

CLIMATE CHANGE AND ADAPTATION STRATEGIES AMONG CASSAVA FARMERS IN EZINIHITE MBAISE LOCAL GOVERNMENT AREA OF IMO STATE, NIGERIA

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ABSTRACT

The study was carried out to analyze climate change and adaptation strategies of cassava farmers in Ezinihite Mbaise Local Government Area of Imo State, Nigeria. A multistage sampling technique was used to select a total of 120 cassava farmers for this study using structured questionnaire. Descriptive statistics (frequencies and percentages) and probit model were employed in data analysis. The results show that the (respondents) farmers were mostly female whose age ranged between 31 -40 years. They were mostly married and attended secondary school with household size that ranged between 6-10 persons. Most of them were contact farmers who had farming experience of the range, 6-10 years and had farm size ranged between 1-2 hectares, from which they earned between N100,000 and N150,000 per annum. The result of regression analysis on the effect of climate change variables on the cassava output in the study area indicated high value of R^2 of 0.695. Result indicates that 69.5% of the variation in cassava output was accounted for by the independent variables. Dourbin Watson statistics value of 1.050 indicated the absence of auto correlation among observations of the factors considered. Test of hypothesis ($F_{cal} > F_{tab}$) at 0.05 level of significance confirmed that climate change

variables had significant effect on the cassava output. The farmers identified use of resistance varieties, changing planting date among others as their coping strategies to climate change. The result of regression analysis on the effect of socio-economic characteristics of farmers on the choice of climate change adaptation in cassava production shows an R^2 of 0.785 which indicates that 78.5% of the variation in the choice of climate change adaptation in cassava production was accounted for by the independent variables. Dourbin Watson statistics value of 0.771 indicates the absence of auto correlation among observations of the factors considered. The farmers also identified flooding, government policies, problem of pest and diseases among others as their constraints to climate change adaptation strategies. It is recommended that well-equipped weather stations be established to prevent weather-related disasters through early warning and effective response/adaptation system.

Key words: Cassava farmers, Climate change, Coping strategies

INTRODUCTION

Climate change is a major constraint to agricultural development in Africa and the world at large. It is not only a challenge to

agricultural development but to food security and the general livelihood conditions of any population (Tologbonse, E.B., Auta, S.J., Bidoli, T.D., Jaliya, M.M., Onu, R.O. and Issa, F.O , 2010). Climate is defined as the measurement of the mean and variability of relevant quantities of certain variables (such as temperature, precipitation or wind) over a period of time, ranging from months to thousands or millions of years.

The classical period is 30 years, as defined by the World Meteorological Organization (WMO). It is in fact, the synthesis of the weather in a given place over a period of at least 30 years. The main elements of weather include temperature, rainfall, dew, humidity, wind, sunshine, mist, haze and cloud. It is the collective pattern of expression, not just in one element of weather. However, the risk associated with increasing climate variability pose technology and economic challenges to societies. The effects of climate are likely to be highly spatially distributed (Molua and Lambi, 2007).

According to Building Nigeria's Response to Climate Change (BNRCC) (2012), data on trends from 30 years and above is a good time span to understand long term climate change patterns. Also, according to Inter-Governmental Panel on Climate Change (IPCC) (2007), mid-to-high latitude crop productivity may increase slightly as local mean temperature increase between 10^oc - 30^oc, depending on the crop, while at lower latitudes, crop productivity is projected to decrease for even relatively small local temperature increase of 100^oc -200^oc. Across the country, millions of farmers are already

experiencing and reacting to changing and more frequent weather events, leading to drought, flooding and storms surges along the coast.

Agriculture being one of the most weather dependent of all human activities is highly vulnerable to climate change. African countries are particularly vulnerable to climate change because of their dependence on rain fed agriculture, high level of poverty, inadequate land distribution and poor infrastructure (Watson, R.T., Zinyorwera, N.C. and Moses, R.H(1997). Generally, climate change is expected to have mixed effect on agriculture with some areas benefiting from moderate temperature increase and others being negatively affected. Positive effect of climate change could arise from changes in seasons and production cycles. For example, Ethiopia and Southern Africa are expected to have extended growing seasons as a consequence of increased temperature and rainfall, in the same vein, livestock could be boosted by temperature increases (FAO, 2009).

