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CLIMATE CHANGE ADAPTATION STRATEGIES AND ITS COPING CHOICE BY RICE FARMERS IN ANAMBRA STATE, NIGERIA

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ABSTRACT

Climate change in the form of higher temperatures, reduced rainfall and increased rainfall variability has irreplaceable toll on food production and food security. These effects are more prominent in developing countries because of their low capacity to cope and adapt to these challenges. However, certain socioeconomic characteristics factors affect farmers' choice of the coping strategies. In this study, efforts are towards "analysis of climate change adaptation strategies and its coping choice by rice farmers in Anambra State, Nigeria" The specific objectives of the study are to describe the socioeconomic characteristics of the rice farmers; identify the adaptation strategies to change in climate as adopted by the farmers and determine the factors affecting households' choice of climate change adaptation strategies in the study area. One hundred and twenty respondents were selected using multi stage sampling techniques for detailed study. Primary data were collected through use of structured questionnaire and oral interview. Percentages responses and multinomial logit model were used to address the objectives of the study. The results of the adaptation strategies adopted by the farmers against climate changes were crop diversification (83.33%), early planting strategy,(68.33%), use of improved crop varieties(65%), use of chemical fertilizer (63.33%), use of crop tolerant variety (65%) and off-farm income (62.5%). Also, the results of the multinomial logit model analysis showed that the coefficients of access to credit, farming experience and perceived rainfall were positive to choice of adaptation. The need to enhance farmers' access to credit and improved farm inputs at subsidized prices were recommended.

Keyword; Climate change, Adaptation strategies, Choice, Coping strategies, Rice farmers.

Introduction

Globally, smallholder farmers constitute the bulk of farming population with an estimated 450 - 500 million, which represents 85% of the world's farmers. One of the characteristic features of this farming class is its vulnerability to climate change, which are occasioned by poor financial resources, low institutional and technological adoption capability (Kim, Ha and Kim, 2017). In Nigeria, this farming class constitutes not only more than 80% of the farming population and responsible for attainment of nation's food security (Akinbobola, Adedokun, and Nwosu, 2015).The vulnerability of this class of farmers, if not checked, will spell doom to the nation's economy considering the roles agriculture plays to her economic growth and development. For instance, ATA, (2012) reported among important of agriculture to include; accounting for between 60-70% of the labour force and contributing between 30-40% of the nation's Gross Domestic Product

(GDP), source of raw materials used in several processing industries as well as a source of foreign exchange earnings.

Rice(*Oryza sativa* L.) is one of the food security crops in the continent of Africa, especially Nigeria, but its production is not growing fast enough in relation to the available potentials in the country (Oluwatusin, 2014). For instance, Uzo,Umunakwe, Ani & Nnadi, (2015) reported that Nigeria demand about 5.0 million metric tonnes of rice annually, however about 3.2 million metric tonnes are produced domestically, resulting to a deficit of about 1.8 million tonnes. The low rice production could perhaps be linked to climate change as generally acknowledged by researchers(Nwafor, 2007; Ejembi and Alfa, 2012; Oluwatusin, 2014, Uzo,Umunakwe, Ani & Nnadi, 2015). Climate change according to IPCC, (2007) is change in climate over time whether due to natural variability or as a result of human activity. It may be referred as any noteworthy change in measures of climate lasting for an extended period.

In many developing countries, Ejembi and Alfa, (2012) reported that rice production depends on environmental factors provided by nature and the optimum combination of these factors, plus production inputs determines yield. They maintained that rainfall characteristics (intensity and duration), relative humidity and temperature constitute some environmental factors that affect rice yield and its variability.

However, the negative influence of climate change in rice production, included reduction in crop yields, reduction in grain quality, loss of crops due to flood, destruction of farm lands by flood, incident of pests and diseases, surge of infectious disease (such as malaria and cholera on farmers) and decrease in soil fertility(Archie, 2014). The other effects are soil erosion, incidence of droughts, high winds velocity, high incidence of weed, post-harvest losses, premature ripening, heat from high temperature, shortening of crop cycle, decrease in soil moistures, change in storage quality of rice, Increased salinity/water pollution and change in production calendar (Abidi, *et al;* 2015).

