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Trend of area, Production and Productivity of major cereals: India and Nigeria Scenario.

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Abstract

The study was conducted to examine trends in area, production and yield of cereals in India as well Nigeria from period 1982-2012. The secondary data collected from the FAO stat data base for the period and were used for the study. The average area, production and productivity in India under cereals was 99,787,727.63 ha, 215,096,746.9tonnes and 2.156 tonnes/ha respectively and from Nigeria was 77,547,885 ha, 101,037,721 tonnes and 1.30 tonnes/ha for area, production and productivity respectively. The computed growth trend for cereals in India was negative (-0.0750) and significant (P<0.01) for area, and production computed growth trend was positive (0.84) and significant (P<0.01) and growth for productivity was positive (0.94) and significant (P<0.01). However, from Nigeria the computed growth were positive (1.056), (1.247), and (0.189) and significant at degree of probabilities 1%, 1% and 5% for area, production and productivity respectively. Although higher productivities were recorded India for rice, wheat and maize than in Nigeria except in millet and sorghum where reverse is the case. In both countries area for cereals is declining as such it is better to focus on increasing production through productivity by encouraging dissemination of high yielding variety, adequate input supply, transfer of technology and advisory services to the farmers engaged in the cultivation of cereals. Likewise, both countries witnessed instability with more than 10% instability index in area and production and a relatively stability in productivity was found.

Keywords: Area, production, growth trend, major cereals, India, Nigeria.

Introduction

In the world of today, Cereal grains have been considered as the principal component of human diet for thousands of years and have played a major role in shaping human civilization. Around the world, rice, wheat, and maize, and to a lesser extent, sorghum and millets are important staples critical to daily survival of billions of people. More than 50% of world daily caloric intake is derived directly from cereal grain consumption. Most of the grain used for human food is milled to remove the bran (pericarp) and germ, primarily to meet sensory expectations of consumers[1].

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. 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[2].

The three most important food crops in the world are rice, wheat, and maize (corn). The three cereal grains directly contribute more than half of all calories consumed by human beings. In addition, other minor grains like sorghum and millet are particularly major contributors of overall calorie intake in certain regions of the world, particularly semi-arid parts of Africa and India. For example, sorghum and millet contribute up to 85% of daily caloric intake in Burkina Faso and Niger. A large part of cereal grain production (particularly corn, barley, sorghum, and oats) also go into livestock feed, thus indirectly contributing to human nutrition. (FAO)[3].

India and Nigeria are among the most important cereals production and consumption countries across Asia and Africa region, but suffers food insecurity problems as cereals cultivation is predominated by smallholders that are characterized by low level output. Cereals crop contributes largely to achievement of food security level of a given country. Food security and cereal productivity are closely related in a country like Nigeria with a very large rural and agrarian population. Therefore, factors that affect the cereals industry also have direct impacts on food security as majority of poor populace depend on cereals as it is comparatively cheaper than any other form of diet. (FAO)[3].

The increase in cereals production witnessed in India over the period 1950-51 to 1976-77 cannot be considered insignificant. The figure nearly 125 million tonnes for 1977-78 presents a sharp contrast to the 1950-51 production estimate of a little over 55million tonnes. Since at the time of independence, cereals production in India stood at a little less than 53million tonnes[4]. The total cereal production has increased from 2.33 per cent in the 1970`s to 2.84 per cent in the 1990`s and it declined to 2.02 per cent and the same trend was experienced in the yield growth of total cereals. The share of superior cereals (rice and wheat) to total cereals production has shown increasing trend from about 20 per cent during the 1970`s to about 41 per cent per year in total grain production during the same periods[5].

The negative growth rates of area under coarse grains were experienced from the period of 1970 to 1990`s. A higher positive growth rate registered in yield (2.54 per cent) and also a production is 1.92 per cent in 1970`s. The decline in coarse cereals production, which is largely grown for self-consumption, has occurred along with change in labour market result, in increase in wage employment and growing casualization of wage labour and also due to changes in consumption pattern in rural India[6].

The decline trend in the growth rate of food grain production during the 1990`s has serious implications for national food security in recent times in Nigeria. Prior to 1980`s, much of the increase in food production has been achieved through the expansion of area, but the 1980`s witnessed the shift towards rise in productivity, as a major factor, contributing to the increase in output. However, during the 1990`s there was stagnation on both the accounts[5].

