Rural Economics and Development

Analyzing Drivers of Food Crop Productivity in Nigeria

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Abstract

Enhanced agricultural productivity is the key issue being presently discussed by agricultural stakeholders as being imperative to the attainment of food security, reducing the present high rate of unemployment and the diversification of Nigeria's economy from being oil dependent. This study therefore attempts to isolate factors that drive agricultural crop productivity in Nigeria. The study made use of panel data from 36 states and Federal Capital territory between 1995 and 2006. Livestock, Fisheries and forestry data were not readily available and therefore not analyzed in this report. The econometric model used in this paper is a panel data model that takes into consideration OLS random and fixed effects as well as GLS with fixed state effect models. The results indicate that increase in agricultural crop production in Nigeria is based on land expansion. The share of the female labour is positively associated with productivity suggesting higher productivity of the female labour. The results confirm the important role that female farmers play in food production and ensuring food security. Fertilizer use was positively associated with productivity but the association was not significant. The non-significant impact of fertilizer on crop productivity might be due to inadequate use of fertilizer, while the positive association is an indication that it is a yield enhancing technology.The results of the models with year dummies show that crop area has a slightly negative and significant association with value of production. The finding of this paper makes it imperative to suggest the need for adoption of technologies that will bring about productivity gains in crop production through less of land expansion practices. It is also recommended that farmers' capacity in terms of right quantity use of fertilizer should be enhanced, while female farmers' participation in crop production should be encouraged.

Keywords: Drivers, Agriculture, Productivity, farmers, Nigeria

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Introduction

Agriculture is the economic mainstay of majority of households in Nigeria (Udoh, 2000). It also constitutes a significant sector of Nigeria's economy. (Amaza, 2000). The growth of Nigeria's economy has been linked with program in the agricultural sector severally. The important roles ascribed to the agricultural sector are the provision of food, contribution to the Gross Domestic Product (GDP) and provision of employment. Others include provision of raw materials for agro-allied industries and generation of foreign earnings. The Nigerian agricultural sector is prominent in the area of employment of labour, contribution to GDP and until the early 1970s;

agricultural exports were the main source of foreign exchange earnings.

A sectoral analysis of the real GDP indicated that the agricultural sub-sector contributed about 42 percent of the GDP in 2006 compared with 41.2 percent in 2005. (CBN, 2006). Agricultural sectoral growth rates of GDP at 1990 constant basic prices grew from 4.2 percent in 2002 to 7.2 percent in 2006 respectively. The agricultural sector also employs over 60 percent of total labour force in Nigeria in 1999 (Adeoti, 2002). The advent of oil in the early 1970's made Nigeria to be highly dependent on oil revenue, with the performance of agriculture adversely affected over years. Though agricultural growth rate in Nigeria has been reported to have increased from an average of about 3 percent in the 1990's to about 7 percent in mid 2000, the food security/sufficiency status of Nigerians continue to decline.

The dismal performance of the agricultural sector in terms of its contribution to Nigeria's yearly total revenue in the last three decades made government to initiate many agricultural schemes and programmes. These are the River Basin Development Authorities, National Accelerated Food Production Project, The Agricultural Development Project, Operation Feed the Nation, Green Revolution and the National Directorate of Food, Roads and Rural Infrastructure. Others are Agricultural credit Guarantee Scheme Fund, National Special Programme for Food Security, Root and tuber expansion project and National Fadama I and II programmes amongst others. The main aim of these schemes and programmes is to enhance agricultural productivity in Nigeria. In the same vein, series of studies (Oredipe, 1998; Ajibefun *et al.*, 1996; Ajibefun and Abdulkadri, 1999; Okike, 2000; Amaza, 2000; Udoh, 2000; Ajani, 2002; Ogundele, 2003; Ajibefun and Daramola, 2003; Rahji, 2003; Adebayo, 2006; Awotide, 2004; and Ogundele and Okoruwa, 2006) have been carried out to assess agricultural productivity as well as its drivers in Nigeria. None however, has assessed food crop productivity in Nigeria using panel data. This is why this study is making use of panel data with input and output data of some key food crop with presidential initiative promotion between 1995 and 2006. This paper therefore intends to shed lights on productivity drivers of staple crops producers in Nigeria in the last one decade or more.

