

# Trend Analysis of Millet Production and Agricultural Output in Nigeria (1981-2018)

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**Abstract** - The study assessed the trend of millet production in Nigeria and its 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 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 Auto Regression (VAR). The result of the study revealed that the trend of millet production has fluctuated considerably over the years but has experienced a fairly constant trend in the last few 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 millet production was 3.6% and decelerating while agricultural output was 4.4% and accelerating respectively during the period of study. There was no co-integration among the variables as a result of the variables having unit roots at different levels therefore; Vector Auto-regression was therefore used to evaluate the short and long run effects of the variables on each other. The result of the millet production model showed that the coefficient of determination ( $R^2$ ) is 0.45. The result also showed that the F-statistics (28.8) was positive and significant at 1% indicating the overall significance of the model. The result further showed that the coefficient of millet production (0.249) in the previous year is positive and significant at 1% level of probability as expected. Also, the coefficient of agricultural output (0.236) is positive but not significant. The study therefore concluded that, conscious effort should be made to strengthen the development of new, well-adapted millet cultivars with high yield potential so as to boost millet production and consequently enhance agricultural output.

**Keywords:** Trend, Millet, Agricultural Output, Production, VAR.

## I. INTRODUCTION

Agriculture as the main stay of Nigerian economy, provides primary means of employment for Nigeria and accounts for more than one third of total gross domestic

product (GDP) (Kolawole and Ojo, 2007), with more than 70% of the working adult populations employed in the agricultural sector directly or indirectly. 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%) from 2000-2007 (Balami *et al.*, 2011).

Agriculture supplies food, raw materials and generates household income for the majority of the people. The food subsector of Nigerian agriculture parades a large array of staple crops, made possible by the diversity of agro-ecological production systems (Awotide, 2012). The major food crops are: cereals - sorghum, maize, millet, rice, wheat; tubers-yam, cassava; legumes - groundnut, cowpeas; others- vegetables.

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 households' diets both in the rural and urban areas (Balami *et al.*, 2011). Today, 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 (Isah, Samuel, Makama and Kiresur, 2015).

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 importance of cereal grains as sources of food for man cannot be over emphasized, particularly in the developing nations. Grains, depending on the processing technique and the types of cereal employed, have offered a wide range of food products to man, particularly in the developing countries, but also to the animals in the developed countries. Millet, maize, rice and sorghum have formed the major food-based grains, particularly in Nigeria (Awotide, 2012).

Millet (*Pennisetum glaucum*) constitutes one of the most important cereal crops produced in Nigeria. Nigeria accounts for about 70% of the total sorghum production and more than half of the pearl millet production in West Africa with millet and sorghum accounting for over 60% of cereal grain production in Nigeria (ICRISAT, 2001).

Nigeria is the fifth largest producers of millet in the world as at 2016 with an annual tonnage of 1.5 million tonnes (FAOSTAT, 2017). Millet is a climate hardy crop which is grown in harsh conditions, but as a subsistence crop. In general, millets are used in the production of beverages and can also serve as a source of food worldwide. They are also used as bird and animal feed.

Ali *et al.* (2018) posited that the primary demand for sorghum and millets is for food in Africa, especially in the dryland regions where these are the principal crops. This continuing demand is reflected in the trend for increasing area under sorghum and millets in Africa over the last fifty years but crop productivity has not kept pace with this increasing demand. 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 (Ali *et al.*, 2018).

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 millet and overall agricultural output cannot therefore be overemphasized.

Other researchers have worked on cereal crops in general and millet in particular in Nigeria such as Tahir (2014) who focused on trend analysis of productivity of some selected cereal crops in Nigeria; Awotide (2012) who assessed the supply response of maize, millet and sorghum in Nigeria, amongst others. However, there is no known study on the trend of millet production and its corresponding impact on agricultural output in Nigeria hence, the need for this study to fill this research gap.

**II. 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°16 and 13°53 north latitude and between 2°40 and 14°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 Nigerian 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.

**2.1 Methods of Data Collection**

The study relied basically on secondary data. Annual time series data spanning from 1981 to 2018 was 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 cereal crops production were collected from the archives of the Food and Agriculture Organization (FAO).

**2.2 Analytical Techniques**

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

**2.3 The trend model is given as:**

$$Y_t = Y_0(1+r)^t \dots\dots\dots (1)$$

Where;  
 $Y_t$  = Millet production in year t.  
 $Y_0$  = Millet 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,

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

Substituting in  $Y_0$  with  $\beta_1$  and  $\ln(1+r)$  with  $\beta_2$ , equation (5) is rewritten as

$$\ln Y_t = \beta_1 + \beta_2 t \dots\dots\dots (3)$$

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

$$\ln Y_t = \beta_1 + \beta_2 t + U_t \dots \dots \dots (4)$$

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  $\beta_2$  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  $\beta_2$  by 100 gives the instantaneous growth rate at a point in time.

$$IGR = b_2 \times 100 \dots \dots \dots (5)$$

Where IGR = Instantaneous growth rate.

