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DETERMINANTS OF PALM OIL OUTPUT SUPPLY IN NIGERIA

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Abstract

This study analyzed the determinants of palm oil output supply in Nigeria. A time series data, from the period of 1970-2014 were collected from the Food and Agricultural Organization data base and other sources. Trend analysis, ADF unit root test, co-integration test and error correction model were used to analyze the data. The trend in the output supply of palm oil shows significant growth rate based on the coefficient of the time trend (b_1). The unit root test using Augmented Dickey Fuller test (ADF) shows that all the variables have constant mean except for palm oil yield which led to the Autoregressive Distributed Lag (ARDL) co-integration test which reveals the presence of long run relationship existing between the variables and short run relationships with error correction term. Imports of palm oil has negative significant short run and long run impacts on the output supply of palm oil while in the short run palm oil exports has a significant negative impact on the palm oil output supply and a significant positive impact in the long run. The error correction model (ECM) suggests a high speed of adjustment of the dependent variable to changes in the independent variables. The import of palm products affects the output supply of palm oil negatively as this impedes the local production of palm oil. Export of palm oil was positively signed indicating that export of palm oil encourages the farmers to increase their output supply. This study therefore, recommends the promotion of export and formulation of export promotion policies to stimulate international market for our palm oil and encourage our farmers to boost their output.

Key words: *determinants, oil, output, palm, supply*

INTRODUCTION

Oil Palm (Ealeisguineensis) is one of the most commonly grown fruit crop and the number one vegetable oil crop. Palm oil which is extracted from the palm fruit is a major global commodity used for food and raw material [12]. Oil Palm cultivation is a source of livelihood for millions of people around the world especially in the southern part of Nigeria which is characterized by tropical forest, watersheds, and biodiversity. The palm oil belt in Nigeria includes the states of Abia, Anambra, Bayelsa, Akwa-Ibom, Cross River, Delta, Eboniyi, Ekiti, Enugu, Ondo, Ogun, Osun, Oyo, Imo and Rivers. Over the years, the country's palm oil capacity has even expanded beyond these traditional palm oil belts. Indeed as a result of extensive research in inputs and good ecology, oil palm is widely grown in over 24 states of the country in both wild groove and small holder farm plantations [3]. No part of the oil palm is a waste. The residue after oil has been extracted is called palm kernel cake, which is useful in feeding livestock. The leaves of palm oil are used for making brooms, roofing and thatching, basket and mats. The thicker leaf stalks are used for walls of village huts. The bark of the palm frond is peeled and woven into baskets [10].

Nigeria was a leading exporter of palm kernel, and largest producer and exporter of palm oil accounting for 43 percent of global palm oil production [1]. Export of cash crops such palm oil contributed significantly to the economy of Nigeria prior to the crude oil boom of the late 1960's [5, 2]. But due to over-reliance on traditional production techniques, excessive tapping of palm tree for palm wine and the civil war in 1967-70 which were more intense in areas where oil palm cultivation activities were predominant, hampered Nigeria's output supply of palm oil.

Nigeria is now a net importer of palm oil. The domestic palm oil produced totalled 930,000 MT in 2014. The growth in palm oil has stagnated at 930,000 MT since 2013. The consumption of palm oil in Nigeria amounts to 2.0 million MT per annum [1].

According to Emeifele, there have been many narratives over the years and in recent times on what led to this downward trend, with blames being apportioned by different parties along the palm oil value chain [5]. This poses a very precarious situation for the manufacturing sector that depends largely on palm oil as a major source of raw material. Nigeria today produces only 1.7 per cent of the world's consumption of palm oil which is insufficient to meet its domestic consumption which stands at 2.7 per cent [1]. The output supply of palm oil in Nigeria has been affected by some factors which may include the import and export of palm oil, the producer price, climatic variables as well as area harvested. Hence, there is the need to study the determinants of palm oil output supply in Nigeria.

Objectives of the study

The main objective of the study is to analyze the output supply response of palm oil in Nigeria. The specific objectives are to:-

(i)Analyze the trend and growth in the output supply of palm oil.

(ii)Analyze the determinants of output supply of palm oil in Nigeria.

