Journal of Inter-Disciplinary Studies on Contemporary Issues
Vol. 5, (1 & 2), 2019

Growth Trend Analysis of Area, Production and Productivity of Oil Palm and Agricultural Policy Regimes in Nigeria (1970 – 2018)

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Abstract
Palm oil production is an important income generating activity in the agricultural sector and thus its implications for the livelihoods of rural people. The main objective of this study is to carry out a trend analysis of area, production and productivity of oil palm in Nigeria under three policy regime(Pre-Sap, Sap and Post-Sap)**.**The study was guided by three objectives, three research questions and three hypothesis. were collected from CBN, NBS Statistical Bulletin, FAO, and World Bank. The time series data were examined using econometric models, graphs, growth models, and kinked exponential model. Using the kinked exponential methodology for growth estimation, the study reveals that the compound growth rates of palm oil production were 1.625%, -0.45% and 2.094% of the pre-SAP, SAP and Post SAP periods respectively. Regarding the differences in output, yield, and area harvested, the result reflected widening instabilities across the regime. Based on the findings, the oil palm production can be improved by the increase in productivity through increasing use of advisory services and provision of input supports to the farmers engaged in the oil palm cultivation.

Keywords : Growth trend, Palm oil production, Agricultural policy regime, Nigeria

Introduction
This study is focused about various agricultural policy regimes or periods in Nigeria and its relation to economic development. Production trend of oil palm was analyzed in detail to see the impact of various policy regimes that have come to dominate the Nigerian state. The agricultural sector has contributed immensely to the Nigeria economy; it was very relevant during the first decade (1961-1971) after independence (Ogen, 2003). The agricultural sector provides about 90% of federal government's foreign earnings, about 70% of the Gross Domestic Product (GDP), and likewise caters for about 70% of the working populace. During the above mentioned period, Nigeria was the world's leading exporter and producer of palm products and also the second largest producer of cocoa.

However, the situation with Nigeria's agriculture began to decline with the exploration of crude oil, despite the scenario the Nigeria's economic growth and development agriculture is still a major means of economic dependency as it accounts for about 37.50% of the Gross Domestic Products (GDP) in 1993 at 1984 constant factor cost. Agriculture's share of Nigeria's GDP has declined from the early 60% in 1960s through 48.8% in the 1970s, 22.2% in the 1980, and 18.34% in 2013

(Udom, 1986; Hyman, 1990; Utomakili & Abolagba, 1996).

Various factors can be traced as the reasons for the fall in agricultures share such as unstable, inappropriate and unfavorable government policies, lack of the use of modern inputs and extension service; previously controlled by monopoly marketing board; low provisions of market information, standards and quality control, and farm level production Agricultural exports as a percentage of total exports declined to about 7% from about 43% in Nigeria between 1970-1974. One of the major setback experience in Nigeria is the lack or inconsistency of our agricultural programme and there is a need to consider the formulation and appraisal of Nigeria agricultural policy in a programme of economic development, corroborating this view Eneh (2011) opined that Institutional/Structural policy inconsistencies have plagued Nigerian developments. There are a few concerns about the growth and development of agriculture in Nigeria. As any high growth rate in agriculture especially the crop sub-sector is brought about by expanding area under cultivation. The major intent of this study is not providing a comprehensive or detailed review of agricultural policy in Nigeria, but rather the study intend to examine the various policy regimes or sub-period which performed better and why, using oil palm as amajor economic and important cash crops cultivated in Nigeria.

Objectives of the Study

The main objective of this study is to carry out a trend analysis of area, production and productivity of Oil palm in Nigeria **.**This main objective will be achieved through the following specific objectives which include to:

(i) detremine the trend in output growth in palm oil production under different policy regimes;
(ii) examine the acceleration or deceleration in the growth performance in output of palm oil under different policy regimes;
(iii) determine the variations in palm oil production (yield, output and harvested area) with a view to identify the effect of the policy regime on palm oil production stability;

Research Questions

The following research questions were raised for the study.

(i) What is the current trend in the palm oil growth rate in Nigeria?
(ii) What is the growth performance of palm oil output in Nigeria?
(iii)How does poor policy implementation affect palm oil output, yield and area harvested?

Research Hypotheses

The following hypotheses were tested in the study.

(i) The differential coefficients of the variables with respect to the growth rate of palm oil output are not significantly different from the benchmark coefficient.
(ii) The differential coefficients of the variables with respect to growth performance in output of palm oil are not significantly different from the benchmark coefficient.

(iii)The differential coefficients of the variables with respect to area, yield and output of palm oil are not significantly different from the benchmark coefficient.

Scope and Data Collection

The study was carried out in Nigeria. Nigeria is between latitude 4^0 and 14^0 North of the equator and longitudes 3^0 and 14^0 East of the Greenwich meridian. Nigeria has an area territory of 923,768.00 sq kilometers; a north-south length of around 1 450 km and a west-east broadness of around 800 km. It is limited on the North by the Republic of Niger, on the South by the Atlantic Ocean, west by the Republic of Benin, and on the East by the Federal Republic of Cameroun while on the North-East fringe is Lake Chad. (The Federal Ministry of Environment of Nigeria 2011 and Online Nigeria, 2015).

The general description of Nigeria, showing states, features and boundary is presented in Figure 1.

