Journal of Agriculture and Environment Vol. 15 No. 2, 2019: 13-28
ISSN: 1595-465X (Print) 2695-236X (Online)

A STUDY ON PRODUCTION BEHAVIOUR AND INSTABILITY OF RICE IN NIGERIA 1960-2015

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ABSTRACT

The paper attempted to analysed production instability in rice crop in Nigeria over a period of five decades using time series data sourced from FAO, NBS and NAERLS. Magnitude of instability in yield, area under cultivation and production was obtained using Coefficient of Variation (CV) and Coppock's Instability Index (CII). Sources of production instability were estimated using Hazell's Decomposition model. The findings revealed that, production instability was moderate during overall period (1960-2015) and low in the other periods thus, indicating low variability in production growth. Area instability was higher than yield variability in all the periods, meaning that, production instability was as a result of area expansion and the results at states and zones level also showed similar trend. Highest instability was observed in Katsina, Kano, Kwara and Anambra states, while lowest was noticed in Kaduna and Benue states. Decomposition analysis indicated that, change in average of rice production was as a result of change in mean area in almost all states and zones, while change in area variance and change in the residuals were major sources of change in variance of rice production during the study period. The results implied that, policies and agricultural programmes and other national interventions had impacted the most in increasing production through expansion in area under rice cultivation. The study therefore recommends policy trust towards increase in yield per hectare as there is limit to area expansion.

Key words: Rice; production; instability; decomposition; Nigeria

INTRODUCTION

Nigeria is heavily dependent on under developed agriculture characterised by considerable low level of technology. Analysis of this sector particularly the food sub-sector is of relevance to the socioeconomic development of the country. In the 1960s, the agricultural sector was the most important in terms of contributions to domestic production, employment, foreign exchange earnings and national food self-sufficiency. The situation remained almost the same three decades later with the exception that it is no longer the principal foreign exchange earner, a role now being played by oil (NBS, 2011; Izuchukwu, 2011). The country depend on imports to meet domestic demand for food to feed its 180 million people (Uche, 2014). Agricultural imports as a share of the total imports rose from 3 per cent in the late 1960s to 7 per cent in the early 1980s to more than 17.9 per cent in 2003. Total Nigerian imports of grain are put at 4.8 million tonnes in 2015 compared with 4.7 million the year before. Nigeria consumes nearly 6 million tons of rice annually, and more than half of this (over 3 million tons) is imported. In 2014, rice demand was estimated at 5.9 million metric tonnes, while only 2.7 million Mt was locally produced, leaving a supply gap of 3.2 Million MT as rice is the primary substitute food consumers eat when their usual staples are not available (Kwabena *et al*., 2016; FAO, 2015; Uche, 2014; Chukwuka, 2016).

Rice is cultivated in virtually all the agro-ecological zones of Nigeria, from the mangrove and swamps environment of the coastal areas, to the dry zones of the Sahel in the North (Akande, 2002; Anyanwale *et al.,* 2011). Rice production in Nigeria is very low and prior to 2016 the country imports rice worth about $3 billion per year, making it one of the largest rice importing countries in the world (Chukwuka, 2016). Milled rice production dropped to 2.4 million tons in 2012/2013 from approximately 2.9 million tons recorded the previous year which accounts for less than 50 percent of its total consumption and the demand gap has been filled by polished/milled rice. In 2014, about 1.9 million hectares were under rice cultivation in Nigeria with an estimated national production of 5.17million metric tons. Production increases to 5.5m tons in 2015 and 5.8 m tons in 2017 from a population of 12 million rice producers (FAO, 2015). From 1970 – 1985 rice production recorded positive growth justifying positive impact of government policies and programmes like, NAFPP, ADPs, OFN, and RBDAs created during the period. These programmes contributed especially in the area of inputs and irrigation facilities which accounted for yield increase from 2 to 4ton ha^{-1}. However, amidst these interventions the demand for rice, much of it imported, increased dramatically during the affluent 1970s, but had to be cut back during the foreign exchange shortages of the late 1980s. SAP placed importation ban to encourage local production, tariff structure was adjusted for local protection, marketing boards scraped to provide competitive environment, RBDAs were also enhanced to provide enabling environment for dry land irrigation. However, increased in rice demand for consumption and negative effect of some macroeconomic policies has cancelled the visible increase in growth. Since the mid-1980’s, rice consumption has increased at an average annual rate of 11% with only 3% explained by population growth (FAO, 2002).Despite the granting of increased incentives to the domestic rice production, agricultural output rose slowly because of inadequate transportation and poor road network, lack of appropriate and high cost of technology, and the ineffective application of rural credit.

During 1999 to 2015 positive growth in area, production and productivity of rice (2.11%, 5.46% and 2.45%) was recorded as shown on graphs (Fig. 1, 2 & 3). A number of policy initiatives were embarked within this period by different administrators to reverse the heavy importation of rice which was in excess of ₦ 2 billion. In 2004 the Federal government launched the presidential initiative on rice to address the widening demand-supply gap and the attainment self-sufficiency in rice production. This was followed up with the national rice development strategy in 2009 aimed at doubling rice production in Nigeria from 3.4 million metric tons in 2008 to 12.85 metric tons in 2018 by annually increasing land area, yield ha^{-1} and milling capacity respectively. In order to achieve this goal, government under the agricultural transformation agenda (ATA) and growth enhancement support scheme (GES) embarked on procurement and distribution of R-Boxes to the states. The R-Box contains rice seeds, agro-chemicals and extension messages to farmers on its applications. Under this there was production of 4.92 metric tonnes of breeder seeds and 25.23 metric tonnes of foundation seed of the new rice for Africa (NERICA) and 12.6 metric tonnes of lowland varieties of foundation seeds. Acceleration growth in paddy rice production was attributed to the increased adoption of the high yielding NERICA rice variety and the adoption of the rice box technology by farmers (Umar, 2016; CBN, 2010).

