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Full Length Research Paper

Choice of soil management techniques as adaptation to climate change among fluted pumpkin farmers in Akwa Ibom State, Nigeria

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The study analyzed factors that influence the choice of soil management technique among fluted pumpkin *(Telfairia occidentalis)* farmers in Ikot Ekpene area of Akwa Ibom State, Nigeria. It was assumed that, the adoption of any soil management technique apart from zero tillage was due to the changing effect of climate. One hundred and fifty fluted pumpkin farmers were randomly sampled and used for this study. Structured questionnaires were used to collect the data needed for the analysis. Multinomial Logit model regression was used to analyze the data collected. The choice of the multinomial Logit model was based on the multi-variate nature of the dependent variable. The explanatory variables used in this study were derived following a careful review of the literature and observed characteristic of respondents. The analysis of the socio-economic characteristics of Telfairia farmers revealed that, most of them were educated, married, aged, experienced and possessed moderate family size. The result of the empirical estimation revealed that, gender (female), age, household size, farm size, extension agent contact, member of a social group, access to credit, farming experience and marital status of fluted pumpkin farmers are important decision variables that influenced the use of bedding and tillage soil management techniques instead of zero tillage in the study area. Based on the research findings, it is recommended that, the socio-economic characteristics of vegetable farmers should be taken into consideration when formulating climate change policies and also when introducing adaptation strategies or technologies to rural farmers in the study area.

Key words: Farmers, fluted pumpkin, multinomial logit, adaptation, soil management.

INTRODUCTION

The issue of climatic change has formed one of the topical discussions among stake holders in agriculture and economic development experts in this millennium. This evolves from the need to assuage the threat, the phenomenon imposes on humanity. Brig dictionary defines climate change as a change in global weather patterns, especially increases in temperature and storm activity. Empirical studies have indicated that, Africa's agriculture is negatively affected by climate change (Pearce *et al.,* 1996 and McCarthy et al., 2001). Adaptation is one of the policy options needed to reduce the adverse effect of climate change (Adger *et al.,* 2003; Kurukulasuriya and Mendelsohn, 2008). Adaptation to climate change refers to the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (Intergovernmental Panel on Climate Change (IPCC), 2001). Similarly, adaptation to climate change involves taking action to reduce either the negative effects or to capitalize on the positive effects of climate change (Anim-kwapong *et al.,* 2003).

In recent years, adaptation to climate change has become a major concern to rural poor farmers, researchers and even policy-makers alike. Common adaptation methods in agriculture especially in the developing countries include; the use of new crop varieties, livestock species, poultry birds, irrigation, crop diversification, adoption of mixed crop, Fadama cultivation, and the use of improved soil management technique among others(Bradshaw *et al.,* 2004;

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Kurukulasuriya and Mendelsohn, 2008; Nhemachena and Hassan, 2007).

To enhance policy towards tackling the challenges that climate change poses to farmers, it is important to know factors influencing farmers' adaptation to adverse climate change. According to Intergovernmental Panel on Climate Change (IPCC) (2001), cited in Ekpo *et al.* (2012), climate change means a change in variability of weather of a region over a period of at least thirty years. It expresses the change in average weather conditions that a region experiences over a specified period of time. The climate change has considerable and sustained effects on agriculture in developing countries, and according to the Nigeria Environmental Study Team (NEST) (2004), the effects of climatic change on agriculture in developing countries have implications for food security in a long run especially in Africa. Ekpo *et al.* (2012), opined that in the face of this impact of climate change on environment and human, there are two responses to the crises. The first is mitigation practices; these are actions aimed to limit or reduce the severity, seriousness, painfulness or the magnitude of the long-term climate change. Climate change mitigation generally involves reductions in human emissions of green house gases (GHGs). Mitigation may also be achieved by increasing the capacity of carbon sinks through reforestation. The second response is the adaptation practices. Climate change adaptation is the actions or responses that seek to reduce the vulnerability of biological systems to climate change effects. It also means, anticipating the adverse effects of climate change and taking appropriate action to prevent or minimize the damage they can cause, or taking advantage of opportunities that may arise. For instance, using scarce water resources more efficiently; adapting building codes to future climate conditions and extreme weather events; building flood defenses and building dikes in response to sea level rise; developing drought-tolerant crops; choosing tree species and forestry practices less vulnerable to storms and fires; and setting aside land corridors to help species migrate (European commission, 2013). In other words, adaptation deals with how people can survive in the presence of climate change events.

