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Climate Change Adaptation Among Cassava Farmers in Okigwe Agricultural Zone of Imo State, Nigeria

Chibuzo Uzoma Izuogu[1*], Loveday Chukwudi Njoku[1], Gillian C. Azuamairo[1], Chikerenma M. Atasie[2], O. O. Ekumankama[2]

[1] *Department of Agriculture, Alex Ekwueme Federal University Ndufu Alike, P.M.B 1010 Abakaliki, Ebonyi State, Nigeria*
[2] *Department of Rural Sociology and Extension, Michael Okpara University of Agriculture Umudike, Abia State, Nigeria*

[*] *Corresponding author's e-mail: chibuzoizuogu@gmail.com*

ABSTRACT

Climate change, which exposes farmers to low productivity, crop failure and worsens food insecurity in developing nations has become a core challenge in Nigeria. These extremes have increased the vulnerability of several arable crop farmers due to inadequate mitigation strategies and restricted access to capital. This study analyzed climate change adaptation among cassava farmers in Okigwe agricultural zone of Imo State, Nigeria. Perception of cassava farmers towards climate change, their adaptation strategies and challenges to climate change adaptation and determinant of farmers' adaptation to climate change were the main objectives. A multi-stage random sampling procedure was used in selecting one hundred and twenty respondents for the study. Data were collected using structured questionnaire and analyzed with percentages, mean and Chi square. Results showed that the mean age of the respondents was 47 years while 78.30% of them had formal education. The main adaptation strategies included planting on mounds (20%), diversification to non-farm activities (15%) and planting of improved varieties (14%). Cassava farmers in the study area perceived climate change as increase in heat waves ($\bar{x}$=2.26), rainfall ($\bar{x}$=2.76) and drought ($\bar{x}$=2.35). The major challenges to adaptation were unsatisfactory weather reports (89.5%), lack of funds (82.4%) and inadequate extension contact (81.2%). Extension contacts and access to credit were the most significant determinants of utilization of climate change adaptation strategies. The study concludes that respondents are aware of climate change with diverse adaptation strategies and recommends that government and agricultural development agencies should integrate the determinant of climate change adaptation and mitigation into policies and programs relating to climate change resilience. It also recommends that the availability of climate change information in real time, mobilization of more extension workers and provision of funds to improve the capacity of cassava farmers for climate change resilience should be prioritized

Keywords:
Adaptation; Cassava; Climate change; Determinants; Farmers.

1. Introduction

The trend of emerging food deficit and malnutrition in sub –Saharan Africa points to regional exposure to the threats of climate change. The gap is widening due to absence of institutional policy on developing the elastic and buffer capacity of the region towards alterations in climatic indicators (Obayelu et al., 2014).

Nigeria is exposed to the effects of climate change due to its range of coastline (800Km). With 0.1828 hectares per person, 77.74 per cent agricultural land area and 37.33 per cent of arable land; the agricultural sector in Nigeria employs about 35% the Nigeria's population (Treding Economics, 2020). It contributes 25.88 per cent to Nigeria's nominal Gross Domestic Products (GDP). The crop sector is the major driver of the sector accounting for 91.6 % of overall nominal growth of the agricultural sector (National Bureau of Statistics (NBS), 2019) Unfortunately, agricultural production in Nigeria is sensitive of alterations in natural resources (Akinbobola et al., 2015). About 70% of Nigerian farmers rely on natural precipitation for their farm production activities and this threatens the food security of a population that is growing at 3.4 percent per annum (Obayelu et al., 2014).

Climate change adaptation reduces the negative outcomes of an event while making gains from alterations in climatic indices. Government policies, farmers' socio-demographic characteristics and the desire to take personal responsibility toward safe livelihood are the motivations for adaptation approaches (Yamba et al., 2019). Majority of small-scale farmers do not explore the opportunities in adaption choices though their likelihood to experience climate change impact is high due to their failure to improve their adaptive capacity.