The fall of oil price worldwide has seen the present administration to diversify the economy to agriculture and this has led to the creation Anchor Barrowers Programme (ABP) for rice farmers. The programme which was launched in November 2016 with a roll out of ₦ 40 billion had 14 participating pilot states; Kebbi, Sokoto, Niger, Kaduna, Katsina, Jigawa, Kano, Zamfara, Adamawa, Plateau, Lagos, Ogun, Cross Rivers, and Ebonyi. The federal government also through the Nigeria Customs Service (NCS) re-introduced the ban of rice import through its land boarders as an effort to boost local production. In view of the foregoing government's interventions and variability in rice production which can either be adjudge as a result of area effect or yield fluctuations, the study seeks to estimate the pattern and sources of instability in cultivated area, production and productivity of rice during the study period.

MATERIAL AND METHODS

Study Area

The study area is Nigeria and time series data between 1960 and 2015 which was divided into four periods (period I, 1960-70; period II, 1971-85; period III, 1986-99; period IV, 2000-15) for analysis at national level, whereas data from 1994-2015 was used for states and zonal levels analysis because of insufficient data. Variables elicited were on area planted, production and productivity of the rice crop, sourced from FAOSTAT database, National Bureau of Statistics (NBS) and National Agricultural Extension Research Liaison Services (NAERLS). Three states were purposively chosen from each geo-political zone based on availability of data and level of production. Data was converted to natural log and analysed using Coppock's Instability Index (CII), Coefficient of Variation (CV) and Hazell's, 1982 Decomposition model.

Table 1: Percentage of rice production distribution at zones, states as at 2010

Zone		% of rice production	Selected states
North Central (NC)		37	Benue, Kwara and Niger
North West (NW)		20	Katsina, Kano and Kaduna
North East (NE)		25	Adamawa, Bauchi and Borno
South West (SW)		6	Oyo, Ogun and Ekiti
South East (SE)		4	Anambra, Enugu and Imo
South South (SS)		8	Rivers, Cross Rivers and Akwa Ibom
Total	6	100	18

Models Specification

Measurement of instability- Coefficient of variation (CV) - It is standard deviation expressed as a percentage of mean value and is most popular measure which indicates the extent of instability and overall variation in data. It is defined as;

$$CV = \frac{\sigma_{ij}}{\bar{x}_{ij}} \qquad (1)$$

Where, CV = Coefficient of variation, σ_{ij} = Standard deviation of the ith variable in the jth crop $\bar{x}_{ij}$ = Arithmetic mean of the ith variable in the jth crop. It was used by, Sadiq, (2014) and Maiadua et, al., (2017).

Coppock's Instability Index (CII)

Gives close approximation of the average year to year percentage variation adjusted for trend. It was employed by Narinder and Singhal, (1988), Rama Rao, (2003) and Umar, *et al*., (2019). CII is specified as:

$$CII = \left(Antilog\sqrt{logV} - 1\right) \times 100 \qquad (2)$$

$$logV = \sum(logX_{t+1} - logX_t - M)^2/N - 1 \qquad (3)$$

$$M = (logX_{t+1} - logX_t)/N - 1 \qquad (4)$$

Where X_t = Area/production/productivity in the year 't', N = Number of years, M = Arithmetic mean of the difference between the logs of X_{t+1} … etc, Log V = arithmetic variance of the series.

Measuring Sources of Instability

Decomposition is the act of splitting a system into its constituent parts. Hazell (1982) primarily developed the model to study instability in Indian food grain production. Agricultural production is a combined result of area and yield. A change in these components will lead to change in variance and average of production between two periods (base year and final year) which can be attributed separately to changes in the means, variances and covariances of area and yield. For this purpose, two period were considered to estimate the variability in production of the crop in Nigeria; period I (2006 to 2015) over period II from (1994 to 2005).

Change in production- Decomposition analysis of change in production assess how much of the increased or otherwise of production in year 'n' over the base year has resulted from change in area, productivity or their interaction.

i) Method of decomposition of change in average production

Change in average production of the crops is affected by changes in the covariances between area and yield and also by changes in mean area and mean yield, it is expressed as;

$$E(P) = \bar{A}\,\bar{Y} + COV(AY) \qquad (5)$$

Where; $E(P)$ = average/mean production, $\bar{A}$ = average/mean area, $COV(AY)$ covariance between area and yield respectively. To differentiate the changes in E(P) average production between two periods, let average production in first and second period be;

$$E(P_1) = \bar{A}_1\bar{Y}_1 + COV(A_1Y_1) \qquad (6)$$

$$E(P_2) = \bar{A}_2\bar{Y}_2 + COV(A_2Y_2) \qquad (7)$$

Taking the first period as base year, each variable in the second period can be expressed in terms of its counterpart in the second period plus the change in the variable between the two periods as follows;

$$\bar{A}_2 = \bar{A}_1 + \Delta\bar{A}, \qquad \bar{Y}_2 = \bar{Y}_1 + \Delta\bar{Y} \qquad (8)$$

Where, $\Delta\bar{A} = \bar{A}_2 - \bar{A}_1$ and $\Delta\bar{Y} = \bar{Y}_2 - \bar{Y}_1$

$$COV(A_2, Y_2) = COV(A_1Y_1) + \Delta COV(A_1, Y_1) \qquad (9)$$

Eq. (7) can therefore be rewritten as;

$$E(P_2) = (\bar{A}_1 + \Delta\bar{A})(\bar{Y}_1 + \Delta\bar{Y}) + COV(A_1Y_1) + \Delta COV(A, Y)$$
$$= \bar{A}_1\bar{Y}_1 + \bar{A}_1\Delta\bar{Y} + \bar{Y}_1\Delta\bar{A} + \Delta\bar{A}\,\Delta\bar{Y} + Cov(A_1Y_1) + \Delta COV(A, Y) \qquad (10)$$

The change in average production $\Delta E(P)$ is then obtained by subtracting equation ((6) from equation (7) as follows:

$$\Delta E(P) = E(P_2) - E(P_1) = \bar{A}_1\Delta\bar{Y} + \bar{Y}_1\Delta\bar{A} + \Delta\bar{A}\,\Delta\bar{Y} + \Delta COV(A, Y)$$

There are four (4) sources of change in average production from above equation. The first two terms represent change in mean area and change in mean yield which are called 'pure effects' and existed even if there were no other source of change. The third term is an interaction effect, which arise from the simultaneous occurrence of changes in mean yield and mean area. The fourth term in the equation represents interaction between area and yield covariance. Thus, the component of change in average production taking the first period as base period can be arranged as shown in Table 2 below.