2. Theoretical framework

Agricultural productivity may be defined in general terms as an index of the ratio of the value of total farm output to the value of total inputs used in farm production (Olayide and Heady (1982). Since one of the main objectives of any society is the attainment of an optimal high level of living with a given amount of effort, any increase in productivity of resources employed in farm production amounts to progress. Increase in agricultural productivity will therefore contribute to the well-being of the economy as a whole. The ultimate objective of the interest of economists in productivity should be to find ways of increasing output per unit of input and of attaining desirable inter-firm, intra-firm and inter-sector transfers of production resources, thereby providing the means of raising standard of living. The input-output process of farm production according to Olayide and Heady (1982) is important in at least four major problem areas. These are distribution of income, the allocation of resources, the relation between stocks and flows and the measurement of efficiency or productivity.

Within the concept of productivity, a meaningful assessment will depend upon a clear and precise definition of input and output in such a way that their movements over time are not equal. Also the need to seek to determine which inputs and outputs are consistent with the particular productivity concept in question. Thus, being faced with separate and distinct conditions efforts are directed out to measurement of labour or capital or land productivity. In other words, resource productivity is definable in terms of individual resource inputs or in terms of combination of them. In this write-up, the concept of labour/land productivity or yield shall be defined as the ratio of total output of a particular crop to labour/land inputs

(i.e. average production concept). Using this definition as a bench-mark, change in productivity over time will depend upon changes in types and quantities of inputs. Maximum resource productivity will imply obtaining the maximum possible output from the minimum possible set of input. In this context, optimal productivity of resources implies an efficient utilization of resources in the production process. This means that productivity and efficiency are synonymous in this context. An increase in farm output will result from one of three forces. First, it will result from an increased quantity of inputs, with no change in output per unit of input. Second, it will result from increased productivity of inputs with no change or a decrease in quantity of inputs. Thirdly, it will result from a combination of changes in inputs and productivity. This situation makes the concept of efficiency a central issue in production economics. It therefore becomes imperative to mention notable efficiency theoretical frameworks developed by Farell, Coelli and Battesse and as well discuss at least one of them in detail.

Coelli and Battesse (1996) defined efficiency couched in three-related terms. First, they define 'technical' efficiency as the measure of a firms' success in producing maximum output from a given set of inputs. This indicates all those undisputed gains that can be obtained by simply organising management better. Second, "price" efficiency was defined as the measure of a firm's success in choosing an optimal set of inputs. This is an indication of the gains that can be obtained by varying the input ratios on certain assumptions about the future price structure. Third, they define "overall" efficiency as the simple product of the technical and the price efficiencies. The graphical presentation of Farrel's definitions assumes an "efficient" isoquant which is SS* which is illustrated in Figure 1. Given the efficient isoquant and the isocost line CC*, the three efficiency measures of Farrel are given by

$$TE = \frac{OQ}{OP} \longrightarrow \text{Technical Efficiency}$$

$$PE = \frac{OR}{OQ} \longrightarrow \text{Price Efficiency}$$

$$OE = \frac{OQ}{OQ} * \frac{OR}{OP} = \frac{OR}{OP} \longrightarrow \text{Overall}$$