The adoption of any soil management technique by farmers is intended to cushion the adverse effects that, the climate change would have on the agricultural productivity and sustainability. Birte *et al.,* (2008) asserted that there is a strong need for identification and adoption of conservation- effective measures in the Sub Saharan Africa. Ezeaku (2012) asserted that, soil conservation techniques are those management strategies adopted by farmers to prevent soil from being eroded or becoming chemically altered by over use, salinization, acidification, or other soils' chemicals contamination. According to him, these strategies involve the combination of methods of management and land use to guard against soil depletion or deterioration by natural or man- induced factors. Thus, effective soil conservation practices reduce land and water pollution; reduce long - term dependency on external inputs which often times led to increase cost of production; enhance environmental management, improved water quality and water use efficiency, reduced emission of green house gases through lessened use of fossil fuel and finally improved agricultural productivity with minimum cost (Dimelu *et al.,* 2013; Smith and Smithers, 2006). In Nigeria, farmers had used various soil conservation practices depending on the terrain and peculiar climate element prevalence in the area. Dimelu *et al.* 2013 opine that, the use of these practices has considerably sustained production at least on subsistence level, but their long term impacts relative to adapting and mitigating the problems of climate variability should be of concern. Therefore, adoption of appropriate soil management measure would help to improve soil quality by enhancing soil organic matter reserves, strengthening nutrient recycling mechanisms, and raise the activities and species diversity of soil fauna (e.g. earth worms, termites, soil micro organism).

Akwa Ibom State in the South-South region of Nigeria is basically an agrarian society. Vegetable cultivation is popular in this region following the presence of rich water bodies at the coastal region and in some spotted upland regions. Popular among vegetables grown in the area is *Telfairia occidentalis* or fluted pumpkin (Akpan and Aya, 2009). The crop is cultivated on upland during rainy season and in wetland or F*adama* areas during dry season. It is the most preferred homestead crop among the *Ibibios* and *Efiks* in the region. The green succulent leaves are used to prepare the most popular traditional delicacy of the *Ibibios* and *Efiks* called "*Edikan Ikong*" (Akpan *et al.,* 2013). The demand for this leafy vegetable is high, and is all year round.

In order to meet the demand of consumers in the state, fluted pumpkin farmers have consciously adopted several soil conservation measures to increase and sustained production.

Literature has documented that increase productivity of crops are affected by several factors including soil depletion, climate change and human related factors (Akpan and Aya, 2009; Emuh *et al.,* 2011). Telfairia farmers have adopted soil enhancing materials like fertilizer, poultry dropping etc to improve soil fertility. But in the face of changing pattern of rainfall in the region, which often resulted in flooding, *Telfairia* farmers have resorted to the adaptation of various soil management technologies in response to the menace of frequent flooding of farm lands following change in climate condition. For instance, some adapted to bedding soil management technology, some prefer tillage, while others still cultivate on flat or zero tillage soil.

Owing to the importance of this leafy vegetable in the dietary need of people, and the fact that, rainfall has assumed unpredictable trend in Akwa Ibom State; there is need to identify those factors that influence *Telfairia* farmers' decisions on the choice of adaptation of soil management technology. Apart from increase productivity of farmers, and issues related to food security, the identification of these factors will help policy makers to make appropriate policies related to climate change. Based on this premise, the study was basically designed to achieve the following specific objectives:

- To examine the socio-economic characteristics of *Telfairia occidentalis* (Fluted pumpkin) farmers in Akwa Ibom State, and
- To identify factors that influences the decision or choice of soil management technology among *Telfairia* farmers in Akwa Ibom State, southern Nigeria.