Table 2: Components of change in average production

Sources of change	Symbols	Components of change
Change in mean area	$\Delta\bar{A}$	$\bar{A}_1\Delta\bar{Y}$
Change in mean yield	$\Delta\bar{Y}$	$\bar{Y}_1\Delta\bar{A}$
Interaction between changes in mean area and mean yield	$\Delta\bar{A}\,\Delta\bar{Y}$	$\Delta\bar{A}\,\Delta\bar{Y}$
Changes in area – yield covariance	$\Delta COV(A, Y)$	$\Delta COV(A, Y)$

ii) Methods of decomposition of the changes in variance of production

In this the variance of production was decomposed into its sources, viz., area variance, yield variance, area-yield covariance and higher order interaction between area and yield. A change in any one of these components will lead to change in variance of production, it is expressed as;

$$V(P) = \bar{A}^2.V(Y) + \bar{Y}^2.V(A) + 2\bar{A}\,\bar{Y}COV(A,Y) - COV(A,Y)^2 + R \quad (12)$$

Where,$V(Q)$= Production Variance, $\bar{A}$ = Mean Area, $\bar{Y}$= Mean Yield, $V(Y)$=Yield variance $V(A)$= Area variance, $COV(A,Y)$ = Area - Yield covariance, $COV(A,Y)^2$ = Higher order covariance between area and yield, R = Residual term

Using first and second periods, variance of production can be partition into its constituent parts as;

$$V(P_1) = \overline{A_1^2}.V(Y_1) + \bar{Y_1}^2.V(A_1) + 2\bar{A}_1\bar{Y}_1COV(A,Y) - COV(A_1,Y_1)^2 + R1 \quad (13)$$

Second period is,

$$V(P_2) = \overline{A_2^2}.V(Y_2) + \bar{Y_2}^2.V(A_2) + 2\bar{A}_2\bar{Y}_2COV(A,Y) - COV(A_2,Y_2)^2 + R2 \quad (14)$$

Variables in the second period can be expressed in terms of its counterpart in the first period plus the change in the variable between the two periods as follows;

$$\bar{A}_2 = \bar{A}_1 + \Delta\bar{A} \quad (15)$$

$$\bar{Y}_2 = \bar{Y}_1 + \Delta\bar{Y} \quad (16)$$

$$V(A_2) = V(A_1) + \Delta V(A) \quad (17)$$

$$V(Y_2) = V(Y_1) + \Delta V(Y) \quad (18)$$

$$Cov(A_2,Y_2) = Cov(A_1,Y_1) + \Delta Cov(A_1,Y_1) \quad (19)$$

Equation 14 can therefore be rewritten as;

$$\begin{aligned} V(P_2) = {} & \{\bar{A}_1 + \Delta\bar{A}\}^2 + \{V(Y_1) + \Delta V(Y)\} + \{\bar{Y}_1 + \Delta\bar{Y}\}^2\{V(A_1) + \Delta V(A)\} \\ & + 2\{\bar{A}_1 + \Delta\bar{A}\}\{\bar{Y}_1 + \Delta\bar{Y}\}\{Cov(A_1,Y_1) + \Delta Cov(A,Y)\} - \{Cov(A_1,Y_1) \\ & + \Delta Cov(A,Y)\}^2 + \{R_1 + \Delta R\} \quad (20) \end{aligned}$$

This can be expressed as,

$$\begin{aligned} V(P_2) = {} & \overline{A_1^2}V(Y_1) + \Delta\bar{A}^2V(Y_1) + 2\bar{A}_1\Delta\bar{A}\,V(Y_1) + \overline{A_1^2}\Delta V(Y) + \Delta\bar{A}^2\Delta V(Y) + 2\bar{A}_1\Delta\bar{A}\,\Delta V(Y) \\ & + \bar{Y_1}^2.V(A_1) + \bar{Y_1}^2\Delta V(A_1) + \Delta\bar{Y}^2V(A_1) + 2\bar{Y}_1\Delta\bar{Y}V(A_1) + \bar{Y_1}^2\Delta V(A) \\ & + \Delta\bar{Y}^2V(A) + 2\bar{Y}_1\Delta\bar{Y}V(A) + 2\bar{Y}_1\Delta\bar{Y}V(A) + 2A_1Y_1Cov(A_1,Y_1) \\ & + 2\bar{A}_1\Delta\bar{Y}Cov(A_1,Y_1) + 2\bar{Y}_1\Delta\bar{A}\,Cov(A_1,Y_1) + 2\Delta\bar{A}\,\Delta\bar{Y}Cov(A_1,Y_1) \\ & + 2\bar{A}_1\bar{Y}_1\Delta Cov(A_1,Y_1) + 2\bar{A}_1\Delta\bar{Y}\Delta Cov(A,Y) + 2\bar{Y}_1\Delta\bar{A}\,\Delta Cov(A,Y) \\ & + 2\Delta\bar{A}\,\Delta\bar{Y}Cov(A,Y) - \{Cov(A_1,Y_1)\}^2 - \{\Delta Cov(A,Y)\}^2 \\ & - 2Cov(A,Y)\Delta Cov(A,Y) \\ & + R_1\Delta R \quad (21) \end{aligned}$$

