OIL PALM FRUIT SUPPLY FUNCTION IN NIGERIA

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ABSTRACT

The study examined the short and long runs supply elasticity of oil palm fruit in Nigeria. The study used time series data from 1991 to 2017 production year. Cointegration and error correction model were used to derive the long and short runs elasticities of supply with respect to the specified explanatory variables. The findings revealed that, all specified variables were made stationary at first difference. The trend analysis of the oil palm fruit supply showed an average annual growth rate of 0.45% with a significant positive sign of accelerating growth in future. Empirical results showed that, in the long run, price of oil palm fruit, price of substitute, value addition, harvested land, rainfall and consumers' income all exhibited positive significant inelastic relationship with oil palm supply in the country. The short-run model also displayed positive significant and inelastic relationship with respect to rainfall, harvested land, value addition and owned price of oil palm fruit. The findings however, did not find evidence of adaptive behaviour of oil palm fruit producers as the previous lag price and output did not respond significantly to the supply of oil palm fruit in the short run. To increase production of oil palm fruit in the country, it is recommended that, sustainable local price of oil palm fruit should be enhanced by introducing price guarantee programme for producers in addition to promoting value addition activities in the sub-sector.

Keywords: ***Oil palm, Nigeria, production, rainfall, price, derivatives***

INTRODUCTION

Palm oil tree (*Elaeis guineensis)* is one of the major cash crops in Nigeria. It is a source to many secondary products or derivatives namely: palm oil, palm kernel oil, palm kernel seed and palm kernel meal among others. In Nigeria, the demand for these derivatives has increased steadily over the years. For instance, the domestic consumption (as food) of palm oil averaged at 2.51% per annum from 1964 to 2017 (Table 1). In the same period, about 2.84% annual growth rate was obtained for the total domestic consumption (both food and industrial consumptions) in the country. Despite this increase in domestic consumption of palm oil, the domestic supply only grew at an annual rate of 1.46% resulting into a supply gap of 2.84% per annum, an equivalent of 149 metric tons per annum. Similarly as shown in Table 2, the average domestic demand for palm kernel oil grew at 18.71%; while the domestic supply stood at 7.74%, hence generating an average supply gap of 10.69 metric tons per annum from 1964 to 2017. For palm kernel oil seed presented in Table 3, the statistics revealed an average annual growth rate of 1.86% in

domestic production, while annual average domestic consumption stood at 5.99%.

Efforts at increasing palm oil fruit production and its derivatives had not yielded the anticipated results as the annual growth rate in supply of palm fruit and its derivatives is far less than the rising annual domestic demand. To bridge this gap between domestic demand and supply, the country has resorted to importation of palm fruit derivatives including palm oil, palm kernel and palm oil seed. For instance, about 5119 tons of oil palm was imported in 1992 and 1195.30 metric tons in 2013. Also, about 45 tons of palm kernel oil was imported in 2000 and 2270 tons in 2012 (FAO, 2018). According to Onwubuya *et al.* (2012), Nigeria was once the world's largest producer of palm oil, but relinquished her position to Indonesia and Malaysia in the 1980s.

TABLE 1: FIVE YEAR AVERAGE PALM OIL PRODUCTION, DOMESTIC FOOD CONSUMPTION, TOTAL DOMESTIC CONSUMPTION AND SUPPLY GAP IN NIGERIA (1964 -2017)

Year	Prod. ('000 tons)	GR %	Domestic Food demand. ('000' tons)	GR %	Total domestic demand. ('000' tons)	GR %	Supply gap . ('000' tons)	GR %
1964 – 1968	435.60	-2.69	370.40	2.21	370.40	2.21	65.20	2.21
1969 – 1973	452.20	2.94	446.20	3.43	446.20	3.43	6.00	3.43
1974 – 1978	507.00	0.72	505.20	1.30	505.20	1.30	1.80	1.30
1979 – 1983	527.00	1.56	601.80	2.49	622.20	3.75	-95.20	3.75
1984 – 1988	608.00	2.30	626.00	3.15	664.00	2.80	-56.00	2.80
1989 – 1993	596.00	0.76	591.00	0.65	670.00	2.76	-74.00	2.76
1994 – 1998	630.00	4.48	614.00	3.52	770.00	4.67	-140.00	4.67
1999 – 2003	760.00	1.10	777.60	4.02	949.20	3.20	-189.20	3.20
2004 – 2008	814.00	1.74	978.60	3.44	1183.60	3.73	-369.60	3.73
2009 – 2013	946.20	2.83	1098.40	3.32	1374.40	3.70	-428.20	3.70
2014 – 2017	970.00	0.00	1127.50	-0.52	1382.50	-1.05	-412.50	-1.05
All Average	**652.96**	**1.46**	**695.48**	**2.51**	**801.96**	**2.84**	**-149.00**	**2.84**

Source: Computed by author and data derived from the US Department of Agriculture, 2018.

Several researchers in Nigeria have asserted that, the declined in importance of oil palm fruit production in the country economy is closely linked to the country's over-dependence on crude oil production, prevalence of traditional palm oil processing techniques and the Nigerian civil war of 1967 to 1970 which was fought mainly in the country's palm oil belt (Patrick *et al.*,2013 and Ekenta *et al.*,2017). As noted by Olukayode (2012), these events were partly responsible for the country's inability to sustain production and increase its production capacity to meet up with the domestic and global demand for palm oil and palm kernel production as well as other derivatives.

