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## **Effects of Climate Change on the Production and Profitability of Cassava in the Niger Delta Region of Nigeria**

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### **Abstract**

Nigeria is the single largest producer of cassava in the world with the bulk of the cassava coming out from the Niger Delta region. Human, economic and agricultural activities are currently threatened in the region by vagaries in climatic factors. These vagaries affect the production and profitability of cassava. The study was therefore conducted to assess the effects of climate change on the production and profitability of cassava in the Niger Delta region of Nigeria. The study made use of a multi-stage sampling technique to select three hundred and sixty respondents across the three highest cassava-producing states (Awka, Imo, Cross Rivers and Ondo) in the region. Data for the study were collected with the aid of well-structured questionnaires assisted with interview schedules. Data collected were analysed using descriptive statistics and regression model. The determinants of cassava profitability were farm size, farmers' experience in cassava cultivation, farmers' experience in adopting climate change coping strategies, number of climate change coping strategies adopted, costs of input materials in Naira and labour cost in Naira.

### **Keywords:**

Climate change, cassava, production, profitability, Niger Delta .

### **Introduction**

Nigeria is the world's largest producer of cassava with other top producers being Indonesia, Thailand, the Democratic republic of Congo and Angola. In the year 2010, Nigeria's production of cassava reached 37.5 million tonnes (Asante-Pok, 2013). The Nigerian Government facilitated the development of new disease-resistant cassava varieties by the joint efforts of International Institute for Tropical Agriculture (IITA), National Root Crops Research Institute (NRCRI), Root and Tuber Expansion Program (RTEP), and the Federal Ministry of Agriculture, in conjunction with State Agricultural Development Programs and cassava farmers.

The Presidential Initiative on Cassava, launched in 2003, brought cassava to the national limelight. The Initiative had as its goal the promotion of cassava as a viable foreign exchange earner and also the development of the production system to sustain the national demand. The Presidential Initiative focused its intervention on the development of production, processing, and marketing of the processed products (Sanni et al., 2009).

### **Cassava production in the Niger Delta region of Nigeria**

Cassava as a crop originated from South America and it is extensively propagated as an annual crop in the tropical and sub-tropical regions for its edible starchy tuber as root. It is an annual crop that may often be left longer than 12 months and usually planted as a sole crop or in combination with other crops. Production is all year round activity and it does well in a warm, moist climate. Cassava is very tolerant and has the ability to grow on marginal land where other food crops cannot grow well, but for its high yield and productivity moderate climatic condition and best soil properties like a light, sandy loamy soil of medium fertility and good aerations or drainage are all crucial (Akanbi, Olabode, 2004). Hence, extreme weather conditions such as prolonged drought and excessive amount of rainfall that leads into flood may be detrimental to cassava outputs and critically affect its productivity.

### **Key traditional cassava products in the Niger Delta region of Nigeria**

Traditional cassava products in the Niger Delta region include gari, lafun, fufun and apu. Gari is

the most consumed and marketed of all cassava food products both within and outside the region. Gari is a partly gelatinised, roasted, free flowing granular flour with a slightly fermented flavor, creamy-white (or yellow, if from yellow-fleshed roots or fortified with red palm oil). Lafun is flour from fermented dried cassava that is later made into a stiff paste and eaten with sauce. Apu is a variant of lafun popularly consumed by people from Ondo State. A granular product made from partly gelatinised cassava starch, is also known as tapioca.

### **Key industrial cassava products in the Niger Delta region of Nigeria**

High quality cassava flour (HQCF) is a major intermediate product. Development of HQCF is a key success in cassava processing, as it became the means to scale up industrial utilisation in the Niger Delta region and across Nigeria. The flour is being used either alone or as a composite in bakery products. Before this, Nigeria used to import over one million tonne of wheat annually. In the 1990s, after the depreciation of the naira, the high cost of wheat almost sent bakers out of business, thus compelling them to look for an alternative. To face this challenge, IITA developed a simple and appropriate process for producing HQCF that is suitable for baking. This was tested in the baking and confectionary industries; it was found successful and the cost implications were favorable (Sanni et al., 2009).