BNRCC (2012) reports that temperature and rainfall patterns provide major constraints on primary productivity, which in turn determines secondary productivity, for instance, cassava growth failure can result if there is excessive rain fall under rain-fed agriculture, which can cause erosion and leaching of the soil nutrient leading too low output.

Wisner,B., Biaikie, P. Canon, T. and Davis, I(2004) pointed out that the vulnerability of agriculture to climate change is not determined by the nature and magnitude of

environmental stress like climate change per se, but by the combination of the society coping capacity and degree of exposure to environmental change. While the society coping capacity and degree of exposure are related to environmental changes, they are both related to changes in societal aspects such as land use and cultural practices.

In Nigeria, agriculture is the main source of food and major employer of labour, employing about 60% of the population. It is predominantly a rain-fed system and hence vulnerable to climate change. Dominant crops cultivated in the country include; yam, cassava, maize, sorghum, millet, rice among others. Cassava is not only a major staple but also a major source of farm income for Nigerian farmers (Nweke, 1996).

When compared to other crops, cassava is the most resistant to extreme weather events. It is therefore most often described as a hardy crop and may in this sense be the most adaptable crop to climate variations. Despite the fact that cassava plant grows and produces well in the Nigerian environment, it has shown different growth behavior and yield in different years as a result of differences in the annual weather condition (Enete, 2003). This is because climate variability has possibility of degrading soil and water resources and subsequently subsistence agricultural production, which is largely, practiced by root and tuber crop farmers (Pidwirny and Sidney, 2007).

Incidence of food crises experienced in Nigeria arises from combination of factors such as rapid population growth and reduced productivity is suspected to be exacerbated by

climate change and related events (Onyenechere and Igbozurike, 2008). Presently, local farmers are no longer able to predict incidence of rain, based on past observation. This has led to planting too early and subsequent losses due to non-envisaged drought. Increased drought incidence in many part of the country decreases water availability to crops, leading to severe yield reduction. The bulk of climate change studies were conducted in temperate and highly industrialized countries (Mendelson, 2006). Most of the empirical work on effect of climate change on crop, production has focused on Europe, the United States, Canada and Australia (Molua and Lambi, 2007). Little research has focused on developing countries like Nigeria, one of the sub- Saharan African nations in the Western part of Africa. Available evidences shows that Nigeria is already being plagued with diverse ecological problems which have been directly linked to the on-going climate change (Adefolalu, 2007; Ikhile, 2007). The southern ecological zone of Nigeria largely known for high rainfall is currently confronted by irregularity in the rainfall pattern. It therefore becomes very imperative to analyze the effect of climate change on cassava production in Ezinihitte Mbaise L.G.A of Imo State, located in the tropical rainforest where the poor who may be most vulnerable to adverse climate changes lives Nigeria Objectives.

This study seeks to describe the socio-economic characteristics of the respondents; determine the effects of climate change variables on cassava output; identify the

climatic adaptation coping strategies by the cassava farmers; determine the effect of socio-economic characteristics of farmers on their choice of climate change adoption in cassava production and identify the constraints encountered by farmers in adopting climate change adaptation strategies.

Hypotheses of the Study: The following hypotheses guided the study.

HO₁: Socio-economic characteristics of farmers do not have significant effect on their choice of climate change adoption strategies in cassava production in the study area.

HO₂: climate change variables do not have significant effect on cassava output in the study area.

