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Pulses production in India and Nigeria: Panacea to Food Security

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Abstract

Pulses are precious leguminous crops especially to those living in semi-arid countries. Its resilience in withstanding poor ecological conditions and its high food and fodder value makes it a commodity that can turn around the fortunes of smallholder farmers and in providing cheapest source of plant protein in both India and Nigeria. A compound growth rate model was used in estimating the trend of area, production and productivity of different types of pulses from the year 1980 to 2015 for both India and Nigeria. The estimated time trend variable revealed a positive trend. However, fluctuations were observed with respect to area, production and productivity of different pulses in both countries, but relatively lower fluctuation in productivity. Furthermore, mean average productivity of soya bean and pulse nes in India was slightly higher than that of Nigeria despite been lower to the world average which was 0.86 ton/ha. In Indian there was accelerative growth trend in area and production of all pulses category but productivity recorded stagnation for black gram and pigeon pea; deceleration for chick pea, green pea and pulse nes; and acceleration for green gram and soya bean. However, in Nigeria, there was deceleration for area and production while acceleration trend for productivity of cowpea dry, soya bean and pulse nes respectively. It conclude that, although area and production trend was decelerating but productivity trend was accelerating in Nigeria, at the same vain, the productivity was slightly lower compared to India. The study therefore, suggest Nigeria need to emphasis the use of high yielding varieties, input and credit support to boost productivity of pulse as major source of cheap plant protein their by improve the nutritional security especially among the Nigerian poor. Likewise, promote diversification into large scale cultivation of pulses such as pigeon pea, chick pea, black and green gram. At the same time, India needs to support research institution to develop higher yielding varieties of pulses, support farmers with inputs, technology and credit towards achieving optimum yield; improving farmer's income, increasing the local supply of pulses and reducing import, employment opportunities and closing the nutritional security gap in a vegetarian nation.

Keywords: Food security Growth, India, Nigeria, Pulses.

Introduction

Legumes belong to the family *Leguminosae*. In the tropics, they are the next important food crop after cereals[1]. They are sources of low-cost dietary vegetable proteins and minerals when compared with animal products such as meat, fish and egg[2]. Indigenous legumes therefore are an important source of affordable alternative protein to poor resource people in many tropical countries especially in Africa and Asia where they are predominantly consumed. In the developing countries, research attention is being paid to better utilizationof legumes in addressing protein malnutrition and food security issues[3].

Pulses are major sources of proteins among the vegetarians in India, and complement the staple cereals in the diets with proteins, essential amino acids, vitamins and minerals[4]. Theycontain 22-24 per cent protein, which is almost twice the protein in wheat and thrice that of rice. Pulses provide significant nutritional and health benefits, and are known to reduce severalnon-communicable diseases such as colon cancer and cardiovascular diseases[5]. Different types of legumes grown are consumed in different tropical regions in the world. Legume growing areas in Tropical Africa include Nigeria, Senegal, Togo, Cameroun and Cote d'Ivoire and in Tropical Asia include Indonesia and India[6]. Some legumes are commonly used as commercial food crops such as cowpea in West Africa while some are lesser known, neglected or underutilized outside their indigenous areas. The share of cowpea production among various grain legumes in Nigeria has increased since 1988, making Nigeria the largest cowpea producing country in the world. Most of the cowpea produced is used for direct consumption in both urban and rural areas[7].

India is the largest producer, consumer and importer of pulses in the world. India accounts for about 33 percent of world area and about 22 percent of world production. About 90 percent of the total global area under pigeonpea, 65 percent under chickpea and 37 percent under lentil is contributed by India, with a corresponding share of production of 93 percent, 68 percent and 32 percent, respectively[8]. The total production of pulses in India was 14.57 million tons in 2008-09 from an area of 22.09 million hectares. The state of Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra and Andhra Pradesh were the leading pulse producing states in the same order with more than 70 percent of the production being contributed by these states taken together. Among different pulses, the leading contributors are

chickpea and pigeonpea. In 2008-09, more than 7 million tons of chickpea was produced from an area of about 8 million hectares with Madhya Pradesh being the highest producer (39.5%). During the same year, the production of pigeonpea was 2.27 million tons from an area of 3.38 million hectares with Maharashtra being the leading producer (26.7 %).