The instability in the production of cereals in Nigeria poses problems for macro-level food management in the country. However, prior to the discovery of crude oil as Nigeria's dominant economic sector, the agriculture sector contributed over 60 percent of Gross Domestic Product (GDP) and 90 percent of exports (UN 2009). The economic relevance of the agricultural sector has since declined, with the share of agriculture in GDP falling to 32.2 percent in the 1975–1979 periods[7] and averaging 35 percent between 1981 and 2006. Moreover, the fall of agriculture in export share has been even more precipitous than ever. From 1960–1970, the export crop subsector contributed 58.4 percent on averages to the total foreign exchange revenueannually. This declined to 5.2 percent over the period 1971–85 and then further to 3 percent from 1995–1999[7]. Similarly, the growth of output in the agricultural sector has been drastically declined from 3.8 percent in the 1987–1990 period to 2.2 percent between 1992–1995[7].

As a result of the slow growth in agricultural output, Nigeria moved from a food sufficient country in the 1960s to a major food importer in the 1980s[9]. Within the 23 years from 1981 to 2003, aggregate agricultural production grew by only 5.4 percent[8].

Nigeria`s estimated current 3.7 percent food production growth rate cannot be enough in keeping pace with the 6.5 percent food demand which is triggered by the high rate of increasing population, moderately rapid income growth, and relatively high elasticities of expenditure[10]. For example, in the year 2004, rice demand was five million tons which far away outstripped the supply of three million tons, as such necessitated the importation of rice to meet the shortfall. The value of rice imports has continually increased from $60 million in 1990 to $280 million in 2001, peaking at over $1billion in 2008[11]. In the year 2002, Nigeria was one of the six largest rice importers in the world[12].

Like the case with most other crops particularly cereals in Nigeria, rice yields are low, averaging about 1.8 tons of paddy per hectare, compared to national potential average of 3 tons per hectare for upland system and 5 tons per hectare for the lowland system[11]. In general, food crop production in Nigeria is far below potential and demand is greater than locally produced supply to a large extent.

Methodology

This study was based on a time series data on productivity and poverty trend collected from the FAO stat, National Sample Survey Organisation (NSSO), National bureau for statistics and other related agencies websites .Basic statistics such as mean, standard deviation and coefficient of variability were computed. In modelling time trend for this study, the exponential trend or log-linear as employed by Ahmed et. a1[13], Nmadu*et.* al [14], and Samuel et. al[15] was used.

The exponential trend equation for production was specified as follows;

$$Yt=e\beta o+\beta 1t1+ut \quad (1)$$

By taking the natural logarithm of both sides, the linear form of the equation was obtained making it amenable to OLS as;

$$LinYt = \beta o+\beta_{iti}+u_t \quad (2)$$

Where: Y= Area or Productivity, t= Time trend variable, β_o=Intercept of the trend equation, β_1= trend coefficient, U_t=error term

From equation-2 the compound growth rate was computed as follows[16];

$$r = (e^{\beta 1}-1)*100 \quad (3)$$

Where: R = compound growth rate, βi= estimated coefficient from equation-2 e=eular's exponential constant (=2.71828)[17].

The time it will take to double the rate of growth was then computed as follows[14]:

$$DT = 69/r \quad (4)$$

Where: DT = Doubling time, r = compound rate of growth as in equation-3,

In order to estimate the pattern of growth so as to determine whether there is acceleration, deceleration or stagnation in sorghum production in the study area, quadratic equation in time trend variable was fitted as follows:

$$LinYt = \beta o + \beta 1ti + \beta 2ti2 + ut \quad (5)$$

All variables as previously defined, βo, β_1 and β_2 are parameters to be estimated. In the specification of equation 5, the linear and quadratic time terms indicate the circular path in the dependent variable (Y^t). The quadratic time variable (t^2) allows for the possibility of determining whether there was acceleration, deceleration or stagnation in cereals production during the period 1982-2012[18]; Nmadu, *et.* al.[14]. In determining the pattern of growth, our main concern is on β_2 (i.e. coefficient of ti^2) which reveals a measure of the growth pattern following[18]; Nmadu, et. al.[14]. If $\beta_2>0$ and statistically significant, then there is acceleration in growth, If $\beta_2<0$ and statistically significant, then there is deceleration in growth, If β_2 is positive or negative but not statistically significant, then there is stagnation in growth[18,14] and Samuel *et.al.*[15]