In lieu to the aforesaid scenarios, the need to develop adaptation strategies in order to mitigate the influence of climate change in order to curtail substantially the indirect effects of the phenomenon. The effects are loss of income, higher food prices, aggravation of rural poverty and food unavailability, instability ,inaccessibility and poor utilization (Adhikari, *et al*; 2017).Adaptation according to Khamal; (2018) entails the use of risk minimizing strategies and adoption of innovative low-input practices that can acclimatize to the environmental adjust. In Africa, smallholder farmers have over the years developed adaptation methods to climatic changes and this is through proper comprehension of farming systems and ability, and more predominantly the utilization of traditional knowledge and their income (Karn, 2014).However, adaptation strategies are usually location and farmer specifics, could be classified as indigenous and introduced adaptation strategies. Uzo, *et al*; (2015) reported that indigenous adaptation strategies can be categorized into crop- and livestock-related strategies, soil-related practices, cultural practices strategies and other indigenous strategies, while, introduced adaptation strategies can be categorized into soil and plant health strategies, improved variety and breeds strategies, recommended agricultural strategies and other introduced strategies. Several studies(Phuyal, *et al;*

2017) reported that in many developing countries, the common adaptation strategies are swapping crops, shifting crop calendar, engaging new management practices for a specific climate regime, changing irrigation system and selecting different cropping technologies.

In Nigeria, the rice farmers adaption strategies are high yielding varieties, inorganic fertilizers, harrowing, early maturing varieties, irrigation, drought tolerant varieties, herbicides, planting during recommended period, reduce farm size and planting in rows (Uzo, *et al;* 2015). However, it becomes necessary to identify the adaptation strategies used by the farmers in Anambra State, Nigeria and factors sway such choice, since there is paucity of such information in the study area to the best knowledge of the researchers. This study could serve as a guide for scholars undergoing similar work, for teaching purposes and the information generated herein, could guide agricultural projects/schemes for effective designing, planning and implementation of climate change adaptation programmes in similar localities. Specifically, the objectives of the study are to: `

(i)describe the socioeconomic characteristics of the rice farmers;

(ii) identify the adaptation strategies to change in climate as adopted by the farmers

(iii)determine the factors affecting faming households choice of climate change adaptation strategies in the study area.

Research Questions

It is needful therefore to ask some pertinent questions which form the following research questions.

(i). What are the background and socio-economic characteristics of the rice farmers?

(ii) What are the adaptation strategies to change in climate as adopted by the farmers?

(iii) What are the factors affecting households choice of climate change adaptation strategies?

Research Method

Study Area

Anambra State is located between longitude 6^0 36`E to $7^0$ 21`of Greenwich Meridian and latitude $5^0$38`N to $6^0$ 47`N of Equator. The State is bounded in the North by Kogi State, in the west by River Niger and Delta State, in the south by Imo State and on the east by Enugu State. It has twenty one (21) Local Government Areas with Awka as the State Capital. It was created in 1991 with a population figure of 3.467 million people (NPC, 2006) and land mass of 4415.54 square kilometres. The State is divided into four agricultural zones of Aguata, Anambra, Awka and Onitsha. The zones are further delineated into 24 extension blocks and 120 circles. Farming is the predominant occupation of the people, majority of who are small holders. The major available crops are yam, cassava, rice, maize, cocoyam, cowpea, tomatoes and vegetables, while the livestock produced in the state include poultry, sheep, goats and to some extent pig. The people also engage into other economic activities apart from farming, included trading, saloon, automobile, vulcanizing, bricklaying, tailoring and among others..

Sample Size and Sampling Techniques

One hundred respondents were selected using multi stage random sampling technique. In stage 1, three out of the four agricultural zones were purposively selected on the basis

of the intensity of rice production. They are Anambra, Aguata and Awka. Two extension blocks were randomly selected from each agricultural zone (Aguata and orumba south from Aguata zone, Awka North and Anaocha from Awka zone as well as Oyi and Anambra from Anambra zone) and 2 circles from each block. Stage 3, ten farmers were randomly selected from each circle for detailed study, giving a total sample size of 120 farmers in the detailed study.

Method of Data Collection

A structured questionnaire and oral interview were used to elicit information on primary data. Structured questionnaire is used to collect information on the respondents' socio-economic characteristics such as; level of education, income level, marital status, age, sex, household size, source of credit. Secondary data was obtained from different literature sources related to this study such as published and unpublished survey articles, journals, textbooks, the internet, proceedings and other periodicals.

Method of Data Analysis

The objectives i, and ii were analyzed using percentage responses, while Objective iii was analyzed using multinomial logistic model.