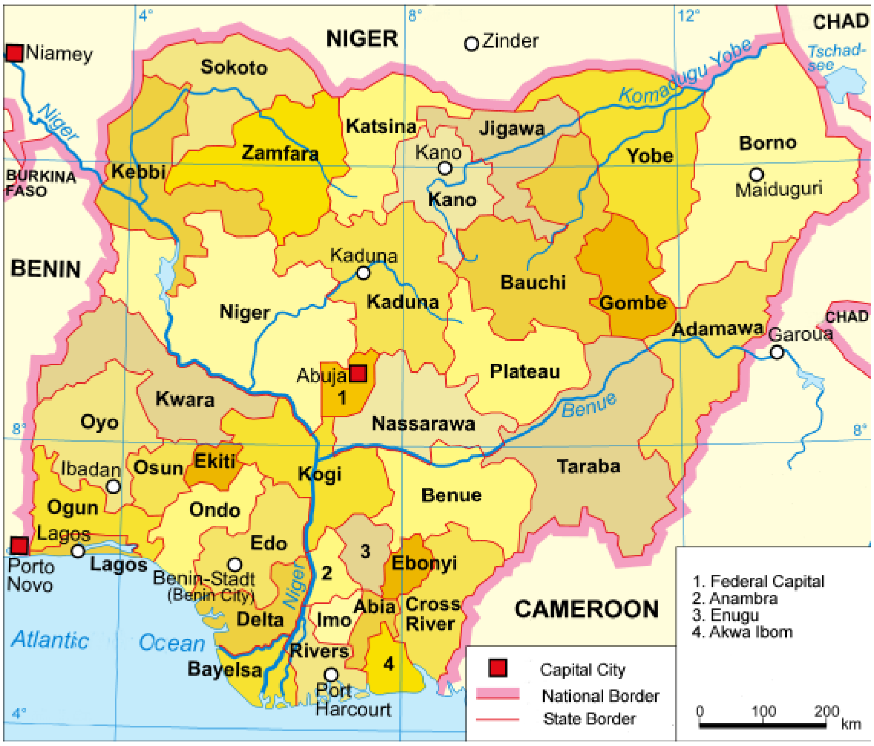

Figure 1 Map of Nigeria

This study relied on aggregate secondary data from 1970-2018 spanning 49 years. Data were acquired from different publications of the Central Bank of Nigeria (CBN), in particular Statistical Bulletin, Economic and Financial review and National trade summary. Data were sourced from various editions of Food and Agriculture Organization (FAO), United States Department of Agriculture, World Bank, National Bureau of Statistics (NBS), and the Federal Ministry of Agriculture and Rural Development. The analytical techniques for this study involved the use of descriptive and inferential statistics.

Method of Study

The analytical tools used to achieve the objectives of this study are examined in this section.

Objective (i) estimated the growth trend in the production of palm oil under different policy regimes within the period of study.

This was realized using the traditional growth regression model (Linear trend equation) and the kinked exponential model. The reason for this was to determine the models with a better estimate. Compound growth model was used to estimate the growth trend in palm oil production. This model was used by Gujarati, (2003); Khalid and Burhan, (2006); Shadmehri (2008) Khan, et al (2008) and Oyinbo and Yusuf (2012) to estimate the growth rate of both annual and perennials crops.

Model Specification

The compound interest formula was used to develop the model. It is expressed as:

$Y=Y_0(1+r)^t$ ………………………………………………………………………. (1)

Let;

Y_t = Output of Palm Oil (‘000 tonnes)

Y_0 = Initial Value of Palm Oil Output (‘000 tonnes) in 1970.

r= Compound rate of growth of Palm Oil output over time

t= Time trend (1970 to 1985, 1986 to 1994 and 1995 to 2018)

Taking the natural logarithm of equation (3.1), equation (3.2) was derived as:

$\ln Y_t = \ln Y_0 + t\ln(1+r)$ ....……………………………………………………………. (2)

let say;

$\ln Y_0=a_0$

$\ln(1+r) =a_1$

Then equation (2) can be rewritten as

$\ln Y_t=a_0 + a_1t$…………………………………………………………………………… (3)

By adding disturbance term to equation (3), the explicit form of the model becomes:

$\ln Y_t= a_0 + a_1t + u_t$………………………………………………………………………… (4)

Where:

Y_t = Output of Palm Oil (‘000 tonnes)

t= Time trend (1970 to 1985, 1986 to 1994 and 1995 to 2018)

a_0= constant term

a_1= Coefficient of time variable

u_t= Random term

After the estimation of trend equation, the compound rate of growth was computed as follows:

$r=(e^{ai}-1)*100$………………………………………………………………………………..(5)

r= Antilnb$_1$-1

compound growth rate = =$(e^{ai}-1)$ X 100; where e = Euler exponential with a value of 2.718281.

or

compound growth rate =(antilog a_1 - 1)x100

Where:

r = compound rate of growth

a_1= estimated coefficient from equation 4

e = eular’s exponential constant (=2.71828) (Sawant, 1983)

The annual compound growth rate (s) can be worked out by using: Antilog (a) =Antilog (log (1+r)).

Antilog (a) =1+r and r = Antilog a-1 When multiplied by 100, it gives the percentage growth rate in area, production and productivity of sugarcane. That is, Compound Annual Growth Rate (CAGR) (%) = r = (Antilog a-1) x100.

Double Time analysis

This analysis provides a simple way to calculate the approximate number of years it takes for the level of a variable growing at a constant rate to double. This rule states that the approximate number of years' n for a variable growing at the constant growth rate of r percent. This model was used by Nmadu, (2009) and Maikasuwa and Ala (2013).

DT = 69/r-- (6)

Where:

DT = Doubling time

69= constant

r = compound rate of growth as in equation (5)

Kinked exponential model

The kinked exponential model was also used to estimate the growth rates in different sub-periods; the model specification is as expressed below;

$$1nY_t = a_1 + b_1(D_1t + D_2k_1 + D_3k_1) + b_2(D_2t - D_2k_1 - D_3k_1 - D_3k_2) + b_3(D_3t - D_3k_2) + u_t$$ …. (7)

In this equation Y_t is Output of Palm Oil ('000 tonnes), b_1, b_2 and b_3 are the growth rates for the first, second and third sub-periods respectively, while K are kinks and D are Dummies.

Where D_1 = 1 in 1970 to 1985(Pre-Sap),
= 0 elsewhere;
D_2 = 1 in 1986 to 1994(Sap),
= 0 elsewhere;
D_3 = 1 in 1995 to 2018(Post -Sap),
= 0 elsewhere;
t = 16.5 ---------, 25.5

t = 0 at the first break point, K_1 (at the mid-point of first two sub-periods - intersection or kink point between two sub periods and it is calculated by taking the average of the last observation of 1st sub-period and first observation of 2nd sub-period.)

t = 17 at the second break point, K_2 (at the mid-point of second and third sub-periods- - intersection or kink point between two sub periods and it is calculated by taking the average of the last observation of 2nd sub-period and first observation of 3rd sub-period.)