Literature Review of Relevant studies

In Nigeria, few literature exist on empirical determination of factors that influence farmer's decisions or choice to adapt to climate change. For instance, Apata *et al* (2009) used Logit model to analyze climate change perception and adaptation among arable food crop farmers in the South Western Nigeria. The data was collected during the late rainy period of September to October 2006 and early rainy period of March-April, 2007. The findings of the study revealed that, increased temperature, intercropping of cereals, mulching, zero tillage, making ridges, farm size, farm experience, education status of the farmer, access to extension services and credit facilities positively influenced adaptation. In addition, the study found that, change in timing of rains, own heavy machines, and household size were also significant factors that influenced adaptation but negatively. Anyoha *et al.* (2013) determined the socioeconomic factors that influenced climate change adaptation among crop farmers in Umuahia South Area of Abia State, Nigeria. Empirical results revealed that, farm size, farming experience, household size, and member of social organization as well as the sex of farmers is important factors affecting climate change adaptation among farmers in the study area. In another research, conducted by Enete *et al.* (2011) on indigenous agricultural adaptation to climate change in the Southeast Nigeria; the result revealed that, age, level of formal education and level of awareness of the climate change issues are major factors driving farmers' investment in adaptation practices in the area. Adebisi-Adelani and Oyesola (2013) investigated the socio-economic factors that influenced the adaptation strategies of selected horticultural farmers in Osun state Nigeria. Data for the study was collected with the aid of both qualitative and quantitative instruments. Linear regression model showed that there is significant relationship between farmers' income, age, marital status, religion and adaptation strategies. However, the reviewed literature showed that, most of these adaptation studies in Nigeria were not crop specific and adaptation strategies were not streamlined to specific areas such as soil management techniques. This research was specifically designed to fill these research gaps in the South –south region of Nigeria. Certain adaptation strategies are peculiar to different regions in Nigeria; for instance adaptation to flooding is common to coastal regions, while adaptation to desertification is peculiar to the northern savanna region of the country. Most of the adaptation to climate change studies in Nigeria did not properly addressed this issue in their models formulation. In this study, we identified three most important soil management strategies adapted by our respondents (that is among sampled farmers in the study area), and were used to model the multinomial Logit in the study area.

Elsewhere, Evengelista (2011) examined farmers' adaptation to climate change in Chivi district of Zimbabwe. A Logit model was employed in the study and findings revealed that, education of the household head, farm household size, access to credit, farming experience and exposure to information on climate change have positive and significant influence on farmers' decisions to adapt to climate change in Chivi district. Also, Hassan and Nhemachena (2007) examined farmers' adaptation strategies to climate change in Southern Africa based on the cross sectional data for South Africa, Zambia and Zimbabwe that was collected as part of the Global Environmental Facility/World Bank climate change and African Agriculture Project. The result of the Probit model revealed accessed to credit, extension services, female headed households, farming experience, increase in mean annual temperature, increase in mean annual precipitation as well as accessed to electricity, tractors, heavy machines and awareness of climate change as some of the important determinants of farm level adaptation to climate change. Again, Hassan and Nhemachena (2008) analyzed the determinants of farm level climate change adaptation in Africa using the Multinomial Logit model on a cross sectional survey data collected in 2002 from 8000 farmers across 11 countries in Africa (that is Burkina Faso, Cameroon, Egypt, Ethiopia, Ghana, Kenya, Niger, Senegal, South Africa, Zambia and Zimbabwe). One of the finding of the study revealed that, mono-cropping is the agricultural practice most vulnerable to climate change in Africa. The study revealed that, better access to markets, extension and credit services, technology and farm assets (land, labour and capital) are critical for helping African farmers to adapt to climate change. Deressa *et al.,* (2009) used a multinomial Logit model to study the determinants of farmers' choice of adaptation strategies. The study analyses perception and adaptation by farmers in the Nile Basin of Ethiopia for mixed crop and livestock farmers during the 2004 and 2005 production year. Findings revealed that, education, age, non farm income, livestock ownership, access to extension services, access to climate information, access to credit, number of relatives in the community positively influenced farmers' choice of adaptation.

METHODOLOGIES

The Study Area

The study was conducted in Ikot Ekpene Senatorial district of Akwa Ibom state, Nigeria. The district consists of ten local government areas namely; Ikono, Ikot Ekpene, Abak, Ika, Etim Ekpo, Obot Akara, Ini, Oruk Anam,Ukanafun and Essien Udim local government areas. The area is popularly known for its raffia production, palm oil production, palm wine and carving as well as crafting. Some of the common food crops grown in the area are; fluted pumpkin, cassava, plantain, waterleaf, sweet yam, cocoyam, maize and banana. Ikot Ekpene is the political headquarter of the district; it has a land area of about 125km^2 or 48 sqaure miles and a population of about 225,000 (NPC, 2006).

