CLIMATE CHANGE ADOPTION STRATEGIES BY ARABLE CROP FARMERS IN ETHIOPE EAST LOCAL GOVERNMENT AREA OF DELTA STATE, NIGERIA: A MULTIVARIATE PROBIT APPROACH †

[ESTRATEGIAS DE ADOPCIÓN DEL CAMBIO CLIMÁTICO POR PARTE DE LOS AGRICULTORES DE CULTIVOS ARABLES EN EL ÁREA DE GOBIERNO LOCAL DEL ESTE DEL ESTADO DEL DELTA, NIGERIA: UN ENFOQUE PROBIT MULTIVARIANTE]

E.A. Ikpoza[1*], N.C. Nwachukwu[2] and O.A Ohwo[3]

[1]Department of Agricultural Economics and Extension, Faculty of Agriculture, Dennis Osadebay University, Anaai Road, Asaba, Delta State, Nigeria. Email: kingsleyeguono@gmail.com
[2]Department of Agricultural Economics and Extension, Faculty of Agriculture, Delta State University, PMB 1 Abraka, Delta State, Nigeria. Email: nonyenwabuisi@gmail.com
[3]Department of Forestry and Wildlife, Faculty of Agriculture, Delta State University, PMB 1 Abraka, Delta State, Nigeria. Email: oghenekevweabigail@gmail.com
*Corresponding author

SUMMARY

Background: The seasonality of most agricultural activities and restricted utilization of inputs in Africa, make it particularly helpless against weather or climate related difficulties across the different phases of the production cycle. **Objective:** This study focused on climate change adoption strategies by arable crop farmers in Ethiope East Local Government Area of Delta State, Nigeria. **Methodology:** A total of one hundred and twenty (120) respondents were used for the study. Data analysis was achieved using descriptive statistics and multivariate probit (MVP) model. **Results:** The study revealed that the average age of the arable crop farmers was 40 years. An average income of ₦28,000 per month was earned by the arable crop farmers. The result on the various climate change adaptation strategies reveals that income diversification (85.0%) was the most utilized adaptation strategy. The result from the multivariate probit regression analysis revealed that age, farm income and extension visits have a significant impact on choice of climate change adaptation method. **Implication:** Households with diversified streams of income have greater chances of adopting climate change adaptation strategies because of their ability to afford them. **Conclusion:** An increase in age, farm income and extension visits have a significant impact on choice of climate change adaptation methods in the study area. It is therefore recommended that farmers in the study area need to expand their source of income in order to form backup savings to invest on adaptation infrastructure.
Key words: adoption; strategies; climate change; crop farmers; multivariate probit; income diversification.

RESUMEN

Antecedentes: La estacionalidad de la mayoría de las actividades agrícolas y la utilización restringida de insumos en África la hacen particularmente indefensa frente a las dificultades meteorológicas o relacionadas con el clima en las diferentes fases del ciclo de producción. **Objetivo:** Este estudio se centró en las estrategias de adopción del cambio climático por parte de los agricultores de cultivos herbáceos en el área de gobierno local de Ethiope East del estado de Delta, Nigeria. **Metodología:** Se utilizó un total de ciento veinte (120) encuestados para el estudio. El análisis de los datos se realizó mediante estadística descriptiva y modelo probit multivariante (MVP). **Resultados:** El estudio reveló que la edad promedio de los agricultores de cultivos herbáceos era de 40 años. Los agricultores de cultivos herbáceos obtuvieron un ingreso promedio de 28.000 libras esterlinas por mes. El resultado de las distintas estrategias de adaptación al cambio climático revela que la diversificación de ingresos (85,0%) fue la estrategia de adaptación más utilizada. El resultado del análisis de regresión probit multivariante reveló que la edad, los ingresos agrícolas y las visitas de extensión tienen un impacto significativo en la elección del método de

