



DETERMINANTS OF THE CHOICE OF ADAPTATION STRATEGIES TO CLIMATE CHANGE BY COCOYAM FARMERS IN ABIA STATE, NIGERIA

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ABSTRACT

Climate change is unpredictable changes of the elements of weather over long periods, with undesirable effects on food security. Farmers have devised adaptation strategies to that effect and the choice of employing any of the adaptation options are usually influenced by the farmers socio-economic characteristics. To that effect, socio economic factors affecting the choice of adaptation methods to climate change by cocoyam farmers in Abia State, Nigeria was studied using 480 respondents. Primary data were collected through use of structured questionnaire and oral interview. Percentages responses and multinomial logit model were used to address the objectives of the study. The result of adaptation strategies to climate change used by cocoyam farmers were organic manure, early planting, changing of harvesting date, and use of resistant varieties. Also, the result of the multinomial logit model analysis showed that the coefficients of farmers' educational level, access to extension services and membership of organization were significant and positive to choose of adaptation. The need to enhance farmers' access to educational programmes, extension services and need to encourage farmers to join or form cooperatives were recommended.

Keywords: Determinants, Climate change, Adaptation strategies, Choice, Cocoyam farmers.

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INTRODUCTION

Agriculture is the major source of livelihood for most rural dwellers in sub-Saharan Africa. Farming in that region is dominated by smallholder farmers, who cultivates amongst other crops, cocoyam (Okoye, 2006, National Root Crop Research Institute, (NRCRI), 2018). Cocoyam is starch provider with nutritional advantage over other energy –giving foods such as yam and cassava in terms of possession of higher protein, mineral, vitamin and more digestible starch (Ume and Kaine, 2017). Nigeria is the world's largest producer of cocoyam with average output of 5, 068,000m, with taro (*Colocasia*) and tannia (*Xanthosoma*) being most widely cultivated by women (Okoye, 2006; NRCRI, 2018). The production of cocoyam like other crops in Nigeria and many countries in the tropics and subtropics, is rain fed and hence vulnerable to climate change (Ume and Kaine, 2017).

Climate change as asserted by Ozor and Cynthia, (2010) is chiefly the steady fluctuations of weather elements, chiefly rainfall and temperature caused by human undertakings and natural

variability over prolonged period leading to alterations of the universal atmosphere conformation. The occurrences of climate change according to Ogbonna and Ume, (2022) could manifest in varied forms, included increase in frequency of pests and diseases infestations, high incidences of weed infestation, increased soil degradation, reduced crop growing period, high loss of land to erosion, declining soil fertility, uncertainties in seasonal climate for example unpredictable rainfall pattern, high prevalence of food insecurity very hot weather, lessening of crop production, high post-harvest losses. The effects of climate change are enormous and more evident in sub-Saharan Africa due to poverty, geographical positions, over reliance on rain-fed farming, insensitivity of government and environmental deterioration (Deressa *et al.*, 2008).

In Nigeria and many developing countries of the world, smallholder farmers have developed adaptation methods to climatic change over decades through proper knowledge of traditional farming systems (Ogbonna and Ume, 2022). The adaptation strategies are usually location and farmer specific and included not restricted to only use of crop resistant varieties, use of manure such as compost, farm yard and green manures, alterations of planting and harvesting periods, mulching/ use of cover crops and modifications of period land cultivation activities and use of irrigation (Mohammed, 2014). It is imperative to state that adaptation to climate change requires that households should first and most acknowledged the occurrences of climate change, then ascertain suitable adaptation options and choice among varied array of selections (Deressa *et al.*, 2014).

Globally, the determinants to choose of adaptation strategies to climate change by farmers varied among localities and farmers. For instance, Ogbonna and Emerole (2019), Ume and Kaine (2017) studies in different locations in Nigeria found credit, farming experience and perceived rainfall as determinant to choose to adaptation by farmers. Besides, Deressa *et al.* (2008) found access to credit, extension information, amount of seasonal rainfall, geographical location, household size, age and literacy of household head as the determinants of farmers' choice of adaptation methods in the Nile Basin in Ethiopia. Additionally, Shongwe *et al.* (2014) in their study in Swaziland found age of household head, occupation of household head, membership of a social group, land category, access to credit, access to extension services and training affected the choice of adaptation strategies. However, the factors influencing their choice of the farmers' adaptation strategies in the study area are unknown, hence it is imperative to abridge the research gap. The specific objectives of the study were to identify the adaptation strategies to climate change and to determine the factors influencing the choice of adaptation strategies by the farmers.