The palm oil fruit production industry in the country is in the hands of small-scale farmers mostly characterized by smallholdings, low

productivity, low resource base and low income (Udom, 1986). About 80% of production comes from dispersed smallholder farmers who harvest semi-wild plants and use manual processing techniques. Several smallholder farmers are spread over an estimated area ranging from 1.65 million hectares to 2.4 million hectares and to a maximum of 3 million hectares in the southern region of Nigeria (Udom, 1986). The prospects for job creation in the sub-sector are high as palm oil production and its chain of value additions remain one of the prominent livelihood activities in many rural communities, involving hundreds of thousands of resource-poor producers mainly women and tens of thousands of poor processors (Patrick *et al.*, 2013).

TABLE 2: PALM KERNEL OIL PRODUCTION, DOMESTIC CONSUMPTION AND SUPPLY GAP IN NIGERIA(1964 -2017)

Year	Prod. ('000' tons)	GR %	domestic demand ('000' tons)	GR %	Supply gap ('000' tons)	GR %
1964 – 1968	34.80	22.84	13.20	-26.92	21.60	267.55
1969 – 1973	37.20	8.65	6.00	119.67	31.20	3.15
1974 – 1978	42.00	-0.12	16.80	-1.51	25.20	7.14
1979 – 1983	75.80	12.79	37.80	44.71	38.00	22.41
1984 – 1988	83.00	0.90	68.00	26.20	15.00	-31.76
1989 – 1993	118.60	14.56	127.60	16.26	-9.00	4.57
1994 – 1998	132.00	2.31	133.60	1.20	-1.60	-20.00
1999 – 2003	158.40	15.20	158.60	15.28	-0.20	-60.00
2004 – 2008	293.60	4.60	290.40	4.24	3.20	0.00
2009 – 2013	312.00	1.61	314.40	2.97	-2.40	-475.00
2014 – 2017	331.25	0.38	338.25	-0.05	-7.00	3.13
Average	143.74	7.74	133.06	18.71	10.69	-25.87

Source: computed by author and data derived from the US Department of Agriculture, 2018.

The sub-sector being an integral part of the economic system is also affected by the interactions among macroeconomic fundamentals. The country has passed through periods of economic boom and recession; with each period exhibiting its own impact on the sub-sector either positively or negatively. Right from the period of commodity board through the era of Dutch disease to the period of exchange rate crises, economic stabilization act, structural adjustment programme down to the era of privatization and commercialization policy regimes among others; palm oil sub-sector has been moulded to conform to the economic realities at each period. At various time intervals and motivated by economic realities, a handful of researchers had attempted to establish an empirical relationship between agricultural production and macroeconomic variables. For instance, Akpan *et al.* (2012) found a positive relationship between per capita income and agricultural productivity in Nigeria. Shortly in Ghana, Enu and Prudence (2013) discovered that, the per capita income exerted

positive significant relationship with agricultural output. In another dimension, mix results have been reported on the relationship between agricultural output and land use. For example, Akanni and Okeowo (2011) in Nigeria discovered that output response of rice to hectarage was statistically insignificant. Considering the impact of climate change on agricultural supply response, Ayinde *et al.* (2011) discovered that temperature change exerted negative effect while rainfall change exerts a positive effect on agricultural productivity in Nigeria. The result further revealed that, previous year rainfall was negatively significant in affecting current year agricultural productivity.

TABLE 3: PALM KERNEL OIL SEED PRODUCTION, DOMESTIC CONSUMPTION AND SUPPLY GAP IN NIGERIA (1960 -2017)

Year	Prod. ('000' tons)	GR %	domestic demand ('000' tons)	GR %	Supply gap ('000' tons)	GR %
1960 – 1963	408.25	-1.13	408.25	-1.13	0.00	0.00
1964 – 1968	324.60	-5.77	74.20	5.41	-250.40	-10.33
1969 – 1973	285.20	4.37	80.40	9.47	-204.80	3.23
1974 – 1978	327.00	1.69	161.20	24.30	-165.80	-13.88
1979 – 1983	324.40	-0.01	252.40	0.15	-72.00	4.56
1984 – 1988	299.00	-5.03	229.60	-7.75	-69.40	11.00
1989 – 1993	256.00	2.80	252.00	13.68	-4.00	-36.00
1994 – 1998	298.00	5.88	298.00	5.88	0.00	-60.00
1999 – 2003	394.00	14.45	391.20	14.97	-2.80	-33.33
2004 – 2008	661.00	2.28	665.80	2.44	4.80	-140.00
2009 – 2013	683.80	1.64	693.40	1.62	9.60	-23.90
2014 – 2017	730.00	0.17	739.25	0.24	9.25	8.81
Average	**410.66**	**1.86**	**346.22**	**5.99**	**-64.43**	**-25.14**

Source: computed by author and data derived from the US Department of Agriculture, 2018.