adaptación al cambio climático. **Implicación:** Los hogares con fuentes de ingresos diversificadas tienen mayores posibilidades de adoptar estrategias de adaptación al cambio climático debido a su capacidad para costearlas. **Confusión:** Un aumento en la edad, los ingresos agrícolas y las visitas de extensión tienen un impacto significativo en la elección de los métodos de adaptación al cambio climático en el área de estudio. Por lo tanto, se recomienda que los agricultores en el área de estudio necesiten diversificar su fuente de ingresos a fin de generar ahorros de respaldo para invertir en infraestructura de adaptación.
Palabras clave: adopción, estrategias, cambio climático, agricultores, probit multivariante, diversificación de ingresos.

INTRODUCTION

The concern about the impact of climate change on sub-Saharan African agriculture stems from its potential to undermine the local economy and livelihoods in farming communities heavily dependent on crop production for food and incomes. The seasonality of most agricultural activities and restricted utilization of inputs in Africa, make it particularly helpless against weather or climate related difficulties across the different phases of the production cycle (Chete, 2019). Predictions suggest that extreme climatic conditions would intensify as a result of greenhouse emissions and associated global warming (IPCC, 2012). This manifests in climate-induced shocks such as floods, serious dry seasons and typhoons which dampens yields, diminishes incomes, increases malnutrition and intensifies food insecurity (Brown *et al.*, 2012).

Sub-saharan Africa experiences excessively climate change because of its colossal reliance on rain-fed agriculture and lacking adaptive capacities with regards to expecting these occasions and lessening their effects (Nelson *et al.*, 2014; Adimassu and Kessler, 2016). As per IPCC fourth African Assessment Report,75 to 250 million people of sub-Saharan Africa would face heightened water stress by 2025 and crop yields from rain-fed agriculture will decline by up to 50%, unless deliberate efforts are made to adapt to climate change (Chete, 2019). To be sure, proof has shown that burning temperature, whimsical rainfall, ceaseless flooding and delayed dry spell reduces soil quality/dampness and crop flexibility, disintegrates productivity and damages food production (IISD, 2007; Apata *et al.*, 2010; Ozor and Nnaji, 2011).

Clearly, adapting to climate change at the farm-level, by modifying current practices is a pivotal adapting technique. The common reaction techniques regularly draw on existing components, for example, adjusting farming frameworks or changing farm innovation and broadening income sources (Taruvinga *et al.*, 2016). The variety of variation methods carried out in agriculture in sub-Saharan Africa to manage the changes of climate incorporates intercropping or crop rotation, adoption of high yielding improved crop varieties resistant to climatic stress or more tolerant of parched conditions, varying of time of planting and diversifying into mixed crop livestock systems or on the other hand off-farm occupations. Different procedures incorporate utilization of soil and water preservation techniques, irrigation plans, ridges across slopes, zero tillage and re-establishing soil richness utilizing agrochemicals or natural stronghold; balancing the corresponding utilization of capital and labour and planting of trees to ensure soil conservation (Maddison, 2006; Nhemachena and Hassan, 2007, Obayelu *et al.*, 2014, Olutegbe, 2016).

The choice of adaptation options is shaped by the socio-ecological context, infrastructure and institutional factors (Ravera *et al.*, 2016). Specifically, adaptation is influenced among others by age, gender, household size, education, farm size, farming experience, farm income, access to credit and extension services, irrigation and distance to market and off-farm employment (Deressa *et al.*, 2009; Oluwatusin, 2014; Taruvinga *et al.*, 2016). It is crucial to note the adaptation reactions of local communities to climate change, and the chaperon difficulties to proactively address them towards charting reasonable adaptation methods for what's to come. This study gives exact proof on decision of adaptation techniques by farming families in Ethiope East Local Government Area (LGA), Delta State, Nigeria. The study also improves on the corpus of research on this subject in sub-Saharan African by harnessing perspectives on farmers' 'reactive coping strategies' to climate change. Specifically, this study examined the various adoption strategies to climate change by the arable crop farmers; and determine factors influencing climate change adaptation strategies by farmers in Ethiope East LGA, Delta State, Nigeria.