The change in variance of production ($\Delta V(P)$is then obtained by subtracting equation 13 from 14, thus:

$$
\begin{aligned}
(\Delta V(P) &= V(P_2) - V(P_1) \\
&= \Delta\bar{A}^{\,2}V(Y_1) + 2\bar{A}_1\Delta\bar{A}\,V(Y_1) + \overline{A_1^2}\Delta V(Y) + \Delta\bar{A}^{\,2}\Delta V(Y) + 2\bar{A}_1\Delta\bar{A}\,\Delta V(Y) + \Delta\bar{Y}^2V(A_1) \\
&+ 2\bar{Y}_1\Delta\bar{Y}V(A_1) + \bar{Y}_1^{\,2}\Delta V(A) + \Delta\bar{Y}^2V(A) + 2\bar{Y}_1\Delta\bar{Y}V(A) + 2\bar{A}_1\Delta\bar{Y}Cov(A_1,Y_1) + 2\bar{Y}_1\Delta\bar{A}\,Cov(A_1,Y_1) \\
&+ 2\Delta\bar{A}\,\Delta\bar{Y}Cov(A_1,Y_1) + 2\bar{A}_1\bar{Y}_1\Delta Cov(A,Y) + 2\bar{A}_1\Delta\bar{Y}\Delta Cov(A,Y) + 2\bar{Y}_1\Delta\bar{A}\,\Delta Cov(A,Y) \\
&+ 2\Delta\bar{A}\,\Delta\bar{Y}Cov(A,Y) - \{\Delta Cov(A,Y)\}^2 - 2Cov(A_1,Y_1)\Delta Cov(A,Y) \\
&+ \Delta R \qquad (22)
\end{aligned}
$$

Change in variance of production has ten sources from equation 22 which is explicitly presented in Table 3.

Table 3: Components of change in variance of production

Sources of change	Symbols	Components of change
Change in mean area	$\Delta\bar{A}$	$2\bar{Y}_1\Delta\bar{A}\,Cov(A_1,Y_1) + \{2\bar{A}_1\Delta\bar{A} + (\Delta\bar{A})^2\}V(Y_1)$
Change in mean yield	$\Delta\bar{Y}$	$2\bar{A}_1\Delta\bar{Y}Cov(A_1,Y_1) + \{2\bar{Y}_1\Delta\bar{Y} + (\Delta\bar{Y})^2\}V(A_1)$
Change in area variance	$\Delta V(A)$	$\bar{Y}_1^{\,2}\Delta V(A)$
Change in yield variance	$\Delta V(Y)$	$\overline{A_1^2}\Delta V(Y)$
Interaction between changes in mean area and mean yield	$\Delta\bar{A}\,\Delta\bar{Y}$	$2\Delta\bar{A}\,\Delta\bar{Y}Cov(A_1,Y_1)$
Changes in area-yield covariance	$\Delta Cov(A,Y)$	$\{2\bar{A}_1\bar{Y}_1 - 2Cov(A_1,Y_1)\}\Delta Cov(A,Y) - \{\Delta Cov(A,Y)\}^2$
Interaction between changes in mean area and yield variance	$\Delta\bar{A}\,\Delta V(Y)$	$\{2\bar{A}_1\Delta\bar{A} + (\Delta\bar{A})^2\}\Delta V(Y)$
Interaction between changes in yield and area variance	$\Delta\bar{Y}\Delta V(A)$	$\{2\bar{Y}_1\Delta\bar{Y} + (\Delta\bar{Y})^2\}\Delta V(A)$
Interaction between changes in mean area and mean yield and changes in area- yield covariance	$\Delta\bar{A}\,\Delta\bar{Y}\Delta Cov(A,Y)$	$(2\bar{A}_1\Delta\bar{Y} + 2\bar{Y}_1\Delta\bar{A} + 2\Delta\bar{A}\,\Delta\bar{Y})\Delta Cov(A,Y)$
Changes in residual	ΔR	$\Delta V(AY)$ - sum of other components

RESULTS AND DISCUSSION

Table 4. Descriptive statistics of area, production and productivity of rice 1960 to 2015

	Mean	Median	Max	Min	Stan. Dev	Skewness	Kurtosis	J-Berra	Prob
Area (‘000ha)	1248.6	893	3124.6	132	985294	0.334	1.61	5.55	0.06
Production (‘000Mt)	2149.9	1930.5	6738	133	1753494	0.644	2.726	4.056	0.13
Productivity (Kg/ha)	16493	16519.5	23893	8926	3425	-0.176	2.143	2.00	0.06