METHODOLOGY

This study involved determinants to Choice of Adaptation Strategies to Climate Change by Cocoyam Farmers in Abia State, Nigeria. Abia State is one of the thirty-six States of the Federal Republic of Nigeria with seventeen (17) Local Government Areas (LGAs). The 2006 National Population census put the population of Abia State at 2,833,999, many of whom are farmers, and the population density of the State at 448 persons per square kilometer (NPC, 2006). The region stretches from the rainforest vegetation of Ukwa East and Ukwa West LGAs to the derived savannah vegetative belt of Umunneochi LGA within latitudes 07000/N and 07012/ North of the Equator and longitudes 60 351E and 60181East of the Greenwich Meridian. Two distinct seasons (rain and dry) characterize the State. The rain season stretches from the month of April to October, and the dry season comes from the month of November to March. Topography of the area is partly flat and rolling in many parts of Aba and Umuahia Agricultural zones, and hilly or undulating in the other parts such as the Ohafia Agricultural zone of the

State. Flood and gully erosion constitute ecological problems ravaging the area, as soils are of the deep porous ferralithic type (Ogbonna, and Emerole, 2019).

The people of the zone are mainly agrarians and still earn living from off-farm income activities. Four hundred and eighty farmers were selected using purposive and multi-stage random sampling technique. Structured questionnaire complimented with oral interview schedule were employed to gather the data. Descriptive statistics such as percentages was used to identify the adaptation strategies to climate change, while multinomial Logit Model (MNL) were used to determine the factors influencing the choice of adaptation strategies by the farmers.

The multinomial logit (MNL) model specification

The MNL model has response odds and stated as;

$$P(y = \frac{j}{x}) = \frac{\exp(x\beta_j)}{1 + \sum_{h=1}^j \exp(x\beta_h), \quad j=1, \dots, j} \dots\dots (1)$$

Where j is kx1, j=1, ..., j.

To define the MNL model, let y designate a random variable assigning the values {1, 2, ..., J} for J, a positive number, and let x indicates a set of preparing factors. In this case, y denotes adaptation options or group and x encloses assorted household factors. The issue at stake is how could changes in the rudiments of x influence the reaction of odds (P(y = j/x), j = 1, 2, ..., J. Since the odds, when added together must equal to 1(unity), P (y = j/x) is definite as soon as we identify the odds for j = 2, J.

Let x be a 1 _ K vector with first element unity. The MNL model has response odds:

$$P(y = \frac{j}{x}) = \frac{\exp(\beta_j x)}{1 + \sum_{h=1}^j \exp(\beta_h x); \quad j = 1, \dots, j; \quad \beta_h \dots\dots\dots (2)$$

Wherever Bj is K - 1; j = 1; J:

Unprejudiced and dependable boundary assessments of the Multinomial logit model in Eq. (5) entails the supposition of independence of superfluous choices for IIA to hold. Additionally, the IIA supposition required that the likelihood of employing an additional adaptation scheme as wanted by particular household to be independent from the chances of selecting another adaptation technique. The MNL Model is discreetly stated as:

$$Y_i = \ln (P_i, P_i) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + e_i \dots\dots\dots (3)$$

Where:

Yi = Adaptation strategy (no adaption; adoption of zero or minimum tillage, use of resistant crop, use of organic manure, changes in planting dates. changes in harvesting dates, mulching/ use of cover crops, cultivation of marginal lands, lengthened fallow, changes in the timing of land preparation activities and irrigation.