or Economic Efficiency

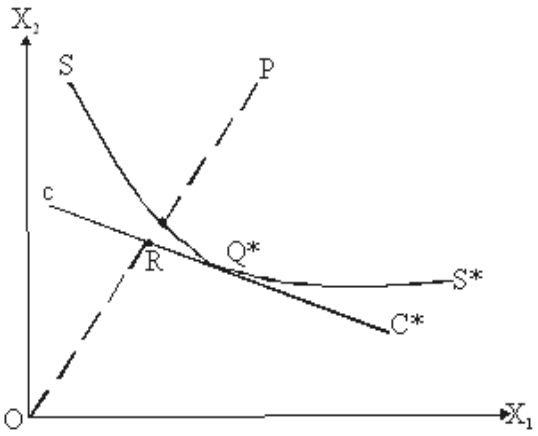

Figure 1: Farel's Efficiency Measures

Farrel's measure of efficiency assumes the existence of an efficient production function with which the observed performance of a firm can be compared. A production function based on the "best" practical results would have to be used as a reference of measuring individual firm's performance. Hence for practical purposes Farrel suggest that it is better to compare actual performance with a "best" obtained result than with an unrealizable ideal. He then obtained from a scatter of diagram of several firms' input-output data, as isoquant which satisfied the least exacting efficiency assumption of convexity to the origin and non-positive slope at any point.

Productivity in this paper was however, assessed using land i.e. the quantity of crop produced per unit area. The analysis was done across the three agroecological zones in order to identify areas where each crop is best suited.

3. Methodology

3.1. Study area and data

Nigeria is a country with a population of over 140 million (NPC 2006). It is basically divided into six geopolitical zones. North central, Northwest and North east. Others are Southwest, Southeast and South south. It can also be classified based on agroecological zone. The three

principal agroecological zones are Dry Savanah, (North East, North West and part of North Central) Humid Forest (Parts of South West, Southeast, North central and south south) and Moist savannah (some parts of south west, South east and mainly south south). The fourth agroecological zone, the Midaltitude is mainly a small part of the North central Nigeria (Okike 2000). Nigeria lies on the west coast of Africa and occupies approximately 923,768 square kilometers of land and shares borders with Chad, Cameroun and Benin. The country is made up of 36 states and Abuja, the Federal Capital Territory. The states and the Federal Capital Territory are divided into approximately 774 local government areas. The spatial distribution of the population is uneven, with majority of the population living in the rural areas, while approximately 36 percent of the population lives in urban areas. However, Nigeria is a country with unique urban population distribution that presents opportunities for the agricultural sector.

With a wide range of climatic, vegetation and soil conditions, Nigeria possesses the potential for wide range of agricultural production. The country is greatly blessed with minerals, forest and water resources (MDG, 2004). Given the discussion above, this study analyze important staple crops common to the four Agro ecological zones in Nigeria: They are cassava, maize, rice and yams. Others are millet and sorghum.

Data was sourced from the Agricultural Development Programmes located in the 36 states (including the Federal Capital territory) of Nigeria. The data were yearly information covering issues such as area planted, socio-economic characteristics of farmers, output and inputs for the period ranging from 1995 to 2006.

3.2. Analytical method

Econometric methods were employed to determine the factors that drive the productivity over time. The production and factor inputs were reported at state level and it was not possible to determine the labour and input allocation to specific crops. Hence, all crops were converted into a total value of production. The independent variables used were the share of female family labour, total family labour, cost of fertilizer used per hectare and cost of seed purchased, share of crop area and total crop area. Selection of these explanatory variables was based on production function literature (Prasad, *et al.* (2006), Reardon and Vosti (1995), Carter and Barrett (2006). These models show that crop yield is a function of production technology used and biophysical characteristics (rainfall intensity and pattern, soil characteristics, altitude and/or temperature, etc), household human, social and physical capital endowment and access to agricultural services (extension services, markets, etc). Production technologies used was represented by the value of purchased seeds and fertilizer. Human capital endowment was represented by the family labor while crop area and total area represented the household capital endowment. However, data on many socio-economic characteristics were not available or not relevant at the state level. We used the agroecological zones to account for the biophysical factors, the general functional form of the models estimated is:

$$Y_{ti} = \beta_0 + \beta_1 X_{ti} + \beta_2 Z_{ti} + e_{ti} \ldots\ldots\ldots (1)$$

Where Y_{ti} is a vector of value of production per unit factor i, i = 1, 2. The factors considered in this study are land and labor. X_{ti} is a vector of random explanatory variables (labor, fertilizer, seeds, area); Z_{ti} is a vector of fixed factors (agroecological zones); e_{ti} is vector of error terms for equation, i = 1, 2, and $\beta_1$is vector of factors associated with explanatory variables.