Research hypothesis

Ho1: producer price, rainfall and area harvested have no significant impact on the output supply of palm oil.

Ho2: import and export have no significant impact on the output supply of palm oil.

MATERIALS AND METHODS

Nigeria is a country located in West Africa along the Atlantic Ocean's Gulf of Guinea, its land borders are with Benin to the West Cameroon and Chad to the East and Niger to the North. It is between latitudes 4^0N and 14^0N and longitudes 3^0E and 15^0E Meridian. It has a tropical climate with relatively high temperatures throughout the year annual average temperature varying from 35^0c in the North to 31^0C in the south. Temperature is highest from February to April in the South and from March to June in the North, and lowest in July and August over most states in the country.

It is the most populous nation in Africa, and has one of fastest growing population in the world. Currently, the population of Nigeria is being put at 167,000,000 people.

The land area is 923,768km2(356,667 square miles).

Sources of Data

Data were obtained from the Food and Agriculture Organization data base and UNDP (United Nations Development Programme) database for a period of 1970 - 2014.

Analytical Technique

Unit Root Test using the ADF test technique to test if the time series data were stationary, Autoregressive Distributed Lag (ARDL) co integration and error correction tests were also used.

Model Specifications

Unit Root Test: Augmented Dickey-Fuller (ADF) Test (for stationary test)

the ADF test consist of estimating the following regression

$$\Delta Y_t = \beta_1 + \beta_1 + \delta Y_{t-1} + \Sigma^m_t=1 \propto_i \Delta Y_{t-1} + e_t$$

Where

y is the series t is trend factor,

e_t is the stochastic error term

t_{-1} is the lag length.

It is a one sided test whose null hypothesis is $\delta=0$ versus $\delta<o$ (hence large negative values of the test statistics lead to the rejection of the null) and Δ is the difference operator. Under the null, Y_t must be differenced to achieve stationarity; under the alternative Y_t is already stationary and no differencing is required.

The Augumented Dickey-Fuller (ADF) unit root test was employed to test the integration level and the possible integration among the variables.

Trend Analysis

However, for measuring the acceleration or deceleration in the growth rate, trend equation was fitted and stated thus.

$$Y= a + b_t + U_t$$

Where

Y= output supply of palm oil (tonnes)

a= constant

b= coefficient

t= trend

U= error term

Positive significant value of c indicates

acceleration while a negative significant value implies a deceleration. A non significant value shows stagnation in the growth process [13].

Co-integration Test and error correction estimates

The Autoregressive Distributed Lag (ARDL) model developed by Pesaran et al is deployed to estimate our model because of three reasons. First, Pesaran *et al*. advocated the use of the ARDL model for the estimation of level relationships because the model suggests that once the order of the ARDL has been recognised, the relationship can be estimated by OLS [15]. Second, the bounds test allows a mixture of I(1) and I(0) variables as regressors, that is, the order of integration of appropriate variables may not necessarily be the same. Therefore, the ARDL technique has the advantage of not requiring a specific identification of the order of the underlying data. Third, this technique is suitable for small or finite sample size [15].

Following Pesaran *et al*., we assemble the vector autoregression (VAR) of order *p*, denoted VAR (*p*), for the following growth function:

$$Z_t = \mu + \sum_{i=1}^{p} \beta_i z_{t-i} + \varepsilon_t \qquad (1)$$

where z_t is the vector of both x_t and y_t, where y_t is the dependent variable defined as palm oil output, x_t is the vector matrix which represents a set of explanatory variables According to Pesaran *et al*., the dependent variable y_t must be I(1) variable, but the independent x_t can be either I(0) or I(1).

The vector error correction model (VECM) is specified as follows:

$$\Delta z_t = \mu + \alpha t + \lambda z_{t-1} + \sum_{i=1}^{p-i} \gamma_t \Delta y_{t-i} + \sum_{i=1}^{p-1} \gamma_t \Delta x_{t-i} + \varepsilon_t \quad (2)$$

$$\lambda = \begin{bmatrix} \lambda_{YY} \lambda_{YX} \\ \lambda_{XY} \lambda_{XX} \end{bmatrix}$$

The diagonal elements of the matrix are unrestricted, so the selected series can be either I(0) or I(1). If $\lambda_{YY} = 0$, then *Y* is I(1). In contrast, if $\lambda_{YY} < 0$, then *Y* is I(0).