METHODOLOGY

Study Area:

The study was conducted in Ezinihitte Mbaise Local Government Area of Imo State. The area is chosen because of her prominence in cassava production. Ezinihitte Mbaise is made up of twelve communities. Ezinihitte Mbaise is bounded in the North by Obowo Local Government Area, in the Northwest by Ahaizu Mbaise Local Government Area, in the West and South by Aboh Mbaise Local Government Area, and in the East by Abia State. It is one of the 27 Local Government Areas in Imo State. It is located 45 kilometers away from the state capital, Owerri (NPC, 2006). The local government area comprises 12 communities namely, Akpodim, Amumara, Choconaeze, Itu, Oboama, Umunama, Okpuofe, Ihitte, Ife, Owutu, Obizu, Eziagbaogu. Ezinihitte Mbaise L.G.A is located between Latitude 5°29' and 5°48' north of the Equator and Longitudes

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7°02' and 7°35' East of the Greenwich Meridian. It has a population of ninety three thousand people and occupies a land area of about one hundred and ten square kilometers (NPC, 2006). It has annual rainfall range of 1500mm to 2500mm. Crop production and livestock farming are the predominant occupation of the people while other economic activities include trading and craftsmanship. Major crops grown in the region include; cassava, yam, cocoyam, vegetable crops and tree crops planted include; cashew, orange, mango pear, banana and plantain. The livestock kept include; sheep, goats, poultry and pigs. This is due to the favourable condition of the climatic factors of the area. Economically exploitable flora like iroko, obeche, bamboo, rubber tree and oil palm predominate (NBS, 2012).

Sampling Procedure:

The sample frame for this study was made up of a list of names and contact details of cassava farmers obtained from the Agriculture and co-operative Unit at Ezinihitte Mbaise Local Government Council. A multi-stage random sampling procedure was used to select respondents for this study. This was done in the following stages. Stage 1 involved random selection of six (6) communities from the 12 communities that make up the Local Government Area. Stage 2 was random selection of two (2) villages from each of the six communities. Stage 3 involved selection of ten cassava farmers from each of the twelve villages making a total of 120 respondents who formed the sample size for the study. Structured questionnaire was used to obtain relevant information from the respondents.

Data Collection

Data for this study were obtained from primary sources using structured questionnaires and interview schedules administered to get the relevant information needed for the study. Mean annual cassava output, rainfall distribution, air temperatures, rainfall, relative humidity, sunshine, wind speed, pressure and cloud cover from 1979 to 2014 (35 years) were obtained from the 120 cassava farmers and Meteorological Stations. Secondary data were obtained from textbooks, published and unpublished works, conference papers, journals, seminars, thesis, workshops and government publications.

Data Analysis:

Descriptive statistics and inferential statistics such as multiple regression and Tobit model were used. Null hypothesis were tested with F-test at 5% level of significance Model Specifications

a. Multiple regression models was used to determine the effect of climate change variables on the cassava output. The model is implicitly represented below as;

$Y = F(x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, \dots, x_n + e)$. Where Y = Cassava output, X_1 = Temperature (°c), X_2 = Rainfall (mm), X_3 = Relative humidity (%), X_4 = Sunshine, X_5 = Wind (m/s), X_6 = Pressure (N/m²), X_7 = Cloud cover

b. Analytical procedure of Tobit model

The Tobit model was developed by Tobin (1958) and is expressed as;

$$Y^* = X\beta + e \dots \dots \dots (1)$$

Where β is a vector unknown coefficient, x is a

vector of independent variables, e is an error term that is assumed to be independently distributed with mean zero and a variance of S^2 . Y^* is a latent variable that is unobservable. If the data for the dependent variable is above limiting factor, zero in this case; Y is observable as continuous variable. If Y is the limiting factor, it is held at zero. This condition is presented mathematically in the following two equations.

$$Y = Y^*, \text{ if } Y^* > Y_0 \dots \dots \dots (1)$$

$$Y = 0 \text{ if } Y^* < Y_0 \dots \dots \dots (2)$$

Where, Y_0 is the limiting factor. These two equations represent a censored distribution of the data. The Tobit model can be used to estimate the expected value of Y as a function of a set of explanatory variables (x) weighed by the probability that $Y_i > 0$ (Oladele, 2002).

