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Socio-Economic Determinants of Cocoyam Farmer's Strategies for Climate Change Adaptation in Southeast Nigeria

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Abstract

The study assessed cocoyam farmers' strategies for climate change adaptation in Southeast Nigeria. Multi-stage sampling technique was used to select 384 respondents for the study. Data were collected using structured questionnaire and interview schedule and analysed using mean, frequency count, percentages and multinomial logit regression analysis. Findings showed that respondents were mainly women (67%), married (92%) and between the ages of 41 and 60 (52%) with a mean household size of six (6) persons. Mean number of years spent in school was 10 years. The majority (40%) earned monthly income of ₦20,000 and below. The average farming experience was 21 years with mixed cropping (71%) as the major cropping system while combination of livestock and crop production (48%) was the major farming activity done. Farm size was mainly one hectare and below (64%) which was accessed mainly through inheritance (76%) and farm labour sourced through hired labour (50%). Major crops cultivated was cassava followed by maize and yam. Major adaptation strategies used by the cocoyam farmers in the study area included increased use of organic manure (42%), frequent weeding (10%), application of indigenous knowledge (20%), use of information from extension agents (16%), use of fallowing (9%) and application of multiple cropping (3%). Choice of adaptation strategies used by cocoyam farmers was influenced by age, gender, location of farmer, monthly income and labour. Based on the result of the study, it was recommended that sex and location specific adaptation strategies that are within the financial status of the farmers should be emphasized.

Keywords: Farmers Adaptation Strategies; Climate Change; Gender.

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Introduction

Agriculture plays a very important role in the Nigerian economic development as it contributes immensely to employment, food production, industrial inputs and foreign exchange earnings (Agwu, *et.al.*, 2010). This enormous role played by the agricultural sector in the Nigerian economy is threatened not only by the over emphasis on oil production but also the increasing climatic changes. The impact of changes in climate occasioned by global warming are felt much by local farmers whose livelihood activities depend more on agricultural activities mainly done at subsistence level. Climate change affects almost all stages of the farming system with rural farmers more vulnerable to its effects as a result of their low infrastructural capacity as well as high dependence on weather signals for their farming activity. Nigeria produces varieties of crops with some having high level of importance while others are neglected and underutilized for instance cocoyam even though it has some economic and nutritional potentials.

Cocoyam (*Colocasia esculenta* “taro” and *Xanthosoma sagittifolium* “tannia”) belong to the *Araceae* family, a major staple carbohydrate food in sub-Saharan Africa (Chukwu, *et.al.*, 2009). According to Food and Agriculture Organization (FAO, 2012), Nigeria was ranked the highest producer of cocoyam in the world with an estimated annual production of 3.45 million metric tonnes. Okoye, *et.al.*, (2008) posits that in terms of digestibility, crude protein and essential minerals such as calcium, magnesium and phosphorus cocoyam is superior to cassava and yam. Despite the potentials of the cocoyam, its production has not experience significant increase over the years, (FAOSTAT 3 database). This may be as a result of many factors ranging from economic, cultural and political to climate factors (Chukwu, *et.al.*, 2010; Ezeh & Arene, 1987). Ukonze (2012) identified climate change as a major threat to cocoyam production in south eastern Nigeria and further listed the various ways climate change affects cocoyam. Although farmers on their own are trying to adapt their farming systems to this change in climate, Oladipo (2010) noted that there is a need for collaborative effort among the farmers, researchers, government and non-governmental agencies to pool resources together to fight more vigorously the effects of climate change as well as helping farmers to adapt more effectively to the already changed climate. Walter (1997) points out that the vulnerability of the agricultural sector in any region of the world to future possible climate change scenarios is determined to a great extent by the vulnerability of the sector to current climatic, economic and policy scenarios. Agricultural systems which are currently subject to extreme climatic inter-annual variability (drought, flood, storms, etc.) are likely to become even more vulnerable under the most commonly expected scenarios of climate change (i.e. increased temperatures, increased rainfall variability). This is not far from what cocoyam farmers in the southeast Nigeria are experiencing as Ukonze (2012) pointed out the different ways the change in climate is already affecting farmers in the zone.