Source: Author’s computation

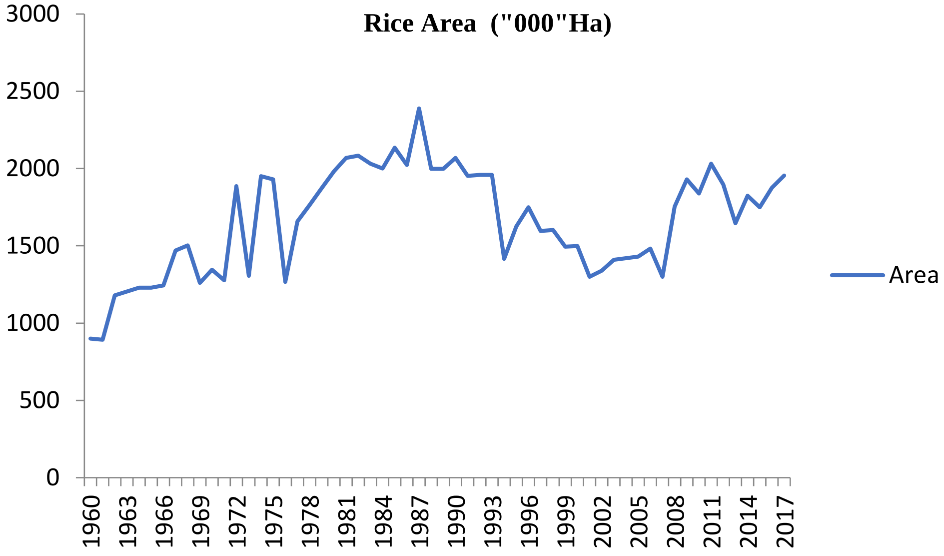

Fig.1. Rice area under cultivation in Nigeria 1960-2015. Source: FAO, 2016

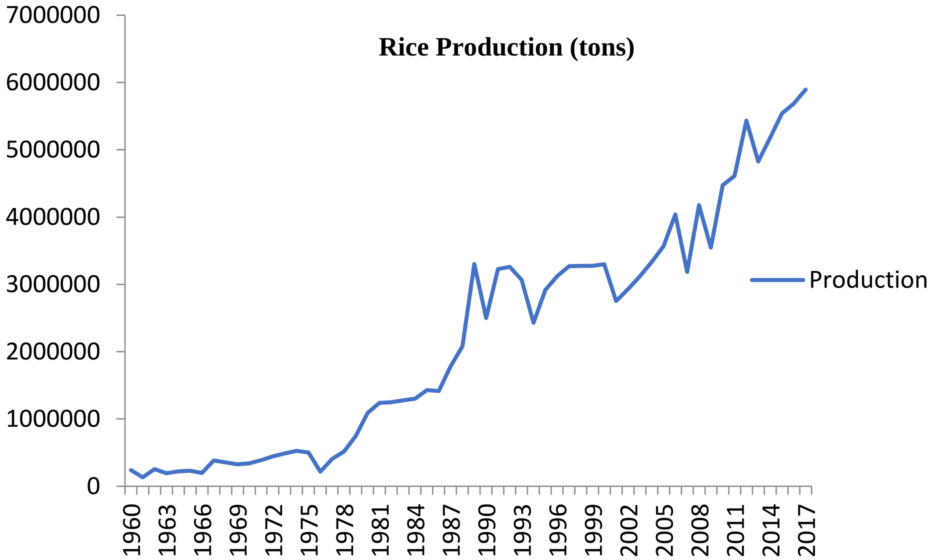

Fig. 2. Rice production (Paddy) in Nigeria, 1960-2017. Source: FAO, 2016

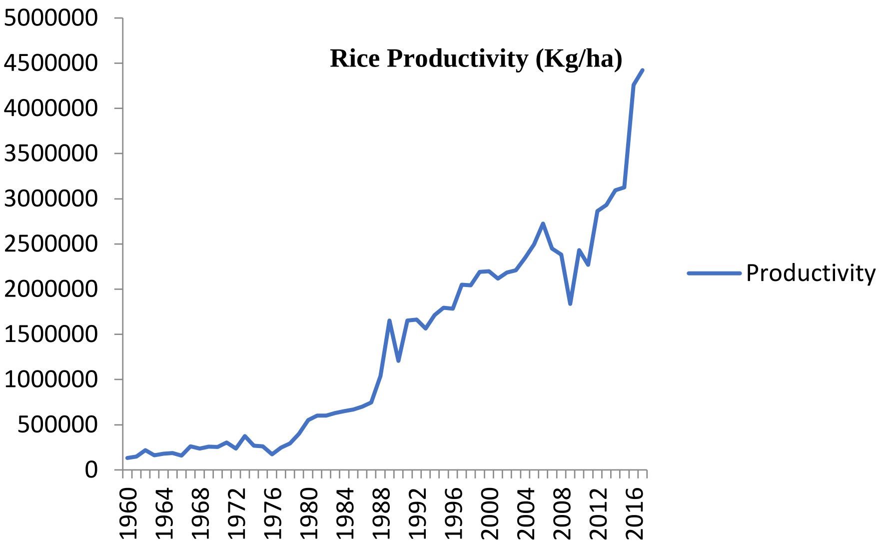

Fig. 3. Rice (Paddy) yield in Nigeria, 1960-2017. Source: FAO,2016

Results of Instability

Analysis of rice instability in Table 5 showed that, instability in productivity exhibited almost similar trend as all the periods were within the category of low instability (0 – 20%) in terms of CV and only period II falls within moderate instability in terms of CII (15.56). Lowest instability in terms of CV was noticed in period III (14.63%) while period IV registered the least productivity instability in terms of CII. Instability of productivity during the overall period was also low in terms of CII (16.11%) and moderate when CV is considered. Area instability of rice as indicated from the results was higher than productivity instability thus, highest area variability was recorded in period II and the lowest was observed in period IV. Overall period exhibited high area instability as measured in terms of CV. Comparison between periods showed that, both CV and CII of production instability were more in period II, indicating the dominance of area over the influence of yield. Lowest production instability was recorded during period III in terms of CV (22.75%) and in period IV in terms of CII (17.63%). Overall period revealed higher production instability in terms of CV (81.56%) and moderate instability in terms of CII (29.21%). It can be inferred from inter period analysis that, instability in area has contributed more in period II and IV than instability in productivity towards instability in production and that generally there was low instability in productivity.

At the states level, Delta State recorded the highest instability in productivity CV was 73.91% and CII was 54.0%. This is indication of growth ostensibly due to impact of good policies, while the lowest instability was recorded in Anambra state, CV (9.0%) and CII (7.6%). Seven states (Adamawa, Taraba, Bauchi, Benue, Oyo, Anambra, and Enugu)) have low instability, whereas nine states fell under moderate instability. Instabilities in yield in these states were ascribed to adoption of different levels of technology, improved variety of seedlings and overall level of government interventions. Area instability indicated a varied result from productivity as almost nine states had high instability and only one state had low instability in terms of CV and five in terms of CII indicating more variability in area growth. Highest instability in area was recorded in Kwara state while the lowest in terms of CV was noticed in Benue state (10.98%) and Anambra state in terms of CII (12.49%). Production instability was noticed to be high in Anambra, Kwara, Kano and Katsina states, ostensibly due to high growth resulting from favourable policies whereas Kaduna state has the lowest instability, thus indicating a normal trend or little fluctuation in production.