Growth rate (1970 to 1985) = b_1*100

Growth rate (1986 to 1994) = b_2 *100

Growth rate (1995 to 2018) = b_3 *100

Estimating the trend break equation also tests for the significance of the difference between the growth rates in two different sub periods:

$$1nY_t = a_1 + b_1t + b_1^*(D_2t - D_2k_1 - D_3k_1 + D_3t) + b_2^*(D_3t - D_3k_2) + u_t$$ ……………….…….. (8)

Where, b_1^* and b_2^* are the difference between the first and second sub-period growth rate andthe difference between the third and second sub-period growth rates, respectively. This model was spearheaded by Boyce (1987), and later utilized by a a good numbers of authors including Chattopadhyay and Das (2000) and Ghosh (2010). From accessible writing the unmistakable element of kinked exponential growth models, instead of using the conventional discontinuous model, is that they make use of information regarding the values of the variable in question throughout the time series in estimating the growth rate for a given sub-period as against the conventional discontinuous model. The rationale for preferring fitted trends over simple points-to-point growth rate calculations is that OLS estimates are less affected by instability or cyclical fluctuations; this eliminates what can be termed the discontinuity bias of conventional sub-period growth rate estimates. The sensitivity of growth rate estimates to instability is thus reduced by the kinked exponential method. Boyce (1987) gave suitable outlines by contrasting option assessments of farming yield development rates in Bangladesh and Indian condition of West Bengal. Thus, by comparing discontinuous growth trend estimates with that calculated using kinked exponential model, Boyce has shown that the former growth rates give anomalous results due to discontinuity bias. Finally, as concluded by Boyce (1987) the kinked exponential model removes this discrepancy as it imposes a continuity restriction at the break points between sub-periods and therefore provides an improved basis for growth rate comparisons. Thus in the absence of special circumstances such as definitional changes or natural disasters, kinked exponential models are preferable to discontinuous ones for growth rate comparisons.

Objective (ii) examined the acceleration or deceleration in the growth performance in terms of yield, output and harvested area of palm oil under different policy regimes.

In order to estimate the pattern of growth so as to determine whether there is acceleration, deceleration or stagnation in palm oil production in the Nigeria. This model was used by Marchenko (2009), Ghosh, (2010), and Maikasuwa, and Ala (2013) to estimate the pattern of growth of crops. The quadratic equation in time variable was fitted to the data to confirm the existence of acceleration, deceleration or stagnation during the same period and it was given as follows:

$$LogY_t = ao+a_1t_i+ a_2t_i^2 +u_t \text{--} (9)$$

All variables as previously defined, a_0, a_1 and a_2 are parameters to be estimated. In the specification of equation 3.9 the linear and quadratic time terms indicate the circular path in the dependent variable (Y_t). The quadratic time variable (t^2) allows for the possibility of determining whether there was acceleration, deceleration or stagnation in palm oil production during the period 1970-2013. In determining the pattern of growth, our main concern is on a_2 (i.e. coefficient of t_i^2) which reveals a measure of the growth pattern following Onyenweaku (2004); Onyenweaku and Okeye, (2005) If $a_2>0$ and statistically significant, then there is acceleration in growth, if $a_2<0$ and statistically significant, then there is deceleration in growth, if a_2 is positive or negative but not statistically significant, then there is stagnation in growth (Onyenweaku, 2004; Onyenweaku & Okeye, 2005)

Objective (iii) determined the variations in palm oil production (yield, output and harvested area) in the period under review. In order to achieve this, regression analysis was carried out inclusive of dummy variables (ANCOVA variables). This was employed in order to be able to quantify the behaviour of the dependent variable within the various regimes based on the assumption that macroeconomic variables measure can be accessed through differential seasonal break (regimes). That is the effect of macroeconomic policy measures within the period covered in this study -Pre -Sap, SAP and Post –SAP regimes. To compare the coefficients of the variables for the three regimes, the following model was developed.

Models specification

$Y_i = b_0 + b_2D_{2i} + b_3D_{3i} + U_t$.

Where

Y = dependent Variables (Yield, output and harvested area of palm oil in year t) ....(10)

D_{2i} = 1 if value is between 1986 to 1994 (SAP regime)

= 0 otherwise (i.e in other regime)

D_{3i} = 1 if value is between 1995 to 2018 (Post –SAP regime)

= 0 otherwise (i.e in other regime)

U_t = stochastic disturbance term

The period 1970-1985 was used as the benchmark period, it was for this reason not included in the model because the b_o (intercept) has already captured it. All other differential intercept slope coefficients from other dummy variables were compared. This was done in order to avoid the situation called dummy variable trap - this is a situation of perfect collinearity or perfect multicollinearity , if there is more than one exact relationship among the variables. (Gujarati and Porter,2009).