This, points to the need for concerted effort towards climate change adaptation. In line with the on-going, this study aimed at assessing the adaptation measures used by cocoyam farmers in Southeast, Nigeria with a view to identify socio-economic factors that affect farmers adaptive capacity hence informing policy development as well as aiding agencies in forming effective sustainable adaption packages. The general objective of this paper was to assess the climate change adaptation strategies used by cocoyam farmers in Southeast Nigeria. Specifically, the study described cocoyam farmer’s socio-economic characteristics and examined the relationship between the cocoyam farmer’s choice of adaptation measures and their socio-economic characteristics.

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Hypothesis of the study

Choice of climate change adaptation strategies used by cocoyam farmers are not determined by their socio-economic characteristics.

Methodology

The study was conducted in Southeast Nigeria. It is located within latitudes 4° 47'' 35''N and 7° 7'' 44''N, and longitudes 7° 54'' 26''E and 8° 27'' 10''E in the tropical rain forest zone of Nigeria, with mean maximum temperature of 27^{o}C, and total annual rainfall exceeding 2500mm (Ezemonye & Emeribe, 2012). It comprises of five states, namely, Anambra, Imo, Enugu, Abia and Ebonyi State. The population of this study comprised all cocoyam farmers in the five states of Southeast Nigeria. Multi-stage sampling technique was used to select sample for the study. The first stage was the random selection of three states (Anambra, Imo and Enugu States) from the five states. The second stage comprised the random selection of two agricultural extension zones (namely Awka, Onitsha, Orlu, Okigwe, Udi and Nsukka) from each of the selected states. In the third stage, two extension blocks (Dunukofia, Awka south, Ihiala, Ekwusigo, Onuimo, Isiala Mbano, Njaba, Orsu, Udi, Ezeagu, Uzouwani and Igboetiti) were randomly selected from each agricultural zone. The fourth stage was the random selection of two circles (Ukpo, Abagana, Umuawulu, Nise, Uli, Okija, Ozubulu, Ihembosi, Umunaa, Okwelle, Osuowerre 1& 2, Osuachara, Nkume, Ugbeleakah, Ebenato, Awoidemili, Amaokwe, Obiaoma/Nsude, Oghe/Iwollo, Obinaofia, Nkporogwu, Ogwurugwu, Ukehie and Ozara) from each block giving a total of 24 circles for the study. The sampling frame was the list of all cocoyam farmers that lived in the selected circles for at least twenty years. This list was compiled with the help of village heads and chiefs, extension agents and key informants. From this sampling frame, a sample size of 384 respondents was proportionately selected for the study.

Data were collected with the aid of structured questionnaire, interview schedule, focused group discussion and in depth interview. A 31 statement 4-point likert type rating of strongly agree, agree , disagree, strongly disagree which was assigned weight of 4,3,2,1 respectively for positive items and 1,2,3,4 for negative items was used to capture the adaptation measures used by Cocoyam farmers in the study area. A midpoint of 2.50 was obtained and based on this, decision rule was that any mean score greater than or equal to 2.50 implies agreement with the adaptation measure and any mean score less than 2.50 implies disagreement. Analysis of data was done using descriptive and inferential statistics namely; mean, frequency count, percentage and multinomial logit regression analysis.

Model specification for the Multinomial logit regression analysis used to test the hypothesis.

Null Hypothesis: Choice of adaptation strategies used by cocoyam farmers are not determined by their socio-economic characteristics.

