COSTS OF CLIMATE CHANGE IMPACTS ON OUTPUT OF CASSAVA AMONG FARMING HOUSEHOLDS IN SOUTH EASTERN, NIGERIA

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ABSTRACT
Cassava is noted to be one of the strongest root crops that serve as a staple food for the populace and as a raw material to industries. Cassava is noted to be less affected by adverse climatic conditions. The challenge of climate change in the face of rising food insecurity makes it imperative to analyze the cost impact of climate change on the output of cassava farming households in south eastern, Nigeria. The cost of the impacts and adaptation measures was used to realize with net returns. The study employed primary data elicited from pre-tested and structured questionnaire sets administered on farmers selected from three Southeastern States using multistage sampling technique during 2011/2012 farming season. The result of the cost and returns analysis on per state basis indicated that farmers in Enugu State recorded the highest cost structure with the least loss due to climate change impacts while their counterparts in Abia State incurred the loss as a result of climate change. Farmers in Imo State, however, posted the highest net profit. On the basis of findings, the study suggested the adoption of appropriate and proactive adaptation cum mitigation measures. These may include use of drought tolerant/resistant varieties, adoption of sustainable land management practices and intensification of campaigns to promote healthy environmental practices among citizenry

Keywords: climate change, cassava, impact cost, farming households.

INTRODUCTION
Climate change has huge cost on the farmers; the negligence of its impacts reduces yields and leads to the increase in the cost of production. It has been defined by the Intergovernmental Panel on Climate Change, IPCC (2001) as statistically significant variations in climate that persist for an extended period, typically decades or longer. It includes shifts in the frequency and magnitude of sporadic weather events as well as the slow continuous rise in global mean surface temperature. Climate, water resources, biophysical and socio-economic systems are interconnected in complex ways, so a change in any one of these induces a change in another. Rising temperatures and changes in rainfall patterns have direct effects on crop yields, as well as indirect effects through changes in irrigation water availability (Nicholas *et al*. 2010).

In developing countries such as Nigeria, climate change reduces the yield of most staple crops such as cassava which is the chief among the staple crops consumed in south eastern part of the country. Cassava is said to be the least affected crop when compared with other major staples such as maize, sorghum and millets (Andy *et al.* 2012). Extreme weather conditions such as prolonged drought and excessive amount of rainfall that leads into flood may be detrimental to cassava output (Ezekiel *et al.* 2012). Cassava as a crop originated from South America and it's 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. Cassava (Manihot esculenta) is the crop with the highest total production in Africa, with 118 million MT of productions across the continent in 2010, contributing significant energy input to the population with an average 196 kcal/capita/day in 2008 (FAO, 2010).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 highly yield and productivity moderate climatic condition and best soil properties like a light, sandy loam soil of medium fertility and good aerations or drainage are all crucial Akanbi and Olabode, (2004) .

The inter-annual variability of rainfall, particularly in the North is large, often culminates in climate hazards especially hoods and droughts with their devastating effects on food production and associated catastrophic consequences. By virtue of Nigeria's location primarily within the lowland humid tropics, the country is generally characterized by a high temperature regime almost through the year. The mean maximum temperature in the far South is between 30°C-32°C while in the North it is between 36°C-38°C. More so, the diverse nature of Nigeria's climate consequently gave rise to a high degree of biological diversity resulting mainly in six vegetation zones: the Mangrove swamps, the Salt water and Fresh water swamps, Tropical lowland rainforests, Guinea savanna, Sudan savanna and Sahel savanna. From a water balance perspective, the country experiences large spatial and temporal variations in rainfall, and less variation in evaporation and evapo-transpiration. Consequently, rainfall is by far the most important element of climate in Nigeria and thereby becomes a critical index for assessing agricultural and water resources in the country (Adejuwon, 2006).

Based on the projections of 1PCC (1996), the humid tropical zone of Southern Nigeria, which is already too hot and too wet is expected to be characterized by increase in both precipitation (especially at the peak of the rainy season) and temperature. Already temperature increases of about 0.2°C-0.3°C per decade have been observed in the various ecological zones of the country, while drought persistence has characterized the Sudan - Sahel regions, particularly since the late 1960s. For the tropic humid zones of Nigeria, precipitation increases of about 2 - 3% for each degree of global warming may be expected. Thus, it is reasonable to anticipate that the precipitation would probably increase by approximately 5- 20% in the very humid areas of the forest regions and Southern Savanna areas. The increase in temperature in these areas would also possibly increase evaporation, reducing the effectiveness of the increase in precipitation.

It is therefore not surprising that there is a growing consensus in the scientific literature that over the coming decades higher temperatures and changing precipitation levels caused by climate change will be unfavourable for crop growth and yield in many regions and countries (Yesuf *et al*., 2008). To what extent this will be the case for Nigeria particularly in the Southeast rainforest zone where both temperature and precipitation levels reach extremes has not received substantial research interest and attention (Nwajiuba and Onyeneke, 2010).