Results and Discussion

Results in table-1 revealed that in India an average area of 99.7 Million ha was devoted to the production of major cereals with 42.71, 25.7, 6.71, 11.5 and 13.43 per cents hectares for rice, wheat, maize, sorghum and millet production respectively. The average production from these cereals in India stand at 21.6 Million tons per hectare and productivity 2.157 tons/ha and was found significant. The average productivity of rice was 2.81 and happened to be the highest compared to 2.44, 1.75, 0.805 and 0.784 tons/ha for wheat, maize, sorghum and millet respectively. This was due to adoption of high yielding varieties of rice and extension prior given to rice as its becoming the staple crop among most Indians.

Meanwhile, in Nigeria the average area for cereals production was 15.5 Million ha with rice share accounting for 11.4 percent, wheat 0.29, maize 23.9, sorghum 36.7and millet 27.4 per cent respectively. This indicates that sorghum occupies more area among cereals because of physiological features (ability to withstand drought) that enables its cultivation in both Northern and Central regions of Nigeria. The average production of cereals is 20.1 Million tons per annum and productivity of 1.30 tons/ha. The mean productivity of cereals in Nigeria 1.30 ton/ha is greater compared to that of Ethiopia with 1.28ton/ha and slightly less than that of East Africa region with average productivity of 1.35 ton/ha as reported in a similar study by Samuel et al[15]. The average productivity of wheat 1.63 ton/ha and millet 1.22 ton/ha is greater than that of Ethiopia with wheat 1.35 ton/ha and millet 1.01 ton/ha productivities respectively.

However, the productivity of rice, wheat and maize of India is significantly greater than that of Nigeria. While the productivity 0.81 and 0.78 of Sorghum and millet in India is statistically less than 1.16 and 1.22 of Nigeria.

Analysis of growth trend in area, production and productivity of cereals was done using the estimated regression coefficient of the time trend variable as in equation 2. The Adjusted R^2 values for India cereals were 0.38, 0.89 and 0.93 for area, production and productivity respectively. This shows that time trend as a variable is very important accounting for 38.4%, 84.8% and 93.3% of the variations noticed in area, production and productivity of cereals in India respectively.

While in Nigeria, the Adjusted R^2 values were 0.44, 0.69 and 0.13 for area, production and productivity respectively. This implies that time trend as variable account for 43.9%, 69.0% and 12.6% of the variations noticed in area, production and productivity of cereals in Nigeria, respectively.

The compound growth rates for area, productions and productivity of cereals in India were 0.075%, 0.85% and 0.94%, respectively and statistically significant ($P<0.01$). This implies that a relatively slow and positive significant growth rates for production and productivity and a significantly very slow of process growth rate in area particularly during the period 1982-2012.

Table-1
Mean Area and production of cereals in India

	India		Nigeria	
	Mean Area(ha)	**Mean production (tons)**	**Mean Area(ha)**	**Mean production (ton)**
Cereals	99,787,727.63	215,096,746.9	77,547,885	101,037,721
Rice	42,620,268.52	120,320,310.32	8,870,685	14,838,937
Wheat	25,618,175.23	63,430,785.03	228,581	344,097
Maize	6,704,987.10	12,106,464.52	18,604,797	27,034,255
Sorghum	11,434,109.68	9,010,809.68	28,519,969	32,988,097
Millet	13,410,187.10	10,228,377.42	21,323,853	25,832,335

Source: FAO stat, 2014

Table-2
Mean, maximum and minimum productivity of Cereals in India and Nigeria in (ton/ha)

	India			Nigeria		
	Mean	**Min**	**Max.**	**Mean**	**Min.**	**Max.**
Cereals	2.15	1.34	2.95	1.30	1.09	1.63
Rice	2.81	1.84	3.59	1.75	1.29	2.38
Wheat	2.44	1.69	3.17	1.63	0.83	2.64
Maize	1.75	1.02	2.54	1.44	0.97	2.19
Sorghum	0.80	0.57	1.02	1.16	0.96	1.63
Millet	0.78	0.45	1.18	1.22	0.43	1.84

Source: FAO stat, 2014

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The compound growth rates for area, productions and productivity of cereals in India were 0.075%, 0.85% and 0.94%, respectively and statistically significant (P<0.01). This implies that a relatively slow and positive significant growth rates for production and productivity and a significantly very slow of process growth rate in area particularly during the period 1982-2012.