The hypothesis is aimed at identifying the socio-economic determinants of adaptation measures used by cocoyam farmers with a view to provide useful information on the influential factors to target in order to encourage farmer's use of viable adaptation measures as well as inform policy making. Multinomial logit (MNL) and multinomial probit (MNP) models are commonly used in adoption decision process study involving multiple choices (Hassan & Nhemachena, 2008). Both MNL and MNP are important for anlysing farmer

adaptation decisions (Hassan & Nhemachena, 2008) as well as evaluating alternative combinations of adaptation strategies including individual strategies (Hausman & Wise,

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1978; Wu & Babcock, 1998). This study used the MNL to identify the socio-economic determinants of cocoyam farmer's adaptation decision. The choice of the model was based on its ability to perform better with discrete choice studies (McFadden, 1974 and Judge, *et al.*, 1985) and its ease of use (Hassan & Nhemachena, 2008).The MNL model for choice of adaptation strategies specifies the relationship between the probability of choosing an adaptation option and the set of explanatory variables. The adaptation strategies used in this analysis were the six actual and mostly used adaptation strategies by the cocoyam farmers namely; use of organic manure; adoption of more frequent weeding; application of indigenous knowledge; use of multiple cropping (or crop diversification); increase in the use of fallowing relative and use of information from agricultural extension agents.

According to Greene (2003), the Multinomial logit model for adaptation choice which specifies the relationship between the probabilities of choosing option A_i and the set of explanatory variables X is stated as follows:

$$Prob\ (Ai = J) = exp^{(\beta' jXi)}$$

$$\Sigma_{k=0}^{j} \exp(\beta' kXi)\ , J = 0,1 \ldots j \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where A_i represents random variable representing the adaptation measure used by any cocoyam farmers with increase in the use of organic manure is the base category. It is assumed that each cocoyam farmer faces a set of discrete, mutually exclusive choices of adaptation measures that are assumed to depend on a number of socioeconomic characteristics and other factors X, where β_j is a vector of coefficients on each of the independent variables X. Following Hassan and Nhemachena (2008), equation 1 can be normalized to remove indeterminacy in the model by assuming that $\beta_0 = 0$ and the probabilities can be estimated as:

$$Prob\ (Ai = J/Xi) = exp^{(\beta' jXi)}$$

$$1 + \ \sum_{k=1}^{J} exp^{(\beta'_k X_i),}\ j = 0,2 \ldots j\ \beta o = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Estimating equation (2) yields the J log-odds ratios

$$\text{In}\ \ (Pij\ /Pik)\ \ = Xi\ \ (\beta_j - \beta_k) = X_i\beta_j,\ \text{if}\ K = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

The dependent variable is therefore the log of one alternative relative to the base alternative. Because of the difficulties involved in interpreting the MNL coefficients and associating the *j*β with the *jth* outcome can be misleading, marginal effects are derived to interpret the effects of explanatory variables on the probabilities. Long (1997) and Greene (2000) explain that marginal effects measure the expected change in probability of a particular choice being made with respect to a unit change in an explanatory variable. According to Greene (2003), marginal effects are usually derived as:

$$\delta_i = \frac{\partial \mathrm{Pi}}{\partial \mathrm{x_i}} = \mathrm{P_i} \sum\ \ (\beta\_j - \sum_{k=0}^{j} P_k\, \beta_k\ ) = P_i(\beta_j - \beta) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

The dependent variable in this study is the choice of an adaptation measure from the list of adaptation measures examined in this study, while the independent variables (X) are listed in Table 1.

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Table 1: Independent variables used in the multinomial logistic regression model

Independent Variables	Variable level	Variable type	Expected Sign
Location of farm = (X_1)	State: Anambra = 1, Imo = 2, Enugu = 3	Dummy	+ or -
Sex = (X_2)	Male = 1, Female = 2	Dummy	+ or -
Age= (X_3)	Actual Figure	Continuous	+ or -
Marital status = (X_4)	Not Married = 1, Married = 2	Dummy	+ or -
Education = (X_5)	No. of years spent in school (Actual figures)	Continuous	+
Monthly income= (X_6)	Actual figures in Naira	Continuous	+
Household size = (X_7)	Actual Figure	Continuous	+ or -
Extension contact = (X_7)	Actual frequency of contact	Continuous	+
Farm size = (X_8)	Hectares	Continuous	+ or -
Land tenure system = (X_9)	Inheritance = 1, purchase = 2, lease/rent = 3, others = 4	Dummy	+ or -
Farming experience = (X_{10})	Actual figures in years	Continuous	+
Labour source = (X_{11})	Family members = 1, hired labour = 2, others = 3	Dummy	+ or -