Xi where i = 1, 2, 8 are explanatory variables; X1 = Age of the farmers (years), X2 = Educational attainment (years), X3 = Experience in farming (years), X4 = Access to extension Services (access=1, otherwise=0), X5 = Membership to social network (member=1 otherwise=0), X6 = Access to credit (access=1, non-access =0), X7 = Farming status (Full-time; 1 and part-time; 0)

ei = error term

Table 1: Definition of Variables Used in the Empirical Analysis

Variables	Definition Value/Measure	Expected Sign
Age of household head	Number of years of Head of Household	-+

Farming experience	number of years spent farming cocoyam	+
Educational Level	Number of years of schooling	+
Membership of cooperatives	1 = yes and 0 = no	+
Access to Extension services	1 = yes and 0 = no	+
Access to credit	1 = yes and 0 = no	+
Farming status	Full Farmer; 1 and part time; 0	+

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Respondents

Table 2: Distribution of Respondents According to Socio-Economic Characteristics

Socio-Economic Factors	Frequency (480)	Percentage
Age in Years		
20 – 40	280	58.34
41 – 61	200	41.66
Mean	38	
Years of Farming Experience		
1 -10	100	20.83
11 – 20	300	62.5
21 and above	80	12.67
Mean	24	
Access to extension services		
Access	100	20.83
No Access	380	79.17
Membership of Organization		
Yes	200	41.67
No	280	58.33
Educational Level (Years)		
No formal education	60	12.5
Primary	300	62.5
Secondary	80	16.67
Tertiary	40	8.33
Mean	7	
Access to credit		
Access	384	80
Non-Access	96	20

Source: Field Survey, 2023

Table 2 shows that most farmers (58.34%) were within age range of 20 – 40 years, while 41.66% were between 41 – 72 years. The mean age of the farmers was 38 years, implying that many of the farmers studied were youths and very innovative. The tendency of such farming group having high information seeking behavior in order to be rational in decision making on choice of adaptation strategies to climate change is not doubtful (Deressa *et al.*, 2008). Also, the mean years of the cocoyam farmers' farming experience was 24 years. Most (62.5%) of the farmers had farming experience of 11 - 20 years, while the least (12.67%), above 21 years. The more experienced a farmer is, the higher the odds of making choice on the best coping strategies to climate change through years of experimentations and observations (Ogbonna and Ume, 2022). Furthermore, 20.83% of the respondents had contacts with extension agents, while the greater majority (79.17%) had no extension contact. The indication is poor extension outreach,

which adversely affected innovation adoption especially as relates to climate change choice of adaptation strategies (Mohammed, 2014).

Majority of the farmers (80%) had access to credit, whereas 20% do not. Farmers with access to credit according to Ogbonna and Ume (2022) facilitate ease of employing adaptation strategies to counterbalance the risks of climate change through procurement of materials on climate change adaptation information, money to pay for labour and obtain necessary inputs needed. Besides, 41.67% of the respondents were members of different organizations such as cooperatives, age grades and others, while 58.33% did not belong to any organization. Cooperative members through exchange of information among themselves could aid in making choice on the better options on climate change adaptation strategies (Ozor and Cynthia, 2010). Table 2 also revealed that 12.5% of the respondents had no formal education, the greatest majority (87.5%) had formal education. Educational attainment diminishes the probability that no adaptation is taken. However, in situation where majority of farmers are illiterates, understanding of new climate change adaptation farming systems and technologies become difficult (Mohammed, 2014).

Adaptation Strategies by Cocoyam Farmers

Table 3: Adaptation Strategies by Cocoyam Farmers

Strategies	Frequency	Percentage (%)
Use of resistant varieties	304	63.33
Organic manure	440	91.67
Irrigation	48	10
Early planting	420	87.5
Minimum or zero tillage	250	52.08
Changing harvesting date	380	79.17
Cultivation of marginal lands	210	43.75
Mixed cropping	280	58.33
No adaptation	78	16.25

Multiple Responses exist

Source: Field Survey, 2023

Most (91.67%) of the respondents adopted application of organic manure in combating climate change in their cocoyam farms in the study area. The use of organic manure as fertilizer aids in furthering the water retention ability and structure of the soil, enhancement of ecological settings and public wellbeing (Ozor and Cynthia, 2010). Also, the least (10%), adopted the use of irrigation to cushion the effect of climate change. The dearth of dependable water sources and high cost of irrigation facilities according to Ogbonna and Ume (2022) may perhaps be cited for the least adoption of the variable. Moreover, farmers who did not adapt, were about 16.25% of the total respondents, possibly due to dearth of information, poor access to fund, unavailability and high cost of labour, shortage of land, and reduced potential for irrigation (Ozor and Cynthia, 2010).

