal Effects
Age	-1.755*	0.937	-0.072
Educational attainment	1.233	2.971	0.017
Householdsize	1.046	0.669	0.157
Non-farm income	0.967	0.615	0.308
Farm income	0.201	0.429	0.081
Access to credit	-0.843***	0.244	0.163
Sex	-1.272*	0.728	0.215
Climate change awareness	0.873**	0.311	0.253
Adaptation to climate change	-1.340	0.912	0.111
Constant	0.766	1.671	
Prob>chi2	0.000		
Log likelihood	-52.8854		
Number of observations	235		
LR chi2(9)	173.09		
Pseudo R2	0.7335		

Source: field survey, 2016

***, ** and * represent significance level at 1%, 5 % and 10 % respectively. Marginal effect (dy/dx) is for discrete change of dummy variable from 0 to 1.

CONCLUSION AND RECOMMENDATIONS

This study examined the vulnerability of arable crop farmers to climate change in Ogun State of Nigeria. It showed the result of the vulnerability index of households with mean score of about 3.4948. The finding further showed that greater fraction (75 percent) of the entire

sample population was seen to be vulnerable to climate change as most of them are lacking in socio-economic attributes that could make them non vulnerable or less vulnerable to climate change and vulnerability level of the female farmers is higher than that of their male counterparts. The Logit regression result revealed that age, access to credit, sex and climate change awareness significantly influence vulnerability to climate change.

Thus, the following recommendations were made:

1. There is need for government at all levels to increase awareness of climate change among arable crop farmers through extension officers and appropriate communication media, providing current information about climate and weather, and adequate information on effective adaptive measures and available facilities that will aid the farmers in making use of those measures.
2. Government should encourage farming households in Ogun State to obtain loan from banks and micro-credit institutions by regulating interest rate on loans for farmers as well as removing the stringent conditions attached to loans. This will increase farmers' adaptive capacity in alleviating the impacts of climate change thus reducing their vulnerability.
3. Also, there is need for government to implement gender specific policy option that will ensure the transition of women from being vulnerable to being able to adapt effectively to climate change. This may be in form of adequate sensitization, and provision of credit facilities for women to tackle the challenges of climate change.

References

Apata T.G, Samuel K.D, Adeola A.O (2009). Analysis of climate change perception and adaptation among arable food crop farmers in south western Nigeria. A Paper Presentation at the International Association of Agricultural Economists" 2009 Conference, Beijing, China, August 16-22, 2009.

Deressa, T., Hassan, R.M. &Ringler, C. (2008). Measuring Ethiopian farmers' vulnerability to climate change across Regional States. International Food Policy Research Institute (IFPRI) Discussion Paper 00806.

Fischer G., Shah M. and van Velthuizen H. (2002). "Climate Change and Agricultural Vulnerability". International Institute for Applied Systems Analysis. Report prepared

under UN Institutional Contract Agreement 1113 for World Summit on Sustainable Development. Laxenburg, Austria.

Gutu, T. (2013). Individual level vulnerability to climate change impact among crop dependent communities of western Ethiopia. *Journal of Agricultural Economics and Development*, 2(9):356-370.

Lobell DB, Burke MB, Tebaldi C, Mastrandrea MD, Falcon WP, Naylor RL (2008). "Prioritizing climate change adaptation needs for food security in 2030". Science 319 (5863): 607–10

Madu, I. A. (2012). Spatial vulnerability of rural households to CC in Nigeria: implications for internal security. Lagos, Nigeria. Retrieved 25 November 2011, from www.strauscenter.org/ccaps/publication/workingpapers.

Mendelsohn, R., Dinar, A. & Arne, D. (2000). Climate Impact on African Agriculture. Climate change, (45), 583-600.

National Bureau of Statistics (NBS), (2007) Provisional of State and Local Government Totals of the 2006 Population Census of the Federal Republic of Nigeria. http://www.nigerianstat.gov.ng accessed 28th February 2009.

National Population Commissions (2006). Nigeria: Report on the Survey of Demographic and Health Survey. Retrieved from http:www.nigeria/npc/.

Nigerian Environmental Study Team (NEST), 2004: Regional Climate Modelling and Climate Scenarios Development in Support of Vulnerability and Adaptation Studies: Outcome of Regional Climate Modeling Efforts over Nigeria, NEST, Ibadan, Nigeria.

Okunmadewa, F., (2003). Risk vulnerability in agriculture: Concept and context. Development of Agricultural Economics. Pender J.J 2008. *What isclimate change? And how it will affectBangladesh*. Briefing Paper {final draft} Dhaka Bangladesh Church of Bangladesh Social Development Programme.

Ozor, N. & Cynthia, N. (2010). Difficulties in Adapting to Climate Change by Farmers in Enugu State, Nigeria. J. of Agric. Extension. 14(2): 106-122.

Paavola J. (2006). "Livelihoods, Vulnerability and Adaptation to Climate Change in the Morogoro Region of Tanzania", Centre for Social and Economic Research on the Global Environment (CSERGE), University of East Anglia, UK Working Paper Pp. 8 -12.

Thapa, (2008): productivity Differentials between men and women in peasant agriculture in Nepal.

Wolfe D.W., M.D. Schwartz, A.N. Lakso, Y. Otsuki, RMPool, N..J Shaulis, (2005). Climate change and shifts in spring phenology of three horticultural woody perennials in northeastern USA. Internat J Biometeorol 49:303-309. Meteorological Organization, Geneva.