Results and Discussion

Socio-Economic Characteristics of Cocoyam Farmers

Table 2 shows the socio-economic characteristics of cocoyam farmers in the study area. They were mainly women (67%), married (92%) and between the ages of 41 and 60 (52%) with a mean household size of six (6) persons indicating that respondents maintained average household size. The mean number of years spent in school was 10 years indicating that they were mainly secondary school dropouts. The majority (40%) earned monthly income of ₦20,000 and below. Their major occupation was farming (77%) with mean farming experience of 21 years and mixed cropping (71%) as the major cropping system. Farm size was mainly one hectare and below (64%) which was accessed mainly through inheritance (76%) and farm labour sourced mainly through hired labour (50%). Major crops cultivated were cassava followed by maize and yam.

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Table 2 Socio-economic characteristics of cocoyam farmers in southeast Nigeria

Variable	Percentage	Mean
Sex		
Male	33	
Female	67	
Age (years)		**51**
21 – 40	25	
41 – 60	52	
61 – 80	22	
Above 80	1	
Marital status		
Single	8	
Married	92	
Number of years spent in school		**10**
0	8	
1 – 6	32	
7 – 13	34	
14 – 19	24	
Above 19	2	
Monthly income (₦)		
0 – 20,000	40	
21,000 – 40,000	24	
41,000 – 60,000	21	
61,000 – 80,000	9	
81,000 – 100,000	4	
Above 100,000	2	
Household size		**6**
⩾ 5	39	
6 – 10	55	
11 – 15	5	
16 – 20	1	
Major occupation		
Farming	77	
Non-Farming	23	
Major cropping pattern		
Mixed cropping	71	
Sole cropping	5	
Both	24	
Major crop cultivated *		
Yam	52	
Cassava	63	
Maize	58	
Vegetables	54	
Cocoyam	49	
Plantain	36	
Others (sweet potatoes, pineapples,	10	
Farm size (Ha)		**0.85**
< 1	64	
1 – 2	27	
Above 2	9	
Method of land acquisition		
Inheritance	76	
Purchase	3	
Lease/rent	19	
Others (to pay debt, gift)	2	
Major source of labour		
Family members	29	
Hired labour	50	
Others(Friendship, to pay debt, to show appreciation for favours received*	21	
Farming experience (Years)		**21**
1 -10	19	
11 – 20	23	
21 – 30	44	
31 – 40	10	
Above 40	4	

***Multiple responses. Source: Field survey, 2015**

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Climate Change Adaptation Strategies Used by Cocoyam Farmers

Table 3 shows the adaptation measures used by cocoyam farmers in the study area. Out of 32 climate change adaptation options used to capture adaptation measures in the study area, farmers consented that they used all. The major adaptation measures used by cocoyam farmers included increased use of organic manure (mean = 2.9), adoption of more frequent weeding (mean = 2.8), application of indigenous knowledge (mean = 2.8), use of multiple cropping (mean = 2.7), increase in the use of fallowing (mean = 2.7) and use of information from extension agent (mean = 2.7).

According to the farmers, reduction in soil fertility is a major effect of climate change in their zone and many farmers now resort to the increased use of organic manure to improve the fertility of the soil. They explained that improving the fertility of the soil is of utmost important as every effort made by the farmer will result to poor yield if the soil is not fertile enough for the crop to thrive well. **S**oil quality is a fundamental component of agricultural production, and soil fertility management is increasingly becoming an important issue in the decisions on food security as well as environment management. This is occasioned by the rising incidence of climate change threats on the farming systems in addition to other stressors. It has become necessary to device soil management methods that will help not only to improve the fertility of already degraded soil but sustain the fertility of farm lands. FAO report noted that soil fertility management is of utmost importance for optimizing crop nutrition on both a short-term and a long-term basis to achieve sustainable crop production. Similarly, Syngenta (2012) annual report stated that fertile soil is the foundation of a sustainable agricultural system, furthermore, poor farming practices expose soil and makes it more vulnerable to erosion either by wind or rain, rendering millions of hectares infertile each year and much of this soil is lost as a result of traditional tillage or plowing for weed control. It stresses the need to help farmers increase soil fertility and improve the productivity on their land in sustainable ways.