However, in Nigeria, the compound growth rates for area, productions and productivity of cereals were 0.189%, 1.0565 and 1.247%, respectively and statistically significant (P<0.01). This implies a relatively positive significant growth in production and productivity and significantly slow process of growth in area of cereals in the particular years under consideration. This calls for concerted and collaborative effort in both countries to increase the process of growth especially in productivity at a higher rate because increasing the production through expansion of area is limited to inelastic supply of land. According to Samuel, 2013, the slow process of growth in productivity of crop could be enhanced by the use of improved extension services and provision of input supports to the farmers involved in the cultivation of cereals.

Among major cereals in India, maize shows higher compound growth rate in area, production, and productivity 0.64, 1.70, and 1.04 respectively. This implies that, a positive significant growth in production and productivity and slow growth trend in the area. The growth may be due to the usage of high yielding varieties and extension services. The compound growth rate for rice area, production and productivity were 0.11, 0.83, and 0.72 respectively and wheat compound growth rate of area, production and productivity 0.34, 1.08, and 0.74 respectively. This implies that a positive significant growth in production and productivity of rice and low growth in area, while slow positive and significant growth in productivity in wheat and insignificant positive growth in area and production of wheat crop.

Table-3
Compound growth rate of area, production and productivity of Cereals in India

Crops	Area			Production			Productivity		
	CGR	R^2	IST	CGR	R^2	IST	CGR	R^2	IST
Cereals	-0.075*	0.38	1.99	0.85*	0.89	5.58	0.94*	0.93	4.89
Rice	0.11**	0.37	3.06	0.84**	0.82	7.42	0.72**	0.88	5.36
Wheat	0.35^{NS}	0.84	3.12	1.08^{NS}	0.92	6.50	0.74**	0.89	5.25
Maize	0.64*	0.87	5.24	1.70*	0.91	11.69	1.05*	0.85	8.99
Sorghum	-1.30*	0.98	4.17	-0.90*	0.71	12.35	0.41*	0.37	11.11
Millet	-0.73*	0.85	6.49	0.34^{NS}	0.14	17.19	1.08*	0.74	13.27

Source: FAO stat, * denotes significant at 1%, ** denotes significant at 5%, CV denotes coefficient of variation. IST denotes instability index, CGR denotes compound growth rate, R^2 coefficient of determination.

Table-4
Compound growth rate of area, production and productivity of Cereals in Nigeria

Crops	Area			Production			Productivity		
	CGR	R^2	IST	CGR	R^2	IST	CGR	R^2	IST
Cereals	0.19*	0.44	18.29	1.06*	0.69	14.59	1.25**	0.13	10.72
Rice	2.11*	0.79	17.19	1.61*	0.75	16.29	-0.48*	0.36	13.32
Wheat	1.40*	0.23	43.16	0.91^{NS}	0.15	47.14***	-0.46	0.09	29.61
Maize	1.41*	0.29	30.24	2.126*	0.53	26.80	37.05*	0.59	12.51
Sorghum	0.84**	0.37	18.91	-55.99*	0.49	18.12	0.15^{NS}	0.058	13.79
Millet	0.76^{NS}	0.238	22.66	0.71^{NS}	0.15	29.27	-0.05^{NS}	0.0017	23.23

* denotes 1% level significance,** denotes 5% level significance (P<0.01), NS denotes not significant.

Moreover, among major cereals in Nigeria, maize registered higher compound growth rate in area, production and productivity 1.41, 2.12, and 37.05 respectively. This implies a positive significant growth in area and production and significantlyhigh growth rate in productivity. It is indicating that farmers are using are using high yielding varieties for maize in Nigeria as reported by Iken J., *et al.*, The compound growth rate for rice were 2.10, 1.61, and -0.483 respectively and wheat were 1.40, 0.91, and -0.47 for area, production and productivity respectively. Implying that, a positive increase in area of both rice and wheat, but a negative and slow reduction in the productivity of both the two.While sorghum and millet are showing no significant growth in productivity.

