GROWTH RATE AND DOUBLING TIME OF YAM AND CASSAVA PRODUCTION IN NIGERIA

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ABSTRACT
The growth rate and doubling time of yam and cassava output, yield and acreage was investigated from data obtained from a secondary source and analyzed using the exponential and quadratic function in trend variable. The study revealed the growth rate during the period under consideration, there were growth as well as retardation, and it also shows acceleration, stagnation and deceleration at different sub-periods for the variables. Average growth rate of 6.7% for yam hectares, 0.03% for yam yield and 7.2% for yam output, translating into doubling time of 10 years for yam hectare, -0.8 year for yam yield and 62 years for yam output were estimated. The average rate of growth for cassava hectare was 11.1%, -0.498% for cassava yield and 8.5% for output. This translates to doubling time of 1 year for cassava hectare,-0.5 year for cassava yield and 14 years for output. This study also revealed that the growth rates of yam and cassava production over the years have more of stagnation than acceleration and deceleration based on the changes in the macroeconomic policy of the country, which implies that planning of the macroeconomic policies were not better than the previous ones. It therefore, indicates that, although there has been some level of increase in some of the sub-periods, the policy presentation for yam and cassava did not in any way translate to sustained increase.

KEYWORDS
Growth rate, doubling time, acceleration, deceleration, stagnation.

Roots and tubers crops, cassava and yam being the principal components, are known to contribute to the energy and nutrients requirements of more than two billion people; constitute an important source of income in rural and marginal area; have multiple uses, most notable as food security crops, regular food crops, cash crops and; are increasingly used as livestock feed raw material for industrial purposes. They have long served as the principal source of food and nutrition for many of the world's poorest and under nourished households and are generally valued for their stable yields under conditions in which other crops may fail (Scott *et al*, 2000).

Nigeria produces about 40 per cent of all the root and tuber crops in Africa. It is the largest producer of cassava globally producing 35% of Sub-Saharan Africa production and produces 70% of yam of the region (Lawrence *et al,* 2006). Yam and cassava are known to be the most important food crops in the southern part of the country. In 1999, production of yams was 25.1 million tons (67% of world production); manioc (cassava) 33.1 million tons (highest in the world and 20% of global production) (Encyclopaedia, 2007). Cassava is a hardy crop, tolerant to extreme ecological conditions and even thrives on impoverished soils. It is well suited to the prevailing farming system across the country, a key food security and income generating crop. This made Nigeria the world's largest producer of cassava (GFRN, 2006). Despite this opportunities for commercial development the crop remain largely unexploited, in contrast to the other major cassava growing regions in Asia and America.

The pattern of yam yields over the last 40 years in Nigeria is difficult to interpret though the gradual decline in yield from about 12 metric ton/ha in the late 1980s to about 8 metric ton/ha in 2004 has been attributed to the use of shorter fallow periods and use of more marginal lands for yam production because of demand to feed the increasing human population (Lawrence *et al,* 2006).Yam are relatively more expensive to grow compared to the other root crops because staking in many areas, and they require greater labour input for land preparation (clearing and mounding), stake tying and careful harvesting. Cassava

production, processing and export have become a major tool in the poverty alleviation and food security programme of the Federal Republic of Nigeria. However, yam is yet to receive sufficient research attention. Several macroeconomic policies have been used in Nigeria which has influenced the country's agricultural output growth directly and indirectly.

In a bid to accelerate food and industrial crops production, the Federal Government have introduced a number of programmes and initiatives. The history of this programmes and initiatives can be traced to the post-independence era starting with the three year development plan. The structural Adjustment Programme (SAP) in 1986 and the National Economic Empowerment and Development Strategy (NEEDS) in 2003 offer a major policy shift in the management of Nigerian economy, including the agricultural sector. In the agricultural sector, the first major programme was the National Accelerated Food Production Programme (NAFPP) in 1973. It was followed by the World Bank assisted Agricultural Development Projects (ADPs) in 1975 and then Green Revolution in 1980. More recently, the various presidential initiatives targeting specific crops, for example, the Root and Tuber Crops Expansion Programme (RTEP) 2003, in the last decade and the agricultural transformation agenda, for example, the voucher system in distribution of agro-inputs to farmers in 2011, embarked upon by the present government. The very fact that a new programme or policy is introduced is an expression of dissatisfaction with the existing one. It is also noticed that in spite of the numerous programme, the basic objective of self-sufficiency in food production has not been realised. In view of this, this paper seeks to determine the type of impact the various policies changes have had on agricultural production. More specifically, the paper assessed the growth rate and doubling time of yam and cassava in Nigeria between 1980 and 2007 in relation to Structural Adjustment Programme (SAP) and National Economic Empowerment and Development Strategies (NEEDS) policies during the period under study.