Sampling Techniques and Data Collection

Combination of sampling procedures were used in selecting *Telfairia farmers*; first, three local government areas were randomly selected from the ten local government areas that constitute the district. In the second stage; five (5) villages from each of the three Local Government Areas were randomly selected. In the third stage; ten (10) *Telfairia farmers* were randomly sampled from each of the selected five (5) villages. A total of 50 *Telfairia farmers* were selected from each local government area. A grand total of one hundred and fifty (150) *Telfairia farmers* were used for data collection.

Empirical Model specification

The Multinomial logistic regression

The Multinomial Logit (MNL) model was employed to determine factors influencing choice of soil management techniques among *Telfairia* farmers in Akwa Ibom State. The study assumes that the choice of soil management techniques among *Telfairia farmers* in the study area was modeled or influence by the changing nature of the environment, which has a direct bearing on climate change. The MNL model was preferred because of its flexibility and ability to analyze multi-decision or choice of soil management techniques among *Telfairia* farmers in the study area (Hassan and Nhemachena, 2008).
The MNL model is expressed as follows:

$$P(y = j/x) = exp\,(x\beta j)/\Big[1 + h{=}1/\exp x\beta h, J{=}0, 1, 2\ldots, J \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where, *y* denotes a random variable taking on the values {0, 1, 2… J}, for a non-negative integer *J;* while *"x"* denotes a set of conditioning variables. In this study, *y* represents soil management techniques while x represents Telfairia farmers' socio-economic characteristics and farm specific constraints. To obtain unbiased and consistent estimates of the MNL model specified in equation 1, the study assumes that, the Independence of Irrelevant Alternatives (IIA) holds (Deressa *et al*., 2008). The IIA assumption requires that the probability of using a single soil management technique by any Telfairia farmer is independent of the probability of choosing another type of soil management technique (that is the probability of using soil management "A" is (P_j/P_h). This is independent of the probability of using the soil management B, and C). This implies that, the error terms generated in equation (1) should have zero mean; uncorrelated and have constant variance. The parameter estimates of the MNL model only provide the direction of the effect of the independent variables on the dependent (choice) variable; thus the estimates represent neither the actual magnitude of change nor the probabilities (Greene, 2000).

Where;

$$\begin{aligned} Y_{i=0.1,\ldots J} = {} & \delta_0 + \delta_1 GEN + \delta_2 AGE + \delta_3 EDU + \delta_4 HHS \\ & + \delta_5 FAS + \delta_6\, OFI + \delta_7 EXT + \delta_8 CRE \\ & + \delta_9 SGP + \delta_{10} LOW + \delta_{11} EXP + \delta_{12} MAS \\ & + \mu_1 \ldots\ldots (1) \end{aligned}$$

Where
Y_0 is the choice of using flat or zero tillage soil management technology (Y =0)
Y_1 is the choice of using bedding soil management technology (Y= 1)
Y_2 is the choice of using tillage soil management technology (Y=2)
The explanatory variables are:
GEN = Gender of *Telfaria* Farmer (dummy variable: 1 for female and 0 for male)
AGE = Age of respondent measured in years
EDU = Farmer's years of formal education in years
HHS = Household size of Telfairia farmer (number)
FAS = Farm size of Telfairia farmer measured in hectare
OFI = Off- farm income of Telfairia farmer measured in naira
EXT = Contact with extension agent (number of times)
CRE = Access to credit facilities (dummy variable; 1 for access and 0 otherwise)
SGP = Member of a social group in years
LOW = Method of land ownership (1 for inherited land and 0 otherwise)
EXP = Farming experience in years
MAS = Marital status of respondents (dummy variable; 1 for married and 0 otherwise)

Test for Collinearity of Variables Used in the Model

Multi-collinearity is among the common econometric problems of the cross sectional data analysis. This property of econometric was tested among explanatory variables to ensure the econometric stability of the Multi-

Table 1. The Variance Inflation factors (VIF) and Tolerance factor test results for the collinearity of explanatory variables used in the model specify in equation 1.