METHODOLOGY

The study was carried out in Ethiope East LGA of Delta State, Nigeria. It's headquarter is located at Isiokolo. Ethiope East LGA has three major communities, namely, Abraka, Agbon and Isiokolo. Ethiope East LGA of Delta State, Nigeria is made up of semi-urban communities of about 100,000 inhabitants, located at latitude 5°N - 6°S and

longitude 5.5°E - 6.5°W (www.population.gov.ng). The region is described by tropical climate with rainy season enduring from March to November. The vegetation goes from mangrove thick forest to blended rain forest and meadows. The inhabitants are mostly native farmers. Because of rainfall for a significant part of the year (8-9 months) and human activity the soil is permeable and moist with temperature between 28-32°C.

Data Collection

Primary data were collected for the study through trained enumerators with the use of well-structured questionnaire. Multistage sampling technique was be used to select the respondents for the study. The three districts, namely, Abraka, Isiokolo and Agbon that make up Ethiope East LGA were selected. Thereafter, forty (40) arable crop farmers were selected randomly from each of the three (3) districts to arrive at a total of one hundred and twenty (120) respondents that were used for the study.

Data Analysis

The socioeconomic characteristics of the respondents and the preferences in the adoption strategies to climate change by arable crop farmers were realized using descriptive statistics such as percentage, mean and frequency distribution, while the factors affecting adoption strategies to climate change was analysed using multivariate probit model.

Following Lin *et al.* (2005), the multivariate probit model for this study is characterized by a set of m binary dependent variables *Yhj* such that:

$$Y_{hj}^* = X_{hj}^1\beta_j + u_{hj} \quad \text{...................................1}$$

$$Y_{hj} = \begin{cases} 1 \; if \; Y_{hj}^* > 0 \\ 0 \; if \; otherwise \end{cases} \text{...........................2}$$

Where *j* = 1, 2 . . .*m* denotes the type of adaptation strategy available; *Xhj* is a vector of explanatory variables, β*j* denotes the vector of parameter to be estimated, and *uhj* are random error terms distributed as multivariate normal distribution with zero mean and unitary variance. It is assumed that a rational *hth* farmer has a latent variable, *Yh*j which captures the unobserved preferences or demand associated with the *jth* choice of adaptation strategy.

Dependent variables

The dependent variables included in the analysis are the adaptation strategies used by farmers in the study

are which are: use of small-scale irrigation, planting of trees, use of improved varieties, mixed cropping and income diversification.

Independent variables

The independent variables included in the model included socioeconomic variables such as age, household size, farming experience, education, number of extension contact (monthly) and monthly farm income.

RESULT AND DISCUSSION

Socioeconomic characteristics of respondents

The result of the socioeconomic characteristics of the respondents as presented in Table 1 showed that 34.2% of the farmers were male and 65.8% were female. This implies that the proportion of female was higher than male farmers. This finding agreed with Okonya (2013) who observed that women in sub-saharah Africa contributed 70 to 75% of agricultural food production in rural areas. In terms of the age distribution of the respondents in the study area, the study revealed that about 36.7% of them were within the age range of 41 – 60 years. Only about 30.8% of the respondents were within the age range of 20 – 40 years while 10.8% and 21.7% of the respondents were less than 20 years and above 60 years respectively. The mean age of the arable crop farmers in the study area was 40 years. This finding corroborates with that of Afolami *et al.* (2015) who stated that majority of arable crop farmers in Southern Nigeria were between the age range of 30 – 40 years.