METHODOLOGY

The Study Area

The study was conducted in the Southeastern zone of Nigeria. The zone consists of five states namely: Abia, Anambra, Ebonyi, Enugu, and Imo States and located on latitudes 5°06'N to 6°34'N of the Equator and longitudes 6°38'L and 8°08'L of the Greenwich (Prime) Meridian (Onyeneke and Madukwe, 2010). The Southeast rainforest zone of Nigeria is a belt of tall trees with dense undergrowth of shorter species dominated by climbing plants. The prolonged rainy season, resulting in high annual rainfall above 1,800mm, humidity of above 80% during the rainy season, and temperature of 27°C annually in this area; ensures adequate supply of water and promotes perennial tree growth. The inhabitants of this zone are predominantly farmers producing mainly food crops like cassava, yam, and maize (Nwajiuba and Onyeneke, 2010). According to NPC (2007), the population of the Southeast zone stood at 16, 381, 729 persons, disaggregated into 8, 306,306 males and 8, 075, 423 females.

Sources of Data

The study employed two sources of data namely primary and secondary sources. Primary data were collected with the use of pre-tested and structured questionnaire administered on farmers in the selected areas. These include farmers' perception of climate change, adaptation measures and its cost. Secondary data were collected from literature, National Root Crops Research Institute (NRCRI), National Meteorological Centre (NIMET), National Bureau of Statistics (NBS), State Agricultural Development Programmes (ADPs), Food and Agriculture Organization data base, World Bank Statistical Bulletin, United Nations Development programme (UNDP) statistical reports and other sources. The secondary data collected include climatic data, market price, yield and cultivated area.

Sampling Technique

The study employed a multistage sampling technique in the selection of farmers from the agricultural zones of the 5 states (Abia, Ebonyi, Enugu and Imo States have 3 agricultural zones each while Anambra has 4). In stage one, 3 states were selected randomly from the 5 states that make up the Southeast zone of Nigeria. In stage two, 4 Local Government areas each were selected randomly from the zones (ie 12 LGAs). The third stage involved a random selection of 2 communities each from the 12 LGAs, set aside for the research (ie 24 communities). The last stage entails the selection of 15 farmers from the communities, giving a sample size of 480 farmers. The study collected the primary data during 2011/2012 farming season.

Analytical Procedure

In assessing the changes in major climate variables trend analysis was performed. Cost of impacts and adaptation measures was examined using cost and returns analysis.

Model Specification

The cost and returns model follows (Folayan and Bifarin , 2013) and specified thus:

NEI = TR - (TVC + TFC)

Where:

NEI = Net enterprise income for the investment options in Naira

TR = Total Return in naira

TVC = Total Variable Cost in Naira

TFC = Total fixed cost in Naira

Gross margin: GM = TR – TVC

TR = Total Revenue.

TVC = Total Variable Cost.

RESULTS AND DISCUSSION

The Changes in Major Climate Variables and Cassava Production (1961 – 2012)

From the result of the analysis, Cassava production in Nigeria maintained a stable trend with a slight increase from 1961 to 1985 before experiencing a sharp increase from 1986 to 2001. There was sharp decrease in 2008 while since 2009 the output continued to increase. It could be seen that the trend in the annual precipitation of Nigeria has been unstable, with precipitation level at the highest in 1997 and at the lowest in 1984. The estimated anomalies of the climate variables indicated that the amount of rainfall and number of wet days varied appreciably from year to year (Oluwasegun *et al,* 2010). The trend in the annual temperature of Nigeria has been unstable as shown in figure 1, with the temperature hitting the highest point in the year 2000. The Carbon dioxide (CO_2) emissions in Nigeria were very low in the early 1960's but experienced a sharp increase in the early 1970's and thus maintained an unstable trend. The CO_2 emission was the highest in 2006.

Cost Impact of Climate Change on the Farmers in South Eastern Nigeria

In an attempt to estimate the cost of the impact of climate change in the study area, net profit analysis was conducted. Cost of the impact was generated from the estimated amount of loss to climate change each farmer incurred. The results are shown in Tables 1, 2, 3 and 4 for Abia, Imo, Enugu States and aggregate respectively. From Table 4, it could be observed that cassava farmers in Abia State posted a net profit of N16, 852,125.00 in 2011/12 farming season generated from the total cost (TC) of ₦2, 206,075.00 and a revenue base of ₦18, 133, 525.00. The total cost disaggregated into the total fixed cost of ₦1, 281, 400.00 and variable cost of ₦128, 140.00. The total fixed cost represents 58.09% of the total cost which implies that the farmers were operating a high fixed cost structure. However, the estimated loss due to climate change recorded ₦7, 685,500.00 and thus accounted for 45.61% of the net profit. The implication of the result is that climate change in the form of increase in temperature, carbon emissions and flooding had a huge impact on the profit of the cassava famers in Abia state.