The VECM procedures described above are imperative in the testing of at most one cointegrating vector between dependent variable y_t and a set of regressors x_t [6, 7]. To derive model, we followed the postulations made by Pesaran *et al*. in Case III, that is, unrestricted intercepts and no trends [15]. After imposing the restrictions $\lambda_{YY} = 0, \mu \neq 0$ and $\alpha = 0$,): the error correction model of the ARDL model is specified as follows

$$\left[\begin{array}{l} \Delta(output)_t = \beta_0 + \sum_{i=1}^{p} \beta_1 \Delta(output)_{t-i} + \sum_{i=0}^{q} \beta_2 \Delta(\exp ort)_{t-i} \\ + \sum_{i=0}^{r} \beta_3 \Delta(import)_{t-i} + \sum_{i=0}^{q} \beta_4 \Delta(price)_{t-i} + \sum_{i=0}^{r} \beta_5 \Delta(rainf all)_{t-i} \\ + \sum_{i=0}^{r} \beta_6 \Delta(areaharvested)_{t-i} + \sum_{i=0}^{q} \beta_7 \Delta(yield)_{t-i} + \text{ECM t - i} \end{array} \right]$$

Where Δ is the first-difference operator and ECM t - i is a Error correction term.
Output = supply of palm oil (in tonnes)
Area harvested = area harvested (hectares)
Price = producer price (naira)
Import = import quantity (in tonnes)
Export = export quantity (intonnes)
rainfall = rainfall (mean rainfall value)
yield = yield of palm oil (intonnnes)
t= time
ECM =error correction term

RESULTS AND DISCUSSIONS

Output supply trend of palm products

The trends was of palm oil area harvested, yield, output, price, import value and export value, where presented in chart 1 to chart 7. The trend of area harvested for the palm oil continued increasing after experiencing fluctuation from 1970-1984, this may be as a result of the policy of Structural Adjustment Program (SAP) prevailing in that era coupled with some agricultural enhancement programs prevalent in the era that led to the expansion of agriculture land especially for the cultivation of cash crops such as oil palm [8, 9].

The yield was constant from 1970 to 1974 but with the increase in the area harvested the yield increased as well.

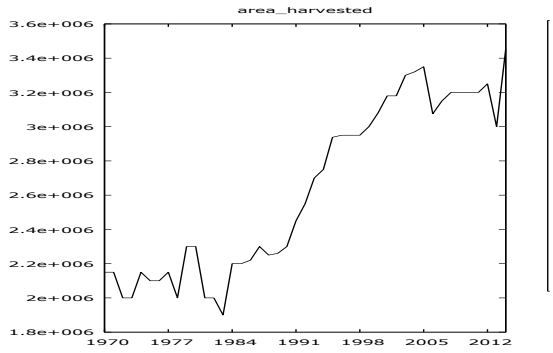

Chart 1. Trend of area harvested
Source: Food and Agriculture Organization data base

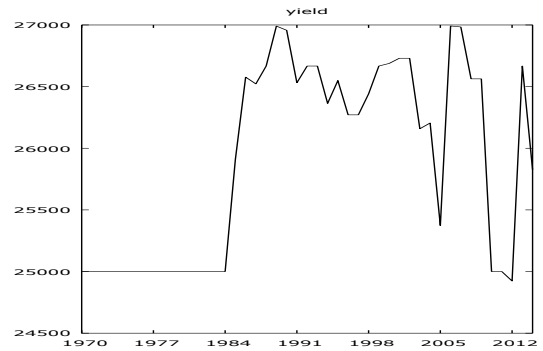

Chart 2. Trend of yield.
Source: Food and Agriculture Organization data base

But from 2000-2014 the yield has continuously dwindled despite policy efforts to improve agricultural production especially palm oil production. Though there were intense policy efforts in the area of cassava production.