Results and Discussion

Growth Trend and Rate in the Production of palm oil

The trend in the production of palm oil is presented in Figure 2

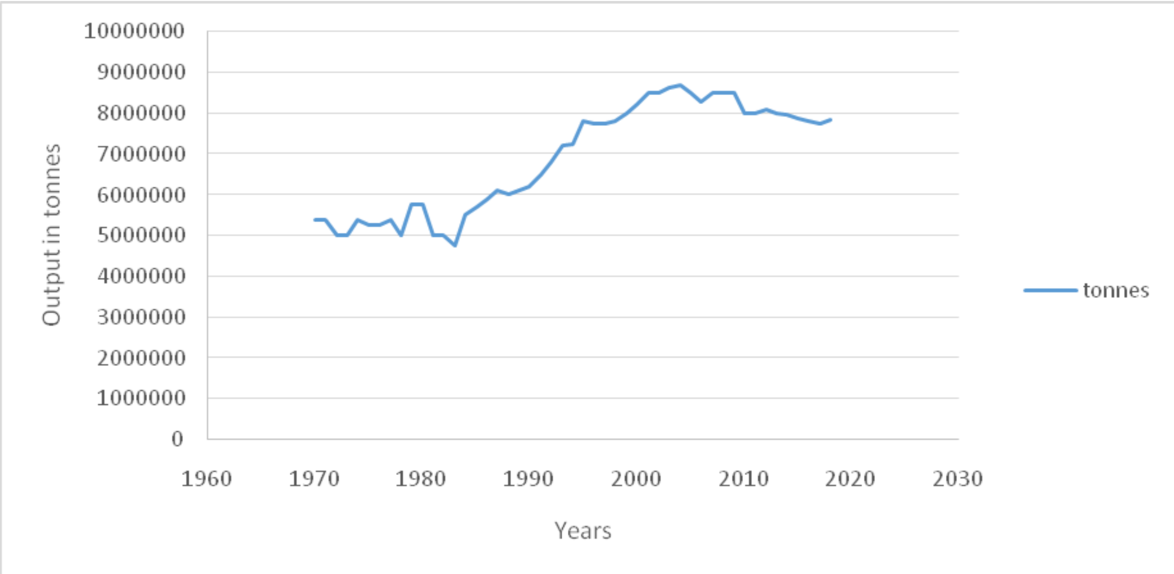

Figure 2: Palm oil Production Trend in Nigeria (1970 – 2018).

The graph of the palm oil output in Nigeria covering the pre-structural adjustment programme period (1970 to 1985), structural adjustment programme period (1986 to 1994) and post-structural adjustment programme period (1995 to

2013). The figure 2 shows that the output of palm oil varies within the three periods. However, in the pre-SAP period (1970-1985) the quantity of output was on the average 507.75 tonnes, in the SAP period (1986- 1994), the quantity of output on the average was 604.44 tonnes while in the Post -SAP period which is from 1995 to 2013, the quantity of output on the average was 788.105 tonnes. In summary the results revealed that the growth in palm oil production increased from 432 tonnes in 1970 to 930 tonnes in 2013, though with fluctuations within the periods.

Ammani (2012) carried out an analysis of the trends in output of the Nigeria agricultural transformation Agenda crops (1970-2007). He noted that after the discovery of crude oil there has been a decline in agricultural output. Several reasons were advanced for the decline in the agricultural sector performance in Nigerian, prominent among which are the increased foreign exchange earnings from the export of crude oil between 1972 and 1980 that resulted in the neglect "of the Nigerian agricultural sector (Ileso, 2000; Asiabaka and Owens, 2002; Walkenhorst, 2007; Sekumade, 2009; Chukwuemeka and Nzewi, 2011; Izuchukwu, 2011).

In line with part of objective one, the growth trend model was employed to estimate the growth rate of the palm oil output within the Pre-SAP, SAP, and the Post –SAP periods, thus identifying the existence of acceleration, stagnation or deceleration in output growth rate within the periods. One of the important reasons for this analysis is that it provides a leeway in assessing the policies and programmes of agricultural development in Nigeria (Antia-Obong and Bhattarae, 2012). The implication of this is that it helps us to assess why the various sources of growth differ and by so doing facilitates the removal of obstacles and the process of growth development is rapidly enhanced.

Growth Rate in the Production of palm oil (Conventional Method)

The growth rates in palm oil production was analysed using the instantaneous growth rate which measures
the growth at a point and the compound growth rates which measures growth rate over a period. The results are laid out in Table 1.

Table 1: Palm oil Growth Rate in Nigeria (Pre-SAP, SAP, and Post -SAP Periods)

Independent Variable	Coefficient	Standard error	t- value	p-value
Pre-SAP Period				
Constant (a_O)	-11.306	1.669	-6.773	0.000
Time (a_1)	0.007*	0.001	8.393	0.000
R^2=0.834;$\bar{R}^2$ =0.822;$F_{(model)}$=70.450,p-value for $F_{(model)}$=(0.000) significant at 5%.				
SAP Period				
Constant (a_O)	7.501	9.733	0.771	0.466
Time (b_1)	-0.002$^{N.S}$	0.005	-0.485	0.642
R^2=0.033;$\bar{R}^2$=-0.106;$F_{(model)}$=0.235,p-value for $F_{(model)}$=(0.642) not significant at 5%.				
Post -SAP Period				
Constant (a_O)	2.803	0.008	345.459	0.000

Time (a_1)	0.009*	0.001	15.321	0.000
R^2=0.914; $\bar{R}^2$=0.910;$F_{(model)}$=234.748,p-value for $F_{(mode\ )}$=(0.000) significant at 5%.				
All Period				
Constant (a_O)	2.637	0.007	354.854	0.000
Time (a_1)	0.007*	0.000	28.207	0.000
R^2=0.944; $\bar{R}^2$=0.943;$F_{(model)}$=795.661,p-value for $F_{(model)}$=(0.000) significant at 5%.				

*P<0.05 significant , P>0.05, Not significant (N.S)

Pre – SAP Period (1970 - 1985) 16 years)

Instantaneous Growth rate (IGR) = relative change(b_1) ×100;

Instantaneous Growth rate (IGR) = 0.007 ×100;

Instantaneous Growth rate (IGR) = 0.70%

SAP Period (1986 - 1994) 9 years

Instantaneous Growth rate (IGR) = relative change (b_1) ×100;

Instantaneous Growth rate (IGR) = -0.002 ×100;

Instantaneous Growth rate (IGR) = -0.20%

Post – SAP Period (1995 - 2013) 24 years

Instantaneous Growth rate (IGR) = relative change (b_1) ×100;

Instantaneous Growth rate (IGR) Growth rate = 0.009 ×100;

Instantaneous Growth rate (IGR) Growth rate = 0.90%

All period

Instantaneous Growth rate (IGR) = relative change (b_1) ×100;

Instantaneous Growth rate (IGR) = 0.007 ×100;

Instantaneous Growth rate (IGR) = 0.70%

The Instantaneous Growth rate (IGR) of 0.70%, -0.20% and 0.90 % for pre – SAP period, SAP period and post – SAP periods respectively implies that over the period, 1970 – 1985, 1986 – 1994 and 1995 – 2018, the output of palm oil in Nigeria increased/decreased at the rate of 0.70%, -0.20% and 0.90 % per annum. However, the growth rate worked out are an instantaneous (at a point in time) rate of growth and not the compound (over period of time) rate of growth.