Table 5: Instability in area, production and productivity of rice 1960 to 2015 (%)

Period	Area harvested		Production		Productivity	
	CV	CII	CV	CII	CV	CII
Period I (1960-70)	23.81	25.24	30.15	34.06	15.75	11.87
Period II (1971- 85)	42.85	28.39	53.44	36.74	15.56	25.02
Period III (1986- 99)	29.93	20.77	22.75	21.13	14.63	13.22
Period IV (2000-2015)	14.96	13.19	29.89	17.63	15.19	11.72
Overall Period (1960-2015)	78.91	21.70	81.56	29.21	20.77	16.31
States and Zones 1994-2015 (base period 1994-2005)						
Katsina state	56.33	53.33	56.39	44.78	32.71	25.75
Kano state	57.91	53.93	60.92	55.55	20.36	34.64
Kaduna state	22.61	28.66	5.53	5.42	20.86	32.17
North West Zone	22.57	10.19	14.34	11.61	18.56	15.91
Adamawa state	27.12	41.48	29.39	25.99	12.96	14.67
Taraba state	20.58	14.46	24.24	19.53	15.32	12.02
Bauchi state	22.14	16.88	30.89	30.48	18.35	17.56
North East Zone	14.54	11.35	24.16	21.39	20.44	23.74
Benue state	10.98	15.35	11.16	16.01	11.96	19.39
Niger state	38.98	26.53	24.06	42.06	27.66	26.07
Kwara state	71.33	58.69	61.81	49.63	23.16	30.54
North Central Zone	35.54	11.82	35.07	12.32	7.73	11.52
Ondo state	44.71	21.51	22.32	21.08	24.42	12.64
Ogun state	29.43	22.06	57.06	12.54	38.05	20.54
Oyo state	40.57	14.07	44.12	15.10	10.74	9.63
South West Zone	67.27	14.51	71.90	17.88	9.18	12.71
Rivers state	32.51	22.02	30.03	30.41	24.04	24.09
Cross River state	43.69	36.49	47.29	19.97	25.69	30.36
Delta state	68.37	34.54	32.83	31.07	73.91	54.00
South South Zone	96.62	106.26	100.36	83.33	15.99	19.19
Anambra state	68.91	12.49	62.32	75.52	9.00	7.61
Enugu state	59.08	33.71	46.55	31.82	13.67	11.63
Imo state	23.36	22.94	28.28	80.09	58.55	22.95
South East Zone	40.17	21.50	44.31	26.06	17.82	19.44

Source: Author's computation

The results of zonal level analysis showed that south -south zone had extremely higher values of CV and CII than other zones in terms of area and production instabilities (96.62% and 106.26%) CV and (100.36% and 88.38%) CII. However, north east zone was indicated to have higher variability in productivity in terms of both CV and CII. Similarly, north -west zone recorded the lowest production instability during the study period (14.34% and 11.61%) respectively. From the ongoing therefore, it could be allude that contribution of area variability was more pronounced in production instability implying that the policies during the period of the study were skewed to or had grossly favoured expansion of area and the hypothesis that there was high instability in productivity should be given a second thought.

Sources of Instability

Change in Average of Rice Production

The findings from Table 6 revealed the analysis of component of change in average rice production, the results showed that, change in mean area was the dominant source of output growth in almost all the states studied (15 out of 18 states) while change in mean yield was predominant in the remaining three states. Change in mean area accounted for 50.83 percent in Katsina state, whereas change in mean yield and interaction between mean yield and mean area contributed 28.25 and 20.28 % respectively. Similarly of the four (4) sources of change in average production of rice, change in mean area has more than doubled the contribution of other sources in Kano state, implying that the effect of growth was more dependent on area variability. In Adamawa, Kwara, Ondo and Enugu states change in mean area was quite high as to render other sources unimportant. Results from Taraba, Niger, Imo and Rivers states showed that interaction between mean yield and area effect was another important component after change in mean area influencing change in average production of rice. Other states where change in mean yield accounted for high contribution were, Bauchi, Oyo, Anambra and Cross Rivers states with 67.62, 81.09, 81.45 and 98.16 percent respectively. In Kaduna state however, change in average production was partly due to change in mean yield (64.06%) and change in mean area (59.63%) while interaction effect and area yield covariance were found to have negative impact thus, indicating a stabilizing effect. Other states that had change in mean yield which was purely responsible for change in average rice production were; Benue and Ogun states (256.87 and 42.26 percent)

The change in average production of rice at zonal level indicated that change in mean area was the dominant source of instability in North West zone and north central zone. Change in mean area was most responsible for the growth in north west zone accounting for 404.56 percent thus rendering change in mean yield and interaction effect to became negative (-210.52 and -96.04 percent) respectively. In north central zone, change in mean area dominated by 89.49% followed by change in mean yield (6.07%) however the result varied in north east zone where component of change in average rice production was solely as a consequence change in mean yield (80.71%), though change in mean area accounted for 24.68 percent. At national level, change in mean area has more impact (133.51%) on the component of change in average rice production, followed by change in area yield covariance. change in mean yield and interaction between changes in mean yield and mean area were resulted in negative contribution.