METHODOLOGY

The data used in this study were mainly sourced from FAO (1980-2007) covering a period of 27 years divided into four sub-periods which are the Pre-SAP (1980-1986), SAP (1986-1993), Post-SAP (1994-2003) and NEEDS period (2004-2007). Exponential function as well as the quadratic function in trend variables was used, this analysis was carried out on both crops mentioned earlier.

The exponential function is given as:

$$Y_C = ae^{bt} (1)$$

Implicit form of the model which was linearized to give equation 2:

$$\ln Y_c = a + bt + u (2),$$

Where: Y_c= Crop variable: production (tones), area (ha) and yield (kg/ha), t = trend variable 1980-2007, u = error term, b = estimated coefficient, a= constant.

To determine the effect of macroeconomic policies on the individual crops by measuring the acceleration or deceleration in food crops economy during the period under study, the log quadratic trend equation was estimated as follows:

$$\ln Y_c = a + bt + ct^2 + u (3)$$

A positive significant value of c indicates acceleration while a negative implies a deceleration and in-significant value implies stagnation in the growth process (Ghosh, 2010).

Doubling time which is the number of years it will take to double the rate of growth of a time series was determined as follows:

$$n = \ln 2 \Big/ \ln\left[1 + \left(\frac{r}{100}\right)\right] \quad (4),$$

Where n is the doubling time (in years) and r is the growth rate (in percent per year) obtained from the growth equation.

When r is 1 (one percent per year) n equals 69.7(the approximate life span of an American) (Barlett, 2011).

The formula therefore, can be approximated by the equation 5:

DT=69/r (5) (Barlett, 2011; Nmadu, 2009),

Where DT=doubling time.

In this study the doubling time was determined using 51.9 as the approximate life span of a Nigerian (United Nations Development Programme UNDP, 2011), thus equation (5) is then transformed into:

DT=52/r(6)

The compound rate of growth was computed for each variable as follows:

$$r = \left(e^{b-1}\right) \times 100 \quad (7),$$

Where r= compound rate of growth, b= estimated coefficient from equation (2).

Equation (1) and (2) were applied to the entire period variable and the sub-periods in the study that is Pre SAP- 1980-1986, SAP-1986-1993 and Post-SAP-1994-2007(NEEDS inclusive).

RESULTS AND DISCUSSION

The results obtained from estimating the exponential growth equations of yam and cassava acreage, yield and output in Nigeria during the period under study are presented on Table 1 respectively while the result of the compound growth rate computed from the growth equation for both yam and cassava are presented on Table 2. The time (in years) required for the variables (acreage, yield and output) to double their rate of growth based on the current trend was computed and the results shown on Table 3. The estimated quadratic equation of yam and cassava acreage, yield and output and there nature of growth are presented in Tables 4and 5 respectively.

The results on Tables 1 show that the area, output and yield exhibited positive trends in the entire period for both crops, except for the cassava yield. During this period the coefficient of the trend variable was significantly different from zero at 1% for yam yield and output; and cassava acreage and output. Yam acreage is significant at 5% while cassava yield is non-significant. The variable behaved somewhat differently during the sub- periods. There was significant reduction in growth for both yam and cassava yield during the post- SAP period despite increase in acreage. The increase in acreage did not give a corresponding increase in output as a result of poor yield realised from the use of more marginal lands accentuated by demand to feed the increasing human population. In addition, it has been argued that fund released for the expansion of rural economy during this period was used for non-farm livelihood activities perceived to have higher returns (Ifeanyi, Godwin, Chuma and Nwakeago, 2007).