Variable	***Variance Inflating Factor***	***Tolerance factor***
GEN	*6.839*	*0.146*
AGE	*6.750*	*0.148*
EDU	*5.735*	*0.174*
HHS	*5.854*	*0.171*
FAS	*2.068*	*0.484*
OFI	*3.585*	*0.279*
EXT	*2.591*	*0.386*
CRE	*4.088*	*0.245*
SGP	*3.323*	*0.301*
LOW	*2.148*	*0.466*
EXP	*2.552*	*0.392*
MAS	*3.713*	*0.269*

Source: Computed by authors. Note: for the variance inflating factor (VIF), the minimum possible value is 1.0; while value greater than 10 indicates a probably collinearity problem. Low tolerance factor implies high probability of collinearity.

nomial Logit (MNL) model estimates. The variance inflating factor (VIF) and the tolerance factor (TOL) were estimated and used to test for the presence of the multicollinearity among the explanatory variables. For VIF, the minimum possible value is 1.0; while value greater than 10 indicates a probably collinearity between the explanatory variable in question and the rest of the predictors in the model. VIF was estimated using the formula stated below:

$$VIF_j = \{1/1 - R_j^2\} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

Where R_j^2 is the multiple correlation coefficient between variable X_j (one of the independent variable) and the other specified explanatory variables X_i^sas shown in equation 3.

$$X_j = \varphi_0 + \varphi_1 X_1 + \varphi_2 X_2 + \ \dots, +\varphi_n X_n + \varepsilon_n \ \dots\dots\dots\dots (3)$$

On the other hand, tolerance (TOL) is an inverse of VIF (i.e. $TOL_j = 1/VIF_j$). A small tolerance value indicates that the variable under consideration is almost a perfect linear combination of other independent variables in the equation and that it should not be added to the specified regression equation. In other words; when R_j^2 = 1 (that is perfect collinearity), TOLj = 0 and when $R_j^2 = 0$, (i.e. no collinearity), TOLj will be equal to 1. Hence, both VIF_j and TOLj can be used interchangeably (Gujarati and Dawn, 2009).

RESULTS AND DISCUSSION

Test Result for Collinearity among Specified Variables in the Model

Table 1 presents the Variance Inflating Factors (VIF) and Tolerance (TOL) test results for the multi-collinearity status of the explanatory variables used in the Multinomial Logit (MNL) model.

The result revealed that, the problem of multicollinearity in the data set could be tolerated and would not pose a serious problem since it has not exceeded the threshold or benchmark point. This means that the VIF has not reached the 10th point mark; on the other hand, the tolerance factor is above 0.1 point mark for all the explanatory variables in the model. The result implies that, the estimates of the Multinomial Logit (MNL) model were non-biased and are consistent.

Descriptive characteristics of variables used in the analysis

The descriptive characteristics of variables used in this study are shown in Table 2. The result as presented contains the means, median minimum values, maximum values, the standard deviation, coefficient of variability and information on the skewness of variables.

Table 2. Descriptive Statistic of Variables.

Characteristics	Mean	Median	minimum	maximum	Std D.	C.V	Skewness
GEN	0.89	1.00	0.00	1.00	0.32	0.36	-2.43
AGE	48.11	44.0	35.0	75	9.97	0.21	0.73
EDU	7.78	6.00	0.0	13.0	3.36	0.43	0.01
HHS	6.00	6.0	0.0	11.00	1.80	0.29	0.36
FAS	0.36	0.34	0.16	0.89	0.17	0.45	0.51
OFI	21497	18000	0.0	1.03e+05	27698	1.29	1.88
EXT	0.74	0.00	0.00	8.00	1.92	2.61	2.92
CRE	0.36	0.00	0.00	1.00	0.48	1.34	0.59
SOG	2.24	0.00	0.00	10.00	3.01	1.34	1.37
LOW	0.07	0.00	0.00	1.00	0.26	3.54	3.25
EXP	7.30	6.00	1.00	15.00	3.48	0.48	0.51
SMG	0.86	1.50	0.0	2.00	0.83	0.97	0.27
MAR	0.68	1.00	0.00	1.00	0.47	0.69	-0.76

Source: From field data, 2013.