Table 6: Components of change in average of rice production (%)

States/Zones/National	Change in mean Area $\Delta\bar{A}$	Change in mean Yield $\Delta\bar{Y}$	Interaction between mean Yield and mean Area $\Delta\bar{A}\,\Delta\bar{Y}$	Changes in Area - Yield covariance $\Delta COV(A, Y)$
Katsina	50.83	28.25	20.28	0.66
Kano	65.41	16.69	10.07	5.54
Kaduna	59.63	64.06	-1.68	-14.01
Adamawa	111.36	-10.92	-1.48	0.55
Bauchi	67.62	26.99	8.84	-2.24
Taraba	698.81	-744.59	118.25	23.58
Benue	-137.35	256.87	-19.78	0.33
Kwara	117.84	-5.19	-11.74	-0.94
Niger	236.64	-228.72	98.67	-4.07
Oyo	81.49	8.54	8.21	1.10
Ogun	34.40	42.26	21.70	1.64
Ondo	277.68	-81.09	-91.00	-5.48
Anambra	81.45	7.02	10.55	0.98
Enugu	127.91	-10.77	-14.99	-2.18
Imo	50.94	11.38	35.65	2.43
Rivers	522.71	-594.24	208.77	-24.82
Cross Rivers	98.16	4.15	2.91	-5.20
Delta	157.76	-7.40	46.49	-4.13
North West zone	404.56	-210.52	-96.04	1.32
North East zone	24.68	80.71	-6.13	0.77
North Central zone	89.49	6.07	4.55	-0.12
All Nigeria level	133.51	-28.06	-16.6	8.41

Source: Author's computation

Change in Variance of Rice Production

Empirical findings presented in Table 7 revealed that change in area variance was responsible for change in variance of rice production in majority of the states meaning that, variability in production over the two periods studied were as a result of change in area under cultivation. Those states include; Katsina (42.49%), Adamawa (107.01%), Benue (67.72%), Kwara (516.71), Oyo (143.41%) Anambra (58.97%), Enugu (258.55%) and Rivers states (957.08). In Katsina, Benue, Oyo and Anambra states interaction between changes in mean yield and area variance was seen next to change in area variance in terms of percentage contribution whereas, in Adamawa state mean yield and mean area were the only positive components after change in area variance affecting variance of production, all other variable were negative thus, implying stabilizing effect on the instability. It was observed that interaction between changes in mean area and yield variance was next contributing factor (64.18%) in Kwara state while in Enugu state change in mean yield and interaction between changes in mean area and mean yield were the only positive components apart from change in area variance to influence the variation in the production. Changes in residuals was found to be the dominant source of variance in rice production in Kano, Kaduna and Bauchi states with 996.74, 588.99 and 48.57 percent respectively. Similarly changes in area-yield covariance was the main source of variability in Taraba, Ondo and Cross Rivers, while Delta state output growth was mainly influenced by interaction between changes in mean area and mean yield and changes in area- yield covariance (1136.36 percent).

Zone wise analysis indicated that, change in area variance was the dominant source of instability in north west zone, north central, south west and south-south zones. In north-east change in area variance constitutes (174.32%) followed by change in residuals (167.52%) and change in mean yield (106.02%) respectively. Interaction between changes in mean yield and area variance and interaction between changes in mean area and mean yield and changes in area- yield covariance were next dominant factors after change in area variance in north central and south west zone accounting for 10.62 and 13.12 percent respectively. The result was however different in north east and south east zones where changes in area-yield covariance was mainly responsible for the change in variance of rice production. Findings further showed that change in average of rice production at all Nigeria level during the study periods was as result of change in residuals (152.52%) and change area-yield covariance (137.36%).

Table 7: Results of components of change in variance of rice production (%)

States, Zones and National	Sources/ Components of change									
	Change in mean Yield $\Delta\bar{Y}$	Change in mean Area $\Delta\bar{A}$	Change in area variance $\Delta V(A)$	Change in yield variance $\Delta V(Y)$	Interaction between changes in mean area and mean yield $\Delta\bar{A}\Delta\bar{Y}$	Changes in area-yield covariance $\Delta Cov(A,Y)$	Interaction between changes in mean yield and area variance $\Delta\bar{Y}\Delta V(A)$	Interaction between changes in mean area and yield variance $\Delta\bar{A}\Delta V(Y)$	Interaction between changes in mean area and mean yield and changes in area- yield covariance	Changes in residuals ΔR
Katsina	0.58	1.55	42.49	-0.35	0.12	6.23	40.65	-0.68	8.78	0.63
Kano	-177.54	-99.97	-1319.96	-163.96	-64.29	883.29	-437.35	-257.44	739.57	996.74
Kaduna	-387.71	0.28	-259.66	-176.07	-0.27	328.48	14.39	9.09	-17.51	588.99
Adamawa	7.6	0.65	107.01	-1.04	-0.01	-2.92	-2.83	-0.30	-0.35	-8.16
Bauchi	-42.17	-25.42	30.79	19.38	-1.38	31.17	8.58	14.77	15.71	48.57
Taraba	-37.49	14.17	-7.89	-11.02	0.82	94.39	-2.90	3.22	-1.55	48.25
Benue	8.74	-2.29	67.72	-8.30	-0.09	20.30	20.91	1.23	1.14	-9.37
Kwara	-25.39	-11.53	516.71	6.66	1.38	-117.52	-97.81	64.18	-225.36	-11.32
Niger	-135.77	-12.90	211.60	13.07	-15.12	-70.74	213.24	-8.84	13.68	-99.22
Oyo	1.32	18.57	143.41	4.31	3.27	-29.62	30.35	12.28	-34.05	-49.84
Ogun	1.04	0.13	6.91	13.58	0.05	18.47	11.47	17.52	27.46	3.37
Ondo	-9.70	-104.63	-1328.63	-172.98	13.61	1009.32	728.15	-606.12	426.34	144.66
Anambra	0.00	0.00	58.97	0.28	0.00	7.55	16.26	1.47	13.91	1.56
Enugu	-1.49	15.47	258.55	-0.69	0.23	-51.49	-57.05	-3.26	-56.52	-3.74
Imo	6.70	7.03	20.55	-0.01	2.27	2.91	38.84	-0.01	19.99	1.80
Rivers	851.31	608.64	957.08	2115.89	-253.21	-1881.59	917.18	-1225.56	172.22	-2161.97
Cross Rivers	-28.04	-505.69	-3343.2	-507.18	-0.58	3080.0	-201.49	-961.28	2274.91	292.64
Delta	125.49	-0.29	-1351.16	-13.58	-62.38	302.98	678.99	-706.04	1136.36	-10.37
North West	-107.34	106.02	174.32	-131.38	9.78	91.17	-72.94	-147.22	10.07	167.52
North East	84.80	-1.34	-136.32	-98.53	0.41	293.92	59.27	14.39	-89.60	27.0
North Central	0.71	0.64	101.82	-0.01	0.02	-6.63	10.62	-0.03	-5.56	-1.58
South West	-0.52	1.28	81.33	-0.15	0.00	5.03	-0.28	-1.78	13.12	1.97
South East	-0.39	-2.22	-2.28	7.23	-0.07	35.64	-0.12	18.89	34.12	9.21
South South	0.01	0.33	50.47	0.02	0.00	1.81	8.21	-0.18	36.45	2.88
All Nigeria	-122.89	-3.66	-112.74	-14.63	6.34	137.36	26.30	-22.44	53.84	152.52