The area, production and productivity of cereals in India were relatively stable during the study period with instability index less than 10% and with relative lower coefficient of variation.

However, in Nigeria, the area, production and productivity of cereals were unstable during the study period with instability index more than 10% and relatively lower coefficient of variation. This was due to the different reasons that were related to the production of cereals. According to Schneider lack of available quality seed was reported as a primary constraint to wheat productivity in Eastern Sub- Saharan Africa, affecting two third of the crop area in most years and resulting in an estimated yield loss of 167 kilograms per hectare. Alemu, found that production instability was caused more by increased yield than instability in area. Yield stability could be the result of changes in technology, changes in policy and changes in weather conditions.

The doubling time computed for the compound growth rates in years for area, production and productivity in India were -918, 81, and 73 years, respectively. The production and productivity growth trend needs to be improved in order to reduce the doubling time.

The doubling time was computed for the compound growth rates in years for area, production and productivity in Nigeria was 65, 55 and 365 years, respectively. Therefore, the area, production and productivity growth trend needs to be improved in order to reduce the doubling time and this could be achieved through creating awareness for farmers on the adoption of new technologies and at the same time increasing their accessibility to farm inputs like fertilizer, hybrid seeds, plant protection chemicals and others.

In order to investigate for the existence of acceleration, deceleration or stagnation in the growth of area, production and productivity of cereals cultivation, the quadratic equation in time trend variable was fitted as in equation 5. The quadratic term (t^2) allows for the possibility of acceleration, deceleration or stagnation in the area, production and productivity growth processes. Result in table 4, revealed the value of the coefficient of (t^2) for area (0.0000031) was not significant and implies that growth is stagnated in the area devoted to cereals cultivation in India. The value of the coefficient of (t^2) for the production and productivity were (0.00015) and (-0.00018) respectively and were significant ($P<0.05$) confirming a deceleration in production and productivity of cereals in India.

In Nigeria, from table-5, above the value of coefficient of (t^2) for area and production were (-0.0012) and (-0.00084) was significant as such implies deceleration in area and production cereals cultivation. The value of the coefficient of (t^2) for productivity (0.000433) and significant ($P<0.01$) confirming an acceleration in productivity of cereals in Nigeria.

Table-4
Compound Rates, Doubling Time and Nature of Growth Area, and Productivity of Cereals in India

Items	Compound growth rate cereals (%)	Doubling (years)	Year doubling would be achieved	[t-ratio]	Nature of growth
Area	-0.075	918	2930	1.45^{NS}	Stagnation
Production	0.84	81	2093	-2.46**	Deceleration
Productivity	0.94	73	2085	-3.85**	Deceleration

*denotes 1% level significance,** denotes 5% level significance ($P<0.01$), NS denotes not significant.

Table-5
Compound Rates, Doubling Time and Nature of Growth Area, and Productivity of Cereals in Nigeria

Items	Compound growth rate cereals (%)	Doubling (years)	Year doubling would be achieved	Coefficient of t^2	[t-ratio]	Nature of growth
Area	1.056	65	2079	-0.0012	-8.982*	deceleration
Production	1.247	55	2069	-0.00084	-7.4745*	Deceleration
Productivity	0.189	365	2379	0.000433	5.1596*	acceleration

* denotes 1% level significance ($P<0.01$), NS denotes not significant

Conclusion

According to the findings of this study, it was concluded that in India there is relatively slow and positive significant growth rates for production and productivity and significantly very slow of process growth rate in area particularly during the period of study in cereals. Moreover, productivity of India rice, wheat and maize are statistically greater than that of Nigeria with the exception of sorghum and millet.

Findings from Nigeria concluded that there is a relatively positive significant growth in production and productivity and significantly slow process of growth in area, of cereals in the particular years under consideration. The relative growth in productivity contributed for the growth in production of cereals but area contribute less for growth in production. Therefore, efforts should be made to enhance the productivity of the area under cereals cultivation to achieve higher production through increasing the use of improved seeds; technology transfer and quality input supply to both countries in order to reduce food insecurity as well as poverty problems.

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