Cassava starch is used as an ingredient in manufactured foods (infant foods, confectionary, glucose, alcohol) and in non- food industries (glues, oil well drilling, adhesives, paper sizing and bonding, textile sizing and strengthening). It is also widely used as a thickening agent in soup and for laundry purposes. The traditional starch is used for clothes or consumed at a local level in the form of tapioca, often with special flavors (vanilla, banana). Some NGOs are encouraging this form of utilization as an income-generating activity as the product can be sold at weekly or seasonal village markets (Sanni et al., 2009).

Dried (split) roots are the cheapest form of storable cassava. They are typically popular in transitional and savanna areas where sun drying is relatively easier than in forest zones. Peeled roots or chips are often slightly molded or fermented to a certain degree, according to climatic conditions, local taste, and consumption habits. They are milled or pounded into (fermented) flour that does not

comply with standards for replacing wheat. The fermentation alters the sensory characteristics of the roots in a way that is often appreciated by local consumers (Sanni et al., 2009).

### **Climate change in the Niger Delta of Nigeria**

Basically, climatic condition as predetermined by the weather pattern and its elements over a long period of between 30 to 40 years is known as climate. This is different from weather which is the atmospheric condition within a very short period of time of at most two weeks. The classical period as determined by the World Meteorological Organization is 30 years which a number of changes in the variables that determine the predominant climatic pattern in the regions are known. The climatic elements include rainfall, temperature, sunshine intensity, relative humidity, atmospheric pressure, cloud cover, snow, dew, frost and wind (Ezekiel et al., 2012)

Human activities have exacerbated climate change with its attendant impacts on agriculture in many communities in the Niger Delta region. Marine resources, fisheries, forest resources and crop production and productivity may not be spared from the effects of vagaries in climatic factors. Climate change also affects livelihood vulnerability (Bryceson et al., 2002, Cochrane, 2006, Ekins et al., 2003, Reed et al., 2013). Terrestrial water and carbon cycles also respond to climate change and variability through a set of coupled physical and physiological processes (Raupach, 2013), Social-ecological system collapse is also possible (Roser, 2001, Richter, 2013)

Global and regional climate changes are affecting all economic sectors to some degrees. Agricultural sector is perhaps the most sensitive and vulnerable. This is because agricultural production remains very dependent on climatic resources. Researches have revealed that that the earth is likely to warm by 0.2°C per decade for the next two decades and to rise between 0.6°C and 4.0°C by the end of the century depending on future emissions. The resultant effects of this is that climate variability will impact food production in several ways (Ezekiel et al, 2012).

Agriculture in the Niger Delta is largely rain-dependent as irrigation is seldom practiced. Nzeadibe et al. (2011) further noted that changes in the rainfall pattern have greatly affected vegetation and agriculture in the region. Cassava

remains key to the food economy of the people of the Niger Delta region. As majority of the people living in the Niger Delta are farmers, the environmental and social consequences of climate change is putting livelihoods at serious risks.

Although notable researches have been conducted in the region on climate change which include environmental degradation, vulnerability and mitigation of climate change impacts (Akinro et al., 2008), coastal management and adaptation to climate change (Etuonovbe, 2008), and Awareness of climate change and implications for achieving the MDGs in the Niger Delta region of Nigeria (Ajayi, 2014). However, there is literature dearth on researches on the effects of climate change on the production and profitability of cassava in the Niger Delta region. This necessitated this research work.

This research therefore attempts to answer such questions as what effects does climate change has on the production and profitability of cassava in the study area? What are the coping strategies to climate change effects in the study area and what are the determinants of profitability of cassava production in the study area? The study of the effects of climate change on the production and profitability of cassava in the Niger Delta region of Nigeria was therefore conducted with the following objectives which include to:

- i. Examine the effects of climate change on the production and profitability of cassava in the study area.
- ii. Investigate the coping strategies to climate change effects on the production and profitability of cassava in the study area and
- iii. Examine the determinants of profitability of cassava production in the study area