Thus in estimating the Compound growth rates (r) the Instantaneous Growth rate (IGR) of 0.70%, 0.20% and 0.90 % were used.

Using the model $\ln(1+r) = b_1$ as discussed in model specification;

r= Antilnb_1-1

$r=(e^{bi}-1)$

compound growth rate = $=(e^{bi}-1)$ X 100; where e = Euler exponential with a value of 2.718281.

or

compound growth rate =(antilog b_1 - 1)x100

Therefore, using the above formula, the compound growth was computed for the pre-SAP, SAP and Post -SAP periods.

Pre-SAP Period

CG = $(e^{0.007\ -\ 1})$ x100

CG (compound growth) =1.625%

SAP-Period

CG = $(e\text{-}^{0.002\ -\ 1})$ x100

CG (compound growth) =-0.459%

Post -SAP

CG = $(e^{0.009\ -\ 1})$ x100

CG (compound growth) =2.094%

All periods

CG = ($e^{0.007 - 1}$) x100

CG (compound growth) =1.625%

Pre – SAP period

The R^2 value of 0.834 means that approximately 83.4% of the variation in palm oil output in the pre sap era was explained by variation in time. The t -value of 8.393 calculated for b_1 indicates that b_1 is positive and statistically significant ($p<0.01$). The coefficient of the trend variable, b_1, in the growth model has a value of 0.007, suggesting that there is a slow process of growth in output of palm oil during the period 1970 - 1985. Also indicating that palm oil production in Nigeria had an annual instantaneous growth rate of 0.70%; and a compound growth rate of 1.625% . The result of the F-statistic (70.450, with P value at 0.000) indicates that as a group, all the explanatory variables are jointly significant in explaining growth rate in Pre-SAP period.

SAP period

The R^2 value of 0.033 means that approximately 3.3% of the variation in palm oil output in the sap era was is explained by variation in time. The t value of -0.485 calculated for b_1 indicates that b_1 is negative and not statistically significant, indicating that there is retardation in palm oil growth over the study period 1986-1994. The coefficient of the trend variable, b_1, in the growth model has a value of -0.002, with $p<0.01$. Suggesting that there has been a 0.2% per annum decreases in output of palm oil over the SAP period. Also it does imply that over the period 1986-1994, palm oil production in Nigeria had a negative annual instantaneous growth rate of -0.20%; and also have compound growth rate of -0.45%

Post – SAP period

The R^2 value of 0.914 means that approximately 91.4% of the variation in palm oil output in the post sap era was explained by variation in time. The t value of 15.321 calculated for b_1 indicates that b_1 is positive and statistically significant, is an indication that there is accleration in palm oil output growth over the study period 1995-2018. The coefficient of the trend variable, b_1, in the growth model has a value of 0.009, with $p<0.01$ suggesting that there has been a 0.9% per annum increase in output of palm oil over the Post -SAP period. Also it does imply that over the period 1995-2018, palm oil production in Nigeria had a positive annual instantaneous growth rate of 0.9%; and a compound growth rate of 2.094%.

Table 2: Summary of instantaneous and Compound Growth rate for Palm Oil in Nigeria (Pre-SAP, SAP, and Post –SAP periods)

Period	Year	Instantaneous Growth rate	Compound Growth rate
Pre-SAP	1970 - 1985	0.70	1.625
SAP	1986 - 1994	-0.20	-0.45
Post –SAP	1995 - 2018	0.90	2.094
All Period	1970 - 2018	0.70	1.625

The compound growth rates for output of palm oil in the Pre -SAP, SAP and the Post -SAP were 0.70%, -0.20% and -1.51%, respectively. This implies a relatively slow process of growth in output of palm oil particularly during the period 1970 - 1985. However, during the SAP and Post -SAP period the result indicates a decline in output for 1986-1994 and 1995 - 2013. This calls for concerted effort to reverse the process of decline to increase the process of growth in output. The process of decline in output could be reversed through expansion of area devoted to palm oil production by making use of land that is put to fallow. It was observed that the compound growth rate of palm oil output in Nigeria during the Pre-SAP was higher than during the SAP and post – SAP eras and also there was slight difference between the compounded rates of growth and the instantaneous growth rates. This finding is at variance with the finding of Ammani (2012) where the instantaneous growth rates and compound growth rates for palm oil within 1970-2007 with an instantaneous growth rates and compound growth rates of -0.2% respectively, but was in agreement with in case of cotton with where an instantaneous growth rates of 3.5% and compound growth rates of 7% within the same period was obtained. In a similar vein Ugwu and Kanu (2011), noted that despite the policy measures in the SAP period, the agricultural sector did not register significant overall growth.

Oyinbo and Yusuf (2012) who reported that rice had higher growth rates during the SAP period than the Pre-SAP and Post –SAP periods. The implication of theses result showed that the policy reform of the SAP era was favourable in ensuring increased cassava and maize production in Nigeria and thus the notion that SAP was a complete failure is misleading. The result also shows that the pre-SAP period had the highest positive growth rate, however this is at variance with Yusuf and Sheu (2007). In their study, they outlined three distinct times (period 1961 and 2003; 1986 – 2003, and 1991-2003), these periods were utilized to simulate the different policy regimes of Regulation, Structural Adjustment era and Liberalization era. In general, output of citrus and mango maintained upward trend over the years. Notwithstanding, the development rate was most noteworthy for the Structural Adjustment period.