Table 3. socio-economic characteristic of respondents.

Characteristics	Freq.	%	Characteristics	Freq.	%
Age (Years)			**Land Ownership**		
< 20	0	0.0	Free	0	0.0
20 – 30	1	0.7	Inheritance	27	18.0
31 – 40	33	22.0	Lease	95	63.3
41 – 50	61	40.7	Purchase	6	4.0
> 50	55	36.6	Rental	22	14.7
Total	**150**	**100.0**	**Total**	150	**100.0**
Education (Yrs)			**Extension contact**		
No schooling	16	10.7	0	100	66.7
Primary school	79	52.7	1 – 2	39	26.0
Secondary school	44	29.3	3 – 4	6	4.0
Tertiary School	11	7.3	> 4l	5	3.3
Total	**150**	**100.0**	**Total**	**150**	**100.0**
Farm Size (ha)			Household size		
0.1 – 0.5	134	89.3	1– 5	61	40.7
> 0.5	16	10.7	>5	89	59.3
Total	**150**	**100.0**	**Total**	**150**	100.0
Soil mgt technique			**Farm Experience (Yrs)**		
Zero tillage	40	26.7	1–5	61	40.7
Bedding	38	25.3	6–10	67	44.7
Tillage	72	48.0	>10	22	14.6
Total	**150**	**100.0**	**Total**	**150**	**100.0**
Marital Status			**Social group (Years)**		
Single	6	4.0	0	83	55.3
Married	100	66.7	1–5	56	37.3
Divorced	11	7.3	>5	11	7.3
Widow	33	22.0	**Total**	**150**	**100.0**
Total	**150**	**100.0**			

Source: Field survey, 2013.

Socio-economic Characteristics of *Telfairia occidentalis (Fluted Pumpkin)* Farmers in Akwa Ibom state

The result in Table 3 shows the socio-economic characteristics of respondents (*Fluted Pumpkin*) in the study area. The age distribution of respondents revealed that, no respondent was below the age of twenty years and only one respondent (0.7% of the total respondents) fell within the age bracket of 20 - 30 years. Majority of respondents were within the age range of 41 -50 years, representing 40.7% of the total respondents. Surprisingly, about 36.6% of the total respondents were greater than 50 years. A mean age of 48.11 years was obtained from the respondents sampled. This result indicates that, the farming population in the area is aging out and there is also increasing outward movement of youth from agricultural activities in the study area. This calls for policy that should encourage rural youth involvement in the agricultural activities. About 89.3% (or 134) of *Telfairia* farmers had formal education as against 10.7%. The sampled farmers had an average of 7.78 years of formal education. This means that, there is high tendency of technology accessibility, awareness and adoption among respondents in the study area. This is because education has a positive correlation with accessibility, awareness and adoption of farm technology. Most of the farmers (138 or 89.3% of respondents) were operating on small farm plots of between 0.1 – 0.5 ha. An average farm size of 0.36ha per farmer was identified during the study.

This finding implies that, most *Telfairia* farmers in the region are basically small scale farmers. This means that, any adaptation technique that is not cost effective will not be appreciated by *Telfairia* farmers in the region. About 26.7%, 25.3% and 48% of respondents practiced zero tillage, bedding, and tillage respectively as soil management techniques. The adoption of bedding and tillage soil management techniques by farmers was considered as adaptation to adverse climatic effect on *Telfairia* productivity. Analysis of the mode of farm land acquisition revealed that about 63.3% of respondents cultivated fluted pumpkin on leased land, 18% on inherited land, 14.7% on rented land and 4% on purchased farm land. This result presents the overview of one of the persistence problems faced by small scale farmers in most developing countries. Land constrained imposed by urbanization and land tenure system is prominent in most traditional societies in Nigeria. Given the intensity of land scarcity among peasant farmers in the country, increase agricultural productivity and sustainability among small farm holders will be an illusion if proactive policy intervention is not undertaken by authorities charge with such responsibility.