It is obvious that literature on the determinants of agricultural supply is scanty especially in Nigeria. Recent literature on this issue reveals that studies on aggregate supply side have received less attention than aggregate demand. Many of the studies employed production index and agricultural gross domestic product as proxies of agricultural outcomes instead of individual crop aggregate. A study that focused on a single crop enterprise would likely reveal more in-depth issues related to the supply response and generate enterprise-specific determinants rather than aggregate sector-based determinants. Secondly, a study like this that focused on aggregated supply function of a long-neglected crop like oil palm would attempt to generate new information that is needed to develop a vibrant policy framework to fast track progress in the sub-sector. The study therefore used a supply model that

incorporates the early beliefs that the past prices are the basic determinants of production and the Nerlove postulation which included both lagged production and prices in the explanatory variables of the supply function. Hence, the study primarily aimed at estimating the supply elasticities of oil palm fruit with respect to selected macroeconomic fundamentals and edaphic as well as the climatic factors in Nigeria.

RESEARCH METHODOLOGY

Study Area: The study was conducted in Nigeria; the country is situated on the Gulf of Guinea in the sub-Saharan Africa. Nigeria lies between 4^o and 14^o North of the Equator and between longitude 3^o and 15^o East of the Greenwich. The country has a total land area of about 923,769km^2(or about 98.3 million hectares) with 853km of coastline along the northern edge of the Gulf of Guinea and a population of 140,461,790 million people (National Population Commission, 2006). The country is an agrarian society and depends so much on crude oil revenue.

Data source: Time series data were used for the study. These data were sourced from the statistical bulletins of the Central Bank of Nigeria (CBN, 2015 and 2017), Food and Agricultural Organization (2018) and Bureau of Statistics (2018). Data covered the period from 1991 to 2017. The choice of the study period was based on data availability.

ANALYTICAL TECHNIQUE

The Trend Analysis of Oil Palm Fruit Supply in Nigeria (1991 – 2017)

The study investigated the movement in supply of oil palm fruits in Nigeria. An exponential trend equation was specified as thus:

$$log_e OUT_t = b_0 + b_1 T + U_t \ldots\ldots\ldots\ldots\ldots (1)$$

where 'T' is the time expressed in year; OUT_t is the annual quantity of oil palm fruit in tons supplied by all farmers at period "t" in Nigeria.

The exponential growth rate is given as:

$$(r) = (e^{b1} - 1) * 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where r = exponential growth rate (%); e = Euler constant value and b_1 = coefficient of time variable in equation 1.

To ascertain whether the aggregate growth rate in oil palm supply accelerated or decelerated during the periods under consideration, a quadratic exponential trend equation was specified as thus:

$$log_e OUT_t = b_o + b_1 T_1 + b_2 T_2^2 + u_t \ldots.(3)$$

If $b_2 > 0$; the supply of oil palm fruit had significant accelerated positive or negative growth rate: when $b_2 < 0$; the growth rate is not significant (Onyenweakuand Okoye, 2005).

The Long-run Supply Function of Oil Palm Fruit in Nigeria

To determine the long-run supply function of oil palm fruit in Nigeria, a dynamic regression model was specified at the level of variables (Udah*et al*. 2015). The model is specified implicitly as thus:

$$\begin{aligned} OUT_t = \beta_0 + \beta_1 RPP_t + \beta_2 RPG_t + \beta_3 RVA_t \\ + \beta_4 HAR_t + \beta_5 TEC_t \\ + \beta_6 RAN + \beta_7 DEM_t \\ + \mu_t \ldots\ldots\ldots\ldots (4) \end{aligned}$$

where;

OUT_t = Annual quantity of oil palm fruit in Tons

RPP_t = Real price of oil palm fruit in Naira per ton

RPG_t = Real price of groundnut oil in Naira per ton

RVA_t =Value addition proxy by the real value of oil palm fruit processed in Naira per ton

HARt = land size proxy by harvested area in hectare

TEC_t =Technology effect on oil palm fruit supply proxy by yield per hectare in period "t"

RANt = Annual aggregate rainfall measured in mm

COIt = Per capita income in the economy to proxy consumer income (Naira/person)

U_t= Stochastic error term and U_t~ IID (0, δ^2_U).

β's are long-run supply elasticity. (Note, nominal values were deflated by using consumer Price Index at 2010 = 100 = constant year).

To authenticate the existence of a stable long-run supply function for oil palm fruit in Nigeria, the study used the Engle and Granger two-step technique and Johansen co-integration test. Following the Granger Representation Theorem, the Error Correction Model (ECM) for the co-integrating series in the study was specified. This model represents the short-run supply function for oil palm fruit in Nigeria. For the short-run supply function to holds, we assume all other determinants of oil palm fruit supply are held constant or fixed. The general specification of the short-run model supply function for oil palm fruit is implicitly shown below:

$$\Delta \mathrm{LnOUT}_t = \varphi_0 + \varphi_1 \sum_{i=1}^{n} \Delta LnOUT_{t-1} + \varphi_2 \sum_{i=1}^{n} \Delta \mathrm{LnX}_{t-i} + \varphi_3 ECM_{t-1} + U_t \quad \ldots (5)$$

Variables are as defined in equation 4; and coefficients ($\boldsymbol{\varphi_3}$) of the ECM_t ($-1<\boldsymbol{\beta_3}<0$) measures the deviation from the long-run equilibrium in period ($_{t-1}$). Gretl (version 2017c) econometric software was used to estimate the specified models.

RESULTS AND DISCUSSION

The descriptive statistics of data used in the study is presented in Table 4. The result revealed relatively low variability in variables except in the real price of the substitute, groundnut oil. For instance, about 6.8% of variability occurred in the quantity of oil palm fruit supplied by farmers. Similarly, only 7.3% and 2.4% variability were discovered in harvested area and amount of rainfall during the period of analysis. However, 65.4% and 38.71% fluctuations were recorded for real price of groundnut and oil palm fruit.