As shown in Table 2, cassava farmers in Imo State recorded a net profit of N27, 797,000 in 2011/12 generated from the total cost (TC) of N2, 784,000.00 and a revenue base of ₦30, 581,000.00. The total cost disaggregated into the total fixed cost of ₦1, 142, 400.00 and variable cost of ₦114, 240.00. The total fixed cost represents 41.03% of the total cost which implies that the farmers' fixed cost structure was within manageable limit (less than 50%). However, the estimated loss due to climate change recorded ₦4, 647,200.00 and thus accounted for 16.72% of the net profit. The implication of the result is that climate change in Imo State within the period of the study had a marginal impact on the profit of the cassava famers.

In Enugu State, the cassava farmers as shown by Table 3 generated a net profit of N26, 626,767 within the period of the study realized from the total cost (TC) of N9, 105, 900.00 and a revenue base of ₦35, 782,667.00. The total cost disaggregated into the total fixed cost of ₦9, 105, 900.00 and variable cost of ₦4, 787.200. The total fixed cost represents 47.43% of the total cost which implies that the farmers' fixed cost structure was within manageable limit (less 50%). However, the estimated loss due to climate change posted ₦2, 282, 800.00 and thus accounted for 8.57% of the net profit. The implication of the result is that climate change in Enugu State within the period of the study had an infinitesimal impact on the profit of the cassava famers.

On the basis of the results, inferences could be drawn with a relatively high degree of accuracy. Enugu posted the highest cost structure and the least loss due to climate change impact; Abia incurred the highest loss due to climate change while Imo State had the highest net profit. This consolidated the findings of Phillips *et al*., (2004) who reported that Imo state produces the highest quantity of cassava in the South east.

As shown in Table 4, the overall cost impact of climate change on the selected sampled states indicated that the total revenue of the cassava farmers in the region was ₦85, 371, 867 with the total variable cost (TVC) of ₦7, 353,475 and a total fixed cost (TFC) of ₦6, 742, 500. With an aggregate loss (due to climate change impact) of ₦14, 619,100, the profit of the cassava farmers in the region plummeted to ₦23, 149,800. This magnitude of aggregate loss accounted for reduction in the net profit of the farmers in the region by 20.51%.

CONCLUSION

Having examined the cost impact of climate change on Cassava Farmers output in Southeastern Nigeria, the need to adopt improved agricultural and environmentally sensitive technologies has become imperative. As shown by the results, on per state basis, Enugu recorded the highest cost structure with the least loss due to climate change impacts while Abia incurred the loss as a result of climate change. Imo State, however, posted the highest net profit. Although observations have shown that much of the climate change menace in Nigeria was triggered more predominantly by man-made causes such as poor drainage system, water disposal habits etc, it is necessary therefore to emphasize the adoption of appropriate and proactive adaptation cum mitigation measures. These may include use of drought tolerant/resistant varieties, adoption of sustainable land management practices and intensification of campaigns to promote healthy environmental practices among citizenry.