Finally, this work was also in agreement with the findings of Akpan, Ini-mfon, Patrick, and John (2012). The result of their work shows that some cash crop productions were boosted during the Green Revolution period (1980-1985). For instance, the outputs of groundnut, cocoa and coffee indicated an improved growth rate compared to the previous policy period. Contrarily, the growth rate of

Cotton, Rubber and palm Oil output deteriorated within the same period. However, their findings is at variance with result from the Structural Adjustment Programme (SAP) period (1986-1993), where some cash crops production (cotton, groundnut, cocoa, rubber and Oil palm) witness improved positive growth rate compared to the immediate previous policy period. Despite this result, coffee output had a negative growth rate during this period with the outputs of cotton (38.7%) and Rubber (35.7%) highly unstable. However, palm oil with a growth rate of 6.6 percent exhibited minimal instability compared to other cash crop during this period.

This result is in agreement with those of Akpan *et al (*2012) whose findings indicated that during the PSAP era (1994-2010) the outputs of Cocoa, Rubber and Coffee had negative growth rates. One likely reason for this poor result is the effect of human activity such as urbanization which is encroaching into plantation estates of most cash crop enterprises in the country. Cotton (5.45%), groundnuts (4.14%), and palm oil fruit (1.01%) witnessed reduced growth rate compared to the immediate policy period.

Growth Rate in the Production of palm oil (Kinked exponential growth Method)

The growth rates of production of palm oil were measured by the kinked exponential growth model. The whole period of 49 years (1970 to 2018) was divided into three sub-periods; first sub-period (1970 to 1985) the Pre-SAP period, second sub-period (1986 to 1994) the SAP period and third sub-period (1995 to 2018) the Post- SAP period. These three sub-periods have special significance to the economy of Nigeria, because the agricultural development of the Nation during these periods witnessed some institutional and technological changes. The results are presented in Table 3.

Table 3: Growth rate for Palm oil in Nigeria 1970-2018 by Subperiod

Kinked exponential growth rates				Trend breaks		
Crop	1970-1985	1986-1994	1995-2018	First Break	Second break	R^2
Palm Oil	0.008(.001)**	0.004(0.002)**	0.009(0.001)**	-0.004(0.003)**	0.002(0.01)	0.9[illegible]

The result indicated that the growth rates of palm oil was 0.8%, 0.4% and 0.9% per annum during the Pre-SAP, SAP and Post-SAP respectively. Thus the growth rates were low especially during the SAP period, indicating that SAP policy did not really encourage palm oil production. The coefficient b_1^* which represent the difference between the first and second sub-period growth rates was -0.4% while b_2^* which represent the difference between the third and second sub-period, growth rate was 0.9%. The result shows that there is a reduction of about 4% in the growth rate from the Pre-SAP period to the SAP period while there is an increment of about 9% in the growth rate from the SAP period to the Post -SAP period. The implication is that the palm oil witnessed increase in growth rate both in the Pre-SAP and the Post -SAP periods.

The doubling time computed for the compound growth rates in years for output using the formula DT/r, showed that doubling time of 42.46 years for output of palm oil for the 1970-2018 production. That is all things being equal, it would take 42.46 years to double the rate of development in output taking into account the present pattern. It in this manner implies that, the productivity growth trend needs to be enhanced with a specific end goal to lessen its doubling time. This could be done through building capacity of the local farmers on new technologies at the same time increasing their accessibility to farm inputs.

Maikasuwa, and Ala (2013) obtained a doubling time of 19.38 years for output of sorghum for the 1983-2012 production period while Ibrahim *et.al*. (2010) obtained a doubling time of 32 years for output of sugarcane for the 1983-2003 production period.

Acceleration, Deceleration and Stagnation in the palm oil Production

Table 4: Acceleration, Deceleration and Stagnation in the palm oil Production

Independent Variable	Coefficient	Standard error	t- value	p-value
Pre-SAP Period				
Constant (a_0)	2.635*	.013	196.164	.000
Time trend (a_1)	.010*	.004	2.778	.016
Time trend squared (a_2)	.000 ^{NS}	.000	-.854	.409
R^2=0.843;$\bar{R}^2$=0.819 ;$F_{(model)}$=34.907,p-value for $F_{(model)}$=(0.000) *significant at1 %				
SAP Period				
Constant (a_0)	2.817*	.051	55.694	.000
Time trend (a_1)	-0.016 ^{NS}	.023	-.686	.518
Time trend squared (a_2)	0.001 ^{NS}	.002	.599	.571
R^2=0.087;$\bar{R}^2$=-0.217;$F_{(model)}$=0.285,p-value for $F_{(model)}$=(0.761) *significant at 1%				
Post -SAP Period				
Constant (a_0)	2.786*	.0120	225.573	.000
Time trend (a_1)	0.012*	.002	5.442	.000
Time trend squared (a_2)	-.001**	.000	-1.671	.110
R^2=0.924;$\bar{R}^2$=0.917;$F_{(model)}$=128.323,p-value for $F_{(model)}$=(0.000) *significant at 1%				
All Period				
Constant (a_0)	2.654*	.011	290.006	.000
Time trend (a_1)	.005*	.001	5.144	.000
Time trend squared (a_2)	4.098E-005*	.000	2.071	.044
R^2=0.949;$\bar{R}^2$=0.947;$F_{(model)}$=427.831,p-value for $F_{(model)}$=(0.000) *significant at 1%				

*P<0.01, **P<0.05 significant , P>0.05, Not significant (N.S)

To investigate the existence of acceleration or deceleration or stagnation in the growth of palm oil production, the quadratic equation in the time trend variable were fitted according to the equation 3.9. Results in Tables 4.4 show the estimated quadratic equation in time trend variable for production, of palm oil during the pre-

SAP, SAP and Post -SAP period. The quadratic term t^2 allows for the possibility of acceleration, deceleration and stagnation in the growth process. Results in Table 4 shows that the values of the coefficients of t^2 variable for pre-SAP, and SAP are 000, and 0.001 while Post SAP is 0.001. while the pre-SAP and SAP is not significant the Post –SAP was significant at 0.05 probability level. The non-significance of the coefficients of the t^2 variable is a confirmation of significant stagnative growth in production of palm oil.