Model Specification

Adoption of Adaptation Strategies to Climate Variability

In determining the econometric model to employ in an adoption decision study involving more than two choices, two models traditionally utilized to evaluate qualitative dependent variables are considered: Multinomial Probit (MNP) and Multinomial Logit (MNL). Both models are similar in their formulation but MNL is chosen because its cumulative distribution function (CDF) is logistic whereas that of MNP is normal distribution. The MNP model also does not enable precision robustness as it fails to allow the researcher to adjust for covariates as in the case of MNL. Hence, the MNL model was chosen to determine factors influencing farmers' adoption of climate change adaptation strategies over the MNP.

Adaptation strategies, with four possibilities—no adaptation strategy, improved varieties strategies, soil-related strategies, and recommended agricultural practice strategies—were used as the dependent variable. In the Multinomial Logit model (MNL), a baseline alternative is chosen because the options must always be in the respondents' choice set to be able to interpret the results in standard welfare economics terms. The choice "no adoption" was used as the baseline and compared with the other choice of adaptation strategies.

The functional form of the MNL model is specified in Equation (1) as

Prob(Ai = j) =

$$Prob(A_i = j) = \frac{e^{\beta'_j} X_i}{\sum_{k=0}^{k=j} e^{\beta'_k} X_i}$$

……(1)

where Ai is the odd that farmer i choosing alternative j, J symbolizes the adaptation strategies (0 = no adaptation, 1 = recommended agricultural practice, 2 = improved varieties strategies and 3 = soil-related strategies), Xi signifies the autonomous variables and _ is a vector of coefficients for each of the independent variables Xi, k explicitly represents the no adaption strategy which was employed as the base category.

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Equation (1) can be normalized to remove indeterminacy in the model. This is attained by assuming that _0 = 0: Prob

$$Prob\left(A_i = \frac{j}{X_i}\right) = \frac{e^{\beta'_j X_i}}{\sum_{k=0}^{k=j} e^{\beta'_k X_i}}$$

……(2)

If k = 0, then Equation (2) yields the j log-odds ratios of the form:

$$\mathrm{Ln}\left(\frac{P_{ij}}{P_{ik}}\right) = X'_i\left(\beta_j - \beta_k\right) = X'_i\beta_j$$

…….. (3)

β_0 denotes the constant term, $\beta_1, \ldots, \beta_n$ denote the regression coefficient, and _ indicates the error term. The MNL coefficients are problematic to deduce and correlating the _j with the jth result is false. To read the influence of explanatory variables on the odds, marginal effects are frequently derived as ( )

$$\delta = \left(\frac{\partial P_j}{\partial P_k}\right) = P_j\left(\beta_j - \overline{\beta}\right)$$

…….(4)

Empirically, the model is specified as:Y β_0 denotes the constant term, $\beta_1, \ldots, \beta_n$ denote the regression coefficient, and _ denotes the error term. The MNL coefficients are had to interpret and associating the _j with the jth outcome is misleading. To interpret the effects of explanatory variables on the probabilities, marginal effects are usually derived as :

.

$$Y_i = \ln\left(\frac{P_{ij}}{P_{ix}}\right) = \beta_0 + \beta_1 Age + \beta_2 Gender + \beta_3 farmsize + \beta_4 Exp + \beta_5 Rainperception + \beta_6 Credit + \mu_i$$

(5)

A major condition that must be satisfied in MNL is the assumption of the Independence from Irrelevant Alternatives (IIA). The IIA Property requires that the relative probabilities of two options being selected are unaffected by the introduction or removal of other alternatives in the model. The IIA test was carried out to satisfy that condition.

Results and Discussion

Farmers' Socioeconomic Characteristics

Table 1: Distribution of Respondents According to Socioeconomic Characteristics

Factors	Frequency (n=120)	Percentage
Gender (dummy)		
Male	30	33.3
Female	90	75
Age in Years		
20 – 29	20	16.67
30 – 39	42	35
40 – 49	36	30
50 – 59	14	10.86
60 and Above	11	9.17
Mean	**40**	
Farm Size (ha)		
0.01-1.00	40	33.3

1.01 – 2.00	30	25
2.01 – 3.00	18	15
3.01 – 4.00	15	12.5
4.01 – 5.00	12	10
> 5.00	5	4.2
Mean	2.7	
Years of Farming Experience (yrs)		
1 – 5	12	10
6 – 10	20	16.7
11 – 15	50	41.7
16 – 20	32	26.7
21 and above	16	13.3
Mean	12	
Access to Credit Use (dummy)		
Yes	78	65
No	42	35