About 27.5% of the respondents were still single, 42.5% were married, 10.0% were divorced while 20.0% were widowed. This result is in line with that of Afolami *et al.* (2015) who stated that majority of arable crop farmers in Southern Nigeria were married. This further infers that the respondents were dominated by married people who constantly added to increment in family size farm labour (Torimiro, 2005). The educational background of the respondents revealed a high number of those with tertiary educational background (36.7%). Respondents with secondary educational background was 33.3%, while those that non formal educational background was 20.0%. This infers on the total that most of the farmers had one type of education or the other, and accordingly enjoyed the benefit of taking on methodologies, since education helps in embracing improved agricultural technologies as seen by Ozor and Madukwe (2005).

Table 1. Socioeconomic Characteristics of the respondents.

Variable	Frequency	Percent	Mean
Sex			
Male	41	34.2	
Female	79	65.8	
Age			
Less than 20 years	13	10.8	
20 – 40 years	37	30.8	40 years
41 – 60 years	44	36.7	
Above 60 years	26	21.7	
Marital Status			
Single	33	27.5	
Married	51	42.5	
Divorced	12	10.0	
Widowed	24	20.0	
Level of Education			
No formal education **(0 years of formal education)**	24	20.0	
Primary education (1 to 6 years of formal education)	12	10.0	
Secondary education (7 to 12 years of formal education)	40	33.3	
Tertiary education (above 12 years of formal education)	44	36.7	
Farm size (Ha)			
Less than 0.5	52	43.3	
0.5 – 1.0	30	25.0	0.82 Ha
1.01 – 1.5	13	10.8	
1.51 – 2.0	10	8.3	
Above 2.0	15	12.5	
Farming Experience (Years)			
1 – 5	24	20.0	
6 – 10	51	42.5	7 years
Above 10 years	45	37.5	
Farm monthly Income ($1 = ₦416.75)			
Less than ₦10,000	31	25.8	
₦10,000-₦50,000	61	50.8	₦28,000
₦51,000-₦100,000	10	8.3	
₦101,000-₦150,000	13	10.8	
Above ₦150,000	5	4.2	
Household size			
Less than 2 persons	24	20.0	
2 – 5 persons	51	42.5	5 persons
6 – 9 persons	31	25.8	
Above 9 persons	14	11.7	
Number of extension contact (monthly)			
Non	38	31.7	
Once	61	50.8	
Twice	12	10.0	
More than twice	9	7.5	

Note: $1 = ₦416.75 (https://www.cbn.gov.ng/rates/exchratebycurrency.asp)

The average farm size of respondents in the study area was 0.82 hectares. This implies that the arable crop farmers were small scale farmers. This finding agrees with Ajieh (2014), that the small-scale farmers had between 0.5 to 3.5 hectares. As a result of the land tenure system in Africa, and Nigeria in particular, lands are fragmented. The crude implement used by our farmers limit scale of production. The results from the study showed an average income of ₦28,000 per month in the study area. This indicates that the arable farmers were mainly small-scale farmers with attendant low

income. The distribution of respondents according to household size indicates that a greater percentage (42.5%) of the respondents had 2 – 5 persons in their families. About 20.0% of the respondents have less than 2 persons in their families while 25.8% and 11.7% of the respondents have 6 – 9 persons and above 9 persons as family members respectively. The mean household size of respondents in the study area was 5 persons. This implies that the household size of arable crop farmers in the study area was relatively small which might not serve as an insurance against short fall in supply of labour. About 50.8% of the respondents had contact with extension agents once in a month and 31.7% had none.

Climate change adaptation strategies used by respondents

The result on the various climate change adaptation strategies as shown in Table 2 reveals that income diversification (85.0%) was the most utilized adaptation strategy. This could be due to the fact that individuals with diversified income sources have more ability to absorb the shocks from climate change than those with one stream of income because they have the option of engaging in other income generating activities. This result supports

that of Chete (2019) who stated that higher incomes and greater assets enable the adoption of climate change adaptation strategies. The result also showed that 62.5% of the respondents adopted small-scale irrigation, 51.7% adopted planting of trees, 72.5% adopted use of improved varieties while 77.5% adopted mixed cropping.