## **Materials and methods**

### **The study area**

The area of this study is the Niger Delta region of Nigeria. The Niger Delta, as defined officially by the Nigerian government, covers about 70,000 km<sup>2</sup> of marshland, creeks, tributaries and lagoons that drain the Niger River into the Atlantic at the Bight of Biafra and makes up 7.5% of Nigeria's land mass

consisting of the nine states of Abia, Akwa- Ibom, Bayelsa, Cross-River, Delta, Edo, Imo, Ondo and Rivers (Mba, Ogbuagu, 2013, Ajayi, 2014). The region is reputed for having diverse vegetation belts: from the largest rain forests in Nigeria to mangrove swamps, savannahs, mountains and waterfalls with rare animals, including endangered species and unusual plant families, making it one of the World's richest biodiversity centres attracting scientists and tourists. The region had a population of 31.2 million people at 2006 census (Ajayi, 2014) with more than 40 ethnic groups including the Bini, Efik, Ibibio, Annang, Oron, Ijaw, Itsekiri, Isoko, Urhobo, Ukwuani, and Kalabari, are among the inhabitants in the Niger Delta, speaking about 250 different dialects, the bulk of which lives in rural fishing and farming communities (Ajayi, 2014). Common crops popularly grown in the region include cassava, cocoyam, white yam, maize, garden egg, pepper, okra, melon, fruited pumpkin and oil palm (Mmom, 2009). Among these, oil palm and cassava remain the leaders in the food economy of the region while cassava is most diversely useful crop in the region serving as raw material to traditional and industrial food processors within and beyond the region.

### **Sampling technique, size and data collection**

A multistage sampling technique was used for this study. In the first stage, three states of Akwa Ibom, Cross Rivers and Ondo were purposively selected from the nine (9) states that make up the Niger Delta region in Nigeria, being the highest cassava-producing states in the Niger Delta. In the second stage, using the delineation by the three (3) states' Agricultural Development Programmes (ADPs), two (2) cassava-producing Local Government Areas (LGAs) were randomly selected from each state giving total of six (6) cassava-producing LGAs. In the third stage, from each of the selected LGAs, two blocks were randomly selected for study. This gave a total of twelve (12) blocks. Initially, residents from the selected blocks were invited to a community forum at which a preliminary identification of different categories of cassava farmers was carried out. At the community forum, fifteen (15) cassava famers made up of males, females and youths who constituted the focus group were purposively selected from the list of those identified and discussions were held with them. During the community forum, using Focus Group Discussion (FGD), and Key Informant Interviews

(KII) with the help of community leaders, a sampling frame of all cassava farmers was built up in each community. From this list, random samples of 30 cassava farmers were selected and interviewed using semi-structured interview schedules thus making a total sum of 360 cassava farmers from the study area.

### **Data collection**

Rapid Rural Appraisal (RRA) (transect walks, identification and inspection of farm lands) was as data collection method. The RRA used had the advantage of encouraging the respondents to describe their relationship with their natural resources. The RRA also had the advantage of identifying of variables of importance to the cassava farmers and in the formulation of questions that were included in the more formal semi- structured interview schedule in locally meaningful terms. Two single gender Focus Group Discussions (FGDs), one for men and another for women were held with farmers in each state with number of participants ranging from 10-20. The resultant six FGDs were very helpful in eliciting clearer information from the respondents.

### **Data analysis**

Descriptive statistics and regression model were used in the data analysis. The descriptive statistics used included means, percentages, frequencies and tables. The effects of climate change on cassava production in the study area was measured on three-point Likert-type scale of “high” (3), “moderate” (2) and “low”. Climate change effects with mean scores of  $\geq 2.5$  were regarded “high”, effects with mean responses from 1.5 to 2.49 were regarded “moderate” while those with mean less than 1.5 were regarded as “low”. Also, the use of coping strategies for climate change in the study was measured on a three-point Likert-type scale of “always” (3), “rarely” (2) and “not at all”. Coping strategies with mean scores of  $\geq 2.5$  were regarded “highly adopted”, strategies with mean responses from 1.5 to 2.49 were regarded “adequately adopted” while those with mean less than 1.5 were regarded as “poorly adopted. Multiple regression analysis was used to isolate factors determining the profitability of cassava production as taken proxy by net farm income. The implicit form of the regression model is presented as:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, \dots, X_{11}, e)$$