Source: Field Survey, 2021

Table 1 shows that 75% of the farmers were males, while 25% were females. Males dominated rice production in the study area. The male folk in traditional society of many developing countries have unrestricted access to farm inputs such as land in traditional Africa setting in order to halt the problems of climate change compare to the female folk (Ndamani and Watanabe, 2015). The finding of Nzeadibe, (2011) concurred to the statement. Besides, 51.67% of the sampled farmers were below 40 years of age, while 48.33% were above 40 years of age. Age of the farmer measured in years and is expected to have a negative effect on adaptation to climate change. This could perhaps be explained by the fact that younger farmers are more motivational and innovative, hence likely to adopt improved technologies than older farmers, who are often conservative. The finding of Enete, *et al*; (2011) confirm to .aforesaid statement. They stated that youthful farmers are usually equipped educationally compare to aged farmers, hence have more information seeking behavior, especially as relates to weather information. Furthermore, 58.3% of respondents farmed 0.01 – 2.00 hectares, while 41.75 farmed 2.01 – 5.00 hectares. This result confirmed to *apriori* knowledge that farmers in Nigeria are largely small scaled and generally farm less than 5 hectares. The finding of Ejembi and Alfa, (2012) was in harmony with the above result. They reported that the farmers' farms in general are small sized, fragmented and scattered and not contiguous land holding. These opposed great challenges to the much desired agricultural modernization/ mechanization and commercialization in Nigeria. Farm size played an important role in farm success because it reflects the availability of capital to procure the necessary farm inputs) and good management ability in combating climate change negative effects (Enete, *et al*; 2015).
Also, 26.70% of the respondents had years of farming experience of less than 11years whereas 73.30% had above 11 years. Experienced farmers are often aware of climate change, its effects and the best coping strategies to be adopted in order to minimize crops and other livelihood losses and still maximize their outputs (Ume, *et al*; 2018). This confirm to the finding of Ndamani and Watanabe, (2015), who opined

that the more experienced farmers are, the better choices of adaptation strategies against climate change they could make and able to set realistic farm goals under adverse climatic variations. Furthermore, Table 1 reveals that 65% of the respondents had access to credit, while only 35% do not. The finding of Odiugo, (2011) agreed with the result. They asserted that credit access helps farmers to pay for labour and procure inputs to offset likely climate change challenges.

Adaptation Strategies to Change in Climate as Adopted by the Farmers

Table 2. Adaptation strategies to change in climate as adopted by the farmers

Source	Frequency	Percentage
Multiple cropping	6	5
Early Planting	82	68.33
Use of improved crop variety	78	65
Irrigation supplementation	3	2.5
Intensive use of Chemical/fertilizer	76	63.33
Off- farm income	75	62.5
Crop diversification	100	83.33
No adaptation	11	9.17

*Multiple Responses
Field Survey, 2021

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Among the adaptation strategies, crop diversification (83.33%) was identified as the major adaptation strategy used by the respondents in the study area. Crop diversification is the cultivating of more than one variety of crop belonging to the same or different species in a given area in the form of rotations and or intercropping. Crop diversification improves soil fertility, controls for pests and diseases and brings about yield stability, nutrition diversity and health (Nzeadibe, 2011)

This was followed by early planting strategy,(68.33 %). The early planting as an adaptation strategy is to ensure that critical growth stage of crop did not coincide with very harsh conditions in the season (Phuyl, *et al;*2017). The finding of Akinbobola, *et al;* (2010) concurred with the above result. They were of the view that recurrent incidence of dry spell is disturbing to crop production; hereafter farmers plant early enough to abate such coinciding with the most sensitive growth stage of crop.As well, the use of irrigation in tackling the effect of climate change in rice production had the least (2.5%) number of respondents. The reasons could be because of high cost of installation of the facility and unsuitability of such project in the area in terms of land fragmentation as result of land tenure system and poor source of reliable water (Odiugo, 2011).

Choice of Adaptation Strategies to Change in Climate

Table 3. Results of Multinomial logit regression.