Nigeria leads other countries of the world in cassava production with around 57.64 million metric tonnes which represents about 38% of cassava production in Africa's or 20.8 % of the universal production. By this, cassava contributes much to her national economic growth. Cassava in Nigeria is an essential food crop that supplies carbohydrate towards food security. It also provides raw materials, employment, and foreign earnings. Several traditional food recipes such as cassava garri, foo-foo and tapioca are produced from cassava. Also, dried chips, starch, ethanol, cassava flour and factory glue are all productions of cassava value addition (Ojiako et al., 2018). Izuogu et al. (2021) had reported that climate change has increased the prevalence of pest and disease, reduced plant growth, discoloration of roots and leaves and reduced cassava production. At the post-harvest stage of cassava production, climate change has escalated post-harvest losses through tuber decays and this has invariably increased the cost of cassava derivatives while posing a severe threat to food security. With the occurrence of these emergencies, farmers suffer losses through low profitability. In view of this, there is need for cassava farmers to take up adaptation strategies in order to survive the challenges of constant climate change.

It is in view of this that this study;

i. Profiled the socioeconomic characteristics of the respondents,
ii. Ascertained their perception of climate change,
iii. Assessed their adaptation strategies,
iv. Identified the challenges of climate change adaptation, and
v. Analyzed the determinant of farmers' adaptation to climate change.

2. Materials and Methods

2.1 Study location

The study population was cassava farmers in Okigwe agricultural zone of Imo State. Okigwe agricultural zone is one of the agricultural zones in Imo State, Nigeria. The zone lies between latitude 5°3′ N to 5°57′ N and longitude 7°04′ E to 7°26' E and an approximate land area 1,824km2 (Nwosu et al., 2013). It is made up of seven Local Government Areas (LGA) of Okigwe, Onuimo, Isiala Mbano, Ehime Mbano, Ihitte

Uboma and Obowo. The zones share border with Abia state on the North and East, Orlu on the West, and Owerri on the South. It experiences seasonal variations in rainfall regime. Although climate change has made it difficult to predict the rainfall pattern within this region, the rainy season commences by February and terminates by December. The soil consists majorly of partly red clay and black soil which supports cassava production.

2.2 Sampling procedure

A multi-staged random sampling procedure was used to select the respondents for the study. Isiala Mbano, Okigwe, and Obowo Local Government Areas were randomly chosen from the six Local Government Areas in the zone. Three communities were picked from each of the two Local Government Areas. Ten respondents were selected from each of the twelve communities to give a total of one hundred and twenty respondents for the study.

2.3 Data collection and analysis

The study utilized both primary and secondary sources of information. Primary data was collected using a pre-coded questionnaire designed to suite the objectives and hypothesis for the study and Focused Group Discussion (FGD). In order to validate the data collection instrument, the design was guided by the researchers and other experts in the field of agricultural extension to ascertain face validity as well as content validity of the instrument. Instrument reliability was established through test-retest technique. The first set of questionnaires was distributed to 20 farmers and a second set was distributed after 4 weeks. The score obtained was correlated using the Pearson's Product Moment Correlation Coefficient. The coefficient of the test was 0.8 hence the instrument was regard to be reliable for the study. Secondary data was acquired from libraries, books, journals, and other internet sources. The questionnaire was administered by the researchers with the aid of other enumerators within the study area. Data was analyzed using the Statistical Package for the Social Sciences (SPSS) software using percentages, mean score, and Chi-square analysis.

2.4 Measurement of Variables

Respondents' socioeconomic characteristics were measured as:
X_1 = Gender (If Male 1, if Female 0)
X_2 = Age (Number of years)
X_3 = Marital status (If married 1, otherwise 0)
X_4 = Household size (Number of household members)
X_5 = Level of Education (Number of years spent learning)
X_6 = Farm size (Hectares)
X_7 = Occupation (If farming 1, otherwise 0)
X_8 = Cooperative members (if a member 1, Non-member 0)
X_9 = Extension contact (If yes 1, No 0)

Perception of climate change was measured using a 3-point Likert typed scale of 'Agreed', 'Disagreed' and 'Undecided' and were assigned scores of 1, 2 and 3 respectively. The scores were added up to give a total sum of 6 which was divided by 3 for a mean score ($\bar{x}$) of 2. The general level of acceptance was obtained by taking an average of the variables that were measured.

Respondents' adaptation strategy and challenges to adaptation were measured at a nominal level of Yes and No with scores of 1 and 0 assigned respectively.