We tested whether the model with fixed effects (agroecological zones) is better than that with random effects only. However, the Breusch-Pagan random effects test showed that the model with

random effects was biased. Hence the fixed effect model results are used in the discussion. Equation (1) is a cross-sectional time series model since we have time series data for each of the 36states and the federal capital territory. A double log model functional form was used. This addressed the skewed distributions that were common for all continuous variables. Test was conducted for the first order autocorrelation and was found to be significant at p = 0.01 for all models considered. Heteroscedasticity was also significant at P = 0.05 for the fixed effect model and at P = 0.01. Hence the generalized least square (GLS) approach that addresses both Heteroskedasticity and autocorrelation was used. The advantage of GLS is that it is not necessary to know the nature of autocorrelation or heteroskedasticity. Further, a model was estimated that assumes that change in productivity is linear. In this case, a time trend – years (1994 – 2005) was included. Results of this model helped to determine the rate of change of productivity each year. However, if such changes are non-linear, then such results will be biased. Hence, another model that included each year as a dummy was also estimated in which the constant was dropped.

4. Results and discussion

Consistent with other studies (e.g. Lamb, 2003; Barrett, 1996; Nkonya, *et al.*, 2005), results from Tables 1a and b shows inverse farm-area-crop productivity relationship. The results are robust for different specifications. Not much productivity gain in crop production is ever achieved through land area expansion. The share of the female labour is positively associated with productivity suggesting higher productivity of the female labour (see Table 1a). This is consistent with other studies that have shown higher productivity of female labour for staple food crops (Quisumbing, *et al.*, 2005; Ojowu, *et al.*, 2007). The results confirm the important role that female farmers play in food production and ensuring food security. Controlling for farm area and crop area, total labour did not affect crop productivity significantly for the model without the linear time trend. As expected however, total labour productivity was positively associated with productivity for the linear time trend model. Reasons for the non-significant impact of the total family labour are not clear (see Table 1).

Fertilizer use was positively associated with productivity but the association was not significant at p= 0.10. The non-significant impact of fertilizer on crop productivity might be due to inadequate use of fertilizer, while the positive association is an indication that it is a yield enhancing technology. The time trend regressions also showed a significant negative productivity trend (-0.8% per year in the GLS model, which is the preferred model due to significant autocorrelation and heteroskedasticity) (see Table1). The time dummies regressions also show a negative time trend. The reason for this could be due to falling real agricultural prices in Nigeria (See Figure 1). However, recent food prices have increased dramatically. Hence there is need for using more recent price data to validate this trend. The negative time trend of productivity could also be due to the falling agricultural productivity due to declining soil fertility and expansion of marginal areas (Ojowu, *et al.*, 2007).

Table 1a: Results of inverse crop productivity of staple food crop farmers in Nigeria