India ranks first in the world in terms of pulse production (25% of total worlds production)[9]. Average yield of pulse crops in India is low compared to the world average. However, the average yield of pulse crops in the country has increased gradually over the period and is 690 kg ha-1 in 2010-11 which is 56percent higher compared to yields during 1950. Interestingly during 2010-11, India produced 18.1 m ton of pulses from 26.3 m ha with a productivity of 690 kg ha-1, which is the highest of all time[10].

Though India is the world's largest producer of pulses, it imports a large amount of pulses to meet the growing domestic needs. During 2009-10, India imported 3.5 million tons of pulses from the countries like Australia, Canada, and Myanmar. Thus, India is the largest importer, producer and consumer of pulses. On the other hand, India is also the largest pulses processor, as pulses exporting countries like Myanmar, Canada and Australia do not have adequate pulses processing facilities[10].

Moreover, cowpea is a very important crop in the semiarid farming systems of West African countries. The crop is unique in that it provides food, cash, and fodder. In West Africa, Nigeria and Niger together account for 87percent of the world's cowpea harvested[11]. In West Africa, cowpea is well adapted to the drier savanna eco-regions and is mostly producedthere[12]. However, it is widely traded and consumed outside the main production areas. Cowpea has a high potential to increase farmers' and traders' incomes, thereby contributing to poverty reduction and food security. As a food crop, cowpea is a primary source of cheap protein for the ever-growing population of both rural and urban dwellers. Cowpea grain contains about 25percent protein and 64percent carbohydrate, thus it has a high potential to reduce malnutrition. The fodder and husks from cowpea form an important source of protein, fiber, and energy for livestock[13].

The objective of this paper is to study the pattern of trend in growth of area, production and productivity of the major pulses grown in India and Nigeria by using quadratic time trend and to compare the average productivity difference between India and Nigeria.

Methodology

This study made use of secondary data which were principally elicited from the FAO Statistical database and journal articles. The secondary data used for analysis was on the area, production and productivity of different varieties of majorly grown pulses crop extending from 1980 to 2015 for both India and Nigeria. Descriptive statistics and inferential statistical (growth rate and quadratic time trend model) were used in the analysis.

Model specification: The compound growth rate formula is adopted for developing the model and is expressed as:

$$Yt = Y0\ (1+ r)t \quad (1)$$

Where: Y = Output of Pulse ('000 tonnes), Y = Initial Value of Pulse Output ('000 tonnes), r = Compound rate of growth of Pulse output over time, t = Time trend (1970 to 1985, 1986 to 1994 and 1995 to 2007).

Taking the natural logarithm of equation (1), equation (2) was derived as:

$$\ln Y = \ln Y0\ (1 + r)t \quad (2)$$

Where: $b_0 = \ln Y_0$, $b_1 = \ln (1+ r)$

Equation (2) is rewritten as:

$$\ln Yt = b_0 + b1_t \quad (3)$$

Adding disturbance term to equation (3), the explicit form of the model employed was derived as:

$$\ln Yt = b_0 + b1_t + U \quad (4)$$

Where: Yt = Output of Pulse in thousand ton, b = constant term, b = Coefficient of time variable, u = Random term.

After the estimation of equation (1), the compound rate of growth was computed as follows:

$$r = (eb1- 1) \quad (5)$$

Where: r = compound rate of growth, b1= estimated coefficient from equation (1)

The coefficient of variability (CV) which measure instability is a normalized measure of dispersion and is the ratio of standard deviation (σ) to the mean (μ):

$$\text{Algebraically, } CV = \sigma/ \mu \quad (6)$$

Quadratic equation in time variable[14] was fitted to the data to confirm the existence of acceleration, deceleration or stagnation for study period which was described as:

$$\text{Log } Y = \beta_0 + \beta it + ct_2 \quad (7)$$

Results and Discussion

Growth trends of pulses area in India: The result in Table-1 reveals that the time variable significantly influences the area for green gram, pigeon pea, green pea, soya bean and pulse nesall at 1 percent respectively, green gram at 5 percent while chick pea was statistically not significant.

