Trend Of Sorghum Production In Nigeria: Implication On Agricultural Output (1981-2018)

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ABSTRACT
The study assessed the trend of sorghum production in Nigeria and it's implication on agricultural output (1981-2018). Time series data obtained from archives of Food and Agriculture Organization (FAO) and Central Bank of Nigeria (CBN) for a period of (37) years were used in the study. The data collected were analyzed using both descriptive and inferential statistics such as mean, maximum and minimum with graphs, trend models and vector error correction model [VECM]. The result of the study revealed that the trend of sorghum production has fluctuated tremendously over the years while the trend of agricultural output in Nigeria has been experiencing an appreciable level of increase over the years. The growth rate and direction of sorghum production was 1.6% and accelerating while agricultural output was 4.4% and accelerating respectively during the period of study. The result of VECM indicated that in a long run, the coefficient of sorghum production is rightly signed with a coefficient of 6.492 as expected and statistically significant at 1% probability level. The result showed that the coefficient of determination (R^2) is 0.42. This implies that 42% of the total variation in agricultural output was explained by sorghum production. The result also showed that the F-statistics (7.613) was positive and significant at 1% indicating the overall significance of the model. The study therefore recommended that, the needed growth in production/productivity of sorghum and agricultural output will continue to be a mirage unless investments in agricultural research and education are maintained or increased.

Keywords: Trend, Sorghum, Output, VECM, Co-integration

INTRODUCTION

Agriculture is the economic mainstay of the majority of households in Nigeria and is a significant sector in the Nigeria economy. Agriculture as an important sector of the economy is the main source of food for over 180 million people in Nigeria. It employs about 60-70 per cent of the

population and contributes between 30-40 per cent of the nation's Gross Domestic Product (Akintunde *et al.*, 2013). The sector remains the main basis of livelihood for most rural communities in developing countries in general. But with advent of petroleum, a great shift was observed, giving rise to huge neglect of the sector which resulted in decline in productivity (yield), low income to farmers, unemployment, high rise in food prices and threat to food security among others.

The agricultural sector comprises crop production, fishery, livestock and forestry. Crop production is the dominant activity accounting for 35.64% from 2000-2007, relative to livestock (2.83%) and forestry (0.59%) (Balami *et al*., 2011). According to NEARLS (1996), the major cereal crops in Nigeria are rice, maize, sorghum, wheat, pearl millet, sugar cane and fonio millet with rice ranking as the sixth major crop in terms of the land area while sorghum account for 50% of the total cereal production and occupies about 45% of the total land area devoted to cereal production in Nigeria. Cereals are a major contributor to agriculture and food security in Nigeria; consist of between 55 - 60% of subsistent farmers output, and provide incomes as well as form the basis of many a households' diets both in the rural and urban areas (Balami *et al*., 2011).

Presently, cereal grains are the single most important source of calories to a majority of the world population. Developing countries depend more on cereal grains for their nutritional needs than the developed world. Close to 60% of calories in developing countries are derived directly from cereals, with values exceeding 80% in the poorest countries. By comparison, approximately 30% of calories in the developed world are derived directly from cereals. However, even in these more affluent societies that rely less on direct cereal consumption, cereals remain the most important food commodity, since they supply most of the nutrients for the livestock that form a major part of diet in these regions (Anon, 2003).

Audu (2012) noted that cereals are becoming scarce and more expensive therefore; the need to increase cereal production becomes more glaring. Because of the increased demand for cereal crops resulting from an increase in population density and income growth, relative to the low productivity of some cereal crops by farms, Nigeria has become a net importer of some cereal crops to other countries. The major cereal crops in Nigeria are rice, maize, sorghum, wheat, pearl, millet, sugar cane and fonio millet with rice ranking as the sixth major crop in terms of the land area while sorghum account for 50% of the total cereal production and occupies about 45% of the total land area devoted to cereal production in Nigeria [National Extension Agricultural Research and Liaison Station (NEARLS, 1996)].