The output supply of palm oil experienced significant increase from 1984 with the increase in area harvested and yield. The price of palm oil experienced a significant increase from 2008 to 2013 as a result of the dwindling output and yield.

The importation of palm oil very insignificant from 1970 to 1991 though there was a slight increase around 1977 to 1984. Nigeria is noted for the production of palm oil but with recent reduction in yield and output Nigeria has increased the importation of palm oil. As presented in chart 3 below export of palm oil has been fluctuating with a significant increase in 2005.

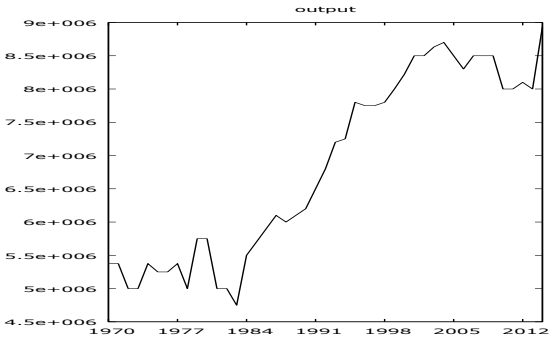

Chart 3. Trend of output of palm oil.
Source: Food and Agriculture Organization data base

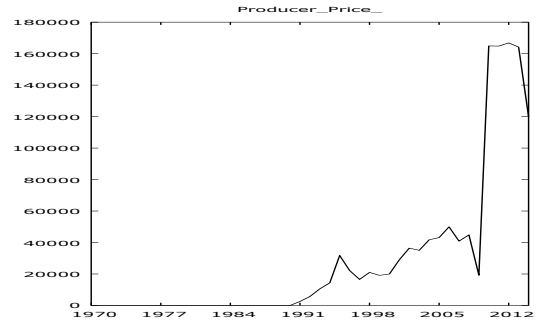

Chart 4. Trend of producer price of palm oil.
Source: Food and Agriculture Organization data base

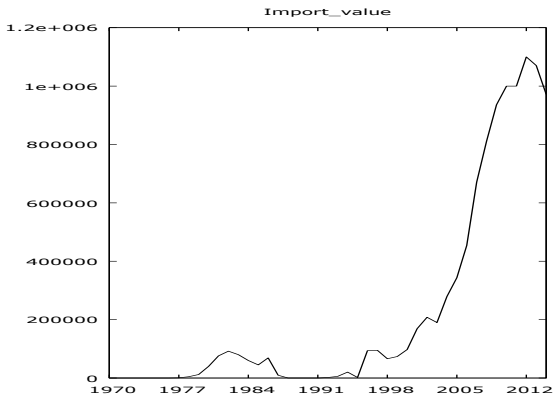

Chart 5. Trend of palm oil import
Source: Food and Agriculture Organization data base

The result of the palm oil output supply trend analysis estimate was presented in Table 1. The coefficient of the time trend was positive and statistically significant.

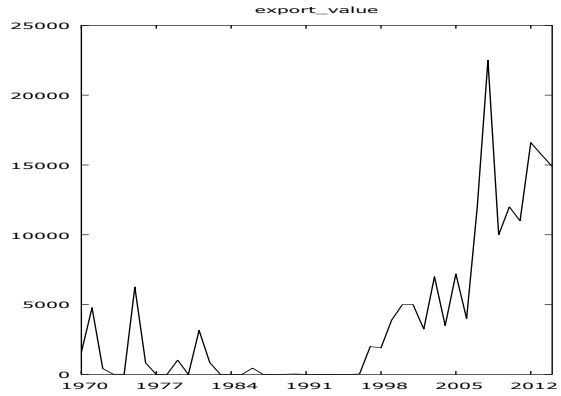

Chart 6. Trend of palm oil export Source: Food and Agriculture Organization data base

This means that time was a positive determinant of the variations in the output of the palm oils. This significant coefficient suggests that the output supply of palm oil grows over time. The model had a good fit with R^2value of 0.867and a significant F value of 279.976. Since the coefficients are positive, palm oil output recorded growth during the period under study.