About 66.7% of the total respondents had no contact with the agricultural extension agents in the previous and the current farming seasons. This revealed that, the agricultural extension agency is not operating at its maximum efficiency in service delivery in the state. The level of education among farmers is high, but they are not persistently exposed to current or updated information on farming activities in the area. Hence provision of infrastructures, training and incentives to extension agents are prerequisites for improvement of service delivery in the state. The results also revealed that, majority (59.3%) of fluted pumpkin farmers have household size greater than 5. An average household size of 6 members was prevalent among respondents. This implies that, the family planning programmes in the state need re-assessment and perhaps new strategies to reach out to small scale farmers in the state. The distributions of the years of farming experience showed that majority of sampled farmers were experienced in fluted pumpkin cultivation in the study area. However, about 7.3 years was identified as an average farming experience among respondents. This means that, there is sufficient potential for increase production and sustainability of *Telfairia* cultivation in the state. About 55.3% of the respondent did not belong to the any social organization. This means that, social capital formation is low among *Telfairia* farmers in the study area.

Result of the Multinomial Logit Regression

Table 4 presents the result of the Multinomial Logit model for adaptation choice of soil management technology by *Telfairia* farmers in Akwa Ibom state. The result revealed that, the log likelihood ratio of 156.488 is significant at 1% probability level. This indicates that the specified model has a strong explanatory power. The pseudo R^2 of 0.3586 shows that about 35.86% of variability in the dependent variables are associated with the specified explanatory variables. This means that, more variables that could have affected the adoption of a particular soil management technique by *Telfairia* farmers in the study area were not included in the model.

For the choice of bedding soil management technology among fluted pumpkin farmers in Akwa Ibom State, the empirical result revealed that the coefficients of gender (female famers), age and farming experience are negative and statistically significant at 5%, 5% and 1% probability levels respectively. This implies that, the adaptation of bedding soil management technique among *Telfairia* farmers in Akwa Ibom State is adversely affected by farmers' age, experience and gender composition (female).

This means that, these variables promote the adaptation choice of zero tillage or flat land soil management technique (which was a reference soil management technique) and reduces the tendency of using bedding soil management technique among sampled farmers. This result satisfied the *priori* expectation as aged and experienced farmers tend to be

Table 4. Estimates of the Multinomial Logit parameters of adoption choice of soil management techniques among *Telfairia* farmers in Akwa Ibom State.

Variables	Choice adoption of Bedding Logistic coefficient		Choice adoption of tillage Logistic coefficient	
Constant	20.95 **(2.56)****		-9.93 **(-1.54)**	
GEN	-8.26 **(-2.56)****		-1.54 **(-0.66)**	
AGE	-0.18 **(-2.31)****		0.17 **(2.29)****	
EDU	0.31 **(1.06)**		0.08 **(0.29)**	
HHS	0.25 **(2.79)*****		-0.75 **(-1.93)***	
FAS	9.37 **(3.69)*****		7.19 **(2.60)****	
OFI	2.62e-05 **(-1.36)**		1.17e-05 **(0.57)**	
EXT	0.17 **(2.08)****		0.55 **(2.38)****	
CRE	1.89 **(1.06)**		4.65 **(2.58)****	
SGP	0.31 **(3.67)*****		0.59 **(3.57)*****	
LOW	1.28 **(0.72)**		2.47 **(1.33)**	
EXP	-0.75 **(-3.45)*****		-0.14 **(-1.29)**	
MAS	2.21 **(2.23)****		5.49 **(4.34)*****	
Mean dependent Var	0.86	S.D. dependent Var		0.83
Log-likelihood	-139.92	Akaike criterion		331.85
Schwarz criterion	417.87	Hannan-Quinn		366.65
Number of cases 'correctly predicted' = 137 (67.82%)				
Likelihood ratio test: = 156.488 [0.0000]				
Pseudo R^2 = 0.3586				

Note: *, ** and *** represent 10, 5 and 1% significant levels respectively. Figures in bracket are t-values. Variables are as defined in Equation 1.

more conservative than the younger one especially in the developing economies. Also, women in most rural communities in Sub-Saharan Africa are culturally restricted and do not have sufficient access to farm resources, as such tended to be tight to the technology they hold at hand. These results corroborate the findings of Enete *et al.,* (2011), Anyoha *et al.,*(2013); Adebisi-Adelani and Oyesola (2013) in Nigeria.