Sorghum is one of the staple food crops in the semi-arid tropics of Africa and Asia in general and Nigeria in particular. It is the main source of energy, protein, vitamins and minerals for millions of the poorest in these regions (FAO as cited in Abu, 2015). It forms a very vital part of the diet which could be in the form of boiled porridge or gruel, unleavened bread, and rice like products (Berenji & Dahlberg, 2004). Nigeria and Sudan produces about 63 per cent of Africa's total production (FAO as cited in Abu, 2015). It is a crop genetically suited to hot and dry agro ecologies where it is difficult to grow other food grains (ICRISAT, 2004). The potential for sorghum to be the driver of economic development in Africa especially Nigeria cannot be over emphasized. Sorghum is a very valuable industrial crop for brewing alcoholic and non alcoholic drinks as well as in the baking and confectionery industries in Nigeria. The leaves and grains are also used for livestock feeds and the stalks for thatching houses and making fences.

Most sorghum grains cultivated in Nigeria comes from the Northern Guinea and Sudan/Sahel ecologies in the following states: Adamawa, Bauchi, Borno, Gombe, Jigawa, Kaduna, Kano Plateau (Aba *et al.,* 2005). Samson *et al.* (1981) opined that sorghum has greater untapped

potentials than any other crop because of all the cereal crops, sorghum contributes about 50 per cent of the calories in Nigeria generally and about 73 per cent in the savannah regions of the country in particular. Sorghum displays a unique agricultural adaptableness to a world in ever growing need for more food (Koleoso & Olatunji, 1992).

In view of the overriding need to enhance the level of agricultural productivity, particularly of food grains, in the face of increasing population and declining agricultural output/yield in developing countries such as Nigeria, the importance of determining empirically quantitative relationships that provide estimates of changes in current and expected output and yield of sorghum and overall agricultural output cannot therefore be overemphasized.

Various scholars have re-echoed the importance of cereal crops in general and sorghum in particular in Nigeria such as Maikasuwa (2013) who assessed factors affecting cereal crops in Nigeria; Abu (2015) focused on long run relationship between sorghum yield, rainfall and producer price in Nigeria amongst others. However, there is no known study that addressed the trend of sorghum production and its corresponding impact on agricultural output in Nigeria hence, the need for this study to fill this research gap.

METHODOLOGY

The study was carried out in Nigeria. Nigeria has a total geographical area of 923, 768 square kilometers constituting land area of 910768 square kilometers and water area of 13000 square kilometers, respectively. It is one of the eight most populous countries in the world with a population of about 140 million (NPC, 2006). With a population growth rate of 2.6%, Nigeria has a projected population of about 206 million in 2020. Nigeria is located between $4^{o}16$ and $13^{o}53$ north latitude and between $2^{o}40$ and $14^{o}41$ east longitude (Central Intelligence Agency [CIA] Fact

Book, 2009). Nigeria has a highly diversified agro-ecological climatic condition and hence, agriculture constitutes one of the most important sectors of the Nigeria economy. The climate varies with Equatorial in South, Tropical in Centre and in the North. There are two seasons – the wet season (April-October) and the dry season (November-March). The type of vegetation is grassland savannah in the North and forest in the south. This vegetation has made agriculture the major employer of labour in the country.

Methods of Data Collection

The study relied basically on secondary data. Annual time series data spanning from 1981 to 2018 were sourced from Central Bank of Nigeria (CBN) and Food and Agriculture Organization (FAO) database. Specifically, data on agricultural output were collected from the statistics of Central Bank of Nigeria (CBN) while data on sorghum production were collected from the archives of the Food and Agriculture Organization (FAO).

Analytical Techniques

The data collected were analyzed using both descriptive statistics (mean, maximum and minimum with graphs) and inferential statistics (trend model, vector error correction model [VECM] after testing for unit root and co-integration among the variables) and t-test.

The trend model is given as:

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

Where;

Y_t = Sorghum production in year t.

Y_0 = Sorghum production in the base year.

r = compound rate of growth of Y,

t = time in chronological years.