Table 2. Analysis of Growth in the output supply of palm oil

	b0	b1	R^2	F STAT
OUTPUT SUPPLY	4.55E+06 (29.1024)***	99115.6 (16.7325)***	0.87	279.98

Source: Food and Agriculture Organization data base
Values in parenthesis are t-value and *** means that the data are statistically significant at 1%

Unit Root Test of the variable in output supply model

The Augmented Dickey Fuller Unit root test was conducted for the variable with constant, and trend. The results revealed that all the variables were integrated at difference except for palm oil yield. With the result we now difference the affected variables.

Since all the variables are not integrated in the same order, there is a need for a co-integration test. This implies that some linear combinations of the series must be co-integrated, such that even though the individual series may be integrated in the order I (1), the series may drift apart in the short-run, and then follow a common trend which permits stable long-run relationship between them.

Table 3.Unit Root Test of the variables

	Level Tau	p-value	Difference Tau	p-value	Order of integration
Area harvested	-2.742	0.4229	-7.786	1.59E-06	I(1)
Yield	-3.842	0.0486	-3.078	0.26	I(0)
Output	-1.485	0.9475	-4.515	0.006151	I(1)
Producer Price (LCU/tonne)	-3.774	0.0764	-5.655	5.10E-05	I(1)
Import value	-0.636	0.9958	-4.476	0.007029	I(1)
Export value	-6.208	0.0001	-4.421	0.00847	I(1)
Mean rainfall	-3.115	0.244	-3.611	0.0872	I(1)

Source: Computations from the data obtained from UNDP and FAOstat various issues.
Note: I(0) and I(1) are integrated at level and first difference

Autoregressive distributed LAG (ARDL) Model Co-Integration Test and Error correction estimates

Table 3 displays the calculated F-statistics (F-statistic = 27.861), showing that the null of no cointegration can be rejected at 1.0 percent level. This implies that there exists a long-run relationship or cointegration between output supply of palm oil and its determinants. Having established the cointegration relationship, the next step is to estimate the long-run coefficients by estimating an ARDL. The result indicates that the long run overall model is well fitted as the independent variable explained over 95% (R^2) movement in the dependent variable.

Table 4. Estimated Long-Run Coefficients ARDL

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.26E+08	22060320	-5.70442	0.0002
(SUPPLY(-1))	12712898	1773358	7.168826	0.000
(EXPORT(-1))	71156.56	27181.45	2.617836	0.0257
(IMPORT(-1))	-218902	57403.74	-3.81338	0.0034
(PRICE(-1))	320994.4	78626.45	4.082524	0.0022
(RAINFALL(-1))	760711.1	660055.7	1.152495	0.2759
(AREAHARVESTED (-1))	-5584171	1816927	-3.07342	0.0118
(YIELD)	1031147	1191392	0.865498	0.4071
R-squared	0.951225	Mean dependent var		8208444
Adjusted R-squared	0.917083	S.D. dependent var		377354.6
S.E. of regression	108660.2	Akaike info criterion		26.33094
Sum squared resid	1.18E+11	Schwarz criterion		26.72666
Log likelihood	-228.979	Hannan-Quinn criter.		26.38551
F-statistic	27.86073	Durbin-Watson stat		2.276116
Prob (F-statistic)	0.000009			

Source: Computations from the data obtained from UNDP and FAOstat various issues

The long-run coefficients show that export of palm oil exhibits a positive significant relationship with output supply of palm oil so does the lag of output supply of palm oil itself. Imports of palm oil and area harvested are inversely related to output supply of palm oil. The coefficient of importation of palm oil was statistically significant at 5% and negatively influencing the output supply of palm oil in Nigeria. This implies that importation of palm oil has negative impact on the output of palm oil in Nigeria. Since the imported products are known to be cheaper and affects domestic production negatively. Most of the manufacturers that use palm oil as a major raw material will go for the imported palm oil leaving the domestic output to suffer. But the export of palm oil had a positive significant impact on the output supply of palm oil in Nigeria. The increase in the level of exports motivates the farmers to produce more output. Price was a positive significant determinant of palm oil output supply; this means that the increase in the price of palm oil results to corresponding increasing the supply of palm oil. Area harvested has negative impact on the output supply of palm oil. As the population grows the area harvested shrinks due to the effect of urbanization and this will reduce output supply of palm oil.