Variable	Recommended agricultural practice,		Improved varieties strategies		Soil-related strategies)		No Adaptation	
	Marginal effect	p-Value	Marginal effect	p-Value	Marginal effect	p-Value	Marginal effect	p-Value
Gender	0.002301	0.063	-0.014007***	0.032	0.004101	0.072	0.001361	0.012
Age	0.007102	0.009	0.005135	0.019	0.002643	0.054	0.002309	0.019
Farm Size	0.001173	0.041	0.003742	0.011	0.004733	0.004	0.004100	0.007
Farm. Experience	0.002933	0.006	0.002276**	0.016	0.008312	0.033	0.000109	0.017
Rainfall Perception	0.002277	0.001	0.001440*	0.005	0.002281	0.036	0.005113	0.029
Access to Credit	0.003080	0.021	0.003381***	0.012	0.001980	0.009	0.007711	0.002

Diagnostic statistics
Number of observations 120
Log pseudo-likelihood 173.755
*, ** and *** Statistical significance at 10%, 5% and 1% respectively
Source; Field Survey, 2021

The coefficient of gender had negative relationship with adoption of improved varieties-related strategies to climate change at about 0.32%. This result is in harmony with previous studies (Enete, etal 2011, Abid, *et al*; 2015). They stated that agricultural improved varieties are usually very expensive, hence likely to be less accessible by female-headed households, who are assumed to be poor compare to the male folk. Also, Odiugo, (2011) reported that because of religious reason in many society and in situation where the extent of access to improved varieties depends significantly on number of extension contact, most female-headed household usually have poor access to improves varieties as they have poor extension outreach, since the system is male dominated. In contrary, Adhikari, *et al;* (2017) finding was not synonymous with the

result above. They stated that male-headed households are not culturally restricted in information seeking behavior compare to the female folk. Also, the finding ofAbidi, *et al;* (2015) was neutral in the relationship between gender and decisions to adopt climate adaptation strategies. They argued that the inconsistency in the findings could be ascribed to differences in location and cultural implications on gender of household in the case of South east, Nigeria.

Furthermore, the farmers' access to credit increases the odd of adopting the recommended agricultural practices and improved varieties by 5% and 1.0 % respectively to curtail the negative influences of climatic change, comparative to not adopting any of the measures. Through having access to credit, Enete, *et al*; (2011) reported that rice farming household could be more opportune in acquiring all indispensable information that could facilitate for change in their management practices in response to climate change. The findings of Ndamani and Watanabe, (2015) concurred to this assertion.

More so, the coefficient of perceived rainfall had direct relationship with adaptation to change in climate by famers. The possibilities of adopting recommended agricultural practices, improved varieties and soil-related strategies increase by about 0.001%, 0.005%, and 0.036 %, respectively, when the rice farmers observe changes in rainfall intensity in relative to no adaptation. That is, farmers who observed changes in precipitation amounts have higher propensity to adopt a measure to lessen the influence of climate change compared to those farmers that are in contrary. The sign identity of the variable could be linked to the fact that most rice farming household in Southeast Nigeria depended essentially on rainfall for their crop production and productivity, thus reduced in rainfall amount could tantamount to poor crop yield and hence the necessity to adapt to the changing climatic conditions becomes imperative (Enete; *et al;* 2011). The finding of Akinbobola, *et al;* (2015) concurred to the aforesaid assertion. Moreover, the coefficient of household farming experience was significant and positively related to adoption of recommended agricultural practices and improved varieties strategies to change in climate as indicated in Table above. The implication is that a year increase in farming experience increased the farmers' likelihood of adopting the recommended agricultural practices and improved varieties strategies by approximately 0.006 % and 0.016 %, respectively, relative to no adaptation. Nzeadibe, *et al*; (2011) was of the view that as the number of years of farmer's years of farming experience increases, the more he/she acquire more knowledge and information about climate change and agronomic practices that could be employed to abate the negative impacts of climate variability on his/her crop yield.

Conclusion and Recommendation

The result of the major adaptation strategies adopted by the farmers against climate changes were crop diversification, early planting strategy, improved crop varieties, use of chemical fertilizer, use of crop tolerant variety and off-farm income **.** Also, the result of the multinomial logit model analysis showed that the coefficients of access to credit, farming experience and perceived rainfall were positive to choice of adaptation were positive, while gender coefficient was negative.

Based on the findings, the following recommendations were proffered;

(1)There is need to ensure credit access to farmers through micro credit institutions and

other financial institutions in order to give them greater flexibility to modify their adaptation strategies in response to climate change..

(2). There is need to encourage both experienced farmers and novice ones to remain in farming through enhancing their access to improved inputs at subsidized rate and information on strategies in averting climate change

(3)Lastly, there is the need for governments and non-governmental organizations to invest in climate resilient projects.

(4). There need to encourage the farmers to engage in off farm income in order to boost their income and purchase material inputs and among others in abating climate change.

(5).Farmers should be persuaded to get into diversification of other crops production in order to cushion the effect of eventual rice failure as result of climate change

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