According to the results on Tables 2, the growth rate of yam acreage was 6.7% on the average, which translated to an average yield of 0.031% during the SAP period giving the only positive yield among all the sub-periods. It was further observed that increase in the yield of yam was mainly due to expansion of area under cultivation. Unlike in yam production, it was observed that the yield of cassava during the SAP period was on decline but gave better result than other sub-periods. However, the average yields of all the sub-periods

showed retardation. The NEED sub-period showed the largest area allocated to cassava. The increase was due to export promotion on crops under a new policy called 'presidential initiative' during this period. However, the increase did not translate into significant increase in output, most likely due to outdated production technology as well as low management skills. Therefore, expansion in area planted to yam and cassava was the main component of increased production. This has being the pattern in the Sub- Saharan Africa in contrast to other regions like Latin America where area planted to cassava decreased annually by -0.3% between 1980 and 1992 and the marginal annual increase in production resulting from increased yields. Likewise, in Asia the annual growth rates of cassava production during the above period averaged 1.2%, largely as a result of increased yields per hectare. Similarly, expansion in yam production which is almost confined to few Africa countries globally averaged 7.4% annually largely as a result of a significant increase in the area planted and marginal increase in the yield per hectare (Technical Advisory Committee (TAC),1997). In view of this, there is a great prospect for increasing yield of yam and cassava as noted by TAC (1997). According to TAC (1997), that there is an unrealized yield potential that could be attained if the needed technology is made available to deal with yield limiting factors (water, nutrients) and yield-reducing factors (disease, pests).

The results on Table 3 show that while it will take 10 years (that is by year 2017) to double the rate of growth of acreage of yam based on the current trend, the doubling time for yield indicated that yam production technology is as old as 2006 and that has translated to very low output, which will double by the year 2070. This confirms the earlier assertion that most policy reforms in the past were translated to acreage 'extensification', meaning that more land is put under cultivation which leads to over-utilization of labour and low efficiency of the other inputs, particularly fertilizers (TAC, 1997). The cassava acreage seems to be growing faster than yam, and has doubled by year 2008 based on current trend but the yield is showing that the current production technology is that of 2006. However, the output is expected to double by year 2021 almost 50 years earlier than yam. The faster growth in cassava output is most likely the recent important policies like promotion of high quality cassava flour for export and replacing 10% wheat flour with cassava flour in bread-baking.

The results on Tables 4 and 5 show that over the entire period, the output, yield, and acreage of both crops decelerated with the exception of cassava yield and output: and yam yield which were stagnant. During all the sub-periods stagnation was observed for cassava acreage and output as well as yam acreage. In addition, there was stagnation in yam yield and output during the pre-SAP period except for cassava yield that recorded acceleration. During the SAP and NEED period however, there was stagnation throughout for both crops. The post-SAP period had acceleration for yam output and yield but recorded deceleration for cassava yield. The implication of this is that, although there has been some level of increase in some of the sub-periods, the policy presentation for yam and cassava did not in any way translate to sustained increase. It has been pointed out that the frequent policy reversals have impacted negatively on agricultural production (Uzor, 2010).

Table 1 - Exponential coefficients of yam and cassava production in Nigeria

	Yam			Cassava		
	Acreage	Yield	Output	Acreage	Yield	Output
Entire period	0.063627***	0.02279***	0.086418***	0.054419***	-0.07884	0.058055***
	(0.004162)	(0.004829)	(0.006438)	(0.03988)	(-0.050257)	(-0.003733)
Pre SAP	0.05361	-0.06685	-0.01324	-0.01741	0.32434*	0.15022
	(0.040335)	(0.038818)	(0.010536)	(0.011287)	(-0.013505)	(-0.013508)
SAP	0.134382***	0.09376**	0.228141***	0.147562***	-0.00956	0.138005***
	(0.021458)	(0.023062)	(0.021716)	(0.015146)	(-0.006754)	(-0.009803)
Post SAP	0.039729***	-0.012*	0.027727***	0.024429***	-0.82347**	0.012728***
	(0.004924)	(0.00567)	(0.002558)	(0.005601)	(-0.293578)	(-0.003129)
NEED	0.031418**	-0.02983	0.001592	0.028627*	0.014238	0.042863
	(0.002395)	(0.039617)	(0.04844)	(0.009594)	(-0.02041)	(-0.022584)

Source: Research study, 2012
*Value in parenthesis are standard errors ***Significant at 1% **Significant at 5% *Significant at 10%.*

Table 2 - Compound growth rate of yam and cassava production computed using the exponential coefficients