Though the farmers agreed to the use of more frequent weeding as an adaptation option, a more critical look may reveal a trade-off between the strategy and soil fertility reduction as frequent weeding weakens the soil structure thereby exposing the soil to nutrient depletion by heavy rainfall. Eriksen, *et.al.*, (2011) note that what seems to be a successful adaptation strategy to climate change may in fact undermine the social, economic and environmental objectives associated with sustainable development. According to them, strategies or policies that make sense from one perspective, or for one group, may at the same time reduce the livelihood viability or resource access of other groups. Similarly, an eagerness to reduce climate risk through specific technologies or infrastructural changes may sometimes lead to the neglect of other environmental concerns, such as biodiversity (Næss *et al.*, 2005; Eriksen and O'Brien, 2007; Eriksen and Lind, 2009). Therefore, it is necessary to ensure that adaptation measures adopted by farmers are not only effective and sustainable but do not undermine the efficiency of other components of the system. Sustainable adaptation should recognize the context of vulnerability, including multiple stressors, acknowledge that different values and interests affect adaptation outcomes, integrate local knowledge into adaptation responses and consider potential feedbacks between local and global processes (Eriksen, *et.al.*, 2011). The six adaptation options that were mostly used by farmers were further examined to know the exact proportion that uses each one on a mutually exclusive basis. It was shown that 42% increased the use of organic manure, 10% weeded more

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frequently, 20% apply indigenous knowledge, 16% resort to information from extension agents, 9% apply the use of fallowing while the remaining 3% apply multiple cropping.

Table 3 Distribution of cocoyam farmers according to climate change adaptation measures used in the study area.

Perceived adaptation measures	Mean	Std. Deviation
Increased use of organic manure to improve the soil fertility.	2.9*	1.013
More frequent weeding than before to put the increased weed under check	2.8*	0.902
Application of indigenous knowledge in combating climate change effects	2.8*	1.219
Planting of different crops (diversity of crops)	2.7*	1.000
Increased fallowing to enable my farm land replenish.	2.7*	0.999
Use of information from agricultural extension agents	2.7*	0.988
Plant where there is trees to reduce excessive heat effect	2.6*	1.009
Carry out early planting	2.6*	1.254
Sought help from agric. extension agent	2.6*	1.005
Increased use of fertilizer to improve soil fertility	2.6*	1.039
Undertake other non-farm income generating activities	2.6*	1.097
Move to a better farm land	2.5*	1.068
Increase my farm size	2.5*	1.156
Use of herbicides to reduce the high rate of weed infestation	2.5*	1.117
Change of planting and harvesting dates	2.5*	1.226
Harvest early	2.5*	1.024
Treat corm with fungicides/pesticides before sowing.	2.5*	1.165
Adhere strictly to information given by weather forecasters	2.5*	1.128
Combine cocoyam production and livestock management to increase my income.	2.5*	1.054
Use more of disease and pest resistant specie of cocoyam	2.5*	1.088
Avoid bush burning method of land clearing	2.5*	1.088
Join cooperative societies in order to pool resources together	2.4*	1.210
Use available credit facilities	2.4*	0.993
Increase the planting of cover crops to reduce heat stress on crops.	2.4*	0.958
Plant other crops as an alternative to growing cocoyam	2.3*	1.128
Use improved storage facilities	2.3*	1.100
Move from crop to livestock production	2.3*	1.198
Increase planting by the river side	2.2*	1.086
Reduce the size of my farm	2.2*	1.119
Reduce planting by the river side	2.2*	1.077
Make use of the available irrigation facilities.	2.1*	1.049
Secure insurance for my farm enterprise	2.1*	1.056

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- **Agree. Source: Filed survey, 2015**

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Choice of Adaptation Strategies Used by Cocoyam Farmers and their Socio-Economic Characteristics.