The equations can be represented as,

$$\sum(Y) \text{ is } \sum Y = x\beta f(z) + \alpha f(z) \text{ and } Z = x\beta/\sigma \dots \dots \dots (3)$$

Where f (Z) is the cumulative normal distribution of Z, f(Z) is the value of the value of the derivative of the normal curve at a given point (unit normal density). Z is the Z score for the area under the normal curve and S is the standard error of the error term. The coefficients for variables in the model, β do not represent marginal effect directly but the sign of the coefficient will give the researcher information as to the direction of the effect. The model for choice of adaptation strategy in the study area can be represented as: $Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, \dots, X_n + e) \dots \dots \dots (4)$ Where: Y = Observable dummy variables that indexes a number of adaptation strategies (no adaptation, use of irrigation, planting of trees, Multiple/intercropping, crop diversification,

changing planting dates), X_1 = Age of respondent (years), X_2 = Gender, X_3 = Level of education, X_4 = Farming experience (years), X_5 = Farm size (hectare), X_6 = Level of income (Naira), X_7 = Family size (number), X_8 = Marital status..

c. The stated hypotheses were tested using the F-test at 5% level of significance using the formula;

$$F\text{-cal} = R^2(N-K)$$

$1 - R^2(K - 1)$. Where R^2 = Coefficient of multiple determination, N = Sample size, K = Number of variables. **Decision Rule:** If $F\text{-cal} > F\text{-tab}$, reject the null hypothesis otherwise accept

Table 1: Socio economic characteristics of the respondents

Characteristics	Frequency	Percentage
Age(Years)		
21-30	42	35
31 -40	53	41.2
41-50	17	14.2
Above 50	8	6.6
Gender		
Male	37	31
Female	83	69
Marital Status		
Single	21	17.5
Married	81	67.5
Window	13	10.8
Widower	5	4.2
Household size		
1 - 3	32	26.7
4 - 6	52	43.3
7 and above	36	30.0
Level of Education		
No formal	9	7.50
Primary school	16	13.00
Secondary school	51	42.50
Tertiary institution	41	37.00
Farming experience		
1 - 5	27	22.5
6 - 10	73	60.8
11 - 15	11	9.2
Above 15	9	7.5

Average annual farm income		
<100,000	31	25.8
100,000 - 150,000	65	54.2
> 150,000	24	20
Farm size (Ha)		
< 1	19	15.8
1 - 2	57	47.5
3 - 4	37	30.8
Above 4	7	5.8

Source: Field survey, 2015

The result shows that the age of the farmers varied, 55.4 percent of the respondents were between 31-50 years of age. This implies that the cassava farmers in the study area were still within their youthful age and energetic. This may be the reason for their ability to adapt to changes in climate. This conforms to the findings of Okunade, *et al.*, (2005) who reported that in Surulere Local Government Area of Oyo State, cassava farmers are mostly between 36 and 56 years of age.

Majority (69%) of the respondents were females indicating that it is a female dominated activity. This result confirms findings of Hjorts (2005) who reported that women in Sub-Saharan Africa perform over 60% of farm activities.

Large percentage (67.5%) of the farmers was married and majority (73.3%) had household size of 4 persons and above. This may reduce the cost of hired labour if the farmers engage their families in the activities on the farm. Result is in conformity with Effiong (2005) and Anoziet *al* (2014), they reported that relatively large family size is proxy to labour availability.

Most (92.5%) of the respondent shad at least primary education and can read and write. The importance of education in improving farm activities cannot be overemphasized. Education predisposes an individual towards

change, enhances skill and hence increases output (Okeke, 1993). With education, farmers will be able to understand the need to take measures to reduce the negative effects of climate change, or exploit the positive ones, by making appropriate adjustments.

Majority (77.5%) of the respondents had at least 6 years farming experience. Farmers with relatively long years of experience acquire better knowledge of farming and ability to distinguish between the effect of climate change and climate variability. Daramola (2004) reported that farmers count more on their farming experience than educational attainment in order to increase their efficiency.

Result also shows that only 54.2% of the farmers earn above N150, 000 per annum from farm activities, with only 5.8% operating on farm land above 4 hectares. This indicates that respondents were subsistence farmers that earned low annual farm income which could be as a result of farmers not utilizing resources efficiently or as a result of change in climate.