TABLE 4: SUMMARY STATISTICS, OF VARIABLES USED IN THE ANALYSIS

Variable	Mean	Median	Min.	Max.	Std. Dev.	C.V.	Skewness	Ex. Kurtosis
OUT	7.98e+06	8.0e+06	6.5e+06	8.7e+06	5.44e+05	0.0682	-1.0125	0.7626
RPP	23395	24946	7489.2	42879	9057	0.3871	-0.0183	-0.5570
RPG	90327	93716	15678	2.43e+05	59071	0.6539	0.9017	0.6058
RVA	9.61e+05	9.02e+05	7.6e+05	1.33e+06	1.66e+05	0.1732	1.0878	-0.0012
HAR	3.04e+06	3.07e+06	2.45e+06	3.35e+06	2.21e+05	0.0726	-1.0798	0.8125
TEC	25282	26441	27.000	26992	5082.5	0.2010	-4.7954	21.354
RAN	111.61	111.88	107.43	120.90	2..6913	0.0241	1.3829	3.4926
COI	2.57e+05	2.13e+05	1.86e+05	3.83e+05	69916	0.2725	0.4452	-1.3760

Source: Computed by author. Variables are as defined in equation 4.

UNIT ROOT TEST OF VARIABLES USED IN THE ANALYSIS

To ascertain the stationary of variables used in the study, the standard Augmented Dickey-Fuller test for unit root was performed. Test statistic for each variable at level and first difference involving trend and without trend equations are presented in Table 5. The ADF test result reveals that, at level all specified variables were non-stationary for equation without constant and trend, but were all stationary at first difference. However, for ADF equation containing trend and constant, the real price of oil palm fruit was stationary at level. Based on the result of the two ADF equations; it is resolved that the specified variables in the study are non-stationary at level but are stationary at first difference.

The result of the ADF unit root test implies that, the analysis of the specified variables at their levels could produce spurious regression estimates which are bias and inconsistent. To avoid inconsistent results and as suggested by Johansen (1988) and Johansen and Juselius, (1990), the specified variables should be tested for the presence of co-integration and error correction mechanism. According to the authors, the suggested models would give better representation of variables used in the study.

TABLE 5:RESULT OF THE UNIT ROOT TEST FOR VARIABLES USED IN THE ANALYSIS

variables	ADF equation with Constant and Trend			ADF equation without constant and Trend		
	Level @ zero lag	1st Diff. @ zero lag	OT	Level @ zero lag	1st Diff. @ zero lag	OT
OUT	-2.4183	-5.3514***	1(0)	1.3665	-4.0665***	1(0)
RPP	-3.8150**	-	1(0)	-1.0805	-7.5916***	1(0)
RPG	--2.0353	-6.6857***	1(0)	-1.9980	-5.8101***	1(0)
RVA	-1.4844	-3.3647*	1(0)	0.1709	-3.3455***	1(0)
HAR	-2.3203	-4.1014**	1(0)	1.3359	-4.7166***	1(0)
TEC	1.8370	-3.5609**	1(0)	-1.1378	-3.5009**	1(0)
RAN	-2.7771	-3.3376*	1(0)	0.5357	-3.6201***	1(0)
COI	-2.5878	-4.5542***	1(0)	1.0335	-4.5923***	1(0)
Residual	-4.0771**			-4.2451***		

Note: OT means order of integration. Critical values (CV) are defined at 1% and 5% and 10% significant levels; asterisks ***, ** and * represent 1%, 5% and 10% significance level respectively. Variables are as defined in equations 4.

RESULT OF TREND ANALYSIS OF OIL PALM FRUIT SUPPLY AND POLICY LINKAGE IN NIGERIA

Estimates of the exponential trend equation for the supply of oil palm fruit are presented in Table 6. The result revealed that, the supply of oil palm fruit in Nigeria has a positive significant relationship with time. This implies that, the supply of oil palm fruit increases over time within the period of this study. An average positive exponential growth rate of about 0.45% was obtained in the supply of oil palm fruit from 1991 to 2017 in Nigeria. With this insignificant growth rate, it is obvious that, the oil palm sub sector's productive capacity was inefficient and could not significantly stimulate backward integration to the industrial sector of the economy. In another perspective, the result means that, several policies and programmes as well as institutions established by various tiers of government were not active enough to trigger a double-digit or appreciable single-digit growth rate in oil palm fruit production in Nigeria. This result shows a clear signal that the oil palm fruit production needs urgent attention in the country.

TABLE 6: EXPONENTIAL TREND ANALYSIS OF OIL PALM FRUIT IN NIGERIA

Variable	Coefficient	Standard Error	t-value
Constant	15.8260	0.04306	367.5***
Time	0.0045	0.0025	1.798*
F- cal.	3.2331		
R-square	0.2575		
Exp. GR (%)	0.45		
	Quadratic trend Equation estimates		
Constant	15.6862	0.0166	943.5****
Time	0.0334	0.0029	11.57***
Time Square	-0.0010	0.0001	-10.08***
F- cal.	78.3501		
R-squared	0.9023		

Note: Values in bracket represent t-values. The asterisks * and *** represent 10% and 1% significance levels respectively.