Factors Influencing Choice of Adaptation Strategies

Table 4: Multi nominal Logit Model Results of Factors Influencing Cocoyam Farmers' Choice of Adaptation

Variables	Minimum or zero tillage	use of organic manure	Early planting	changes in harvesting dates	cultivation of marginal lands	Mixed cropping	Irrigation	No adaptation
Age	-1.06548 *(0.2451)	-1.2254 *(0.1156)	-2.3157 ***(0.5256)	0.4257(0.1354)	-1.2256*(0.1151)	-2.2854* *(0.3433)	0.0004(0.2001)	0.3154(0.5411)
Educational level	0.1264* ***(0.0154)	2.2157 ***(0.0053)	4.5556 ****(0.2771)	5.0654(1.3352)	0.0654(0.2451)	3.0664* ***(0.0958)	0.0294(0.0057)	0.0654(0.2451)
Experience	0.0104(0.0052)	0.0116(0.0922)	0.0009(0.0239)	0.0024(0.0108)	0.0669(0.0118)	0.0190(0.0052)	0.0276(0.0328)	0.0319(0.0181)
Extension Services	1.0097* (0.0126)	2.0051 ***(0.0173)	1.2100 *(0.0112)	2.1159** (0.0257)	2.1152** (0.0177)	0.2100(0.0910)	0.0037(0.0116)	0.2113(0.0113)
Organization	4.0014* ***(0.0038)	3.0236 ****(0.0901)	2.1962 ****(0.0502)	3.0109** *(0.3300)	5.06008* ***(1.0098)	3.7763* ***(0.0901)	3.7760* ***(0.0359)	3.9994(0.0702)
Access to credit	0.7102(0.0217)	0.2209(0.0173)	0.2199(0.0119)	0.2107(1.0883)	0.3102(0.0173)	0.2100(0.2007)	0.0109(0.0781)	0.4450(0.0663)
Constant	4.0050* ***(0.0713)	5.0097 ****(0.055)	3.2157 ****(0.053)	4.2161** *(0.0993)	5.2290** *(0.0883)	3.2111* ***(0.9951)	3.8847* ***(0.0613)	5.0007* ***(0.7008)

Diagnosis based category

Number of observations	480
LR chi-square (50)	187.34***
Log Likelihood	-169.72294
R2	0.4765

***, **, * significant at 1.0%, 5.0% and 10.0% levels of probability respectively

The figure in parenthesis is the t-ratio

Source: Field Survey, 2023

Table 3 shows that the choices of adaptation strategies inserted into multinomial Logit (MNL) model were adoption of zero or minimum tillage, use of organic manure, early planting, changes in harvesting dates, cultivation of marginal lands, mixed cropping, irrigation and no adoption were ran. The likelihood ratio statistic is indicated by statistics π^2 (187:34) and was highly significant, suggesting that the model has a strong explanatory power. The coefficient of age of the household had a negative and significant impact on the choice of adaptation strategies to climate change. This implies that as the farmer start advancing in age, the probability of choosing adaptation strategies to climate change in cocoyam production using adoption of zero or minimum tillage, use of organic manure, early planting, mixed cropping and cultivation of marginal lands could be high. The finding of Ogbonna and Ume (2022) was in contrast to this assertion. They reported that as farmer advances in age, the less vigorous in strength he or she had to handle labour intensive adaptation strategies no matter how effective and efficient the option could appear. Further, the coefficient of educational level of the sampled farmers had a positive and significant impact on the choice of adaptation strategies to climate change in cocoyam production. This implies that as the farmer is educated, the higher the likelihood of adopting use of all adoption strategies considered in the study with exception

of adoption of zero or minimum tillage. This assertion conforms to the findings of Deressa *et al.* (2008) was in line with the above assertion. They were of the view that educated people are better equipped with information as relates to climate change and the best adaptation coping options.