The estimated instantaneous growth rates (r) of area indicated 106.4, 101.6, 100.3,100.7, 104.5, 109.4 and 98.4 percent respectively, are the rate of growth of black gram, green gram, chick pea, pigeon pea, green pea, soya beans and pulse nes with respect to area in India over the years from 1980 – 2015 (compound rates of growth).

Growth trends of pulses area in Nigeria: The result from the Table-2 indicated that the time variable has significantly influences the area for cowpea dry and pulse nes all at 1 percent; while Soya bean at 5 percent respectively. Moreover, the estimated instantaneous compound growth rates (r) of area indicated 104, 100.6 and 102.5 percent for cowpea dry, soya bean and pulse nes respectively.

Growth trends of pulses production in India: From Table-3 results indicated that time variable has significantly influences the productions of black gram, chick pea, green pea and soya bean all at 1 percent respectively; pigeon pea 5 percent; green gram and pulse nes were statistically not significant.

Table-1
Growth trends of pulses Area in India

Type of pulse/Statistical tool	Regression Coefficient(B_1)	(R_2)	Compound growth rate (%)
Black gram	3951.9	0.753	106.4**
Green gram	201.6	0.824	101.6***
Chick pea	144.671	0.058	100.3^{NS}
Pigeon Pea	1.895	0.549	100.7***
Greeen pea	82.652	0.945	104.5***
Soya beans	2367.6	0.904	109.4***
Pulse nes	0.8965	0.701	98.4***

Note: ***, ** and * indicates significance at 1, 5 and 10 per cent levels of probability. Ns: Statistically insignificance.

Table-2
Growth trends of pulses Area in Nigeria

Type of pulse/Statistical tool	Regression Coefficient(B_1)	(R_2)	Compound growth rate (%)
Cowpea dry	0.039	0.735	104***
Soya beans	0.058	0.521	100.6**
Pulse nes	0.741	0.524	102.5***

Note: ***,** and * indicates significance at1, 5 and 10 per cent levels of probability. Ns: Statistically insignificance.

Table-3
Growth trends of pulses Production in India

Type of pulse/Statistical tool	Regression Coefficient(B_1)	(R_2)	Compound growth rate (%)
Black gram	0.990	0.059	101.6***
Green gram	367.9	0.743	101.5^{NS}
Chick pea	453.5	0.459	101.5***
Pigeon Pea	323.7	0.159	100.5**
Greeen pea	134.8	0.758	102.9***
Soya beans	172.6	0.897	111.2***
Pulse nes	0.994	0.046	99.4^{NS}

Note: ***,** and * indicates significance at1, 5 and 10 per cent levels of probability. Ns: Statistically insignificance.

Moreover, the estimated instantaneous compound growth rates (r) of production revealed 101.6, 101.5, 101.5, 100.5, 102.9, 111.2 and99.4 per cent respectively, are the rate of growth of black gram, green gram, chick pea, pigeon pea, green pea, soya beans and pulse nes with respect of production in India over the years of 1980 – 2015 (compound rates of growth).

Growth trends of pulses production in Nigeria: From Table-4, result reveals that the time variable has significantly influences the productions of cowpea dry, soya bean and pulse nes all at 1 percent respectively. Moreover, the estimated instantaneous rates of compound growth rates (r) of production reveal that 106, 108.2 and 101.1 percent for cowpea dry, soya bean and pulse nes respectively.

Growth trends of pulses productivity in India: The result in Table-5 shows that time variable was significant in influencing productivity for chick pea, green pea and soya bean all at 1 percent respectively; pulse nes at 5 percent; while pigeon pea and green gram were statistically not significant. The instantaneous rate of compound growth rates (r) were estimated and the productivity revealed 100.6, 100, 101.2, 99.8 and 101.7 percent, respectively, are the rate of growth of black gram, green gram, chick pea, pigeon pea, green pea, soya beans and pulse nes in terms of productivity in India over the periods 1980 – 2014 (compound rates of growth).