Source: Author's computation

CONCLUSION

The study attempted to analyse production instability in rice crop in Nigeria using time series data covering a period of 56 years (1960-2015). Magnitude of instability in area, production and productivity was measured by coefficient of variation and Coppock's instability index while sources of production instability were determined through Hazell's decomposition model.CV showed that there was high instability in area and production during the overall period (1960 – 2015), this was however moderate when adjusted for trend. Moderate production instability was similarly observed in Period I, II, III and IV using CII indicating uniform growth across periods. Low instability in productivity implied that, production instability was due to higher area instability. Period II recorded the highest instability in area, production and productivity, ostensibly due to favourable policies and creation of various programmes during this period. Instability in production at state level was high in Anambra, Kano, Kwara and Katsina states, whereas, lowest instability was recorded in Kaduna and Benue states. Pattern of instability was seemingly as a result of growth due to impact of policies. From decomposition analysis change in average of rice production was mainly due to change in mean area whereas change in variance of rice production was as a result of change in residuals and changes in mean yield–area covariance. The study concludes that, policies and programmes during the study periods grossly favoured expansion of area under rice cultivation and impacted in the least manner, increase in yield of rice on per hectare basis. It is recommended that, policies and rice interventions programmes should focus more on increasing yield of rice as there is limit to area expansion. This may possibly be achieved through investment in research and technology.

REFERENCES

Akande, T. (2002). An Overview of the Nigeria Rice Economy. The Nigerian Institute of Social and Economic Research (NISER). lbadan. 1-15.

Ayanwale, A.O.S., V.O Akinyosoye, S.A. Yusuf and A.O. Oni, (2011). Rice supply response in Nigeria; whither changing policies and climate. *World Rural Observations,* 3(4):78-84

Central Bank ofNigeria, (2010). Statistical Bulletins. *Domestic production, consumption and prices.*

Chukwuka, O. (2016). Towards rice self- sufficiency in Nigeria: Contemporary issues and challenges. Centre for the Study of the Economies of Africa (CSEA), January, 13 2016.

FAO (2002). *The state of food and agriculture*. Food and Agriculture Organization of the United Nations, Rome.

FAO (2015). FAOSTAT. *Production data base*. Food and Agriculture Organization of the United Nations Rome.

Hazell, P.B.R. (1982). Instability in Indian food grains production. Research Report No. 30, International Food Policy Research Institute, Washington D.C 20036 U.S.A. 60.

Izuchukwu Oji-Okoro (2011). Analysis of the contribution of agricultural sector on the Nigerian economic development. *World Review of Business Research.* 1(1): 191- 200.

IICA (2011). Federal Republic of Nigeria Study for Poverty Profile (Africa). Final Report March, 2011. Japan International Cooperation Agency. Public Policy Department Mitsubishi. UFJ Research Consulting Company Ltd

Kwabena, G.B., Micheal, E.J, and Hiroyuki, T. (eds) (2016) The Nigerian Rice Economy: Policy Option for Transforming Production, Marketing and Trade. Washington D.C.: International Food Policy Research Institute (IFPRI). http://ebrary.ifpri.org/cdm/ref/collection/p15738

Maiadua, S.U., Suhasini, K., Sadiq, M.S and Aminu, A. (2017). Growth and instability in yam production in Nigeria: An inter state level analysis. *Dutse Journal of Agriculture and Food Security*, 4(1):10-24

Narinder, K., and Singhal (1988). India's export instability. *Margin.* 21(1): 54-61.

NBS (2011). Annual Abstracts of Statistics, National Bureau of Statistics, Federal Republicof Nigeria

Rama Rao, I.V.Y. (2003). Growth and instability of agriculture in Andhra Pradesh an unpublished PhD thesis submitted to the Department of Agricultural Economics, Acharya N.G. Ranga Agricultural University Rajendranagar, Hyderabad.

Sadiq, M.S. (2014). Empirical growth rate analysis of rice in Nigeria and its implication on food security: comparative assessment of three economic reforms phases in Nigeria. *Journal of Agricultural Economics, Extension and Rural Development.* 1(12): 218-223

Uche, N. (2014). Nigeria: Grain and feed annual report (2013), USDA. Foreign Agricultural Service, Global Agricultural Information Network. 1-14.

Umar, S.M (2016). Growth and supply response for some selected food crops in Nigeria. Published PhD thesis submitted to the Department of Agricultural Economics, Professor Jayashankar Telangana State Agricultural University Rajendranagar, Hyderabad www.krishikosh.egranth.ac.in

Umar, S.M., Suhasini, K., Jainuddin, S.M and Makama, S.A. (2019). Sources of growth and instability in cassava production in Nigeria: An evidence from Hazell's decomposition model. *SKUAST Journal of Research*, 21 (1): 86-95