3. Results and Discussion

Results should be clear and concise. The results should summarize (scientific) findings rather than providing data in detail. Please highlight differences between your results or findings and the previous publications by other researchers. The discussion should explore the significance of the results of the work, not repeat them. Separation or combination of Results and Discussion section is accepted. Avoid extensive citations and discussion of published literature.

3.1 Socioeconomic Characteristics

There is a relationship between farmers' socio-economic characteristics and the preference for adaptation strategies. Results on Table 1 show that the average age of the farmers was 47 years which implies that they are youthful and working. The table also shows that 48.30% of the respondents were married. Also, 78.30% of the farmers attended formal education with 9.1% attending up to the tertiary education level. A mean household size of 8 members shows that the farmers had several mouths to feed. Majority of the cassava farmers had a farm size of less than 1.5 hectares.

Madu (2019) had in a study indicated that the mean age of cassava farmers was 46 years. Izuogu et al, (2021) opined that this age range will aid the transfer of farm knowledge and experiences to younger farmers and guarantee sustainable agricultural production. Also, Chete (2019) emphasized that farmers' age influences their ability to create social links and mobilize finance which will enhance the utilization of adaptation strategy.

This result agrees with Yamba et al. (2019) who affirmed that the desire to sustain sources of income and food for household welfare encourages couples to engage in climate change adaptation. Izuogu and Ekumankama (2015) affirmed that farmers with formal education have access to advanced information and this supports improved productivity.

The focus group discussion reveled that some of the land that could have been used for agricultural production activities were dedicated to deities thereby reducing the size of the cultivable land area. This encourages climate change as farmers may find it challenging to practice some adaptation strategies such bush fallow and crop rotation. Majority have not had contact with extension agents implying that they may not possess adequate knowledge on the modern methods of climate change adaptation. Agricultural extension and advisory service is an institution which targets farmers and the security of the farmers' sources of livelihood in its supports to climate change adaptation (Yamba et al., 2019)

Education is an essential decision-making tool in agricultural production as the rate of adoption of new technology increases with level of education. In supporting this result, Ifeanyi-Obi and Issa (2013), Ndamani and Watanebe (2016) affirmed that farmers with formal education have access to advanced information and this supports improved productivity. Unfortunately, low level of education was observed among these farmers and this would influence their choice of adaptation strategy.

Tabel 1. Distribution of respondents by their socio-economic characteristics

Socio-economic characteristics	Categories	Frequency	Percentage	Mean
Sex	Male	77	64.1	
	Female	43	35.9	
Age	21-30	20	16.7	
	31-40	22	18.3	47
	41-50	23	19.2	
	51-60	21	17.5	
	61-70	15	12.5	
	70-and above	18	15.8	
Marital Status	Single	35	29.2	
	Married	58	48.3	
	Divorced	3	2.5	
	Widowed	24	20	
Household Size	0-5	33	27.5	7
	6-11	49	40.8	
	12-17	32	26.7	
	17 and above	6	5	
Level of Education	Non-formal	26	21.7	
	Primary	54	45	
	Secondary	29	24.2	
	Tertiary	11	9.1	
Farm size (acres)	Less than 0.5	19	15.8	
	0.5-1	34	28.3	
	1.0-1.5	47	39.2	
	1.6-2.0	20	16.7	
Access to credit	Yes	47	39.2	
	No	73	60.8	
Cooperative society	Yes	85	70.8	
	No	35	29.2	
Extension contacts	Yes	27	22.5	
	No	93	77.5	

The implications of the large household size are that reduction in farm output will deal a severe blow to the farm household as they would be vulnerable to malnutrition and poverty. Respondents in the study area can rely on their family members for farm labour (Chete, 2019). The result on farm size is in concordance with Obayelu et al. (2014) who opined that most farmers in Nigeria are smallholder farmers. The inheritance land tenure system as practiced by the communities in South East, Nigeria has mounted pressure on the land area leading to increased fragmentation. The focus group discussion reveled that some of the land that could have been used for agricultural production activities were dedicated to deities thereby reducing the size of the cultivable land area. According to Madu (2019) the small land size also accounts for the engagement of most of the respondents in subsistent agriculture as it is usually difficult to practice mechanized agriculture on fragmented lands. This encourages climate change as farmers may find it challenging to practice some adaptation strategies such bush fallow and crop rotation. Majority have not had contact with extension agents implying that they may not possess adequate knowledge on the modern methods of climate change adaptation. Agricultural extension and advisory service is an institution which targets farmers and the security of the farmers' sources of livelihood in its support's climate change adaptation (Yamba et al., 2019)

3.2 Perception of Climate Change

Increasing trend of uncertainty in the commencement and ending of rainfall possess a challenge to cassava producer who majorly use crude implements in their production activities. Entries in Table 2 shows that respondents indicated that climate change has become evident as drought increases ($\bar{x}$=2.35), rising heat waves ($\bar{x}$=2.26) and uncertainty in the onset and end of the rainy season ($\bar{x}$=2.76).

