Rainfall and priority investment commodities in southern Nigeria

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ABSTRACT: This paper uses regression analysis to examine the relationship between the rising output of the priority investment commodities in southern Nigeria and the rainfall pattern of the same region. The Augmented dickey Fuller test showed that the variables were stationary at different levels. The trace cointegration test showed cointegration in the output of sweet potatoes and the weather parameters and so the error correction model was used to analyze the relationship between them. Output of Plantain and sweet potatoes were found to have a positive relationship with rainfall which signifies that production was still largely dependent on rainfall. However, output of the commodities have a negative relationship with rainfall of previous years (lagged rainfall) which signified that output of the crops continued to rise irrespective of changes in the amount of rainfall. The output of cocoyam was found to have a negative relationship with rainfall which signifies that an increase or decrease in rainfall had no effect on the increasing output. Temperature had no effect on the output of sweet potatoes. It is therefore recommended that to maximize the output of these commodities farmers should be educated on the nutritional and export potentials of these crops and the use of irrigation facilities should be encouraged and provided.

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INTRODUCTION

In Nigeria, about two thirds of its agricultural production is done by traditional small holders who use simple techniques of production and the bush fallow system of cultivation. Despite this, a steady growth has been observed in the agricultural sector since 1990. The aggregate index of agricultural production increased by 4.1 percent in 1997 but declined in 1998 however, from 1999 all major staples have recorded significant increases over the preceding year level. According to African Economic Outlook (AEO), in 2010 the Nigerian agricultural sector performed remarkably well with an estimated growth rate exceeding 6.0 percent reflecting the good weather conditions that boosted agricultural production together with government interventions. Increasing rainfall from the semi arid north to the tropical rain forested south allows great crop diversity from short season cereals (sorghum, millet and wheat) in the north, to cassava yams and rice in the wetter areas. On commercial grounds, food crops can be grouped into subsistence crops and cash crops. Subsistence food crops (mainly sorghum, maize, taro, yam, cassava, rice and millet) are grown in the central and western areas of Nigeria and are traded outside the cash economy. Cash crops (mainly palm kernels, cotton, cocoa, rubber and groundnuts) are grown in the east, west, mid – west and northern states of the country.

Also on commercial grounds, food crops can also be classified as priority commodities based on the area of major production. A study by Manyong et al, 2008 classified major staples into priority primary commodities in the major zones of Nigeria. Yam, cassava, rice, and maize were priority commodities in both north and southern Nigeria, while millet, cowpea and sorghum were priority only in the north and sweet potato, cocoyam, plantain and melon were priority in the south. This study focuses on plantain, sweet potatoes and cocoyam which are priority commodities in the south.

PLANTAIN

In Nigeria, plantain production is becoming a significant economic activity for income generation for both large scale and small holder farmers especially for those who produce them within their home compounds or gardens (Fakayode et al, 2008). It comes after yam and cassava as priority in south south Nigeria and has become a delicacy in urban Nigeria and unlike other starchy staples whose demand tends to fall with increasing income its demand rises. According to Akinyemi et al 2010, the inadequate knowledge of improved cultural practices of the crop by farmers, an inefficient system of extension services and skewness of specialization in areas of research are part of the reasons why the output potential of plantain is still low in the country.

SWEET POTATO

Nigeria today is the first largest producer of sweet potato in Africa with 3.46 million metric tons annually. Globally, Nigeria is now the second largest producer in the world. Its production, marketing and utilization has expanded in the last decade to almost all ecological zones of Nigeria, presently between 381,000 and 510,000ha of land are under sweet potato cultivation (FAO, 2008). The importance of sweet potatoes is increasing in the Nigerian food system because it is very easy to plant, matures easily and has numerous industrial and economic potentials (Chukwuka, 1999), it ranks among the five most important food crops in over 50 developing countries (All about sweet potatoes, 2008) and as the fifth primary investment commodity in south east Nigeria. It offers a particularly significant potential for increasing food production and income in Nigeria.

COCOYAM (TARO)

In the past, cocoyam was regarded as a lowly important crop which cultivation and consumption lay within the less privileged farmers. Presently, it ranks third in importance after cassava and yam among the root tuber crops cultivated and consumed in Nigeria (NRCRI). Cocoyam is the most widely cultivated crop in both western and eastern region of the country in terms of area devoted to it and the number of farmers growing it. South - east and south - south Nigeria still remains the largest producer around the world with an annual production output of four million metric tons as against the potential 160 million metric tons per annum (Ukeagbu, 2011). Nutritionally, cocoyam is superior to cassava and yam however ignorance of its nutritive value and failure of cocoyam farmers to enter the international trade market has contributed to the low returns from the crop. The conventional breeding practice and the accumulation of pathogens have also affected the yield. Cocoyam starch is also easily digested when compared to yam and cassava starch. The potentials of the crop as a solution to food security, nutrition enhancer and source of income particularly in the rural settlement is grossly underutilized.