Where,  $Y$  = Net farm income (profitability in Naira)

$X_1$  = age of cassava farmers

$X_2$  = sex of cassava farmers

$X_3$  = education of cassava farmers

$X_4$  = farm size (in hectares)

$X_5$  = fousehold size

$X_6$  = farmers experience in cassava cultivation

$X_7$  = farmers experience in adopting climate change coping strategies

$X_8$  = number of climate change coping strategies adopted

$X_9$  = cost of input materials (in Naira)

$X_{10}$  = cost of labour (in Naira)

$X_{11}$  = variety of cassava cultivated

$e$  = error term

Three functional forms of the regression model were fitted to the data collected and the best fit was selected based on established criteria. The a priori expectation was that the coefficients of the independent variables should be greater than zero.

## **Results and discussion**

### **Effects of climate change on cassava productivity in the study area**

From the analysis of the respondents’ perceived effects of climate change on cassava production in the study area as shown in Table 1, it is now very evident that climate change has effects on the cassava productivity in the Niger Delta region of Nigeria. These effects are responsible for the dwindling cassava production figures in Nigeria. Should the effects be adequately checked with necessary coping strategies by cassava farmers and policy makers, the present productivity of cassava in the Niger Delta region will improve and by extension snowball Nigeria into greater heights in cassava production and marketing providing more food, employment opportunities and foreign exchange for the nation in the global market should more international markets be created for the crop.

### **Coping strategies to the effects of climate change on cassava production in the study area**

From the analysis of the respondents’ coping strategies to the effects of climate change on cassava production in the study area as shown in Table 2,



Effects of climate change on cassava	High	Moderate	Low	High	Moderate	Low	Mean	Remarks
	Frequency			Percentage (%)				
High subseptivity to pests and diseases	240	80	40	66.67	22.22	11.11	2.56	High
Runof of soil nutrients due erosion	178	99	83	49.44	27.5	23.06	2.26	Moderate
Increased weed population	54	70	236	15	19.44	65.56	1.49	Low
Inadequate water supply/drought for nutrient circulation	211	127	22	58.61	35.28	6.11	2.52	High
Late maturing of cassava roots	165	145	50	45.83	40.28	13.89	2.32	Moderate
High temperature destroying soil nutrients	134	139	87	37.22	38.61	24.17	2.13	Moderate
Discoloration of cassava leaves	254	89	17	70.56	24.72	4.722	2.66	High
Discoloration of cassava roots	267	27	66	74.17	7.5	18.33	2.56	High
Reduced cassava roots	221	116	23	61.39	32.22	6.39	2.55	High
Reduced dry matter of cassava roots	67	26	267	18.61	7.22	74.17	1.44	Low
Reduced starch content of cassava roots	178	81	101	49.44	22.5	28.06	2.21	Moderate
Reduced water content of cassava roots	194	78	88	53.89	21.67	24.44	2.29	Moderate
Stunted growth of cassava plants	213	122	25	59.17	33.89	6.944	2.52	High

Source: Computed from field survey, 2014

Table 1: Effects of climate change on cassava production in the study area.