Factors influencing adaptation strategies to climate change

The determinants of adoption strategies to climate change by arable crop farmers in the study area is shown in Table 3. The various factors influencing choice of adaptation strategies investigated were farmer's age, household size, educational level, farm size farm income and extension visit. The various climate change adaptation strategies that were examined are use of small-scale irrigation, planting of trees, use of improved varieties, mixed cropping and income diversification. The likelihood ratio of the model −29.3021 was statistically significant (P<0.01), indicating strong explanatory power and implying that the socioeconomic and other characteristics of the farmers had significant influence on their choice of climate change adaptation strategies.

Table 2. Climate change adaptation strategies used by respondents.

Adaptation strategies	Frequency	Percentage
Use of small-scale irrigation	75	62.5
Planting of trees	62	51.7
Use of improved varieties	87	72.5
Mixed cropping	93	77.5
Income diversification	102	85.0

Note: multiple response

Table 3. Determinants of adoption strategies to climate change.

Variable	Small-scale irrigation	Planting of trees	Improved varieties	Mixed cropping	Income diversification
Age	0.2013***	0.3513***	-0.5294***	0.6635***	0.3753***
Household size	0.1865	1.5194	2.0546	0.7395	0.1818**
Education	1.1841	1.2355	0.2821	4.3793	0.3972
Farm size	-0.2015	3.2004	-4.0349	-0.7932*	1.1493
Farm income	0.9760***	0.9976**	1.1522**	0.8658***	0.2690
Extension visits	1.7160**	0.6883**	0.3404**	2.0218**	0.0645**
Constant	1.3147**	1.7518	1.3963	1.2546	0.1867
Wald chi	20.1				
Prob > chi^2	0.0002***				
Log likelihood	−29.3021				
No. of observation	120				

*, **, and *** are statistically significant at the 10%, 5% and 1% alpha levels, respectively.

Age of farmer, which addresses insight, influenced adaptation to climate change emphatically and fundamentally at 1% level of probability. Since as the age of the family head increases, the individual is relied upon to have gotten more experience in weather forecasting and that helps improve in likelihood of using the diverse adaptation methodologies to climate change such as use of small-scale irrigation, planting of trees, use of improved varieties, mixed cropping and income diversification. This result is in line with that of Tazeze and Haji (2012) whose study showed that age of farmer increased their likelihood of practicing different adaptation strategies to climate change.

The farm income of the farmers reviewed altogether affects likelihood of using the various adaptation systems to climate change. At the point when the main source of income in farming would build, farmers will in general contribute on efficiency smoothing alternatives, for example, use of small-scale irrigation, planting of trees, use of improved varieties, mixed cropping and income diversification. According to Ayanlade *et al.* (2017) and Zizinga *et al.* (2017), farmers who earned more income from their farming activities presumably have more resources in the form of backup savings to invest on adaptation infrastructure.

Extension visits had significant positive relationship with the likelihood of making particular adaptation choices. The hands-on knowledge exchanges with extension agents including those exposing the dangers of climate change and the merits of alternative adaptation paths, underpins the choices made by the farmers (Leeuwis and Hall, 2013; Phillipo, 2015).

CONCLUSION

The knowledge of the adaptation methods to climate change enhance policy towards tackling the challenge that climate change is imposing on Nigerian farmers. In relation to this, the study identified factors affecting the choice of climate change adaptation strategies by arable crop farmers in the study area. Income diversification was seen as a major coping strategy against climate change. Age, farm income and extension visits have a significant impact on choice of climate change adaptation methods. The study therefore recommended that farmers should diversify their source of income in order to form backup savings to invest on adaptation infrastructure. Social and physical framework need to be improved and institutions managing climate related issues including the meteorology organization be reinforced to increase adaptive limit.

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