According to the Granger representation theorem, when variables are cointegrated, there must also be an error correction model (ECM) that describes the short-run dynamics or adjustment of the cointegrated variables towards their equilibrium values. The result of the ECM is presented in Table 4. The error term is negative and highly significant. The coefficient of -5.705 indicates an evidence of fast adjustment towards long-run equilibrium. Exactly saying 57.1 percent of disequilibrium is corrected in the long-run level for equilibriums to be re-established. Both the short run and long run results gave the same sign for the selected variables except exports and yield, which takes negative sign in the short run. Export and yield of palm oil had a short run negative impact on the output supply of palm oil.

Table 5. Error Correction Estimates of the ARDL Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-997175.2	138254	-7.212632	0.0001
D(SUPPLY)	6.864844	1.227962	5.590435	0.0003
D(SUPPLY(-1))	4.560429	1.315715	3.466123	0.0071
D(SUPPLY(-2))	5.162884	1.226117	4.210758	0.0023
D(SUPPLY(-3))	-0.110299	0.071532	-1.541967	0.1575
D(AREAHARVESTED)	-15.22084	3.173964	-4.795531	0.001
D(AREAHARVESTED(-1))	-8.962561	3.381184	-2.650717	0.0264
D(AREAHARVESTED(-2)	-10.33207	3.140098	-3.290367	0.0094
D(AREAHARVESTED(-3)	13.33217	3.164022	4.213678	0.0023
D(EXPORT)	-28.5339	11.16626	-2.555367	0.0309
D(EXPORT(-1))	-13.77047	11.75166	-1.17179	0.2714
D(EXPORT(-2))	-3.027679	14.07584	-0.215098	0.8345
D(EXPORT(-3))	-4.931221	13.07068	-0.377274	0.7147
D(IMPORT)	-0.703292	0.490502	-1.433823	0.1854
D(IMPORT(-1))	-0.714521	0.493713	-1.447241	0.1817
D(IMPORT(-2))	0.044152	0.480294	0.091927	0.9288
D(IMPORT(-3))	-0.001639	0.566694	-0.002892	0.9978
D(PRICE)	5.639327	1.530769	3.683984	0.005
D(PRICE(-1))	4.062636	1.387681	2.927645	0.0168
D(PRICE(-2))	3.310468	1.625302	2.036833	0.0721
D(PRICE(-3))	6.66184	4.525607	1.472032	0.1751
D(RAINFALL)	1088.896	2391.247	0.455367	0.6596
D(RAINFALL(-1))	2264.22	2574.735	0.879399	0.4021
D(RAINFALL(-2))	-3084.705	3368.531	-0.915742	0.3837
D(RAINFALL(-3))	-3260.259	3069.707	-1.062075	0.3159
D(YIELD)	-1561.162	341.7433	-4.568231	0.0014
D(YIELD(-1))	-779.9873	339.6494	-2.296448	0.0473
D(YIELD(-2))	-1119.707	320.7522	-3.490879	0.0068
D(YIELD(-3))	69.42599	56.17636	1.235858	0.2478
ECM	-5.704776	1.097454	-5.198192	0.0006
R-squared	0.999438	Mean dependent var		6918000
Adjusted R-squared	0.997626	S.D. dependent var		1347325
S.E. of regression	65645.18	Akaike info criterion		25.09404
Sum squared resid	3.88E+10	Schwarz criterion		26.3737
Log likelihood	-459.3338	Hannan-Quinn criter.		25.55317
F-statistic	551.6715	Durbin-Watson stat		1.933627
Prob(F-statistic)	0.000			

Source: Computations from the data obtained from UNDP and FAOstat various issues.

Impulse response of palm oil output supply

This means to test track the time path of the sudden changes that can be exposed to different variables of the model and how other variables respond to any sudden change in any variable included in the model. And chart 4 Shows Impulse Response Function of palm oil supply output to a sudden change rate of one standard deviation in each of the area harvested, yield, import, export, price and rainfall.