WATER REQUIREMENTS OF PRIORITY COMMODITIES

In plantain production, water is an essential resource as yield increases with the amount of water available. Plantain and banana (Musa Sp) are widely adapted at elevations 0 – 920m (0 – 3000ft) or more, depending on latitude. They thrive well at mean annual temperature of 26 – 30^{0}c and an annual rainfall of 2000mm (80 in) or higher in commercial production. They grow in a wide range of soils preferably those well drained. Most plantain production in Nigeria is rain fed which accounts for the low yield. Even where irrigation is practiced, it is poorly done (Akinro et al, 2009). The reasons for poor irrigation practice in the region are due largely to the belief that precipitation is more in the south than in the north and consequently, most crops grown in the south have the ability to survive drought though the yield may be lower than what would be obtained if supplementary irrigation is introduced.

Sweet potatoes require a reasonable amount of water to grow. Annual rainfalls of 750 – 1000mm (30 – 39in) are considered most suitable, with a minimum of 500mm (20in) in the growing season. They do not do well in water logged soil as it may cause tuber rots and reduce storage roots if aeration is poor.

Cocoyam is best planted when the rainy season is steady in well drained soil (as stagnant and warm water cause rotting). It can be grown in paddy fields where water is abundant or upland situations where watering is supplied by rainfall or by supplemental irrigation. It is one of the few crops that can be grown under flooded conditions (apart from rice and lotus). For maximum yields, the base of the plant should always be under water. They do well in deep, moist or even swampy soils where annual rainfall exceeds 250cm.

PROBLEM STATEMENT

The output of plantain, cocoyam and sweet potatoes in southern Nigeria has continued to increase over the years and they have been described as crops which have the potentials to help improve the export potentials and ease the looming food crisis of the country. Majority of these crops are still produced locally by rural farmers (who constitute the backbone of the Nigerian agricultural sector) producing about 80% of the total nutritional agricultural output (Fayinka, 2004) using traditional methods under rain fed conditions. Ayinde 2010 looked at the effects of climate change on agricultural production however little has been done on looking at the effects of the weather parameters on these southern priority commodities whose yield has continued to rise over the years. Nigeria presently is the largest producer of sweet potatoes in Africa and with the increased interest in production of plantain and cocoyam by small and large scale farms it is believed that Nigeria will continue to be one of the largest producers of these commodities. This study therefore aims at comparing the trends of output of these food crops with the trend of the average total annual rainfall in southern Nigeria. The comparisms would help to determine the relationship between the rainfall patterns and the level of output of the commodities.

OBJECTIVE

This study aims at determining the relationship between the trend of average total annual rainfall and the total annual output of the priority commodities in southern Nigeria over twenty years (1989 – 2008).

HYPOTHESIS OF THE STUDY

There is no significant relationship between the trend of total annual rainfall and the output of priority investment commodities in southern Nigeria over the years.

METHODOLOGY

The study focuses on southern Nigeria which lies in the West African sub region of the belt of the tropical rain forest. It takes in the coastal area that reaches from the Benin border in the west to the Cameroon border in the east. This region experiences heavy and abundant rainfall usually above the 2,000mm (78.7in) rainfall totals giving for tropical climates worldwide. The southern region of Nigeria experiences a double rainfall maxima characterized by two high rainfall peaks, with a short dry season and a longer dry season falling between and after each peaks .This study looks at the trend of the output of sweet potato, cocoyam and plantain over twenty years and compared it with the total annual rainfall of the region over the same number of years to determine the effect of rainfall on the output. This study is carried out using secondary data. The rainfall and temperature data were gotten from the National Bureau of Statistics Nigeria, while data for the output of commodities were gotten from the FAOs (Food and Agriculture Organization of the United Nations) FAOSTAT – Agriculture. All data were from periods1989 to 2008. Analytical tools used in this study include descriptive statistics (tables and graphs), the augmented Dicky Fuller test (to test for stationarity), the error correction model (to analyze the relationship between variables when there is cointegration) and ordinary least squares regression (to analyze the relationship between variables when there is no cointegration).