Growth trends of pulses productivity in Nigeria: The result in Table-6 shows that time variable was significant in influencing productivity for cowpea dry and soya bean at 1 percent while pulse nes is at 10 percent respectively. Moreover, the estimated instantaneous compound growth rates (r) of production revealed that 101.8, 101.2 and 100.5 percent for cowpea dry, soya bean and pulse nes respectively.

Table-4
Growth trends of production in Nigeria

Type of pulse/Statistical tool	Regression Coefficient(B_1)	(R_2)	Compound growth rate (%)
Cowpea dry	644513.008	0.891	106***
Soya beans	116401.371	0.834	108.2***
Pulse nes	21549.222	0.370	101.1***

Note: ***, ** and * indicates significance at1, 5 and 10 per cent levels of probability. Ns: Statistically insignificance.

Table-5
Growth trends of pulses Productivity in India

Type of pulse/Statistical tool	Regression Coefficient(B_1)	(R_2)	Compound growth rate (%)
Black gram	3.235	0.094	100.6*
Green gram	0.854	0.003	100.0^{NS}
Chick pea	64.855	0.677	101.2***
Pigeon Pea	0.888	0.028	99.8^{NS}
Greeen pea	23.894	0.435	0.985***
Soya beans	43.006	0.581	101.7***
Pulse nes	0.383	0.120	101.0**

Note: ***,** and * indicates significance at1, 5 and 10 per cent levels of probability. Ns: Statistically insignificance.

Table-6
Growth trends of productivity in Nigeria

Type of pulse/Statistical tool	Regression Coefficient(B_1)	(R_2)	Compound growth rate (%)
Cowpea dry	0.005	0.402	101.8***
Soya beans	0.033	0.811	105.2***
Pulse nes	0.009	0.149	100.5*

Note: ***,** and * indicates significance at1, 5 and 10 per cent levels of probability. Ns: Statistically insignificance.

Acceleration, deceleration and stagnation in pulse in India: Result of Table-7 reveals that the quadratic term t_2 allows for the possibility of acceleration, deceleration and stagnation in the growth process.

Table-7
Estimates of Quadratic equation in time trend variable for the period 1980-2014 in India

Parameters	Area	Production	Productivity
Black gram			
Constant (β_0)	20154.2	10104021	0.328
Time trend (β_1)	17251	-795160	0.001
Time trend squared (β_2)	523.18**	19743.748**	4.082E-05^{NS}
R2	0.721	0.221	0.109
F-ratio	7.21	4.262**	1.840^{NS}
Status	Acceleration	Acceleration	Stagnation
Green gram			
Constant (β_0)	368532.549	368532.549	2.786
Time trend (β_1)	-4374.809	-4374.809	-0.021
Time trend squared (β_2)	337.164***	337.164***	0.001^{NS}
R2	0.835	0.835	0.067^{NS}
F-ratio	76.156***	76.156***	1.071***
Status	Accelerative	Accelerative	Accelerative
Chick pea			
Constant (β_0)	7673736.694	4655702.273	0.587
Time trend (β_1)	-150979.114	-39577.459	0.012
Time trend squared (β_2)	5154.032***	3636.378***	-9.096E-05***
R2	0.311	0.541	0.710
F-ratio	6.762***	17.693***	36.756***
Status	Accelerative	Accelerative	Deccelerative
Pigeon Pea			
Constant (β_0)	2903947.947	2143518.842	0.733
Time trend (β_1)	43538.206	20860.613	-0.003
Time trend squared (β_2)	-594.175***	-254.779*	4.937E-05^{NS}
R2	0.557	0.160	0.032
F-ratio	18.886***	2.850	0.500^{NS}
Status	Accelerative	Deccelerative	Stagnation
Green pea			
Constant (β_0)	83474.620	1095329.985	11.725
Time trend (β_1)	6025.042	67617.971	0.055
Time trend squared (β_2)	91.306***	-289.438***	-0.006***
R2	0.940	0.726	0.459
F-ratio	233.720***	39.824***	12.748***
Status	Accelerative	Deccelerative	Deccelerative
Soya bean			
Constant (β_0)	-202030.678	-238987.903	0.633
Time trend (β_1)	271030.697	202295.061	0.023
Time trend squared (β_2)	1743.091***	5329.282***	0.000***
R2	0.984	0.945	0.599
F-ratio	912.635***	258.842***	22.431***
Status	Accelerative	Accelerative	Accelerative
Pulses nes			
Constant (β_0)	2616009.604	688692.082	0.222
Time trend (β_1)	-53603.754	46296.235	0.035
Time trend squared (β_2)	646.938***	-1502.756***	-0.001***
R2	0.703	0.286	0.425
F-ratio	35.522***	6.009***	11.093***
Status	Accelerative	Deccelerative	Deccelerative

Note: ***,** and * indicates significance at1, 5 and 10 per cent levels of probability. Ns: Statistically insignificance.