Taking the natural log of equation (1) to make it linear, it is stated thus

$InYt = In\ Y_0 + tIn(1+r)$ ...……(5)

Substituting in InY_0 with β_1 and $In(1+r)$ with β_2, equation (5) is rewritten as

$InYt = \beta_1 + \beta_2 t$……..…… (2)

Adding the disturbance or error term to equation (6), we obtain

$InYt = \beta_1 + \beta_2 t + Ut$……..……. (3)

Equation (4) is the growth rate model developed for this study. A semi-log growth model was developed for this study instead of a linear trend model because the point of interest in this study is both absolute and relative in the parameters of interest. The most important parameter in equation (3) is the coefficient of β_2 which is the slope and measures the constant proportion or relative change in Y for a given absolute change in the value of the regressor t. multiplying β_2 by 100 gives the instantaneous growth rate at a point in time.

$IGR = b_2 \times 100$……..…….…….. (4)

Where IGR = Instantaneous growth rate.

b_2 is the least square estimate of the coefficient of β_2, then taking the anti-log of b_2 and subtracting it 1 and then multiplying the difference by 100 will give the compound growth rate (CGR) over a period of time.

$CGR = [antilog\ b_2 - 1] \times 100$…….……. (5)

If the coefficient of b_2 is positive and statistically significant or negative and statistically significant, there is acceleration or deceleration in the growth respectively. If b_2 is not statistically significant there stagnation in the growth process. However, if the coefficient of b_2 is not statistically significant, then there stagnation in the growth.

The linear trend analysis model with the form $Q = b_0 + b_1T + e$ and the quadratic model with the form $Q = b_0 + b_1T + b_2T^2 + e$ was also tested to determine the best fit.

RESULTS AND DISCUSSION

Trends of Sorghum Production in Nigeria (1981-2018)

Figure 1 presents the trend of sorghum production in Nigeria. The result shows that the trend of sorghum production in Nigeria ranges between 9691 tonnes and 16332 tonnes with a mean of 11695.68 during the period under study. This can be attributed to the fact that sorghum production in Nigeria has been considerably low over the years. This is due to both a lag in crop improvement efforts in these crops and the extreme environmental conditions and the low input agriculture under which these crops are grown. Specifically, 1981 to 1982 sorghum production was fairly constant but decreased drastically till 1985. Sorghum production experienced an increase from 1985 to 1988 and decreased sharply yet again from 1988 to 1989. Between 1989 and 2002 sorghum production fluctuated tremendously alternating between increases and decreases but increased sharply from 2002 to 2006. From 2006 to 2013 sorghum production fluctuated yet again and reached an all time in 2013. Between 2013 and 2014 there was a sharp increase in sorghum production but fluctuated yet again till 2018 where there was a decline in sorghum production. This is consistent with the findings of Harold (2015) who observed that the continued demand is reflected in the trend for increasing area under sorghum in Africa over the last fifty years but crop productivity has not kept pace with this increasing demand.