ANALYTICAL FRAMEWORK:

Economic behavior in any one period is to a great extent determined by past experience, past occurrences and past patterns of behavior (Koutsoyiannis, 1973). In time series analysis, independent variables are often lagged to represent this influence and this leads to a regression model with a lag variable which in its explicit form is given as:

$$y_t = \beta_0 + \beta_1 x_1 + \beta_2 x_{t-1} + \beta_3 \ldots\ldots(1)$$

Where y_t is the dependent variable and x_{t-1} and y_{t-1} are lagged dependent and independent variables and $\beta_0 \beta_1 \beta_2 and \beta_3$ are parameters. Fuller, (1976) defined a stationary data as one that has its mean and variance constant over time. Most empirical work based on time series assumes that the underlying time series is stationary however, if the time series data are not stationary and regression is done it leads to a spurious result. To avoid this, the level of stationarity of the data can be tested using the Dickey – Fuller (DF) and Augmented Dickey Fuller test (ADF) statistic (Dickey and Fuller, 1981). This study used the Augmented Dickey Fuller test as it captures the additional dynamics left out by the DF and normally gives a more accurate result (Oyekale 2007). The Augmented Dickey Fuller is expressed as follows

$$\Delta X_t = \alpha_0 \delta X_{t-1} + \sum \beta \Delta x_{t-1} + e_t \ldots (2)$$

Where ΔX_t is the first difference, ΔX_{t-1} is the lagged difference of X_t in year t, δ and β are parameters and e_t is the error term.

Where data is non stationary, we apply the cointegration test to determine which of the variables will co move in the long run. The unrestricted cointegration rank test (trace) is expressed as:

$$Y_t = \beta_1 + X_1 + X_2 + X_3 \ldots\ldots\ldots.(3)$$

The error correction mechanism is used where there is cointegration in the variables to correct for the disequilibrium and to reconcile the variables to the long run behavior. The ECM is expressed as:

$$\Delta Y_t = \alpha_0 + \alpha_1 \Delta X_1 + \alpha_2 \Delta X_2 + \alpha_3 \Delta X_3 + \alpha_4 ECM(-1) + e_t \ldots\ldots(4)$$

Where Y_t, X_1,X_2,X_3 are as previously defined, Δ is the difference operator, ECM(-1) is the error correction factor and e_t is the stochastic error term assumed to be normally distributed with zero mean and constant variance.

RESULTS AND DISCUSSIONS

Changes in output of priority crops and rainfall pattern:

On the overall, the output of plantain, cocoyam and sweet potatoes continued to increase over the period as shown in figure 1 below. However for plantain, there were drops in output between 1989 and 1990 of about 198,000mt, between 1994 and 1998 of about 33,000mt and between 2007 and 2008 of about 264,000mt. Only the drop between 2007 and 2008 had a corresponding drop in total annual rainfall of about 71.55 millimeters. For cocoyam, there was a drop of 477,000mt between 2006 and 2007 there was however no corresponding drop in rainfall in this period. For sweet potatoes there was a drop in output of about 469,000mt between 2000 and 2001 with a corresponding drop in rainfall of about 161.147

millimeters at this time. There was also a drop in output between 2006 and 2007 of about 471,000mt with no corresponding drop in rainfall.

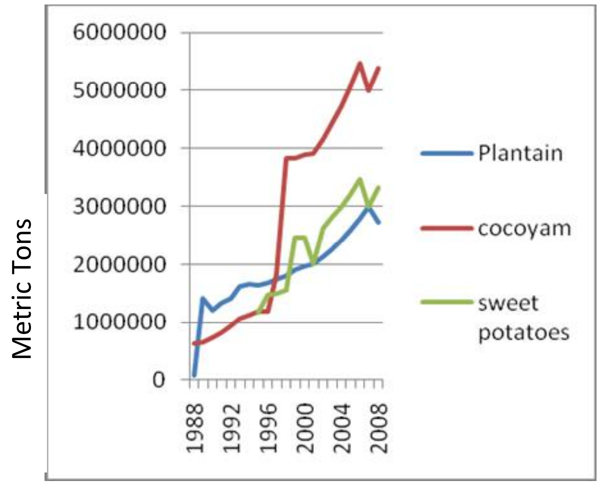

FIGURE 1. Trend of output of priority investment commodities over 20 years (Source FAO).

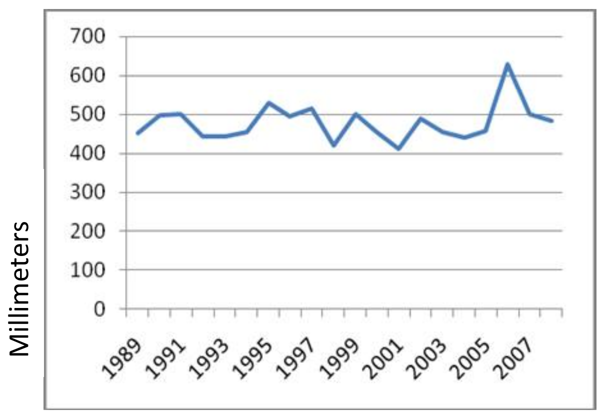

FIGURE 2. Trend ot average total annual rainfall (Source: National Bureau of Statistics).