It indicated that the values of the coefficients of $t_2$variable for area in all pulse categories were all significant at 0.001 probabilities. The t_2 variable indicated significance which confirms the accelerative growth in area for all pulse.

Therefore, the significant positive coefficient of t_2 value for the production of black gram, green gram, chick pea, green pea and soya bean confirms further, the significant accelerative growth in production; the significant coefficient t_2 value for pigeon pea and pulse nes is the confirmation of decelerated growth in their production in India over the period of time.

The results further for green gram and soya bean indicates accelerative growth in productivity; chick pea, green pea and pulse nes indicated decelerated growth in productivity; while black gram and pigeon pea indicated stagnation in productivity growth.

Acceleration, deceleration and stagnation in pulse in Nigeria: From the results in Table-8, the t_2 variable coefficients for area and production in the cowpea dry, soya bean and pulse nes, all being negative but however significant at 0.001 probability. The negative coefficients of the t_2 variable were significant which further confirms the significant decelerated growth in area and production of these crops.

Further, in the case of productivity, result indicate accelerative growth in the productivity of cowpea dry, soya bean and pulse nes at 1, 10 and 10percent significant level of probability respectively.

Instability analysis of pulse in India: The result from Table-9 indicated a fluctuation in production, area and productivity of all pulse in India during the study period. The variability in terms of production was relatively higher when compared to area and productivity within this period.

This suggests that the production of pulses in India has witnessed a relative higher instability during the periods as compared to area and productivity of black gram, green gram, chick pea, green pea, pigeon pea, soya bean and pulse nes. However, pigeon pea, green gram and chick pea shows comparably lower variability in terms area, production and productivity respectively.

Instability analysis of pulse in Nigeria: From the results in table 10 there was an observed fluctuation of area, production and productivity of all pulse in Nigeria within the study period. The variability in terms of production was relatively higher when compared to area and productivity within this period.

This suggests that the production of pulses in Nigeria has witnessed a relative higher instability during the periods as compared to area and productivity of cowpea dry, soya bean and pulse nes. Further, pulse nes among all others shows comparable lower variability in terms area, production and productivity respectively in Nigeria.

Conclusion

The compound growth rates of major pulse in both India and Nigeria was computed with growth rate model. Computed functions in time trend variable indicated a positive trend. Moreover, there was an observed fluctuation in area, production and productivity of different pulses in both India and Nigeria, but relatively lower fluctuation in productivity.

Furthermore, mean average productivity of soya bean and pulse nes in India was slightly higher than that of Nigeria, but despite that, India's yield was lower to the world average which was0.86ton/ha.

In Indian there was accelerative growth trend in area and production of all pulses category but productivity recorded stagnation for black gram and pigeon pea; deceleration for chick pea, green pea and pulse nes; and acceleration for green gram and soya bean.

However, in Nigeria, there is deceleration for area and production while acceleration trend for productivity for cowpea dry, soya bean and pulse nes respectively. It conclude that, although area and production trend is decelerating but productivity trend is accelerating in Nigeria despite that productivity is slightly lower compared to that of India.

Recommendation: The study therefore, suggest Nigeria need to emphasize the use of high yielding varieties, input and credit support to boost productivity of pulse as major source of cheap plant protein their by improve the nutritional security especially among the Nigerian poor.

Likewise, promote diversification into large scale cultivation of pulses such as pigeon pea, chick pea, black and green gram among local farmers.

This would reduce importations of these pulses, increases income, stem employment opportunity and increase food security level in the country.