Quadratic equation in time trend variable for Palm Oil Production in Nigeria (Pre-SAP, SAP, and Post -SAP periods)

After estimating the model, the variable in the model for all periods can be written as the following equation:

$LogYt = 2.654 + 0.005ti + 4.098E\text{-}0.05ti^2$

Se= (0.011) (0.001) (0.000)

t= (240.006) * (5.144) * (2.071) *

$R^2=0.949$, F=427.831

The result showed that the coefficient during the entire period 1970 - 2018 with respect to output of palm oil was significant $p<0.01$. However, the coefficients of t^2 was positive and significant at 1% in other words, the coefficients of t^2 is a confirmation of acceleration in the growth of palm oil output during these periods. This can also be said to be the reason for equality of instantaneous and compound growth rate. Therefore, the Null hypothesis was rejected since a^2 is statistically significant meaning that there is acceleration in the growth process with respect to output of palm oil.

Results in Table 4 show that the values of the coefficients of t^2 variable for Pre-SAP, and SAP are 0.000, and 0.001 for production, all being not significant at 0.05 probability level except for Post-SAP period. The significance of the coefficients of the t^2 variable is a confirmation of significant accelerative growth in production during the Post -SAP period, while the coefficients of the t^2 variable is a confirmation of significant stagnative growth in production during the Pre-SAP and SAP. This result corroborates the findings of Onyenweaku (2004) where stagnation in output was confirmed for rice in pre-SAP period, and conforms to the findings of Tanko *et al.* (2010) where significant decelerative in production, area and productivity was observed for rice in SAP period. Tanko *et.al* (2010) observed a decelerative growth in area, production and productivity of rice for the period 1985-2006, Ibrahim *et.al.* (2010) realized accelerated growth in rice for the period 1983-2003 while Onyenweaku (2004) discovered a stagnated growth in the Nigerian agricultural production for the period 1970-2000. However, Sadiq (2014) confirms a statistically significant deceleration during the SAP period for rice production in Nigeria.

Variations in palm oil Production (Yield, Output and Harvested Area) Overtime

The ANOVA result on the variation on yields, output of palm oil and harvested area of palm oil are shown in Table 5, Table 6 and Table 7 respectively

Table 5: Palm Oil Production in Nigeria (Pre-SAP, SAP, and Post –SAP periods).

Independent Variable	Coefficient	Standard error	t- value	p-value
Constant (b_O)	507.750*	22.297	22.772	0.000
D_1 (SAP)	96.694*	37.161	2.602	0.012
D_2 (Post -SAP)	314.958*	28.785	10.942	0.000
R^2=0.723; $F_{(model)}$=63.794,p-value for $F_{(model)}$=(0.000) *significant at 1%;				

Note: Pre-SAP period is the Constant (b_0)

The empirical results in Table 5 shows that, statistically the mean output of palm oil during the period of SAP and Post –SAP was statistically different from the slopes obtain during Pre-SAP policy periods at 1%. The result implies that the mean palm oil production during SAP and Post –SAP periods was statistically and significantly higher than the mean output during Pre-SAP by 96.694 and 314.958 units respectively. In other to get the actually mean output of the SAP and Post SAP period the constant mean output is added to the mean output during SAP and Post SAP to arrive at a mean output of 604.444 for SAP and that of the Post –SAP to be 822.708. This result implies that the effect of Pre-SAP, SAP and Post -SAP policy period impact on palm oil production in the country. The results reflect widening instabilities across the variables from the Pre-SAP period.

After estimating the model, the variable in the model can be written as the following equation:

Y_t= 507.750(Pre-SAP) + 604.444SAP+ 822.708Post -SAP

Se= (22.297) (37.161) (28.785)

t= (22.713) * (2.602)* (10.942)*

R^2=0.723, F=63.794

The result showed that the coefficient during the Pre-SAP, SAP and Post -SAP with respect to output were significant at 1 % (p<0.01). Therefore, the Null hypothesis was rejected and the Alternative hypothesis was accepted meaning that the regression coefficients with respect to output of palm oil are not identical across the periods. The implication of this is that the mean of the SAP and Post -SAP were significant different from the intercept (Pre-SAP).

In a similar vein, Akpan *et al* (2012) reported that in their study on output volatility of cash crops (Cotton, Groundnut, Cocoa, Rubber and Oil palm) in Nigeria across policy periods, the result reveals that the mean cash crop output volatility during post structural adjustment programme period was significantly different from other policy periods for most cash crop exception of coffee. For instance, their study reveals that the mean volatility of palm oil was statistically and significantly different between Post- SAP period and the other policy periods specify. The differential intercept coefficients with respect to PRE-Operation feed the Nation, Operation feed the Nation, Green Revolution and SAP were 0.077, 0.067, and 0.091 respectively. These coefficients were negative and statistically significant at various levels of probabilities, it implied that, the differential coefficients with respect to PREOFN, OFN, GR and SAP policy periods are statistically and significantly less than 0.096 during PSAP period by the value of their coefficients. Therefore, the impacts of PSAP, PREOFN, OFN, SAP and GR policy periods on palm oil volatility were significantly different. These findings corroborate the findings of Antia-Obong *et al* (2013), using the coefficient of variation on data from 1961-2007, their finding indicates the presence of a high variation in palm oil output, thus implies a high level of instability across the entire study period 1961-2007. Likewise, the coefficients of variation on data from 1961-1969, 1994-2007 and 1961-1969 with respect to output also show high level of instability. The results reflect widening instabilities across the variables, in addition the coefficients of variation with regards to output the value ranges from 5.74 in the Pre-SAP period, 0.68 in the SAP period and 5.32 in the Post -SAP period.

Table 6: Estimates of Palm Oil Yield in Nigeria (Pre-SAP, SAP, and Post –SAP periods).