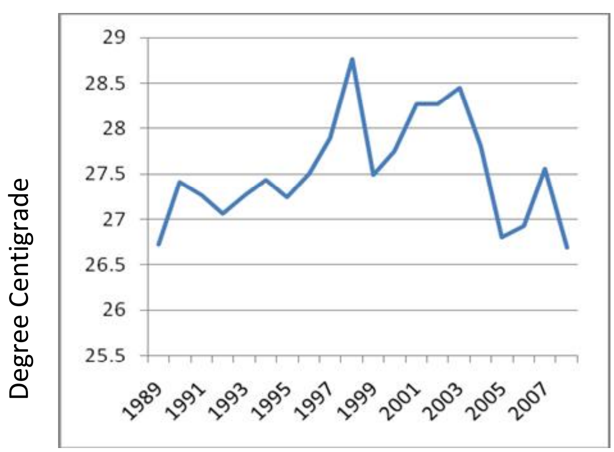

FIGURE 3. Trend of average temperature over 20 years (source: National Bureau of Statistics)

RESULT OF REGRESSION ANALYSIS:

The first step involves determining if the variables are stationary at their present levels or not by using the Augmented Dickey Fuller test (ADF).

Table 1. Result of stationarity of variables

Variables	Level	1st diff	2nd diff	3rd diff	Unit root
Sweet potatoes	1.371	4.200	4.560	-	1(2)
Cocoyam	0.479	3.831	3.781	3.886	1(3)
Plantain	0.018	3.831	3.857	-	1(2)
Rainfall	4.134	3.831	-	-	1(1)
Tempera-ture	2.495	3.831	3.831	3.857	1(2)

Table 1 indicates that the variables are stationary at different levels showing disequilibrium among them, this prompts the need for a co integration test for each of the variables.

Table 2: Result of Co integration test for Sweet potato

Hypothe-sis	Eigen value	Trace statistics	0.05 critical value	Prob**
K = 0*	0.94185	54.4651	35.1927	0.0002
K ≤ 1*	0.73058	20.3267	20.2618	0.0490
K ≤ 2	0.31776	4.58860	9.16454	0.3315

* = cointegration among variables.

Trace statistics indicates two cointegrating equations at the 0.05 level and so an error correction model is used to analyze the relationship between the output of sweet potatoes, rainfall and temperature.

Table 3: Regression (ECM) results for sweet potato output, rainfall and temperature.

year

Variable	Coefficient	T - statistic	Prob.
C	160824.6**	2.9876	0.0305
YS_{-1}	0.431911**	2.3498	0.0656
R	3226.291*	1.7756	0.1359
R_{-1}	2392.449*	1.8823	0.1185
T	399929.2**	2.1906	0.0800
T_{-1}	41494.15	0.2894	0.7839
ECM(-1)	0.266862**	2.1234	0.0871

R^2 = 0.8984 F Statistic = 7.3709
*t = value significant at 10%
**t = value significant at 5%

Where Y_{S-1} is lagged output of sweet potatoes, R is rainfall, R_{-1} is lagged rainfall, T is temperature and T_{-1} is lagged temperature.

The regression result in table 3 is given by:

$Y = 160824.6 + 0.431911YS_{-1} + 3226.291R – 2392.449R_{-1} – 399929.2T + 41494.15T_{-1}$

This result indicates a positive relationship between rainfall (3226.291) significant at 10 percent and output of sweet potatoes which shows that an increase in rainfall increases output (of sweet potatoes) in a particular year. However there is a negative relationship between the lagged rainfall (ie. rainfall of the previous year) (– 2392.449) significant at 10 percent and output which shows that output continued to increase irrespective of decrease in total annual rainfall between years. This means that changes in output (increase) is not affected by the changes (decrease) in rainfall between years. In Oyekale, 2007 other land parameter with coefficient -0.625 implied that agricultural land would decline as land areas devoted to housing and urban development increase.

The trend of temperature in Nigeria is relatively constant, which can also be linked to irregular movements of rainfall which regulates the condition of the atmosphere. According to Ayinde (2010), there is no significant relationship between temperature and agricultural production in Nigeria. This result also shows a negative relationship between temperature and yield of sweet potatoes.