The result also showed that, farm size, household size, extension agent visit, membership of a social group and marital status are positive determinants of the choice of using bedding soil management technology among *Telfairia* farmers in the study area. This means that, increase in farm size, increases the chance of using bedding soil management technology instead of zero tillage or flat land soil management technology among *Telfairia* farmers in Akwa Ibom State. Increase in farm size will imply moving towards commercialized farming, which entails more investment. To achieve this, improved technology must be adopted. In addition, married *Telfairia* farmers have higher probability of using bedding soil management technology than the single ones. Perhaps, the cheap family labour available could be responsible for this result; and for the single farmers, it is the high cost of hired labour or its scarcity. Increased household size provides incentive for lower cost of farm inputs especially farm labour mostly attributed to imputed cost or unaccounted cost of family labour. This will have a positive effect on the adoption of farm innovation such as the bedding soil management technology. An extension agent is a change agent; hence increase contact with farmers will result in a change of farmers' attitude and increase adoption of improved technology. The result for membership of a social group satisfied the *priori* expectation. This is because, increase interactions among farmers and between farmers and other social groups increases awareness, social capital formation, knowledge sharing and exchange of facts concerning farming activities. This enhances adoption or the used of any improved farm technology. This finding is in tandem with the research report of Apata *et al.* (2009) and Anyoha *et al.* (2013) in Nigeria; (Evengelista, 2011) in Zimbebwe, (Hassan and Nhemachena, 2007) in Southern Africa and (Hassan and Nhemachena, 2008) in Africa (Deressa *et al.,* 2009) in Ethiopia.

For the choice of adaptation of tillage soil management technology among Telfairia farmers in the study area, the empirical result revealed that age, farm size, extension agent visit, access to credit, membership of a social group and marital status are positive determinants of the choice of tillage soil management technology among Telfairia farmers in the study area. This result corroborates the finding of Orebiyi *et al.* (2005) who reported that age, extension contact and access to credit had positive significant influence on adoption of improved IITA cassava production in Imo State. This means that, to reduce the adverse effect of climate change among Telfairia farmers through the use of tillage soil management technology in the study area, the above policy variables are prerequisites. For instance, increase access to credit will increase means of financing farm activities and stimulate farm adoption of technology.

Household size has a negative significant coefficient with respect to the choice of tillage soil management technology among fluted pumpkin farmers in Akwa Ibom State. It is pertinent to note that, tillage technology is capital intensive and thus requires huge amount of money to finance such technology. In the face of increasing labour scarcity, increase in household size will increase the household expenditure and reduce farm investment in such operation as tilling. This is a plausible reason for this relationship between tillage soil management adoption and the size of farmer's household. This result agreed with the findings of Apata *et al.* (2009), Anyoha *et al.* (2013), Enete *et al.* (2011) and Adebisi-Adelani and Oyesola (2013) in Nigeria; (Evengelista, 2011) in Zimbabwe, (Hassan and Nhemachena, 2007) in Southern Africa, (Hassan and Nhemachena, 2008) in Africa and (Deressa *et al.,* 2009) in Ethiopia have reported similar results.

CONCLUSION AND RECOMMENDATIONS

The study specifically focused on the identification of farm level policy variables that influenced the used of improved soil management technologies among *Telfairia* farmers in Ikot Ekpene Senatorial district of Akwa Ibom State. The study upheld that, the adoption of these soil enhancing technologies is one of the numerous ways to cushion the adverse impact of climate change among *Telfairia* farmers in the study area. Zero tillage or flat land soil management technology was used as a reference technology relative to bedding and tillage soil management technologies. The analysis of the socio-economic characteristic of *Telfairia* farmers revealed that, most of them were educated, aged, experienced and possessed moderate family size. The empirical results identified some policy variables needed to formulate effective farm level policies especially on issues related to climate change.

Based on the research findings, it is recommended that, the socio-economic characteristics of vegetable farmers should be taken into consideration when formulating climate change policies and also when introducing adaptation strategies or technologies to rural farmers. Exogenous supports such as credit and formation of farmers' social or cooperative groups will enhance adaptation of improve soil management technology among farmers. Strengthening the state extension system will guarantee that, up to date information on climate change and other farm technologies or innovations reached *Telfairia* farmers on appropriate time and form.

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