The finding also revealed that, the coefficient of the square time in the quadratic trend equation is negative and significantly related to the supply of oil palm fruit in the country. The result showed a marginal decline in the quantity of oil palm supplied by farmers over a doubled increase in time. Decline in supply of oil palm fruit over doubled time period implies that, the domestic production over time could not match the demand. This result further showcases the inefficiency of the agricultural sector and the inability of government to sufficiently stimulate agricultural production in the country. Furthermore, the findings indicate that, the various policies designed and implemented by government to increase the importance of oil palm sub-sector in the country's economy during this period of study were not very effective and thus had adversely influenced on oil palm fruit supply in the long run.

To further clarify the behaviour of the trend of oil palm fruit in Nigeria, Figure 1 shows the linear trend graphs of tonnage of oil palm fruit supplied by farmers from 1991 to 2017 in the country. The trend graph showed a progressive growth from 1991 to 2003. These periods coincided with the periods of structural adjustment programme (SAP) and the early era of guided deregulation policies. One of the major policy components of this era were the issues of privatization and commercialization of most government-owned agro-allied industries. The sub-sector responded positively to the policy package by gradually increasing its production quota.

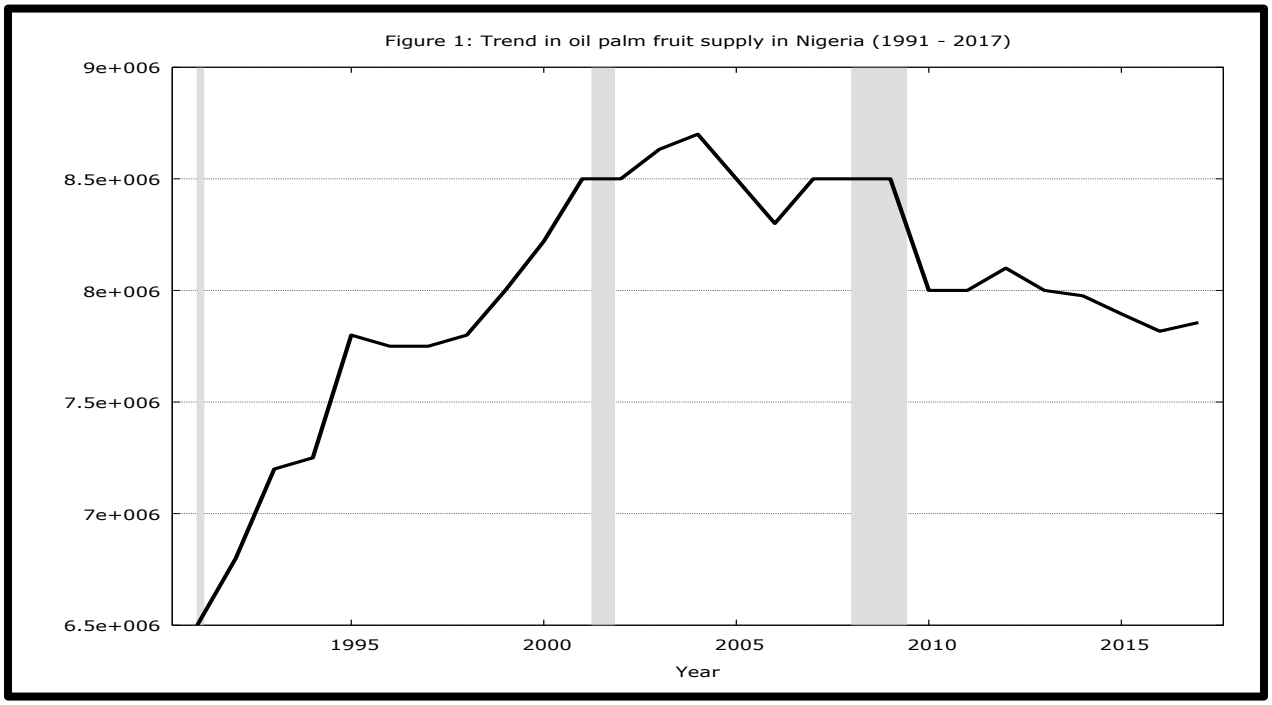

FIGURE 1: TREND IN OIL PALM SUPPLY IN NIGERIA (1991 – 2017)

During this period, a dual exchange rate emerged: one official, which was used for government essential transactions; the other, which served as the inter-market exchange rate. Thereafter, the exchange rate was deregulated resulting in the depreciation of the naira. The overvalued exchange rate had served as an implicit tax on farmers as it cheapened imported oil palm products (Akande, 2003). This perhaps explains the undulated growth in oil palm fruit during this period.

In the period between 2002 to 2004, the supply of oil palm fruit was at the peak. The growth in oil palm fruit in this period was enhanced by several incentives ranging from credit, tax holiday, tariff protection, presidential initiatives on cash crop production, democratic environment and favourable trade policies. The trend in oil palm fruit from 2015 to 2017 showed relatively declining trend. Apart from the policy environment, the rapid urbanization and the continuous degradation of oil palm estates across the country in addition to modernized pilfering as well as increase importation are some of the root causes of this trend during this period.