Table 2. Respondents' perception of climate change

S/NO	Items	Agreed	Undecided	Disagreed	X
1	Yield reduction	31(29.24)	10(9.43)	65(61.3)	1.67
2	Increase in drought	62(63.91)	7(7.21)	28(28.86)	2.35
3	Increase in rainfall	75(76.53)	12(12.24)	11(11.22)	2.65
4	High infestation by pest and diseases	6(6.38)	29(30.85)	59(62.76)	1.43
5	Rising heat waves	59(53.63)	21(19.09)	30(27.27)	2.26
6	Reduction in water level	39(34.84)	12(10.71)	61(54.46)	1.80
7	Temperature increase	53(51.96)	15(14.70)	34(33.33)	2.04
8	Uncertainty in the onset and end of rainy season	77(76.23)	13(12.87)	11(10.89)	2.76
9	Increase in rate of desert encouragement	23(25)	11(11.95)	58(63.04)	1.61
10	Floods and erosion	28(26.16)	12(11.21)	67(62.61)	1.63
11	Loss of soil nutrient	24(20.51)	21(17.94)	72(61.53)	1.42

Arable crop farmers usually perceive climate change to imply increase in rainfall regime (Snap et al., 2018). In the study area, farm production has a relatively fixed calendar as it depends on the vagaries of weather. Farmers easily dictate changes in the pattern of rainfall although the Focused Group Discussion (FGD) shows that their perception differed minimally. While some of the respondents reported early onset of rains others complained of high volume of rain fall within a short period. Respondents reported incidence of rise in temperature when compared to their previous experience over the last ten years. Yamba et al., (2019) had predicted a rising pattern in temperature and rainfall variability for the tropical regions. When the farmers were questioned on their perception of alteration in the temperature, majority of the respondents reported that temperature has been on the increase within the past ten year with a shorter period of harmattan.

3.3 Adaptation Strategies

Fig 1 shows that some of the adaptation strategies utilized by farmers were planting on mounds and ridges, planting cover crops, applying soil and water conservation, diversification to non-farm activities, planting of improved varieties etc.

This supports the findings of Snap et al. (2018) that there has been increase in farmer's cultivation of improved cultivars as they target to consolidate their resilience against climate change. The planting of improved cassava stem varieties reduces the extent of exposure of farmers to climate change. One of the farmers confirmed that 'we have obtained improved varieties of cassava stem from National Root Crop Research Institute, Umudike. These stems mature earlier than our local varieties and are resistant to diseases and pests. They have been quite helpful to us. Some of the varieties that were transferred to the farmers include UMUCASS (36, 37, 38, 42, and 43 varieties), NR 0220, TMS 1371, TMS 0593, and TMS 0539 (Onyeneke et al., 2020). Yamba et al. (2019) in a study of Bosomtwe District of Ghana identified changing of the crop variety as a means of mitigating the effects of climate change among small holder farmers.

Farmers also identified diversification as another strategy for climate change adaptation. Ayamga et al. (2019) and Munoz (2018) reported that when the conditions of agricultural production become less productive, most smallholder farmers go in search of better alternatives. It serves as a buffer against risk.

Planting of tree crops such oil palm, citrus, mango etc., was also adopted towards climate change resilience as these crops are less exposed to climate change disaster. This practice supported the livelihood of farm household through additional sources of nutrition and income. Some of these tree crops were planted in the farm and close to the farmers' buildings. While these served as wind breaks during storms and protects the buildings, tree crops planted in the farms aided reduction in the washing away of the soil surface (soil erosion), minimized evapotranspiration which is caused by high sunlight radiation, improved the organic matter content of the soil, and reduced the rate of infestations by pests and disease.