$b_2$  is the least square estimate of the coefficient of  $\beta_2$ , 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.

$$CGR = [\text{antilog } b_2 - 1] \times 100 \dots \dots \dots (6)$$

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 is stagnation in the growth process. However, if the coefficient of  $b_2$  is not statistically significant, then there is stagnation in the growth.

The linear trend analysis model with the form  $Q = b_0 + b_1 T + e$  and the quadratic model with the form  $Q = b_0 + b_1 T + b_2 T^2 + e$  were also tested to determine the best fit.

### III. RESULTS AND DISCUSSION

#### 3.1 Trends of Millet Production in Nigeria (1981-2018)

Figure 1 presents the trend of millet production in Nigeria. The result shows that the trend of millet production in Nigeria ranges between 909560 tonnes and 9064000 tonnes with a mean of 4407013 during the period under study. This can be attributed to the fact that millet is one of the most important cereal crops produced in Nigeria; however, millet production in Nigeria has been inconsistent. Specifically, from 1981 to 1986 there was a steady increase in millet production. Between 1986 and 1988 there was a decline in millet production but increased sharply from 1988 to 1991. From 1991 to 2001 millet production increased fairly and consistently but declined till 2002. Millet production however continued to increase sharply from 2001 to 2009. There was a drastic reduction in millet production from 2009 to 2013 but began to increase fairly from 2013 to 2018. This is in line with the reports of CBN (2009) who posited that millet production in Nigeria has stagnated or underperformed over the years.

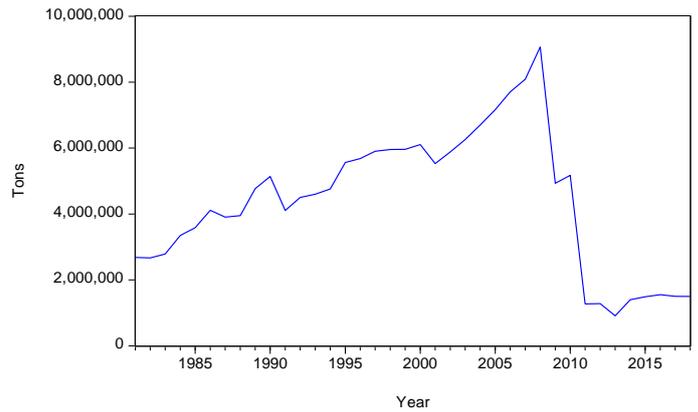


Figure 1: Trends of Millet Production (1981-2018)

Source: Data analysis, 2019.

#### 3.2 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 to 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.

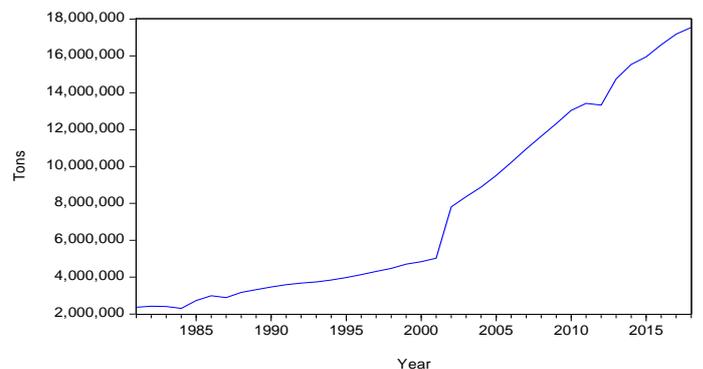


Figure 2: Trends of agricultural output in Nigeria (1981-2018)

Source: Data analysis, 2019

### 3.3 Growth Rates and Direction of Millet Production in Nigeria (1981-2018)

The result of the trend analysis of millet production is shown in Table 1. The trend equation revealed that the growth rate of millet production was positive which implies a positive growth rate. The coefficient for estimating the growth (0.136) was positive and significant at 1%. The instantaneous growth rate (growth at a point) of millet production is 3.6% while the compound growth rate is 4.7%. The direction of growth of millet production shows that there was deceleration in millet production over the years.

This implies that millet production growth rate has been erratic and had not improved appreciably over the years. This is synonymous with the reports of FAOSTAT (2017) that there has been a significant downward in millet production. The coefficient of multiple determination ( $R^2$ ) value of 0.67 shows that 67% of the variations in the trend of millet production are explained by time.