Independent Variable	Coefficient	Standard error	t- value	p-value
Constant (b_O)	25.057*	0.119	211.265	0.000
D_1 (SAP)	1.604*	0.198	8.112	0.000
D_2 (Post -SAP)	1.105*	0.153	7.219	0.000
R^2=0.638;$F_{(model)}$=40.488,p-value for $F_{(model)}$=(0.000) *significant at 1%				

Note: Pre-SAP period is the Constant(b_0)

Similarly, the empirical results in Table 6 shows that, statistically the mean yield of palm oil during the period of SAP and Post –SAP was statistically different from the slopes obtain during Pre-SAP policy periods at 1%. The result implies that the mean palm oil yield during SAP and Post –SAP periods was statistically and significantly higher than the mean output during Pre-SAP by 1.604 and 1.105 units respectively. In order to get the actually mean output of the SAP and Post SAP period the constant mean output is added to the mean output during SAP and Post SAP to arrive at a mean output of 26.661 for SAP and that of the Post –SAP to be 26.162. This result implies that the effect of Pre-SAP, SAP and Post -SAP policy period impact on palm oil yield in the country. The results reflect widening instabilities across the variables from the Pre-SAP period.

After estimating the model, the variable in the model can be written as the following equation:

Yt= 25.057 (Pre-SAP) + 26.661(SAP) + 26.162(Post -SAP)

Se= (0.119) (0.127) (6.431)

t= (211.265) * (8.112) * (7.219)*

R^2=0.638,F =40.488

The result showed that the coefficient during the Pre-SAP, SAP and Post -SAP with respect to yield were significant at 1 % (p<0.01). Therefore, the Null hypothesis was rejected and the Alternative hypothesis was accepted meaning that the regression coefficients with respect to yield of palm oil are not identical across the periods. The implication of this is that the mean of the SAP and Post -SAP were significant different from the intercept (Pre-SAP).

This finding corroborated that of Antia-Obong et al (2013), using the coefficient of variation on data from 1961-2007. The study indicated the presence of variation in palm oil yield, the highest variability (instability) captures the entire under review period 1961-2007, besides the 1961-1969, 1994-2007 and 1961-1969 with respect to harvested area, were the most unstable periods. The results reflected widening instabilities in the variables with value ranges from 0.91 Pre-SAP periods, 0.68 in the SAP period and 1.56 in the Post -SAP period.

Table 7: Oil Palm Harvested Area of in Nigeria (Pre-SAP, SAP, and Post –SAP periods).

Independent Variable	Coefficient	Standard error	t- value	p-value
Constant (b_O)	2106.250*	34.726	60.653	0.000
D_1 (SAP)	313.750*	57.877	5.421	0.000
D_2 (Post -SAP)	1005.273*	44.83	22.423	0.000
R^2=0.917;$F_{(model)}$=267.353,p-value for $F_{(model)}$=(0.000) significant at 1%				

Note: Pre-SAP period is the Constant(b_0)

In respect of the harvested area the empirical results in Table 7 reveal that, statistically the mean harvested area of palm oil during the period of SAP and Post -SAP period was statistically different from the slopes obtained during Pre-SAP policy periods at 1%.The results implies that the mean palm oil harvested area during SAP and Post –SAP periods was statistically and significantly higher than the mean harvested of palm oil during Pre-SAP period by 313.750 and 1005.273 units respectively. In order to get the actually mean output of the SAP and Post SAP period the constant mean output is added to the mean output during SAP and Post SAP to arrive at a mean output of 2420 for SAP and that of the Post –SAP to be 3111.523. This result implied that the effect of SAP and Post -SAP policy period impact positively on palm oil area harvested in the country. The results reflect widening instabilities across the variables from the Pre-SAP period.

After estimating the model, the variable in the model can be written as the following equation:

Yt= 2106.250(Pre-SAP) + 2420(SAP) + 3111.523(Post -SAP)

Se= (34.726) (70.854) (57.699)

t= (60.653)S* (5.421)* (22.423)*

R^2=0.917, F=267.353

The result showed that the coefficient during the Pre-SAP, SAP and Post -SAP with respect to area harvested were significant at 1 % (p<0.01). Therefore, the Null hypothesis was rejected and the Alternative hypothesis was accepted meaning that the regression coefficients with respect to area harvested palm oil are not identical across the periods. The implication of this is that the mean of the SAP and Post -SAP were significant different from the intercept (Pre-SAP).

This finding corroborate that of Antia-Obong *et al* (2013) using the coefficient of variation on data from 1961-2007. Their study indicates the presence of the variation in palm oil harvested area, the highest variability (instability) captures the entire study period 1961-2007, besides, the 1961-1969, 1994-2007 and 1961-1969 with respect to harvested area, were the most unstable periods. The results reflect widening instabilities in the variables.

Conclusion and Recommendations

The study was embarked upon to examine trend and growth rates of oil palm under varuious policy regime.The findings of the study revealed that the differential coefficients of the variables with respect to the growth rate of palm oil output, are not significantly different from the benchmark coefficient. The kinked exponential growth model was used alongside the conventional growth model in analysing palm oil growth rate within three sub-periods; first sub-period (1970 to 1985) the Pre-SAP period, second sub-period (1986 to 1994) the SAP period and third sub-period (1995 to 2013) the Post -SAP period. The result showed that palm oil experienced slow growth rate in all periods, but most worrisome was the SAP period, indicating that SAP policy did not really encourage palm oil production. The study also demonstrated that using the kinked exponential growth model alongside with the conventional discontinuous model resulted in a better basis for growth rate comparisons. This is because while the conventional discontinuous model growth rates, give anomalous results due to discontinuity bias, the exponential model removes the discrepancy as it imposes a continuity restriction at the break points between sub-periods. It was suggested that this growth rate of oil plam can be improved upon through expansion of area devoted to oil palm cultivation. This could be achieved through increased sensitization and mobilization of the local farmer on the need to bring back use such land area that were put to fallow. The process can also be improved by the increase in productivity through increasing use of advisory services and provision of input supports to the farmers engaged in the oil palm cultivation.

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