	Yam			Cassava		
	Acreage	Yield	Output	Acreage	Yield	Output
Entire period	6.56948	0.23052	9.0262	5.59269	-0.7581	5.97733
Pre SAP	5.5072	-0.6466	-1.3153	-1.7259	3.83118	16.209
SAP	14.383	0.98296	25.6262	15.9005	-0.0951	14.7981
Post SAP	4.05288	-0.1193	2.8115	2.47298	-5.6109	1.28094
NEED	3.19168	-0.2939	0.15933	33.1452	0.1434	4.37949
Mean	6.74084	0.03073	7.2616	11.0771	-0.4979	8.52897

Table 3 - Doubling Time for Yam and cassava production in Nigeria

	Yam			Cassava		
	Acreage	Yield	Output	Acreage	Yield	Output
Entire period	7.91539	2.2558	5.76101	9.29784	-0.6859	8.69954
Pre SAP	9.44219	-0.8042	-39.536	-30.129	0.13573	3.2081
SAP	3.61539	0.52901	2.02917	3.27034	-5.4654	3.51396
Post SAP	12.8304	-4.3594	18.4955	21.0272	-0.0927	40.5954
NEED	16.2924	-1.7693	326.373	1.56886	3.62626	11.8735
Mean	10.0192	-0.8296	62.6247	1.00712	-0.4964	13.5781

Table 4 - Quadratic coefficients of yam and cassava production in Nigeria

	Yam			Cassava		
	Acreage	Yield	Output	Acreage	Yield	Output
Entire Period	-0.00116**	-0.00129*	-0.00245***	-0.00114**	-0.00313	-0.00114
	(0.000541)	(0.000632)	(0.000767)	(0.000516)	(0.00708)	(0.000516)
Pre SAP	-0.03168	0.037343*	-0.01105	-0.00448	0.014264**	0.009786
	(0.020665)	(0.01671)	(0.01819)	(0.006933)	(0.005012)	(0.007217)
SAP	0.012757	-0.02381**	0.005667	0.003493	-0.00078	0.002718
	(0.010276)	(0.006796)	(0.006183)	(0.008147)	(0.003683)	(0.00523)
Post SAP	-0.00251	0.004487**	0.01977**	0.001437	-0.25327**	0.001882
	(0.001852)	(0.001693)	(0.000781)	(0.002304)	(0.078911)	(0.001115)
NEED	-0.00321	-0.05494	-0.05815	-0.01294	-0.01695	-0.02989
	(0.002006)	(-0.030094)	(-0.028088)	(0.00792)	(0.027463)	(0.019542)

Source: Research study, 2012.
*Value in parenthesis are standard errors ***Significant at 1% **Significant at 5% *Significant at 10%.*

Table 5 Nature of growth of yam and cassava production in Nigeria

	Yam			Cassava		
	Acreage	Yield	Output	Acreage	Yield	Output
Entire Period	D	D	D	D	S	S
Pre SAP	S	A	S	S	A	S
SAP	S	D	S	S	S	S
Post SAP	S	A	A	S	D	S
NEED	S	S	S	S	S	S

A=Acceleration S=Stagnation D=Deceleration

CONCULSION AND RECOMMENDATION

Analysing the production of yam and cassava in Nigeria for the period of 1980 to 2007 has shown a need to adequately look into the enterprise with an aim to improving the production in future as the result shows that there was more of stagnation of growth during certain period under investigation than acceleration and deceleration depending on the variable and the changes in the economy. The average rate of growth for yam acreage was found to be 6.7%, 0.03% for yield and 7.2% for output, which translated to doubling time of 10 years for acreage, -0.8 years for yield and 62 years for output. For cassava, the average growth rate was found to be 11.1% for acreage, -0.49% for yield and 8.5% for output, which translated to doubling time of 1 year for acreage, -0.5 year for yield and 14years for output. Therefore based on these findings it is recommended that rather than farmers translating

new policies initiatives to acreage expansion, effort should be made to fund research to produce high-yielding seeds and other improved production technologies before farmers are invited to participate. Technology-generating institutions, that is research stations and various faculties of Agriculture in the Universities should be involved in the conceptualization of new policies in order to ensure that implementation is not focused on other objectives outside the original targets. The new transformation agenda, seeking to privatise inputs distribution through the voucher system should be properly implemented to pave way for the take-off of commercial agriculture in Nigeria.

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