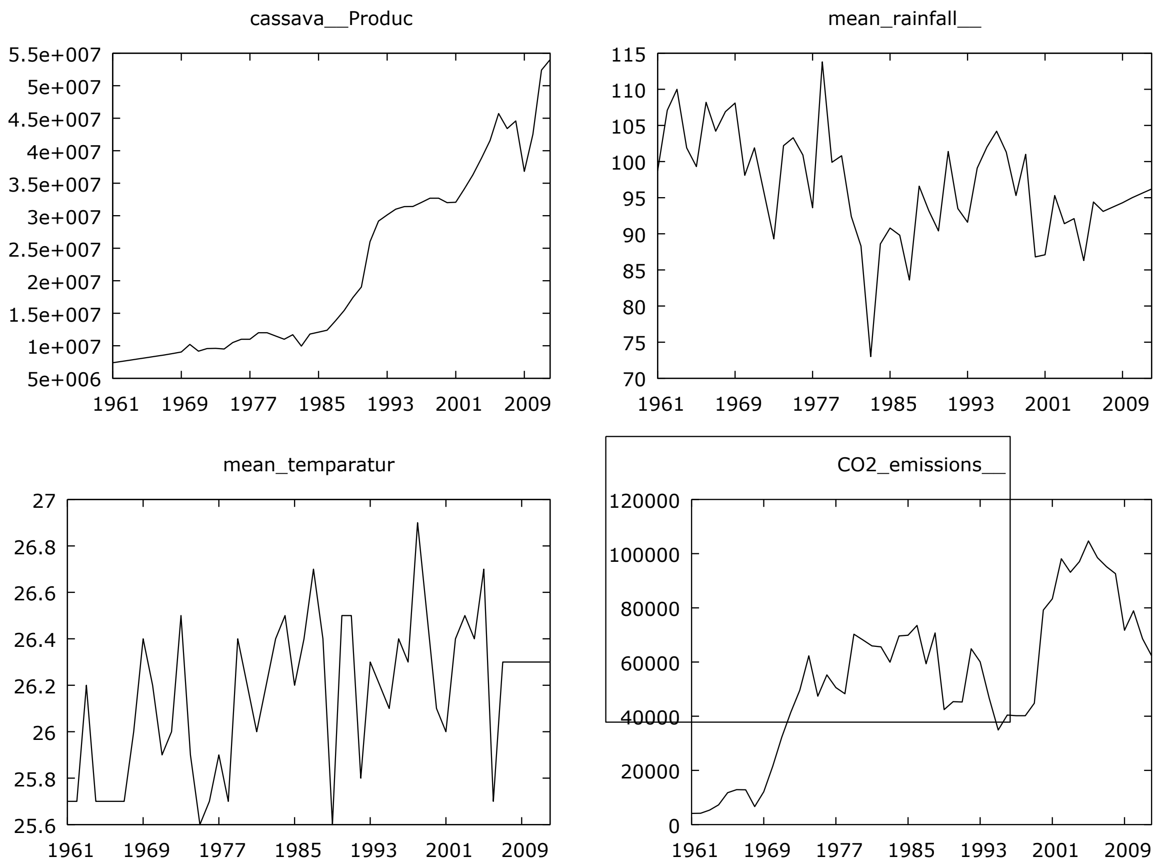

Figure 1: Series in Nigeria major climate variables and cassava production.
Source: Computations from the data obtained from UNDP, FAOstat and World Bank various issues.

Table 1: Cost of the impact of climate change in Abia state, Nigeria

Item	**Amount(N)**
Total revenue	19,058,200
Expenditure	
Inputs	110,961
Wages (labour)	554,805
Fuel/energy	184,935
Other variable cost	73,974
Total variable cost	924,675
Rent	640,700
Levies	128,140
Equipment	384,420
Other fixed costs	128,140
Total fixed cost	1,281,400
Total cost	2,206,075
Gross profit	18,133,525
Net profit	16,852,125
Estimated loss due to climate change impacts	7,689,500
Gross profit after estimated loss due to climate change impacts	10,444,025
Net profit after estimated loss due to climate change impacts	9,162,625

Source: Computations from Field survey data, 2012

Table 2: Cost impact of climate change in Imo state, Nigeria

Item	Amount(N)
Total revenue	30,581,000
Expenditure	
Inputs	196,992
Wages (labour)	984,960
Fuel/energy	328,320
Other variable cost	131,328
Total variable cost	1,641,600
Rent	571,200
Levies	114,240
Equipment	342,720
Other fixed costs	114,240
Total fixed cost	1,142,400
Total cost	2,784,000
Gross profit	28,939,400
Net profit	27,797,000
Estimated loss due to climate change impacts	4,647,200
Gross profit after estimated loss due to climate change impacts	24,292,200
net profit after estimated loss due to climate change impacts	23,149,800

Source: Computations from Field survey data, 2012

Table 3: Cost impact of climate change in Enugu state, Nigeria

Item	Amount(N)
Total revenue	35,732,667
Expenditure	
Inputs	574,464
Wages (labour)	2,872,320
Fuel/energy	957,440
Other variable cost	382,976
Total variable cost	4,787,200
Rent	2,159,350
Levies	431,870
Equipment	1,295,610
Other fixed costs	431,870
Total fixed cost	4,318,700
Total cost	9,105,900
Gross profit	30,945,467
Net profit	26,626,767
Estimated loss due to climate change impacts	2,282,400
Gross profit after estimated loss due to climate change impacts	28,663,067
Net profit after estimated loss due to climate change impacts	24,344,367

Source: Computations from Field survey data, 2012

Table 4: The overall cost of the impact of climate change on cassava production in South Eastern, Nigeria

Item	Amount(N)
Total revenue	85,371,867
Expenditure	
Inputs	882,417
Wages (labour)	4,412,085
Fuel/energy	1,470,695
Other variable cost	588,278
Total variable cost	7,353,475
Rent	3,371,250
Levies	674,250
Equipment	2,022,750
Other fixed costs	674,250
Total fixed cost	6,742,500
Total cost	14,095,975
Gross profit	78,018,392
Net profit	71,275,892
Estimated loss due to climate change impacts	14,619,100
Gross profit after estimated loss due to climate change impacts	63,399,292
Net profit after estimated loss due to climate change impacts	56,656,792

Source: Computations from Field survey data, 2012

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