Planting of cover crops assists in suppressing the growth of weeds and helps in nitrogen fixation (Ackerl et al., 2023). Ifeanyi-Obi et al. (2017) asserted that mixed cropping reduces the influence of crop failure on farm households. Yamba et al. (2019) consented that during periods of crop failure, farmers utilized such adaptation strategies as mixed cropping, migration and changing of eating patterns.

The FGD reveals that cassava farmers engaged in fasting and prayers for divine intervention on the challenges of climate change. The respondents were advised that even though prayers are important, it should never be a reason for them to fail from doing what God expects of them towards climate change.

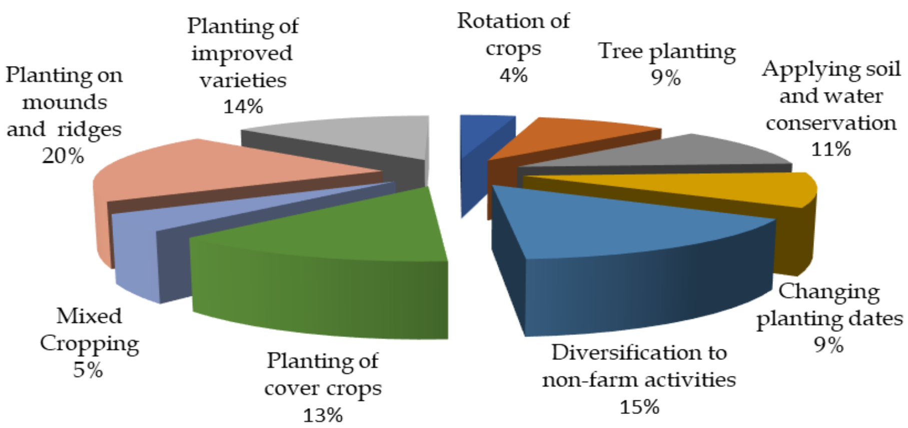

Figure 1. Respondents' adaptation to climate change

3.4 *Challenges to Farmers' Adaptation to Climate Change*

As cassava farmers modify their farm practices and means of livelihood to counter the effects of climate change, they identified the following challenges to their climate change adaptation to include among others; unsatisfactory weather forecast (89.5%), inadequate extension contacts (81.2%), non-availability of funds (82.4%) and absence of government support (57%).

Lack of extension contact was identified by Izuogu et al. (2022) as a core institutional factor affecting climate change awareness and adaptation strategy. The World Bank extension farmer ratio is represented as 1:800 against the current ratio of 1:5,000-10,000 in Nigeria. Poor contact with agricultural extension can lead to reduction in farm output especially during the period of climate change and heighten the vulnerability of farmers. New extension policy must therefore target a reduction in this ratio to ensure that innovations on climate change resilience are transferred effective to the farmers (Huber et al., 2017 & Izuogu et al., 2021). Ogisi and Begho (2023) in a study in Ghana reported that absence of adequate information made it difficult for farmers to adjust in line with climate change. This may be attributed to insufficient extension contact.

Table 3. Challenges to climate change adaptation

Variables	Frequency	Percentage
Unstable weather	25	30.0
Inadequate extension contacts	67	81.2
Unsatisfactory weather forecast	75	89.5
Overpriced labor	27	32.0
Non-availability of funds	68	82.4
Lack of access to improved cultivars	37	44.0
Absence of government support	48	57.0
Lack of irrigation facilities	32	38.0
Inadequacy of land	20	24.0

According to Chete (2019), irrigation facilities are expensive for rural farmers to acquire and would require the assistance of external bodies. Given that a greater percentage of the respondents are participants in cooperative societies, they can acquire these facilities through joint efforts. Yamba et al (2019) explained that farms are manually irrigated in many countries of West Africa (against the mechanized forms of irrigation in developed countries). Also, the undulating state of some of the farm locations was a challenge for farmers to engage in the use of irrigation.

