CLIMATE CHANGE AND COPING ADAPTATION STRATEGIES BY YAM FARMERS IN EBONYI STATE, NIGERIA

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ABSTRACT
Climate change and coping Adaptation strategies by yam farmers in Ebonyi State, Nigeria were studied using 120 respondents. Primary data were collected using structured questionnaires and oral interviews. Percentage responses and a multinomial logit model were used to address the objectives of the study. The result of the major adaptation strategies adopted by the farmers against climate change were crop diversification (83.33%), off-farm income (68.33%), early planting strategy (62.5%) and use of chemical fertilizer (63.33%). Also, the result of the multinomial logit model analysis showed that the coefficients of credit, farming experience, and extension services access were positive in the choice of adaptation. The need to enhance farmers' access to extension services programmes, and credit facilities, among others, was recommended.

Keywords Climate Change, Coping Strategies, Yam, Farmers, Multinomial Logit, Nigeria

INTRODUCTION

Yams (*Dioscorea* species) are annual root tuber-bearing plants with more than 600 species out of which six are socially and economically important in terms of food, cash and medicine in sub-Saharan African countries (Reuben and Barau, 2012). It could be eaten boiled or fried. It is also processed into yam flour or pounded. Yam is also a source of industrial starch, the quality of which varies with the species, and the quality of starch of some species of yam is said to be comparable to starch found in cereals (Ume, Kaine and Ochiaka 2020). Apart from these, yam plays a vital role in culture, rituals and religion as well as local commerce of the African people (Ike and Inoni, 2006; Reuben and Barau, 2012). Some of the yam species are water yam (*Dioscorea alata)*, white yam (*Dioscorea rotundata*), yellow yam (*Dioscorea cayanensis)*, Chinese yam (*Dioscorea esculant*) and three-leaf yams. National Root Crop Research Institute (NRCRI) classified yam into seed yam (259grams–1 kg) and miniset < 50grams) (Ume, Ebe, Ochiaka and Ochiaka, 2017, Ayanwuyi, Akinboye and Oyetoro, 2011). Yam has intrinsic features, which endeared to smallholder farmers included, rich in carbohydrates especially starch, with a multiplicity of end uses, available all year round making it preferable to other seasonal crops, contains some level of protein (2.4%), and a substantial amount of vitamins (Thiamine, Riboflavin and Ascorbic acid) and some other minerals like calcium, phosphorus and iron not common in other common tuber crops (Ume, *et al,* 2020).

The production of yam like other crops in Nigeria is rain-fed, hence vulnerable to climate change (Ayanwuyi, *et al*, 2011).

Climate change according to Deressa, Hassan, and Ringler, (2011) is unpredictability changes of elements of weather over long *periods* attributed directly or indirectly to human activities that alter the composition of the global atmosphere, and which are in addition to natural variability. The incidences of climate change could manifest in the form of an increase in the incidence of pests and diseases soil erosion, a decrease in soil fertility, and uncertainties in seasonal climate for example changes in rainfall pattern, and temperature, decrease in yields of crops, storage losses in roots and tubers (Dressa, *et al;* 2011; Ejembi and Alfa, 2012). The effects of climate change include risky investments in agriculture and other weather-dependent livelihoods, increased food insecurity through crop destruction in the field, post-harvest losses, loss of arable land and increased growth of weeds as a result of abnormal rainfall and drought (Deressa, *et al*; 2011, Enete, Madu, Mojekwu, Onyekuru, Onwubuya, and Eze, 2011). In most countries in sub-Saharan Africa, smallholder farmers have developed adaptation methods to climatic change, including the use of resistant crops, the use of organic manure, changes in planting dates, changes in harvesting dates, mulching/ use of cover crops and changes in the timing of land preparation activities (Ume, Eeano and Okeke, 2018, Ndamani and Watanabe, 2015). The socioeconomic characteristics that influence the choice to adaptation by farmers according to literature are access to credit, extension information, amount of seasonal rainfall and among others (Nzeadibe, Chukwuone, Egbulen and Agu; 2011). 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. Specifically, the objectives of the study are to identify the adaptation strategies to climate change and to determine the factors influencing the choice of adaptation strategies by the respondents.