THE LONG-RUN SUPPLY FUNCTION FOR OIL PALM FRUIT IN NIGERIA

The estimation of the long-run supply function for oil palm fruit in the country was necessitated by the presence of the co-integration among specified variables. The result as presented in Table 7 revealed that; the annual price of oil palm fruit, value addition, harvested area, annual volume of rainfall and consumer income are important or significant determinants of supply of oil palm fruit in the long run in Nigeria. The diagnostic tests of the estimated long-run model revealed satisfactory goodness of fit.

TABLE 7: LONG RUN SUPPLY FUNCTION FOR OIL PALM FRUIT IN NIGERIA (1991 – 2017)

Variable	Coefficient	Standard Error	t- value	Probability
Constant	4.0363	1.3914	2.901***	0.0092
Real price of oil palm fruit	0.0153	0.0026	5.831***	<0.0005
Real price of groundnut oil	−0.0049	0.0124	−0.394	0.6982
Real amount of value addition	0.1137	0.0324	3.515***	0.0023
Harvested land	0.7894	0.0861	9.164***	<0.0001
Technology used	0.0026	0.0019	1.286	0.2138
Rainfall	0.2349	0.1155	2.033*	0.0563
Consumer income	0.0369	0.0192	1.918*	0.0716
Diagnostic Test				
Mean dependent variable	15.88956	S.D. dependent variable		0.070980
Sum squared residual	0.006688	S.E. of regression		0.018761
R-squared	0.948945	Adjusted R-squared		0.930136
$F_{(7, 19)}$	141.3907	P-value(F)		4.99e-15
Log-likelihood	73.78325	Akaike criterion		−131.5665
Schwarz criterion	−121.1998	Hannan-Quinn		−128.4839
Rho	0.169248	Durbin-Watson		1.647325

Note: Variables are expressed in logarithm. Figures in bracket are t-tests. Asterisks *, ** and *** represents 10%, 5% and 1% significance level respectively.

CO-INTEGRATION TEST FOR OIL PALM FRUIT SUPPLY IN NIGERIA

The study applied the Engle and Granger two-step technique and Johansen co-integration approach to examine the co-integration relationship among specified variables. The result of the Engle and Granger two-step technique of co-integration test is presented in the lower portion of Table 5; while the result of co-integration is presented in Table 8. The result from the Engle and Granger two-step technique revealed that at 1% probability level, the ADF of residual generated from equation 4 is significant. Hence, the Engle-Granger co-integration test rejects the null hypothesis of no co-integration. Thus, there exists a long-run equilibrium relationship between the quantity of oil palm fruit supply and the specified determinants of its supply in Nigeria.

TABLE 8: JOHANSEN CO-INTEGRATION TEST (UNRESTRICTED CONSTANT) AND USING LAG 1

Rank	Eigen value	Trace test (p-value)	L_{max} test (p- value)
0	0.6198	52.727 (0.0149)**	35.146 (0.0290)**
1	0.4994	27.581 (0.0899)*	25.992 (0.09337)*
2	0.2374	9.5893 (0.3195)	7.0474 (0.4921)
3	0.0931	2.5418 (0.1109)	2.5418 (0.1109)

Note: Trace test indicates more than one co-integrating equations at 10% significant level.

Similarly, the Johansen co-integration test presented in Table 8 shows that there is evidence of co-integrations among the specified variables. This verifies the earlier report derived from the Engle-Granger two-stage method. However, based on the AIC criterion, the maximum lag length has been set to 2.

THE SHORT-RUN SUPPLY FUNCTION OF OIL PALM FRUIT IN NIGERIA FROM 1991 TO 2017

The estimates of the ECM for the oil palm fruit is presented in Table 9. The primary reason for estimating the error correction model was to capture the dynamics in the oil palm fruit supply equations and identify the speed of adjustment as a response to departure from the long-run equilibrium.

TABLE 9: SHORT-RUN SUPPLY FUNCTION OF OIL PALM FRUIT IN NIGERIA

Variable	Coefficient	Standard Error	t- value	Probability
Constant	0.0013	0.0032	0.4036	0.6922
Supply of oil palm fruit (t-1)	0.1133	0.0951	1.1920	0.2518
Real price of oil palm fruit (t)	0.0145	0.0049	2.9634***	0.0016
Real price of oil palm fruit (t-1)	−0.0034	0.0166	−0.2014	0.8433
Real price of groundnut oil (t)	0.0167	0.0144	1.1640	0.2626
Real amount of value addition (t)	0.1146	0.0417	2.7470**	0.0150
Harvested land (t)	0.6359	0.1552	4.0980***	0.0009
Technology used (t)	0.0013	0.0014	0.9132	0.3756
Rainfall (t)	0.0227	0.1158	3.0958***	0.0010
Consumer income (t)	0.0015	0.0195	0.0764	0.9401
Residual (t-1)	−0.7199	0.1570	−4.5850***	0.0004
Diagnostic tests				
Mean dependent variable	0.005774	S.D. dependent variable		0.026302
Sum squared residual	0.004137	S.E. of regression		0.016608
R-squared	0.750810	Adjusted R-squared		0.601296
F(7, 19)	17.37143	P-value (F)		2.15e-06
Log-likelihood	73.35868	Akaike criterion		−126.7174
Schwarz criterion	−114.5286	Hannan-Quinn		−123.3367
Rho	0.021264	Durbin-Watson		0.120844

Note: Variables are expressed in logarithm difference. Asterisks *, ** and *** represents 10%, 5% and 1% significance level respectively.