Table 1: Trend Analysis of Millet Production

Variables	Coefficient	t-statistics
Constant	14.56	87.10
@ trend	0.136	6.52***
@ trend <sup>2</sup>	-0.004	-7.67***
R <sup>2</sup>	0.67	
F-statistics	35.59	

\*\*\* Significant at 1%

Source: Data analysis, 2019

### 3.4 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 determinations ( $R^2$ ) 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 <sup>2</sup>	0.000469	2.611086**
R <sup>2</sup>	0.970363	
F-statistics	606.7469	

\*\*\* Significant at 1%, \*\* significant at 5%

Source: Data analysis, 2019

Table 3: Growth Rates and Direction of Millet Production and Agricultural output

Variables	Growth rate	Direction of growth
Agricultural Output	4.4%	Acceleration
Millet	3.6%	Deceleration

Source: Data analysis, 2019

### 3.5 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 result indicated that total cereal production was integrated of order zero. However, agricultural output was 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	1.247	-3.636	-2.946	-2.611	-4.858*	-3.636	-2.946	-2.611	I(1)
Millet Production	-4.489*	-3.670	-2.964	-2.621	-	-	-	-	I(0)

\* Significant at 1%

Source: Data analysis, 2019

### 3.6 Vector Auto Regression (VAR) Model Result for Effect of Millet Production on Agricultural Output in Nigeria in the Short and Long Run

Consequent upon the existence of stationarity of both variables at different levels, the Vector Autoregressive (VAR) model was estimated as both variables became endogenous. There was no further need for co-integration test because of the levels of stationarity of the variables. The result of the Vector Autoregressive (VAR) as shown in Table 5 indicates that both variables become endogenous and therefore have effect on each other.

The result of the millet production model showed that the coefficient of determination ( $R^2$ ) is 0.45. This implies that 45% of the total variation in agricultural output was explained by millet production in the previous year and agricultural output in the previous year. The result also showed that the F-statistics (28.8) was positive and significant at 1% indicating the overall significance of the model. The result further showed that the coefficient of millet production (0.249) in the previous year is positive and significant at 1% level of probability as expected. Thus, this implies that a unit increase in total cereal crop production in the previous year will increase total cereal production by 0.249%. This is synonymous with the findings of Harold (2015) who posited that millet production contributes to in no small way to the volume of cereal production which in turn boost agricultural output.

The result of the agricultural output model showed that the coefficient of determination ( $R^2$ ) is 0.28. This implies that 28% of the total variation in agricultural output was explained by millet production in the previous year and agricultural output in the previous year. The result also showed that the coefficients of agricultural output in the previous year (-0.124) is negative but not significant. Thus, this implies that a unit increase in agricultural output in the previous year will decrease agricultural production by 0.12% which rightly points out that agricultural output does not have a significant effect on millet production in Nigeria.

Table 5: Effect of Millet Production on Agricultural Output in Nigeria

Regressors	$\Delta AOUT$	$\Delta MP$
Constant	-0.191 (-0.313)	2.997 (4.077)***
$\Delta AOUT_{t-1}$	-0.124 (0.008)	0.236 (1.049)
$\Delta MP_{t-1}$	0.021 (0.285)	0.249 (8.134)***
$R^2$	0.28	0.45
Adjusted $R^2$	0.26	0.42
F statistics	0.05	28.8
Akaike Info. Criteria	-2.174	--1.672
Schwarz Criteria	-2.042	-1.539
Log Likelihood	42.134	33.086

Figures in parentheses are t-values, \*\*\*significant at 1%

Source: Data analysis, 2019

### IV. CONCLUSION AND RECOMMENDATIONS

The study assessed the trend of millet production in Nigeria and it's implication on agricultural output (1981-2018). The study revealed that, millet 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 millet is been produced in Nigeria, the more the improvements in the performance of agricultural output in Nigeria. Also, the trend of millet production has fluctuated considerably over the years and has become fairly constant over the years while agricultural output in Nigeria has been experiencing an appreciable level of increase over the years. The study therefore recommended that:

- i. Cereal crop sub-sector in Nigeria needs to be further strengthened in terms of increased financing, policy enactment and government commitment in order to enhance the quantity and quality of cereal production in Nigeria.
- ii. Conscious effort should be made to strengthen the development of new, well-adapted millet cultivars with high yield potential.
- iii. Government should encourage the use of modern mechanized farm tools, and subsidize the prices of agro-chemical and fertilizer for farmers in order to improve cereal crop production in the country and to encourage soil conservation methods.

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