Effects of climate change variability's on the cassava output

Table 2 shows the result of the effect of climate change variables on cassava output as analyzed in four functional form using regression model statistics. The linear functional form was chosen as the lead equation based on coefficient of multiple determination (R^2) value, number of significant variables, Durbin Watson value and F-value.

The R^2 value (0.695) indicates that 69.5% of the variation of dependent variables was

accounted for by the included independent variables and the remaining 30.5% were due to error term. The overall effect of the independent variables on the dependent variables as shown by F-ratio (3.885) was significant at 1% level of significance. The low value of Durbin Watson constant which was below 2.5 indicates the absence of auto correlation in the regression model. This implies that the forecasting power of the explanatory variables were very high since relevant variables were not omitted in the regression model. The result is a good fit.

However, the coefficient of X_1 (Temperature) was positive and statistically significant at 1% level of significance. This implies that change in temperature affect the output of cassava in the study area. The higher the temperature, the less the output and vice versa. These effects of temperature could result to soil draught, infestation of pest and diseases and other effects.

The coefficient of X_2 (Rainfall) was positive and significant at 5% level of significance. This implies that change in rainfall effects the cassava output. High rainfall (flooding) may lead to soil erosion, leaching, salinity etc which reduces soil nutrients.

The coefficient of relative humidity (X_3) was positive and significant at 5% level of significance indicating that the relative humidity affects the cassava productivity in the area. When there is high temperature in the study area, it may lead to reduction in the soil relative humidity and this could delay or stop seed germination, development, maturity and over- all reduction in output.

Table 2: Effects of climate change variables on the cassava output in EzinihitteMbaise L.G.A

Variables	Linear ⁺	Exponential	Double log	Semi-log
Constant	3.681 (4.713)***	4.694 (6.256)***	5.646 (1.803)*	5.266 (9.287)
Temperature (°c)	0.267 (2.727)***	0.732 (6.25)***	-0.787 (-1.611)	-0.846 (-9.017)***
Rainfall (mm)	0.520 (3.378)***	0.343 (1.897)*	-1.106 (-1.464)	-0.397 (-2.548)**
Relative humidity (%)	0.145 (2.107)**	0.178 (2.405)**	0.023 (0.073)	0.039 (2.101)**
Sunshine	0.041 (0.514)	0.045 (0.477)	0.115 (0.295)	0.015 (0.826)
Wind (m/s)	-0.028 (-0.394)	-0.006 (-0.214)	0.004 (0.036)	-0.019 (-0.758)
Pressure (N/m ²)	-0.080 (-0.725)	0.047 (0.270)	0.349 (0.477)	0.189 (1.273)
Cloud cover	-0.065 (-0.732)	0.011 (0.385)	0.036 (0.299)	-0.011 (-0.429)
R ²	0.695	0.337	0.436	0.484
F-value	3.885***	8.142***	0.671***	15.006
Durbin Watson	1.050	0.720	2.094	1.111

Source: Field survey, 2015

*, ** and *** implies significant at 10%, 5% and 1% respectively, figures in parenthesis are the t-ratio. + = lead equation

Climate change Adaptation Copping Strategies Practiced by the Cassava Farmers

Table 3 shows the result of climate change adaptation strategies practiced by the cassava farmers in the study area. Data show that 40% of the respondents used resistance varieties of cassava, 33.3% changes the dates of planting, 1.7% use irrigation farming. Other methods practiced by the respondents were planting of trees (4.2%) and crop rotation (9.2%). About 5% of the farmers reported not using any strategy to adapt with the climate change.