The study adopted Hendry's (1995) approach in which an over parameterized model was initially estimated and then gradually reduced by eliminating insignificant lagged variables until appropriate ECM model was obtained. The result of the exercise is presented in Tables 9. The slope coefficient of the error correction term in each equation is negative and statistically significant at the conventional level of probability. This result

is in line with *apriori* expectation. The result validates the existence of a stable long-run equilibrium for the supply function of oil palm fruit and also indicates that the supply of oil palm is sensitive to the departure from its equilibrium value in the previous periods. The result assumed that, the adjustment mechanism of the error correction term is linear and symmetric. This means that, the adjustment speed in the supply of oil palm fruit equation is the same no matter the shock in the specified explanatory variables.

The slope coefficient of the error correction term (−0.7199) in Table 9 represents the speed of adjustment and also is consistent with the hypothesis of convergence towards the long-run equilibrium once the respective equation is disturbed. The stronger the negative value of the ECM, the shorter the period it takes the supply of oil palm fruit to adjust to equilibrium position amidst specified explanatory variables in the long run and vice versa. The diagnostic test for the ECM model revealed R^2 value of 75.08%. The Durbin-Watson and Lagrange Multiplier values for the estimated equation indicate a significant effect of serial correlation. However, the ECM model has been shown to be robust against residual autocorrelation. Therefore, the presence of autocorrelation does not affect the estimates (Laurenceson and Chai, 2003).

STABILITY TEST

Figure 2 below represents stability test of the estimated short-run supply model. All residuals are stable at 5% confidence interval, because the cumulative sums are located between the two standard deviations. The result indicates that, the short-run model is stable, as it is maintained within the 5 per cent significance level within the observation period. Further stability tests are presented in Table 10. The result shows that, the estimated short-run model is adequately specified, and the error terms normally distributed.

TABLE 10: TEST OF VALIDITY OF PARAMETERS OF THE SHORT-RUN SUPPLY FUNCTION OF OIL PALM FRUIT

Test	Probability	Inference
RESET test F(2, 13) = 12. 16825	0.0000	Specification is adequate
Normality test Chi-square (2) = 7.37714	0.0000	Error normally distributed
White test LM = 28.3648	0.0301	Heteroskedasticity not significant
CUSUM test Harvey –Collier t(14) = 17.99	0.0212	No change in Parameters

Source: Data analysis, 2017.

The analysis also revealed that, there is no presence of heteroskedasticity, while the CUMSUM test confirm no change in estimated parameters.

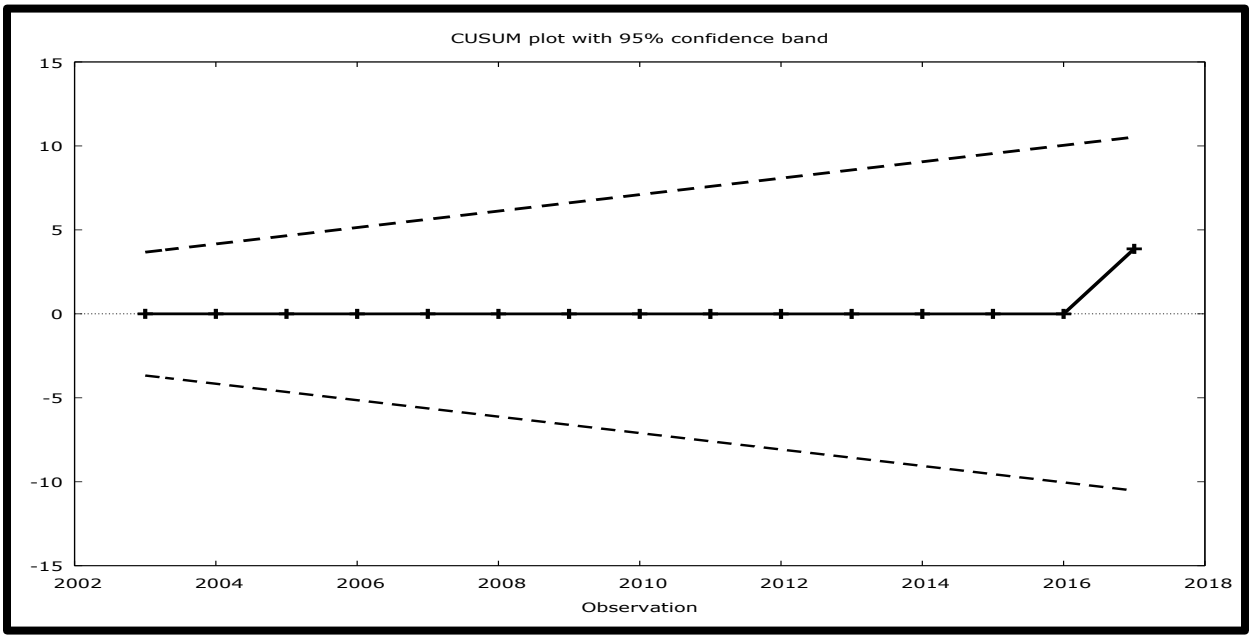

FIGURE 2: STABILITY TEST FOR THE ECM

DISCUSSION OF THE LONG-RUN AND SHORT-RUN SUPPLY ELASTICITY'S FOR OIL PALM FRUIT IN NIGERIA

The Long-run model results in Table 7 revealed significant positive inelastic relationship between consumers' income and the quantity of oil palm fruit supply in the economy. The result implies that, as the consumers' income increases, the quantity of oil palm fruit supplied increases over time. This result is easily linked to the consumer behaviour and preference for oil palm products produced locally. Perhaps it is the lower price of the domestic oil palm products compared to imported ones. For instance, palm oil, one of the derivatives of palm fruit has formed one of the compulsory dietary components of the majority of Nigerian and is sold all over the country. As such, an increase in consumers' income would increase the patronage of oil palm fruit derivatives, and thus directly influencing the fruit production.