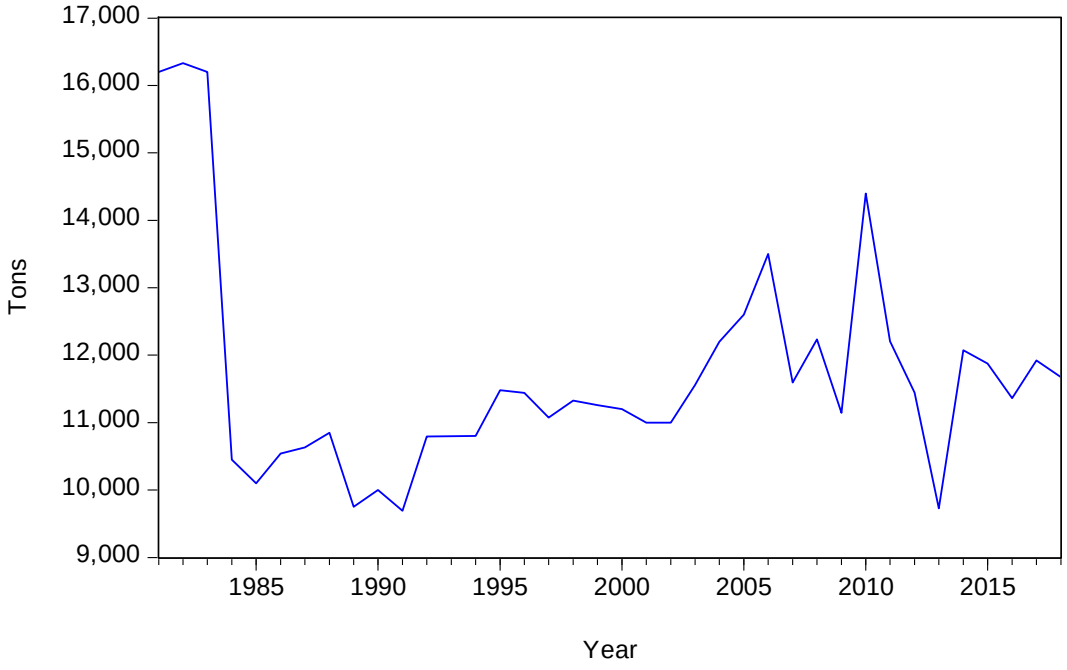

Figure 1: Trends Sorghum Production (1981-2018)
Source: Data analysis, 2019.

Trends of Agricultural Output in Nigeria (1981-2018)

Figure 2 presents the trend of agricultural output in Nigeria. The result shows that the trend of agricultural output in Nigeria ranges between ₦2303510 to ₦17544147 with a mean of ₦7671357 during the period under study. This can be attributed to political instability, lack of focused and visionary leadership, economic mismanagement and corruption (Adekanye, 1993). Specifically, from 1981 to 1982 agricultural output was fairly constant but decreased from 1982 to 1984. Between 1984 and 1990 agricultural output increased at a steady rate but became constant from 1990 to 1991. Agricultural output continued to increase from 1991 to 1998 and became constant yet again from 1998 to 1999. From 1999 to 2001 there was a slight increase in agricultural output but from 2001 to 2015 there was a rapid increase in agricultural output. However, agricultural output declined from 2015 to 2016 but has continued to increase from 2016 till 2018. This is in line the findings of Kalikume (2015) who asserted that agricultural output in Nigeria has risen

substantially over the years, with annual average of 7.4 per cent in the last decade. But the growth has not been inclusive, broad-based and transformational.

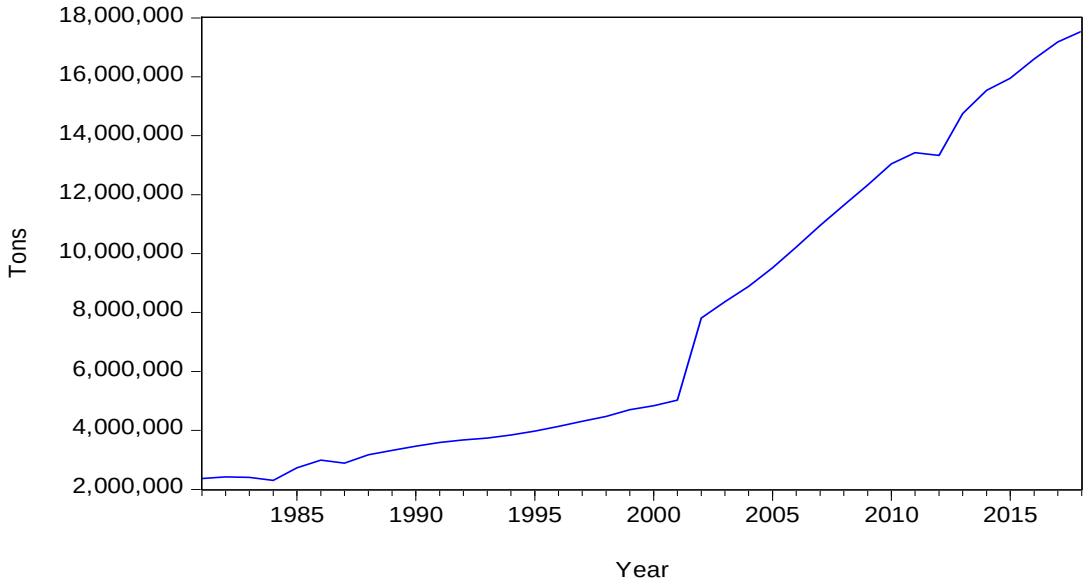

Figure 2: Trends of agricultural output in Nigeria (1981-2018)
Source: Data analysis, 2019.