Table 4: Result of Cointegration test for Cocoyam:

Hypothesis	Eigen value	Trace statistics	0.05 Critical value	Prob**
K = 0	0.6690	25.8628	35.1927	0.3496
K ≤ 1	0.1998	5.95602	20.2618	0.9517
K ≤ 2	0.1023	1.94355	9.16454	0.7889

The result in table 4 shows no cointegration at 0.05 significant level, the ordinary least squares regression is thus used to analyze the relationship between yield of cocoyam and rainfall.

Table 5: Result of regression for cocoyam output and rainfall

Variable	Estimate	T.stat	Prob
Constant	1404351.04*	1.172	0.258
R	-1685.316*	0.693	0.498
YC_{-1}	0.976***	14.801	0.000
R_{-1}	-582.892	0.559	0.584

$R^2 = 0.939$ F statistics = 81.50

*t = value significant at 10%

***t = significant at 1%

The regression results in table 5 are given by:

$YC = 1404351 – 1685.3R + 0.976YC_{-1} – 582.89R_{-1}$

Where R is rainfall, YC_{-1} is the lagged yield of cocoyam and R_{-1} is lagged rainfall.

The regression result shows a negative relationship between yield of cocoyam, rainfall (–1685.3) significant at 10 percent, and lagged rainfall (– 582.89) (not significant). This shows that output continued to increase irrespective of decrease in rainfall during the year and between years. This could be attributed to Nigeria being the largest producer of cocoyam in Africa.

Table 6: Result of Cointegration test for Plantain:

Hypothesis	Eigen value	Trace statistic	0.05 critical value	Prob**
K = 0	0.6616	31.2820	35.1927	0.1244
K ≤ 1	0.3764	11.7777	20.2618	0.4689
K ≤ 2	0.1663	3.2751	9.1645	0.5305

The result in table 6 shows no cointegration between the variables at 0.05 significant level and so the ordinary least square regression is used to analyze the relationship between the variables.

Table 7: Result of regression for plantain output and rainfall

Variable	Estimate	t statistic	Prob
Constant	1176444.467*	2.522	0.23
R	44.260	0.046	0.964
R_{-1}	-2179.356***	-4.236	0.001
YP_{-1}	0.961***	10.086	0.000

$R^2 = 0.885$ F statistic = 41.016

*t = value significant at 10%

***t = value significant at 1%

The regression result is gotten from

$YP = 1176444 + 44.260R + 0.961YP_{-1} – 2179.356R_{-1}$

Where R is rainfall, YP_{-1} is lagged yield of plantain and R_{-1} is lagged rainfall.

The regression result shows a positive relationship (44.260) between rainfall and plantain even though its coefficient was not significant. However there is a negative relationship (– 2179.356) significant at 1 percent between the lagged rainfall (ie. rainfall of the previous year) and output which shows that output continued to increase irrespective of the changes in total annual rainfall between years.

CONCLUSION AND RECOMMENDATION

This study looks at the relationship between rainfall and primary investment commodities in southern Nigeria. The output of plantain and sweet potatoes were found to have a positive relationship with the amount of rainfall which shows that the production of these commodities irrespective of their increasing output were still dependent on the amount of rainfall. According to Ayinde, 2005, a 0.24 change in rainfall will likely lead to a unit increase change in agricultural output and vice versa. The output of the commodities were however found to have a negative relationship with rainfall in the previous year which shows that farmers were willing to plant more irrespective of the amount of rainfall in the previous year. Even though the output of the priority commodities has continued to increase, their potentials are still underutilized (Ukeagbu, 2011). This study shows that to further increase output, improved irrigation practices with improved cultivation practices are required as most of the present production is still rain fed and produced locally by subsistence farmers. The output of cocoyam was found to have a negative relationship with rainfall which means the increase or decrease in its output over the years is not as a result of increase or decrease in rainfall but the improvement in the technical and allocative efficiency of cocoyam farmers. This involves activities such as improved cultivation practices (cultivation in well drained soil to prevent rotting, application of fertilizer and constant supply of water), greater area of cultivation and use of improved planting stock. According to Ogunniyi, 2008, the average farm producing cocoyam could increase profits by 88% by improving their technical and allocative efficiency. To further increase output, improved irrigation practices are required as cocoyam thrive best in well drained soils where there is a steady and continuous source of water. According to the FAO, ignorance of its nutritive value and failure of cocoyam farmers to enter the international trade market and generate foreign exchange has lead to low returns from the crop. Farmers should therefore be enlightened and encouraged to produce more and export cocoyam. Farmers can also be assisted to obtain higher output through the introduction of modern and effective farm technologies which would not contribute to changes in climate but would increase production and increase the efficiency of farmers.

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