It is clear from chart (4) that output supply of palm oil is affected negatively by the previous output supplies of palm oil. The continuous harvest of the oil palm reduces the subsequent

output. The impulse response of palm oil output supply clearly shows a negative shock. Changes in the yield of palm oil, results to moderate increase in the output supply in the initial five years before a subsequent significant positive response in the palm oil output supply. Shocks in the producers' price of palm oil will result to positive response in the output supply of palm oil within the initial six years before a negative response sets in.

Changes in the export of oil palm results to a positive response of palm oil output from the first year to the third year before a slight decrease from the fifth to the sixth years. But a positive response will follow immediately. Changes in importation of palm oil results to a negative response of output supply in consonance with the long run regression coefficients. Shocks in the area harvested had a negative effect on the supply of palm oil in the short run while changes in rainfall had a positive impact on the output supply of palm oil.

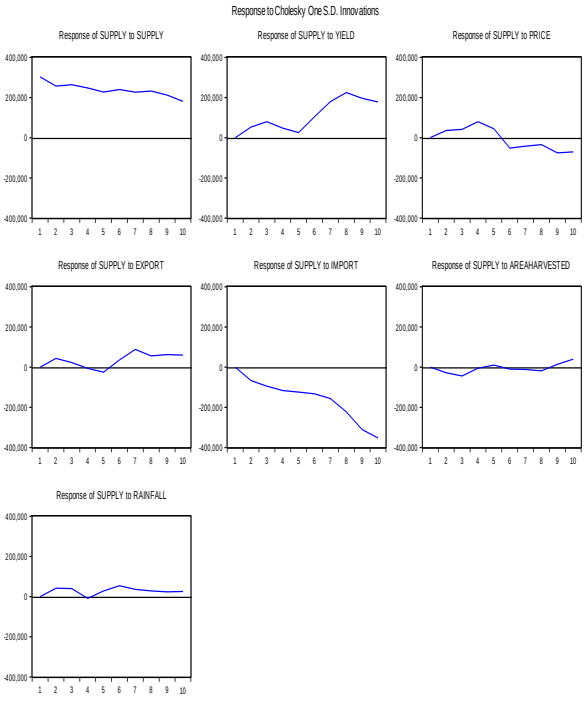

Chart 7. Impulse response of palm oil output supply
Source: Computations from the data obtained from UNDP and FAOstat various issues

CONCLUSIONS

This study provides evidence in the nature of output supply response of palm oils in Nigeria. It was found that the trend in the output supply of palm oil shows significant growth rate based on coefficient of time trend which was significant at 1% and positive. The study also found that all the variables have constant mean except for palm oil yield using the Augmented Dickey Fuller test (ADF) unit root which led to the Autoregressive Distributed Lag (ARDL) model co-integration test. The co integration test revealed that there exist a long run relationship between output supply of palm oil and its determinants. The independent variables with significant long run coefficients were imports, exports and area harvested. The error correction term shows high level of adjustment towards long run equilibrium. In the long run the impact of export was positive while in the short run it was negative. By implication in the short run exports of palm oil affects the output supply inversely while in the long run it results to the increase in the output supply palm oil. The impulse response shows the response of the palm oil output supply to its determinants, which was in line with the findings of the short run and long run coefficients.

Based on the findings of the study, the trend indicated the growth in the output supply of palm oil over the years. Also the import of palm oil revealed that the consumer will go for the imported product leaving the output supply of our farmers to suffer. The export of palm oil indicated that exporting of palm oil encourages the farmers to increase their output supply in the long run.

The following solutions become necessary for the objectives of supply response of palm oil to be achieved.

(i)The promotion of exports and formulation of export promotion policies to create interaction market for our palm oil and encourage our farmers to boost their output.

(ii)There is need for government to restore palm oil production in Nigeria through replanting programs and producer price supports.

(iii)Farmers and growers should adopt technological driven production to enhance the yield of palm oil.

(iv)The need for collaborations between industries and research institution should be encouraged to boost palm oil production.
(v)With the short run and long run coefficients of price were positive, this suggest a serious policy concern for the price regularization and stabilization measures to promote the output supply of palm oil.

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