METHODOLOGY

The study was carried out in Ebonyi State of Nigeria. The State is located between latitude $5^0$41' and $6^0$50'N of the Equator and Longitude $5^0$25' and $7^0$30E of the Greenwich Meridian. Its rainfall ranges from 1500 mm-2500 mm per annum, temperature of 28-48^{0}C and average relative humidity of 75%. It is bounded in the North by Benue State, South by Abia State, in the East by Cross River State and in the West by Enugu State. Ebonyi State is made up of 13 local government areas and three Agricultural zones namely North, Central and South. The North agricultural zone consists of four local government areas: Abakaliki, Ebonyi, Izzi and Ohaukwu. The Central Agricultural zone has four Local Government Areas: Ezza North, Ezza South, Ikwo and Ishielu, while the South agricultural zone has five local government areas: Afikpo North, Afikpo South, Ivo, Ohaozara and Onicha. Among the crops planted there are cassava, yam, sweet potato, rice, maize and tomato. Also, among the domestic animals reared are goats, sheep, local cows, poultry, rabbits, piggery and others. The inhabitants also engaged in off-farm income activities such as saloons, petty trading, auto-mechanics, civil servants and bricklayers. The farmers are members of different cooperative societies.

The purposive and multi-stage random sampling procedure was used to select 120 respondents. In the first stage, two (2) Agricultural zones out of three (3) were purposively selected. The choice was made based on the high intensity of yam production existing there. The selected zones were Ebonyi Central and South agricultural zones. In the second stage, three (3) Local Government Areas were selected randomly from each of the Agricultural Zones. These brought to a total of six (6) Local Government Areas (LGAs). In the third stage, two (2) communities were randomly selected from each of the six LGAs, totalling twelve (12) communities. Finally, from the lists provided by extension agents in the community on yam farmers, ten (10) rice farmers were randomly selected, bringing to a total of one hundred and twenty (120) respondents. A structured questionnaire and oral interview schedule were used to collect the data for the study.

The multinomial logit (MNL) model was used to access the determinants of yam farmers' choice of adaptation strategies in Ebonyi State, Nigeria. This method can be used to analyze crop choices as techniques to adapt to the negative impacts of climate change. The gains of the MNL are that it allows the analysis of decisions across more than two categories, permitting the determination of choices for diverse categories (20) and it is as well computationally easy. Let x be a 1x k vector with the first element unity. The MNL model has response probabilities.

P(y = j/x) =

$$\frac{\exp\,(x^{\beta}j)}{[1+\sum_{h=1}^{j} \exp.\,(x_{\beta}\,h), j = 1, \ldots, j]} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where j is kx1, j=1,…,j.

To describe the MNL model, let y denote a random variable taking on the values {1, 2,..., J} for J, a positive integer, and let x denote a set of conditioning variables. In this case, y denotes adaptation alternatives or group, and x contains diverse household, institutional and environmental features. The question is how cetirus Paribus variation in the elements of x Affect the response probabilities (P(y = j/x), j = 1, 2,..., J. Since the probabilities must sum to unity, P(y = j/x) is resolute once we recognize the probabilities for j = 2,..., J.

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

Pðy ¼ jjxÞ ¼ expðxbjÞ 1 þPJh¼1 expðxbhÞ; j ¼ 1;... ;Jhi ……………………(2)

Where Bj is K - 1; j ¼ 1;...; J:

Unbiased and reliable parameter estimates of the MNL model in Eq. (1) entail the assumption of independence of extraneous options (IIA) to grip. More intentionally, the IIA assumption necessitated the possibility of using an exact adaptation system by a given farmer who desires to be autonomous from the odds of choosing another adaptation method. The MNL Model is stated implicitly as follows:

$Y_i = \ln(P_i, P_I) = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X + e_i$ ………. (3)

Where

Yi = adaptation strategy (no adaption; Recommended agricultural practice, Improved varieties strategies, and Soil-related strategies)

Xi, where i = 1, 2, 8 are explanatory variables, X_1 = Age of the farmers (years), X_2 = Off farm income (access=1, otherwise=0), , X_3 = Years of farming experience (years), X_4 = Access to extension Services (access=1, otherwise=0), X_5 = Membership to organization (member=1 otherwise=0),X_6 = Access to credit (access=1, non-access =0),X_7 = Rainfall Perception(Dummy) ei = error term.