3.5 Determinants of Climate Change Adaptation

Entries in Table 4 show that age, level of education, gender, access to credit and extension contact have a positive significant relationship with climate change adaptation. Extension contacts and access to credit were the most significant factors determining the utilization of climate change adaptation strategy respectively. Household size and gender ranked 3rd while age, education, farm size and membership of cooperative society ranked 5th. This implies that the more respondents had access to extension officers, the more the likelihood of them utilizing adaptation strategies. This result agrees with Izuogu et al. (2021) who opined that agricultural extension service provides tools for the dissemination of essential ideas on modern farm practices with the aim of boosting the level of food production and improving the livelihood of farmers. Extension contact will increase the level of awareness of these adaptation strategies

Table 4. Determinants of respondents' adaptation strategy

Variables	Planting of improved variety	Mixed cropping	Diversification to non-farm activities	Changing of planting date	Planting on mounds or ridges	Planting cover crops	Tree planting	Applying soil and water conservation	Rotation of crops
Age	-26.603 (-11.21) ***	23.83 (6.10)	-6.295 (1.85) *	29.314 (2.83) ***	-0.023 (-2.88) ***	0.007 (0.70)	0.071 (1.52) *	1. 378 (-0.61)	-0.001 (-0.51)
Level of education	0.608 (0.29)	1.568 (0.87)	4.123 (1.03) **	4.743 (3.01)	1.361 (-0.87)	0.011 (0.54)	0.010 (1.380) *	0.012 (1.23) *	0.125 (1.67) ***
Gender	0.303 (0.26)	2.023 (1.26)	5.879 (4.31) ***	3.76 (2.32) ***	1.352 (1.02)	-0.003 (-1.71) *	-0.011 (-3.64) ***	-0.021 (-2.31) ***	0.007 (1.32)
Farm size	-0.000 (-0.89)	0.761 (0.31)	(0.73)	0.001 (-1.61) *	(0.56)	1.32e-17 (3.10) **	* 5.43e-03 (1.83)	1.01e-01 (1.35) **	0.005 (0.31)
Household size	1.720 (1.33)	0.723 (0.62)	6.212 (2.62) *	-1.056 (-0.23)	1.534 (1.23)	0.101 (1.54) *	0.121 (4.523) **	0. 014 (3.01) **	-0.050 (-2.32) ***
Access to credit	3.572 (3.21) **	0.765 (0.87)	2.816 (1.36) **	5.180 (1.18) **	0.521 (1.12)	0.151 (1.32) *	0.141 (3.41) ***	0.213 (1.51) *	0.132 (2.52) ***
Cooperative Membership	1. 713 (-1.32) ***	4.75 (1.23)	7.476 (1.54) *	4.044 (-3.25) **	0.535 (0.24)	-0.121 (-1.01)	-0.02 (-0.64)	0.125 (2.12) **	-0.025 (-0.71)
Extension contacts	0.352 (0.10) ***	-0.612 (-2.34)	3.243 (2.27) ***	0.143 (4.62) ***	2.810 (-1.44)	0.032 (2.30) **	0.131 (1.32) ***	0.033 (2.97) *	0.031 (1.76) *
Chi Square Likelihood	198.34***								

This result also agrees with Danso-Abbeam et al. (2021) and Magesa et al (2023) who identified age, level of education, gender, and access to credit as factors influencing farmers' adoption of such adaptation strategies as diversification to non –farm activity, adopting new crop varieties, changing planting time, homestead gardening, planting trees and planting of cover crops. Access to credit is an essential variable as the implementation of adaptation strategies involves extra cost to the far household. Hence, the stronger the financial capacity of a household, the easier it is for them to acquire information, buy improved varieties, engage in diversification to non-farm activities etc. Also, farmers who have access to credit are more likely to take risk as their capital base can cushion the negative outcomes of such risks.

On the other hand, education supports changes in attitude, knowledge, and skill. Respondents who had formal education demonstrate advanced knowledge of the importance of different adaptation strategies. They are expected to understand the gains from these practices more than the less educated farmers (Ifeanyi-Obi et al., 2017).

4. Conclusion

The mean age of cassava farmers in the study area is 47 years. Among the climate change adaptation strategies were planting on mounds and ridges (20%), diversifying to non-farm activities (15%), applying soil and water conservation (11%) and planting of improved varieties (14%). The major challenges to climate change adaptation include unsatisfactory climate change information, inadequate contact with extension agents and insufficient funds. Availability of climate change information in real time, mobilization of more extension workers and provision of funds to improve the capacity of cassava farmers for climate change resilience should be prioritized.

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