Membership of organization significantly influenced adapting to climate change using all the strategies considered. This implies that being a member of a social group increases the probability of adapting using of zero or minimum tillage, use of organic manure, early planting, changes in harvesting date, cultivation of marginal lands, mixed cropping and irrigation. This is because social groups such as farmers' cooperatives as asserted by Mohammed, (2014) provide information on farming through training, credits and resources that can be used when adapting to climate change. More so, access to extension services significantly influenced the choice of adaptation to climate change using zero or minimum tillage, use of organic manure, early planting, changes in harvesting dates and cultivation of marginal lands. Farmers with access to extension services is expected to be better informed with superior information and knowledge on climate change, which could result in making informed choices on the adaptation coping strategies to adopt (Shonngwe *et al.*, 2014).

CONCLUSION AND RECOMMENDATIONS

The major conclusions deduced from the study were that the result of adaptation strategies to climate change used by cocoyam farmers were use of organic manure, early planting, changing of harvesting date, and use of resistant varieties Also, the determinants to choice of adaptation strategies to climate change were educational level, access to extension services and membership of cooperatives.

Based on the findings, the following recommendations were proffered:

1. The need to formulate policy options aimed at enhancing farmers' access to educational programmes such as adult education, workshops and seminar programmes on climate change adaptation is very imperative.
2. Farmers should be encouraged to form or join social organization such as cooperatives, as this could aid them (farmers) in selection of suitable adaptation options through cross breeding of ideas with other member cooperative farmers
3. Extension agents should be mobilized to be effective in their duties of information dissemination on climate change and the best adaptation options at least cost to be supported with mobility and frequent payment of salaries and other fringe benefits.
4. Department of metrological services should regularly furnish farmers with information on climate change and the best options to cushion the effects

REFERENCES

- Deressa, T. T., Hassan, R. M., Ringler, C., Alemu, T. and Yesuf, M. (2008). Analysis of the determinants of farmers' choice of adaptation methods and perceptions of climate change in the Nile Basin in Ethiopia. IFPRI Discussion Paper No:798, Washington D.C., 2008.
- Mohammed, N. U. (2014). Factors affecting farmers' adaptation strategies to environmental degradation and climate change effects: A Farm Level Study in Bangladesh. *Climate*. 2, 223-241.
- NPC (2006). National population commission. Sample survey: Abuja, Nigeria.

- NRCRI (2018). Annual report of National Root Crop Research Institute, Umudike, Umuahia.
- Ogbonna, S. I. and Emerole, C. O. (2019). Climate-Related Damage to Crops: Estimation and Adaptation by Small Farmers in Abia State, Nigeria. *Journal of Agriculture and Food Environment Volume*, 6(4): 31-39.
- Ogbonna, S. I and Ume, S. I (2022) Analysis of the adaptation strategies to climatic variations by maize farmers in South East, Nigeria *Journal of Forestry Environment and Sustainable Development (JOFESD)*, 8(1): 34-43.
- Okoye, B. C. (2006). Efficiency of smallholder cocoyam farmers in Anambra State, Nigeria. M.Sc. Thesis Department of Agricultural Economics. Michael Okpara University of Agriculture, Umudike, Nigeria.
- Ozor, N. and Cynthia, C. (2010). Climate change and the uncertainties facing farming communities in the middle belt region of West Africa. Paper presented at the 7th International Science Conference on the Human Dimensions of United Nations University, Bonn, Germany between 26th April and 1st May.
- Shongwe, P., Masuku, M. B. and Manyatsi, A. M. (2014). Factors influencing the choice of climate change adaptation strategies by households: A Case of Mpolonjeni Area Development Programme (ADP) in Swaziland. *Journal of Agricultural Studies*, 2(1): 86
- Ugwumba, C. O. A., Okoh, R. N., Ike, P. C., Nnabuife, E. L. C. and Orji, E. C. (2010). Integrated farming system and its effect on farm cash income in Awka South Agricultural zone of Anambra State, Nigeria. *America-European Journal of Agriculture & Environmental Science*, 8 (1): 01-06.
- Ume, S. I. and Kaine, A. I. N. (2017). Determinants of Cocoyam Farmers' Choice of Adaptation Methods to Climate Change in South-East, Nigeria. *Journal of Agriculture and Food Environment*, 4(2): 23-34,
- Ume, S. I., Ezeano, C. I., Onunka, B. N. and Nwaneri, T. C. (2016). Socio-economic determinant factors to the adoption of cocoyam production technologies by smallholder farmers in South East, Nigeria. *Indo - Asian Journal of Multidisciplinary Research*, 2(5): 760 -769.