Similarly, the long and short runs elasticity of oil palm supply with respect to rainfall had showed positive inelastic correlations. This means that, increase in rainfall would result in increased in oil palm fruit supply in both short and long runs in the country. The result satisfies the *apriori* expectation as oil palm trees do well in rainforest belt high in annual rainfall amount. Hence, the period that produces heavy rains would result in a higher quantity of oil palm fruits in both short and long runs. This result stresses the importance of rainfall in oil palm fruit production in the country. Water management has been a serious issue in the country and the ramping menace of climate change has further worsened the hope of sustained production of oil palm fruit in the country. Optimal production might be difficult to obtain under uncontrolled environment. This issue of

depending on rainfall for agricultural production has provided along lasting challenge yet to be unruffled in the sub-sector.

The coefficient of harvested land showed positive inelastic relationship with oil palm fruit supply both in the long and short-run periods in the country. This implies that, as harvested land area increase, more oil palm fruits would be produced. The result is in line with *apriori* expectation especially when obsolete technology is used in the production process. Often, experts have attributed marginal increase in agricultural production in developing countries to resource expansion rather than increase in the technical, economic and allocative efficiencies of resources. This assertion is glaring in oil palm sub-sector, as the marginal increase in the quantity of oil palm fruit in the country is often associated with land expansion and not improvement in the technology used. It is no more news that Nigeria once was the world highest producer of oil palm but has been relegated to the lower portion among the top producers in the world today (Food and Agricultural Organization, 2018).

The findings also revealed that, value addition is a positive determinant of oil palm fruit supply in both short and long runs in the country. This implies that, increase in value addition to oil palm fruit would result to increase production of the fruits. The result satisfies the *apriori* expectation as increase in value addition would increase the absorptive capacity of the allied industry. An increase in value addition also implies that, the level of technology injection in the sub-sector had an increase in both short and long-run periods. This could be linked to the various policy impacts implemented in years past. During the structural adjustment programmes (SAP) era and post SAP era, emphasis was targeted at developing expanded value chain and increasing greater role of private enterprises on production. The sub-sector witnessed marginal growth in this aspect due to some incentives available to the private sector. However, the impact of increase value addition in the sub-sector was stronger in the long run compared to the short-run period.

The findings further revealed a positive price inelastic supply. This means that, the coefficient of owned price has a positive significant relationship with the supply of oil palm supply in the country. The findings therefore suggest that, producers or farmers are relatively unresponsive to price changes. The result reflects the true nature of the sub-sector in terms of coordination, organization of transactions, information dissemination and human capacity development. The sub-sector has long been neglected by the government of Nigeria, and is being managed by few sloppy merchants who often took advantage of the poor and poorly informed rural farmers. The lagged price coefficient of oil palm fruit was insignificant which further substantiate the fact that oil palm fruit price was not responsive to the previous price change. Similar result was obtained for the previous supply of oil palm fruit.

CONCLUSION

Oil palm sub-sector in Nigeria was once a prime mover of the country's economy in terms of its contribution to the country's

GDP. Currently the domestic production has fell short of domestic demand and the gap is serviced by import even with the deteriorating value of the naira in the international market. Concerted efforts by the government to upsurge domestic production has shown a positive effect in terms of marginal growth rate in output produced. Being part of the larger economic system, oil palm sub-sector is also affected by economic and environmental variables. Critical assessment of the factors that could influence the performance of oil palm fruit production is absolutely necessary now, especially in this period of high uncertainties in the global crude oil market which the country's depends so much. Consideration of the short and long-run supply function of oil palm production is important due to presumed adaptive nature of oil palm producers in the country. Short and long term determinants of oil palm fruit production identified in the study should be considered as the major policy target in effecting positive and significant changes in the sub-sector in the country.

RECOMMENDATIONS

To achieve an increase in oil palm fruit production in Nigeria, the following recommendations are strongly advocated:

- A sustainable local price of oil palm fruit should be enhanced by introducing and sustaining measures such as price guarantee programme, regulated market roles, continuous import restriction, sustained tax reduction for processors and other stakeholders in oil palm fruit processing.
- A long term value addition programme should be encouraged in the sub-sector by investing and developing both the upstream and downstream activities.
- Land expansion programme should be initiated in the sub-sector and a legal framework designed to prohibit encroachment and pilfering in oil palm estates in the country. It is also recommended that farmers should thrive to adopt the best method of production that would ensure optimal and most efficient output within the domain of their land area rather than depending on the expansion of land.
- Research should be intensified to produce high yielding hybrids of oil palms that are less sensitive to rainfall. Also, for the existing estates, alternatives to rainwater should be provided to enhance higher and sustained yield.
- Measures to promote consumers income in the country is strongly advocated

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