Explanatory variables	Without time trend			With time trend		
	OLS random effects	OLS fixed effects	GLS with fixed state effects	OLS random effects	OLS fixed effects	GLS with fixed state effects
Log crop area	-0.078*** (0.03)	-0.095** (0.04)	-0.054* (0.03)	-0.067* (0.04)	-0.047 (0.04)	0.013 (0.03)
Share female labor	0.472** (0.22)	0.509** (0.24)	0.159 (0.21)	0.624*** (0.24)	0.814*** (0.26)	0.415** (0.21)
Log total labour	0.094 (0.07)	0.033 (0.1)	-0.06 (0.08)	0.305*** (0.07)	0.318*** (0.09)	0.189*** (0.06)
Log fertilizer cost per ha	0.028 (0.1)	0.015 (0.07)	0.005 (0.05)	0.037* (0.02)	0.018 (0.87)	0.005 (0.59)
Share of crop area(cf Maize):	0.05 (0.09)	0.06 (0.56)	0.05 (0.76)	0.05 (0.88)	0.05 (0.54)	0.04 (0.98)
Cocoyam	-0.086 (0.47)	0.071 (0.48)	-0.035 (0.32)	-0.594 (0.52)	-0.542 (0.54)	-0.448 (0.32)
Melon	-0.503 (0.58)	-0.655 (0.58)	-0.451 (0.32)	-1.647*** (0.64)	-1.753*** (0.64)	-0.900*** (0.33)
Rice	0.769** (0.31)	0.789*** (0.30)	0.656*** (0.24)	0.611* (0.34)	0.642* (0.34)	0.427 (0.27)
Cassava	0.274 (0.35)	0.272 (0.36)	0.739*** (0.26)	-0.266 (0.39)	-0.311 (0.40)	-0.04 (0.28)
Cotton	-0.994 (1.35)	-1.398 (1.36)	-0.062 (0.93)	-1.517 (1.47)	-2.295 (1.52)	-0.543 (1.17)
Yam	0.830** (0.40)	0.980** (0.43)	0.813*** (0.29)	-0.558 (0.41)	-0.57 (0.44)	-0.831*** (0.27)
Bean	-0.825** (0.36)	-0.863** (0.37)	-0.857*** (0.25)	-1.118*** (0.40)	-1.404*** (0.42)	-1.548*** (0.28)
Groundnut	-0.397 (0.42)	-0.467 (0.43)	-0.418 (0.30)	-0.890* (0.46)	-1.085** (0.48)	-0.886*** (0.29)
Sorghum	-0.865** (0.35)	-0.858** (0.370	-0.855*** (0.23)	-1.003** (0.39)	-1.278*** (0.42)	-1.394*** (0.26)
Millet	0.025 (0.32)	0.027 (0.34)	0.01 (0.23)	-0.221 (0.36)	-0.538 (0.38)	-0.733*** (0.28)
Groundnut	-0.397 (0.42)	-0.467 (0.43)	-0.418 (0.30)	-0.890* (0.46)	-1.085** (0.48)	-0.886*** (0.29)
Agro ecological zones						
Dry savannah	-0.353 (0.29)			-0.135 (0.31)		
Moist savannah	0.008 (0.180)			-0.098 (0.20)		

Table 1b: Continuation of results of inverse crop productivity of staple food crop farmers in Nigeria

Explanatory variables	Without time trend			With time trend		
	OLS random effects	OLS fixed effects	GLS with fixed state effects	OLS random effects	OLS fixed effects	GLS with fixed state effects
Year (Trend)				-0.021*** (0.001)	-0.017*** (0.001)	-0.008*** (0.001)
Y1994	13.213*** (0.69)	13.827*** (0.95)	14.209*** (0.74)			
Y1995	13.007*** (0.69)	13.631*** (0.96)	14.000*** (0.74)			
Y1996	13.123*** (0.70)	13.751*** (0.97)	14.124*** (0.75)			
Y1997	13.249*** (0.70)	13.873*** (0.97)	14.241*** (0.76)			
Y1998	13.202*** (0.70)	13.830*** (0.97)	14.193*** (0.75)			
Y1999	13.187*** (0.70)	13.823*** (0.98)	14.216*** (0.76)			
Y2000	13.066*** (0.70)	13.707*** (0.97)	14.109*** (0.76)			
Y2001	13.015*** (0.70)	13.654*** (0.97)	14.063*** (0.75)			
Y2002	12.973*** (0.70)	13.621*** (0.98)	14.027*** (0.76)			
Y2003	12.926*** (0.71)	13.583*** (0.99)	13.966*** (0.77)			
Y2004	12.853*** (0.71)	13.513*** (0.98)	13.902*** (0.76)			
Y2005	12.756*** (0.71)	13.422*** (0.98)	13.827*** (0.76)			
Constant				56.678*** (7.66)	47.534*** (8.67)	30.360*** (6.16)
Number of observations	431	431	431	431	431	431
Hausman test (p-value)		0.555			0.013***	
Breusch-pagan LM random effects test (p-value)	0.000***			0.000***		
Wooldridge test Ho: No first order autocorrelation(p-value)	0.000***	0.000***		0.000***	0.000***	
Breusch-pagan test Ho: Homoscedasticity ()p-value	0.019**	0.000***		0.083*	0.000***	