This was tested using multinomial logistic model. The analysis was done using the six adaptation strategies that were mostly used by the cocoyam farmers. The five categories compared with the base category included adoption of more frequent weeding, application of indigenous knowledge, use of multiple cropping (or crop diversification), increased fallowing and use of information from agricultural extension agents. The response variable, adaptation strategies, was treated as categorical under the assumption that the levels of adaptation to climate change by farmers have no natural ordering. Increase in the use of organic manure was chosen as the reference group. The analysis explained the coefficients in terms of relative risk ratios. The estimated marginal effects with their respective P-levels from the multinomial logit model were presented in Table 5. The model fitness result showed that the log likelihood estimate was = -608.273. The estimated Chi-square is 85.88 while the p-value is 0.016. Based on this, the null hypothesis was rejected. The small p-value from the LR test indicate that at least one of the regression coefficients in the model is not equal to zero. The estimated Pseudo R^2 of 0.0659 is McFadden's pseudo R-squared. The results or parameter estimates of the models were explained in Table 4.

Table 4: Marginal effects of explanatory variables from multinomial logit model

Variables	mofrwe	apinkn	mulcrp	incrfa	Infrex
Location of farm	-1.700*	-0.290	-0.910	0.300	2.510**
Sex	-1.250	-2.280**	-0.130	0.080	0.630
Age	-1.830*	-1.590	0.220	0.540	-0.620
Marital status	0.230	1.050	-0.300	0.170	-0.130
Education	-1.350	-0.010	-0.890	0.150	-0.010
Monthly Income	0.050	0.340	-0.130	0.400	2.010**
Household Size	0.460	-1.050	-0.260	0.950	-1.340
Extension Contact	0.760	1.030	-1.240	-0.540	0.990
Farm size	0.380	-0.110	-0.110	0.630	0.240
Land Tenure System	-0.380	-1.490	0.700	0.300	0.160
Farming Experience	-0.290	1.300	0.630	-0.520	1.410
Labour Source	-0.500	-1.260	-1.600*	0.000	-0.660

*P≤.10; **P≤0.05
mofrwe = More frequent weeding; apinkn = Apply indigenous knowledge; mulcrp = use of multiple cropping; incrfa = Increase in fallowing; infrex = Information from extension agent.

The result in Table 4 indicated that a reasonable number of the explanatory variables showed relative risk ratios whose p values were very low or statistically significant at less than 0.05 in the multinomial logistic model estimated. All the estimated ratios (RRR) indicated positive signs implying that the direction of choice tends towards the outcome given higher estimated risk ratios of the respective variable in the group. Of the eight examined explanatory variables used for the analysis, two factors, geographical location of the farm and age of the farmer, indicated statistically significant (p>0.10) relative risks of choosing more weeding of the farm as an adaptation strategy when exposed to choice of adding of organic manure. The

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respective relative risk ratios of these factors were 0.669 and 0.976, respectively. These were the multinomial logit estimate for a one-unit increase in geographical location and age scores for frequent weeding option relative to frequent application of organic manure, given the other variables in the model are held constant. Thus, if a subject were to increase his geographical location score by one point, the multinomial log-odds for preferring frequent weeding to addition of organic manure would be expected to increase by 0.669 unit while holding all other variables in the model constant. Similarly, if the farmer's age were to increase by one year, the multinomial log-odds for preferring frequent weeding to addition of organic manure would be expected to increase by 0.976 unit while holding all other variables in the model constant.