At the same vein, India needs to support research institution to develop higher yielding varieties of pulses, support farmers with inputs, technology and credit towards achieving optimum yield; improving farmer's income, increasing the local supply of pulses and reducing import, employment opportunities and closing the nutritional security gap in a vegetarian nation.

Table-8
Estimates of Quadratic equation in time trend variable for the period 1980-2014 in Nigeria

Parameters	Area	Production	Productivity
Cowpea dry			
Constant (β_0)	667638.911	259734.842	0.440
Time trend (β_1)	1433124.979	644513.008	0.005
Time trend squared (β_2)	-28365.380***	-6672.488***	0.000***
R2	0.735	0.891	0.402
F-ratio	41.686***	122.137***	10.418***
Status	Deceleration	Deceleration	Acceleration
Soya beans			
Constant (β_0)	840461.345	-154610.447	0.387
Time trend (β_1)	181779.497	116401.371	0.009
Time trend squared (β_2)	-3939.925***	-736.034***	0.000*
R2	0.521	0.834	0.149
F-ratio	16.296***	75.280***	2.718*
Status	Deceleration	deceleration	Acceleration
Pulse nes			
Constant (β_0)	460528.865	159750.400	0.387
Time trend (β_1)	32867.906	21549.222	0.009
Time trend squared (β_2)	-844.637***	-518.789***	0.000*
R2	0.524	0.370	0.149
F-ratio	16.537***	8.799***	2.718*
Status	Deceleration	Deceleration	Acceleration

Source: Authors calculation 1980-2014. Note: ***,** and * indicates significance at1, 5 and 10 per cent levels of probability. Ns: Statistically insignificance.

Table-9
Instability analysis of Pulses production in India

Parameters	Area (`000`ha)	Production(`000`ton)	Productivity (ton/ha)
Black gram			
Arithmetic mean	9,298.6	4082.3	0.41
Standard deviation	2468866	4289549.4	0.112
Coefficient of variability (%)	26.6	105	17.1
Green gram			
Arithmetic mean	159.2	422.1	2.713
Standard deviation	28999.7	80895.7	0.185
Coefficient of variability (%)	18.2	19.2	6.978
Chick pea			
Arithmetic mean	7,063.9	5363.4	0.755
Standard deviation	869053.7	1177293.5	0.101
Coefficient of variability (%)	12.3	29.9	13.192
Pigeon Pea			
Arithmetic mean	3,418.5	2401.4	0.703
Standard deviation	309262.2	299811.5	0.066
Coefficient of variability (%)	9.04	12.5	9.480
Green pea			
Arithmetic mean	220.5	2134.9	10.347
Standard deviation	91395.3	656096.9	2.258
Coefficient of variability (%)	41.4	30.7	21.820

Parameters	Area (`000`ha)	Production(`000`ton)	Productivity (ton/ha)
Soya bean			
Arithmetic mean	5,067.2	5372.7	0.938
Standard deviation	3223189.5	3840657.4	0.190
Coefficient of variability (%)	63.4	71.4	20.273
Pulses nes			
Arithmetic mean	1,950.4	905.1	0.472
Standard deviation	369976.6	246830.4	0.129
Coefficient of variability (%)	18.9	27.3	27.128

Source: Authors calculation 1980-2014. Note: ***,** and * indicates significance at1, 5 and 10 per cent levels of probability. Ns: Statistically insignificance.

Table-10
Instability analysis of Pulses production in Nigeria

Parameters	Area (`000`ha)	Production (`000` ton)	Productivity (ton/ha)
Cowpea dry			
Arithmetic mean	14,261	8,683	0.597
Standard deviation	5943987	4318599	0.171
Coefficient of variability (%)	41.7	49.7	28.691
Soya beans			
Arithmetic mean	2,435	1,544,	0.592
Standard deviation	782476	969866	0.293
Coefficient of variability (%)	32.1	62.8	49.5
Pulse nes			
Arithmetic mean	699	329	0.466
Standard deviation	110783	93,755	0.073
Coefficient of variability (%)	15.9	28.5	15.729

Source: Authors calculation 1980-2014. Note: ***,** and * indicates significance at1, 5 and 10 per cent levels of probability. Ns: Statistically insignificance.

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