Table3: Climate change Adaptation Copping Strategies Practiced by the Cassava Farmers in the Study Area

Strategies	Frequency	Percentage
Use of resistant varieties	48	40
Irrigation	2	1.7
Planting of trees	5	4.2
Multiple/intercropping	8	6.7
Crop diversification	11	9.2
Changing planting dates	40	33.3
Did nothing	6	5
Total	120	100

Source: Field survey, 2015

Effects of Socio-economic Characteristics of Farmers on their Choice of Climatic Change Adaptation strategy in Cassava Production

The result of Tobit analysis in table 4, shows an R^2 value of 0.6326. This indicates that 63.26% variation in the dependent variable was influenced by the independent variables considered in the study. The log likelihood of 64.622644 indicates a good fit for the model. Specifically, Educational level, Farming experience, Farm size, Annual income and Marital status had positive and significant influence on choice of climate change adaptation strategy by cassava farmers at varying degrees of significant.

Table 4: Tobit estimates of effects of Socio-economic Characteristics of Farmers on their Choice of Climatic Change Adaption strategy in Cassava Production in the Study Area

Variable	Coefficient	Std. Error	t-value
Constant	3.67669	0.5621761	(5.90)***
Age-0.0080082	92	0.20273	(-2.01)
Gender-0.0255016		0.0100048	(-2.18)
Edu.level0.021336	4	0.0428019	(1.74)**
Farming exp 0.10833446	0.0171806		(2.99)***
Farm size0.0103105	0.0251606		(3.07)**
Annual income.0.0168684	0.0170313		(1.29)***
Household size. -1.051690		0.2347847	(-6.28)

Marital status	0.234984	0.1460364	(2.27)**
Number of Obs	120		
Pseudo R ²		0.632	6
Prob > Chi ²		0.0000	
LR-Chi ² (8)		7	1.53***
Log likelihood		64	.622644

** , *** are significant at 10% and 5%.

Constraints to Farmers Climate Change Adaptation Strategies in Ezinihite Mbaise L.G.A

Table 5 shows the constraints encountered by farmers in adopting climate change adaptation strategies. Five most critical constraints were flooding, government policies, poor transportation network, deforestation and lack of improved cassava technologies. This constraints created barriers to climate change adaptation of farmers and resulted in low yield and low investment and poor standard of living by the cassava farmers.

Table 5: Distribution of Farmers according to Constraints to Climate Change Adaptation Strategies

Constraints	Frequency ⁺	Percentage
Land tenure	15	12.5
Poor extension service	9	7.5
Lack of improved cassava technologies	19	15.8
Government policies	25	20.8
Problems of pest and disease	15	12.5
Illiteracy	6	5
Poor transportation network	21	17.5
Low income	15	12.5
Flooding	31	25.8
Deforestation	21	17.5

+ Multiple responses

Source: Field survey, 2015

Test of Hypotheses

HO₁: F-cal (30.885) > F-tab (2.09) at 0.05 level of significance, the null hypothesis was rejected and the alternative hypothesis accepted. This implies that the climate change variables had significant effect on cassava output in the study area.

HO₂: F-cal (11.174) > F-tab (4.022) at 0.05

level of significance, the null hypothesis was rejected and the alternative hypothesis accepted. This implies that the socio-economic characteristics of farmers had significant effect on their choice of climate change adaptation strategy in cassava production in the study area.

Conclusion

This study revealed that the cassava output is influenced by changes in temperature, rainfall and relative humidity. Their choice of coping strategies was influenced by Age, Gender, level of education, farm size and household size in the study area. The research identified flooding, deforestation, lack of improved varieties, government policies as major constraints to farmers' adoption of climate change adaptation strategies in the study area.

Recommendations

Based on the findings of this study, the following recommendations were made;

- i. The change agents should take to the local farmers the various climate change adaptation strategies so as to improve agricultural productivity of the rural areas.
- ii. Government should enact and implement laws to guard the natural ecosystems. This would reduce the effects of climate change.
- iii. Provision of irrigation facilities should be of vital use, for this could solve the problem of low rainfall as caused by the change in climate.
- iv. The farmers should form and organize well-structured cooperative societies, so as to meet up with adequate capital for farm mechanization and adoption of improved technologies that could help reduce the effect of climate change.
- v. Better-equipped weather stations to prevent weather-related disasters through early warning and effective response/adaptation system should be established, this will help in preventing weather-related disasters through early warning and effective response system.

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