The relative risk ratio of choosing sex as an option for adaptation was 0.426. This finding underlies the significance of gender in determining the choice of climate change adaptation strategy among cocoyam farmers in this study. Therefore, we can infer from the result that, if a farmer's sex were to change to being a male by one point, the multinomial log-odds for preferring application of indigenous knowledge to addition of organic manure would be expected to increase by 0.426 unit while holding all other variables in the model constant. The findings here is in tandem with Ifeanyi-obi, *et.al.*, (2014) who noted that gender was a significant factor to consider when choosing an adaptation strategy to cope with risk of climate change effects in crop farming. The farmers thus have 0.426 times the risk of choosing the use of indigenous knowledge when exposed to use of organic manure since it posed less risk when compared to the organic manure application option.

It was also found that the choice of multiple cropping as an adaptation strategy by cocoyam was significantly explained the source of labour used on the farm by the cocoyam farmer with a high probability (RRR = 0.630 at $p = 0.10$) of choosing it when exposed to the choice of increase in addition of organic manure. This finding emphasizes the relevance of labour source used in the farm (whether it is family, hired or cooperative labour) in determining the choice of climate change adaptation strategy among cocoyam farmers in the study. Therefore, we can infer from the result that, if a farmer's labour source were to change to another by one point, the multinomial log-odds for preferring application of multiple cropping option of adaptation relative to use of organic manure would be expected to increase by 0.63 or 63 percent while holding all other variables in the model constant. The findings here acknowledge that multiple cropping choice would require higher labour intensity compared to addition of organic manure and so the choice of source of labour could not be under estimated. The farmers thus have 0.63 times the risk of choosing the use of multiple cropping when exposed to use of organic manure since it posed less risk when compared to the organic manure application option especially when appropriate source of labour to handle multiple cropping is available. As for the option of increase the length of fallow period, even though the socioeconomic variable assessed did indicate increase in relative risk ratios of choosing the option when exposed to the use of organic manure option, we found that none of the factors that exhibited a statistically significant effect on the probability of choosing it. Hence we ignore this option as being a relevant alternative choice of adaptation strategies of farmers in adapting to climate change when faced with option of using organic manure as an adaptation strategy in cocoyam farming.

Use of information from extension agents was another option considered in the multinomial logit model estimated. Two factors were found to have significant relative risk ratios of

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choosing it when faced with the default choice of using organic manure as an adaptation strategy. The two factors included the geographical location of the farm and farmer's total income. Their relative risk ratios were 3.512 and 1.000 respectively with the two factors significant at 5 percent level of statistical significance. It would be inferred from the result that, if a farmer's geographic location and the total income earned by them were to change to another by one point, the multinomial log-odds for preferring application of use of information from agricultural extension agents as an option of adaptation relative to use of organic manure would be expected to increase by 3.512and 1.000 units respectively for the factors, geographical location of the farm and farmer's total incomes while holding all other variables in the model constant. While one can infer that being located in a place where farmers can more easily assess extension service increases the propensity to adopt the use of agricultural extension service information, it is not very clear how the amount of income earned by the farmers could propel them to choose extension. Sometimes agricultural extension agents could sell some learning materials that could help farmers adapt to climate change risks on their farms. Those who have more income, in this case are more likely to purchase such materials and this could explain why the total income of farmers could affect the probability of choosing the option of using information from agricultural extension agents when faced with the more common option of using organic manure in the farm. In the same vein, money is required to travel to where extension services are provided if they do not visit the farmers.

Conclusion and Recommendations

The study identified that use of organic manure, more frequent weeding, application of indigenous knowledge, use of information from extension agents, fallowing and multiple cropping were the major climate change adaptation measures used by cocoyam farmers in Southeast Nigeria. It further concludes that the choice of climate change adaptation measures used by these cocoyam farmers are significantly influenced by their socio-economic characteristics specifically age, sex, location of the farmer, monthly income and labour source. There is a need to identify location specific adaptation measures as the location of the farmers influence the adaptation measures used by farmers. Also, gender should also be an important component to consider in developing adaptation measures for farmers as this also influences the adaptation measures used by farmers.
It is also important to identify as well as develop adaptation measures that are within the financial status of the farmers. Adaptation measures that are above farmers' financial capacity may not be readily adopted even though it may be effective. When they adopt it out of cogent need, it may not be sustainable.

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