RESULTS AND DISCUSSION

Socioeconomic Characteristics

The socioeconomic characteristics of the yam farmers are shown in Table 1

Table 1: Distribution of respondents according to socioeconomic characteristics

Factors	Frequency (n=120)	Percentage
Age in Years		
20 – 29	20	16.7
30 – 39	42	35
40 – 49	36	30
50 – 59	14	10.9
60 and Above	11	9.2
Mean	**40**	
Farm Size (ha)		
0.01-1.00	40	33.3
1.01 – 2.00	30	25
2.01 – 3.00	18	15
3.01 – 4.00	15	12.5
4.01 – 5.00	12	10
> 5.00	5	4.2
Mean	2.7	
Years of Farming Experience (yrs)		
1 – 5	12	10
6 – 10	20	16.7
11 – 15	50	41.7
16 – 20	32	26.7
21 and above	16	13.3
Mean	12	
Access to Credit Use (dummy)		
Yes	78	65
No	42	35
Access to Extension services		
Yes	40	33.3
No	80	66.7
Access to off farm income		
Yes	90	75
No	30	25

Source: Field Survey, 2024

Table 1 shows that 51.67% of the sampled farmers were below 40 years of age, while 48.33% were above 40 years of age. Most of the farmers were youths, hence they have the strength to undertake yam production activities aimed at mitigating the problems of climate change (Neadibe et al., 2011). Additionally, 26.70% of the respondents had less than 11 years of farming experience, whereas 73.30% had more than 11 years. Experienced farmers are often aware of climate change, its effects, and the best coping strategies to adopt to prevent crop failure (Ume et al., 2018). This finding is consistent with Ndamani and Watanabe (2015) and Phuyal, Devkota, and Shrestha (2017), who opined that more experienced farmers can easily set realistic farm goals to address the hazards associated with climate change.

Furthermore, Table 1 reveals that 65% of the respondents had access to credit, while only 35% did not. The findings of Enete et al. (2011) support this result, asserting that credit access helps farmers procure print media to access relevant information on climate change. Moreover, 66.67% of the respondents had no access to extension services, while 33.33% did. Extension services aid in disseminating relevant innovations to farmers to help them mitigate the effects of climate change (Ume et al., 2020). Additionally, 75% of the respondents had no access to off-farm income, while 25% did. Off-farm income helps to mitigate the seasonality of primary agricultural production, ensures multiple streams of income to support people's welfare, and provides a risk insurance mechanism against climate change, among other benefits (Okonya, Syndikus, and Kroschel, 2013).

Adaptation Strategies to Change in Climate

The adaptation strategies to change in climate by the farmers are shown in Table 2.

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

Source	Frequency	Percentage
Multiple cropping	6	5
Off- farm income	82	68.3
Irrigation supplementation	3	2.5
Agrochemicals	76	63.3
Early Planting	75	62.5
Crop diversification	100	83.3
No adaptation	11	9.2

Field Survey, 2024. *Multiple Responses

Among the adaptation strategies, crop diversification (83.33%) was identified as the major strategy used by the respondents in the study area. Crop diversification improves soil fertility, controls pests and diseases, and brings about yield stability, nutritional diversity, and health benefits (Nzeadibe et al., 2011). This was followed by the off-farm income strategy (68.33%). Off-farm employment provides a risk management tool to lessen the income variability associated with farm households, effectively tackling climate change difficulties (Okonya et al., 2017).

The findings of Enete et al. (2011) align with this result. They noted that increased dependence on off-farm employment affects the allocation of family labour and consequently influences crop productivity, making crops more susceptible to the vagaries of climate change. Additionally, the use of irrigation to confront the effects of climate change on yam production was the least adopted strategy (5%). This could be due to the high cost of installing irrigation facilities and the unsuitability of such projects in the area, given land fragmentation resulting from the land tenure system and the poor availability of reliable water sources (Phuyal et al., 2017).