Coping strategies	Always	Rarely	Not at all	Always	Rarely	Not at all	Mean	Remarks
	Frequency			Percentage (%)				
Early and late planting	230	90	40	63.89	25.00	11.11	2.42	A
Soil and water conservation	187	90	83	51.94	25.00	23.06	2.41	A
Use of organic manures	213	83	64	59.17	23.06	17.77	2.51	H
Use of inorganic fertilizer	211	117	32	58.61	32.50	8.89	2.41	A
Planting pest and disease resistant cassava cuttings	187	103	70	51.94	28.61	19.44	2.38	A
Use of cassava cuttings that are well acclimated	134	129	97	37.22	35.83	26.94	1.99	A
Draining of wetland for cassava cultivation	122	120	118	33.89	33.33	32.78	1.86	A
Making of contour bund around farmland	67	26	267	18.61	7.22	74.17	2.10	A
Planting of trees	101	81	178	28.05	22.5	49.44	2.50	H
Minimum tillage system (zero/minimum)	184	78	98	51.11	21.67	27.22	2.28	A
Use of irrigation system/water storage	79	89	192	21.94	24.72	53.33	1.89	A
Reforestation/ Afforestation	99	114	147	27.50	31.67	40.83	1.83	A
Use of chemicals like herbicide, insecticide	187	111	62	51.94	30.83	17.22	2.49	A
Increase in number of weeding	123	145	92	34.17	40.28	25.56	2.54	H
Use of early maturing cassava varieties	165	105	90	45.83	29.17	25.00	2.48	A
Protection of water sheds and mulching	89	66	205	24.72	18.33	56.94	2.51	H
Preservation of cassava cuttings for planting	212	92	56	58.89	25.56	15.56	2.51	H

Source: Computed from field survey, 2014

Table 2: Coping strategies to the effects of climate change on cassava production - beginning.

Coping strategies	Always	Rarely	Not at all	Always	Rarely	Not at all	Mean	Remarks
	Frequency			Percentage (%)				
Use of weather-resistant cassava variety	180	90	90	50.00	25.00	25.00	2.11	A
Reducing access to eroded/ erosion prone area	231	89	40	64.17	24.72	11.11	2.60	A
Mixed cropping practices	197	67	96	54.72	18.61	26.67	2.24	A
Use of recommended planting distance	267	76	21	74.17	21.11	5.83	2.36	A
Changing the timing of land preparation	193	90	77	53.61	25.00	21.39	2.33	A
Changing harvesting dates	201	90	69	55.83	25.00	19.17	2.27	A
Out migration from climate risk areas	79	67	216	21.94	18.61	60.00	2.48	A
Use of windbreaks/shelter belts	207	90	63	57.50	25.00	17.50	2.63	H

Source: Computed from field survey, 2014

Table 2: Coping strategies to the effects of climate change on cassava production - continuation.

use of organic manures; planting of trees; increase in number of weeding; protection of water sheds and mulching; preservation of cassava cuttings for planting; use of windbreaks/shelter belts were rated “high adopted ” coping strategies while the remaining coping strategies were rated “averagely adopted”. They include Early and late planting; soil and water conservation; use of inorganic fertilizer; planting pest and disease resistant cassava cuttings; use of cassava cuttings that are well acclimated; draining of wetland for cassava cultivation; making of contour bund around farmland; minimum tillage system (zero/ minimum); use of irrigation system/water storage; reforestation/ afforestation; Use of chemicals like herbicide, insecticide; Use of early maturing cassava varieties; use of weather-resistant cassava variety; reducing access to eroded/erosion prone area; mixed cropping practices; use of recommended planting distance; changing the timing of land preparation; changing harvesting dates and out migration from climate risk areas. Meanwhile, none of the coping strategies was poorly adopted by the respondents.

### **Regression results of determinants of cassava profitability in the study area**

Table 3 shows the results of the regression analysis to examine the determinants of cassava profitability in the study area. The double-log functional form provided the best fit as shown in the regression model. Six of the independent variables;  $X_4$ ,  $X_6$ ,  $X_7$ ,  $X_8$ ,  $X_9$  and  $X_{10}$  were significant at 5% level (i.e. 95% confidence interval). These variables were farm

size, farmers’ experience in cassava cultivation, farmers’ experience in adopting climate change coping strategies, number of climate change coping strategies adopted, cost of input materials and cost of labour. The parameter estimates of each of these variables also carried signs, which conformed to a priori expectations. The results indicate that farm size, farmers’ experience in cassava cultivation, farmers’ experience in adopting climate change coping strategies, number of climate change coping strategies adopted positively influenced cassava net farm income (profitability) in the study area. Thus, the major determinants of cassava profitability were these four factors. All the explanatory variables together explained about 91% of the variations observed in cassava profitability. The positive effect of adoption of improved varieties of cassava on yield has been earlier observed by both (Dipeolu et al, 2004) and (Mafimisebi, 2005). The (CBN, 1999) also observed that adoption of improved variety was responsible for increase in production from 31 million tonnes in 1994 to 34 million tonnes in 1998.