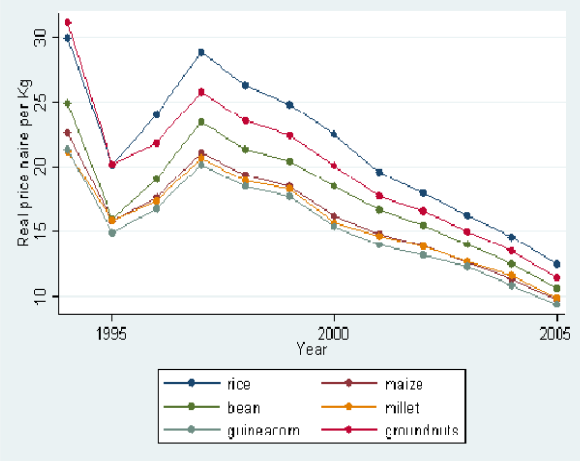

Figure 1: Trend of real price of crops from 1995 – 2005

The results of the models with year dummies show that crop area has a slightly negative and significant association with value of production. Hence, a 1% increase in crop area reduces productivity only by 0.054%. On the competitiveness of the selected crop, results show rice, cassava, and yams recorded higher value of production per unit area than Maize. Both rice and cassava are among the presidential crops while Maize is also included. The results justify inclusion of rice and cassava in the presidential initiative crops. However, given the growing importance of Maize, there is need for increased investment in the production of maize in Nigeria. Results also show that the value of production per hectare for maize was higher than that of beans, and sorghum. This demonstrates the economic importance of maize and the need to invest more in the cereal to respond to the growing demand and the recent increasing prices of maize due to the bioenergy and other factors.

5. Conclusion and research implication

This paper has provided empirical evidence to show that agricultural crop production has grown in the past decade, mainly due to area land expansion and – to a limited extent – improved agricultural productivity. Though the Nigerian government has designed a number of policies and strategies to reduce poverty and improve food security, achievement of such strategy requires facilitating adoption of improved crop production technologies. Results from our study suggest the share of female family labor increases agricultural productivity. This implies that female farmers are critical to productivity enhancement in crop production in Nigeria. The fact that fertilizer exhibit positive sign and was not significant makes this paper to conclude that fertilizer is a yield enhancing technology but that there exist high level of inadequate use. It therefore becomes imperative to either increase supply to farmers as at when due or enhances their capacity in terms of right quantity to apply. This study also shows that two of the presidential crops cassava and rice have higher returns than Maize. These results justify the inclusion of cassava and rice in the presidential initiative. However, given the increasing demand for maize in Nigeria and worldwide (i.e. the current efforts to use maize to produce ethanol), price of maize has increased dramatically and has likely increased its competitiveness compared to other presidential initiative crops. This implies that there is a need to increase maize productivity as well as stepping up productivity of cassava and rice which are main drivers of agricultural crop productivity in Nigeria. Arising from findings of this study, it recommends adoption of technologies that will bring about productivity gains in crop production through less of land expansion practices. It is also recommended that farmers' capacity in terms of right quantity use of fertilizer should be enhanced, while female farmers' participation in crop production should be encouraged.

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