Determinants of adaptation choice strategies

The multinomial logit regression on the choice of adaptation strategies to changes in climate is shown in Table 3

Table 3. Results of Multinomial logit regression on choice of adaptation strategies to change in climate

Variable	**Recommended agricultural practice**		**Improved varieties strategies**		**Soil-related strategies**		**No Adaptation**	
	dydx	p-value	dydx	p-value	dydx	p-value	dydx	p-value
Age	-0.007**	0.029	0.006	0.023	-0.005**	0.054	0.001	0.021
Mem. of org.	0.001	0.041	0.004	0.011	0.005	0.004	0.004	0.007
Farm. Exp.	0.003	0.006	0.002**	0.016	0.008	0.033	0.0001	0.017
Rainfall percep.	0.003376	0.002	0.003240	0.006	0.004289	0.026	0.006118	0.021
Access to credit	0.004	0.021	0.003***	0.012	0.002	0.009	0.008	0.002
Ext. service	0.002***	0.033	0.024***	0.044	0.006	0.078	0.001	0.026

Diagnostic statistics
Number of observations 120
Log pseudo-likelihood 173.755
*, ** and *** Statistical significance at 10%, 5% and 1% respectively
Source; Field Survey, 2024.

The coefficient for the age of the farmer had a negative association with the adoption of soil-related strategies and recommended agricultural practices in response to climate change, at approximately 0.54% and 0.29%, respectively. Older farmers are often risk-averse and may prefer to maintain the status quo, which can affect their response to climate change in yam production (Ume et al., 2020).

Furthermore, farmers' access to credit increases the odds of adopting recommended agricultural practices and improved varieties by 5% and 1.0%, respectively, to mitigate the negative impacts of climate change, compared to not adopting any measures. Access to credit enhances farmers' access to information, facilitating changes in their management practices in response to climate change. This finding is supported by Ndamani and Watanabe (2015).

Moreover, the coefficient for household farming experience was significant and positively related to the adoption of recommended agricultural practices and improved varieties in response to climate change, as shown in the table above. An additional year of farming experience increased the likelihood of adopting these practices by approximately 0.006% and 0.016%, respectively, compared to no adaptation. The wealth of farming experience, as noted by Abid, Scheffran, Schneider, and Ashfaq (2015), enhances a farmer's capacity to maximize output and profit at minimum cost. This result aligns with the findings of Adhikari, Devkota, and Phulyal (2017), who noted that the farming experience enhances the efficient use of scarce resources by smallholder farmers in tackling the effects of climate change in crop production.

The coefficient for extension services had a positive relationship with the adoption of improved varieties-related strategies and recommended agricultural practices in response to climate change, at approximately 0.32% and 0.34%, respectively. This result is consistent with previous studies (Enete et al., 2011; Abid et al., 2015). Farmers with access to extension services can mitigate the effects of climate change by adopting new technologies and receiving technical assistance from change agents (Akinbobola, Adedokun, and Nwosa, 2015).

CONCLUSION AND RECOMMENDATIONS

The results indicate that the major adaptation strategies adopted by farmers against climate change include crop diversification, off-farm income, early planting, improved crop varieties, use of chemical fertilizers, and crop-tolerant varieties. The multinomial logit model analysis showed that access to credit, farming experience, and extension services positively influenced the choice of adaptation strategies.

Based on these findings, the following recommendations are proposed:

1. There is a need to ensure credit access for farmers through microcredit institutions and other financial institutions to give them greater flexibility to modify their adaptation strategies in response to climate change.

2. The government should encourage both experienced and novice farmers to remain in farming by enhancing their access to improved inputs at subsidized rates and providing information on strategies to avert climate change.

3. Farmers should be encouraged to engage in off-farm income activities to boost their income, enabling them to purchase material inputs and other necessities to mitigate climate change.

4. Farmers should be persuaded to diversify their crop production to cushion the effects of potential yam failure due to climate change.

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