Growth Rates and Direction of Sorghum Production in Nigeria (1981-2018)

The result of the trend analysis of sorghum production is shown in Table 1. The trend equation revealed that the growth rate of sorghum production was negative which implies a negative growth rate. The coefficient for estimating the growth (-0.016) was negative and significant at 5%. The instantaneous growth rate (growth at a point) of sorghum production is 1.6% while the compound growth rate is 2.38%. This implies that the growth rate of sorghum production in Nigeria has been slow and may not be able to maintain pace with the rapid population growth so as to achieve food security. The direction of growth of sorghum production shows that there was acceleration in sorghum production over the years. The coefficient of multiple determination (R^2) value of 0.23 shows that 23% of the variations in the trend of sorghum production are explained by time.

Table 1. Trend Analysis of Sorghum Production

Variables	Coefficient	t-statistics
Constant	9.46	164.43
@ trend	-0.016	-2.24**
@ trend^2	0.0004	2.27**
R^2	0.23	
F-statistics	2.59	

** Significant at 5%
Source: Data analysis, 2019.

Growth Rates and Direction of Agricultural Output in Nigeria

The result of the trend analysis of agricultural output in Nigeria is shown in Table 2. The trend equation revealed that the growth rate of agricultural output in Nigeria was positive which implies a positive growth rate. The coefficient for estimating the growth (0.044) was positive and significant at 1%. The instantaneous growth rate (growth at a point) of agricultural output is 4.4% while the compound growth rate is 5.06%. The direction of growth of agricultural output in Nigeria shows that there was acceleration in agricultural output. The coefficient of multiple determination (R^2) shows that 97% of the variations in the trend of agricultural output in Nigeria are explained by time. This is similar to the findings of Soyibo and Olayiwola (2000) who observed that agricultural output in Nigeria has been good relative to annual GDP growth rate.

Table 2. Trend Analysis of Agricultural output

Variables	Coefficient	t-statistics
Constant	14.59709	265.3317
@ trend	0.043810	6.368046***
@ trend^2	0.000469	2.611086**
R^2	0.970363	
F-statistics	606.7469	

*** Significant at 1%, ** significant at 5%
Source: Data analysis, 2019.

Table 3. Growth Rates and Direction of Maize Production and Agricultural output

Variables	Growth rate	Direction of growth
Agricultural Output	4.4%	Acceleration
Sorghum	1.6%	Acceleration

Source: Data analysis, 2019.

Unit Root test

The Augmented Dickey Fuller (ADF) test for unit root was employed to test whether or not a variable is stationary and also determine the order of integration of the variable. The rationale was to overcome the problems of spurious regression. A stationary series tends to always return to its mean value and variations around this mean value. The result indicated that the variables were not integrated of order zero and this implies that the variables were not stationary at level form. However, the variables were found to be integrated of order one and became stationary on first differencing. This indicates that the variable exhibit random walk (unit roots) or the future values of these variables do not converge from their past values or their mean are unpredictable.

Table 4. Result of Augmented Dickey-Fuller (ADF) Test

Variable	Level				First Difference				
	ADF	1%	5%	10%	ADF	5%	1%	10%	Inference
Agricultural Output	-1.814	-3.736	-2.994	-2.638	-3.625***	-3.743	-2.951	-2.614	I (1)
Sorghum Production	-2.096	-3.736	-2.994	-2.638	-4.621***	-3.743	-2.951	-2.614	I (1)

*** Significant at 1%
Source: Data analysis, 2019.

Result of Co-integration rank test for the long run relationship among the variables

According to Engle and Granger (1987), regressing a non-stationary series on another non-stationary series yields spurious regression, but if the linear combination of the series is stationary, we could say the variables are cointegrated and the regression is no longer spurious. Variables are said to be cointegrated if they have long run association. Since our variables are non-stationary, it becomes imperative to test whether or not the variables are cointegrated. To do this, the study adopted the Johansen Cointegration Trace test; the result is presented in Table 4. Further investigation into the series properties of the variables through the use of Johansen co-integration mechanism indicates that co-integration exists among the variables. The result shows that the

computed trace statistic (40.056) is greater than the critical value (35.192) at 5% level of significance therefore, co-integration exists among the variables. On this basis, the null hypothesis of none of the hypothesized number of equation(s) is rejected.