The regression model is therefore given as:

$$5.274 = f(-0.006X_1 + 0.002X_2 + 0.003X_3 + 1.0230X_4 + 0.006X_5 + 0.007X_6 + 0.012X_7 + 0.015X_8 - 0.04X_9 - 0.046X_{10} + 0.002X_{11} + 0.01135)$$

Variables	Simple Log		Semi-Log		Double Log	
	Coefficients	T-value	Coefficients	T-value	Coefficients	T-value
Constants	3577.234 (4725.093)	0.757	807428.401 (1.357)	1.357	5.274 (0.110)	47.772
$X_1$	-60.498 (34.909)	-1.733	-7713.567 (-0.299)	-0.299	-0.006 (0.005)	-1.352
$X_2$	-698.924 (1014.861)	-0.689	1964.363 (0.079)	0.079	0.002 (0.005)	0.499
$X_3$	450.851 (533.548)	0.845	37514.570 (1.862)	1.862	0.003 (0.004)	0.807
$X_4$	134293.121 (2032.285)	66.080*	928356.192 (7.778)	7.778*	1.023 (0.022)	46.216*
$X_5$	406.309 (203.430)	1.997*	7714.022 (0.409)	0.409	0.006 (0.003)	1.65
$X_6$	61.431 (52.032)	1.181	12642.747 (0.723)	0.723	0.007 (0.003)	2.150*
$X_7$	-9.263 (110.466)	-0.084	35099.513 (1.292)	1.292	0.012 (0.005)	2.400*
$X_8$	-202.327 (242.199)	-0.835	11816.024 (0.452)	0.452	0.015 (0.005)	3.000*
$X_9$	-0.033 (0.023)	-1.478	-73538.809 (-1.018)	-1.018	-0.004 (0.013)	-3.067*
$X_{10}$	-0.011 (0.021)	-0.512	-80388.113 (-0.840)	-0.84	-0.046 (0.018)	-2.556*
$X_{11}$	340.086 (1114.042)	0.305	42773.952 (1.546)	1.546	0.002 (0.005)	0.482
	R <sup>2</sup> =0.89		R <sup>2</sup> =0.87		R <sup>2</sup> =0.91	
	SE=8155.62361		SE=61160.72031		SE=0.01135	
	F value=22293.9		F value=370.7		F value=17428.7	

Note: \*means significant at 5% level

Values in parenthesis are *t* ratios

Source: Computed from field survey, 2014

Table 3: Regression results of determinants of cassava profitability in the study area.

## Conclusion

The results of analysis show that high effects of climate change include high susceptibility to pests and diseases; inadequate water supply/drought for nutrient circulation; discoloration of cassava leaves; discoloration of cassava roots; reduced cassava roots and stunted growth of cassava plants while runoff of soil nutrients due erosion; late maturing of cassava roots; high temperature destroying soil nutrients; reduced starch content of cassava roots and reduced water content of cassava roots were “moderate” effects; increased weed population and reduced dry matter of cassava roots were of “low” effects. It is also needful

to say that all the coping strategies to climate change effects on cassava productivity in by the farmers were either highly or averagely adopted with none being poorly adopted. This emphasizes the farmers’ awareness level and commitment to prevent cassava production which is their economic source of living from the effects of climate change. The study further revealed that the determinants of cassava profitability were farm size, farmers’ experience in cassava cultivation, farmers’ experience in adopting climate change coping strategies, number of climate change coping strategies adopted, cost of input materials and cost of labour.

The study therefore recommends that more coping



strategies should be adopted while encouraging high adoption of the strategies which have not been highly adopted. These should be done in search of new innovations for reducing climate change effects on cassava production and profitability

in the study area. Also, combination and experience in several coping strategies have been found to reduce effects of climate change on cassava production with improved net farm income to cassava production in the study area.

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