Table 5. Johansen co-integration Test for unrestricted co-integration Rank Test (Trace)

Hypothesized No. of CE(S)	Eigen value	Trace Statistics	0.05 critical value	Prob**
None*	0.763	40.056	22.299	0.0183
At most 1	0.392	11.204	15.892	0.2371
At most 2	0.243	8.293	10.423	0.867

* denotes rejection of the hypothesis at the 0.05 level of significance
** MacKinnon-Haug-Michelis (1999) p-values
Source: Data analysis, 2019.

Vector Error Correction Model result for Effect of Sorghum Production on Agricultural Output in Nigeria

Given the existence of a co integrating relationship between the variables, implying long run relationship exist among the variables, the Vector Error Correction Model (VECM) was estimated. The result of VECM as shown in Table 6 indicates that in a long run, the coefficient of sorghum production is rightly signed as expected and statistically significant at 1% probability level. Thus, this implies that a unit increase in sorghum production will increase agricultural output by 6.492 units. This shows that sorghum is a very important crop in Nigeria therefore; its production will inevitably bring about a significant increase in agricultural output in Nigeria in the long run. This is consistent with the findings of Samson *et al.* (1981) who posited the contribution of sorghum production to agricultural output in Nigeria as it contributes about 50 per cent of the calories in Nigeria generally and about 73 per cent in the savannah regions of the country in particular.

The result of the short run Vector Error Correction Term [VECM (-1)] is positive (0.004) as expected, indicating a quick speed of adjustment (that is, the speed at which the deviation from

long run equilibrium is adjusted quickly where 0.004 of the disequilibrium is removed immediately in each period). The result shows that the speed of adjustment where sorghum production will equilibrate agricultural output in Nigeria is at 0.4% in the short run and statistically significant at 10% probability level. More so, the coefficient of multiple determination (R^2) is 42%. This implies that the independent variable is found to explain 42% of the movement of the dependent variable.

Table 5. The Vector Error Correction Model of long and short-run relationship between sorghum production and agricultural output in Nigeria

Long run Estimates		
Regressors	**CointEq1**	
Agricultural output	1.000000	
Sorghum production	6.492 (3.923***)	
Constant	-281.998	
Short-run Estimates		
Error Correction Model	**Agricultural output model**	**Sorghum production model**
CointEq1	0.004 (1.669*)	0.003 (-1.717*)
Agricultural output-1	-0.0040 (-0.0217)	-0.186 (-1.135)
Sorghum production-1	0.0815 (0.6116)	0.149 (1.183)
Constant	0.0291 (2.683**)	0.019 (2.159)**

R^2 = 0.421; Adjusted R^2 = 0.398; F statistics = 7.613 Likelihood 69.908
Akaike Information Criteria -7.663 Schwarz Criteria -7.215
Figures in parentheses are t-values,*significant at 10% ** significant at 5%
Source: Data analysis, 2019

CONCLUSION AND RECOMMENDATIONS

The study used annual time series data for the period (1981-2018) to assess the trend of sorghum production in Nigeria and it's implication on agricultural output. The study revealed that, sorghum production has a positive and significant relationship with agricultural output in Nigeria both in the short run and in the long run. This implies that the more sorghum is been produced in Nigeria, the more the improvements in the performance of agricultural output in Nigeria. Also, the trend of sorghum production and agricultural output in Nigeria has been experiencing an appreciable level of increase over the years. The study therefore recommended that:

i. In order to boost production, government should ensure timely and adequate provision of inputs, provide affordable credit to farmers and fund extension services adequately.

ii. Conscious effort must be made to increase sorghum production level geometrically so as to maintain pace with the rapid population growth if food security is to be ensured in Nigeria.

iii. The needed growth in production/productivity of sorghum will continue to be a mirage unless investments in agricultural research and education are maintained or increased.

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