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Investigating the Sources of Agricultural Growth in Africa: Factor Accumulation, Total Factor Productivity, and Technology Absorption

Guy Blaise NKAMLEU

International Institute of Tropical Agriculture (IITA, Ibadan-Nigeria). c/o LW Lambourn & Co, Carolyn House 26 Dingwall Road, Croydon CR9 3EE, United Kingdom.

Abstract

This paper investigates sources and determinants of agricultural growth in Africa, concentrating on the growth path during the last three decades. The analysis employs the broader framework provided by empirical growth literature and recent developments in Total Factor Productivity (TFP) measurement to search for fundamental determinants of growth in African agriculture. One main contribution and new findings in this analysis is the quantification of the contribution of the productivity growth and the contribution of different inputs such as land, labor, tractor and fertilizer in the agricultural growth. Growth accounting computation highlights the fact that factor accumulation rather than TFP accounts for a large share of agricultural output growth and fertilizer has been the most statistically important physical input contributor to agricultural growth. The study also highlights the extent to which agricultural growth contributors vary in relation with different country conditions, institutions and politico-historical factors.

Key words: Growth accounting, TFP, Factor accumulation, Capital absorption, Africa.

JEL classification: N50 ; O47 ; D24

Background

Efforts to understand Africa's idiosyncratic economic performance, should first explore the determinants of African economic growth. This paper applies a growth accounting method to investigate sources of agricultural growth in Africa over the last three decades, an issue of special interest with regard to the importance of this sector in African economies.

In recent years, there has been a burgeoning of empirical research into the factors affecting economic growth in both developed and developing countries (O'Connell and Ndulu, 2000). Most of this research was inspired by the development of 'endogenous growth theory', which emphasizes the role of technological progress and innovation and human resource development in the growth process (Downes, 2001). Several theoretical models have been used to explain economic growth. The point of departure for most theoretical models used to explain economic growth is the production function approach pioneered by Solow (1956) who specified a neoclassical model of economic growth, where physical inputs, labor and an exogenous technology influence the level of output. The recent literature is centered on whether the differences in physical and intangible capital observed for different countries can account for the large international income difference that characterize the world economy today. This has led researchers to examine the main sources of growth for different countries and regions of the world. However, past studies focused on overall economic growth pattern, and did not highlight the specificity of the issue for some major sectors.In this paper, we investigate the source of growth in the agricultural sector in Africa. The focus is to evaluate the relative contribution of main sources of growth in African agriculture by estimating how much growth in output is associated with growth in different physical inputs and how much is due to TFP, institutional change and other factors.

Data and Theoretical framework

The analysis is based on data mostly drawn from FAOSTAT system of statistics used for the dissemination of statistics compiled by the Food and Agriculture Organization (FAO). Panel data on the top 26 African agricultural producers, from 1970 to 2000, are analyzed. Data used consist of information on agricultural production and conventional and non-conventional inputs. The specific variables used in the study include agricultural output (agricultural production value) and means of production (agricultural labor, number of tractors in use, quantity of fertilizer used, agricultural land and livestock).

The point of departure of our analysis is the neoclassical production function which is written as:

$$\ln Q_{it} = f(x_{itj}, t; \beta) + \varepsilon_{it} \qquad \begin{array}{l} i = 1,.....,n \\ t = 1,.....,T \\ j = 1,.....,J \end{array} \qquad \text{(Eq 1)}$$

Where Q_{it} is output of the i-th country in time period t, x_{it*} is an N*1 vector of the logarithm of inputs for the i-th country in time period t, β is a vector of unknown parameters, and ε_{it} is random variable which assumed to be iid $N(0, \sigma^2_{\varepsilon})$.

We use this production function to break down the growth rate of aggregate output into contribution from the growth of inputs versus productivity change (Fulginiti et al., 2004; Limam and Miller, 2004):

$$\dot{Q}_{it} = \sum_j \alpha_{itj} \dot{x}_{itj} + \dot{TFP}_{it} \qquad \text{(Eq 2)}$$

Where dots over variables indicate rate of change $\dot{X}_t = \frac{X_t - X_{t-1}}{X_{t-1}}$, and α_{itj} is the output elasticity of input j, for country i in time t. $\alpha_j = \frac{\partial f(x,t;\beta)}{\partial x_j}$.

The aggregate production function in growth rates is given by:

$$\dot{Q}_{it} = c + \alpha_1 \dot{Land} + \alpha_2 \dot{Labor} + \alpha_3 \dot{Fertilizer} + \alpha_4 \dot{Tractor} + \alpha_5 \dot{Livestock} + \dot{TFP} + v_{it} \qquad \text{(Eq 3)}$$

That is:

$$\begin{pmatrix} Growth\ rate \\ of\ output \end{pmatrix} - \begin{pmatrix} Growth\ rate \\ of\ TFP \end{pmatrix} = c + \alpha_1 \begin{pmatrix} Growth\ rate \\ of\ land \end{pmatrix} + \alpha_2 \begin{pmatrix} Growth\ rate \\ of\ labor \end{pmatrix} + \alpha_3 \begin{pmatrix} Growth\ rate \\ of\ fertilizer \end{pmatrix} + \alpha_4 \begin{pmatrix} Growth\ rate \\ of\ Tractor \end{pmatrix} + \alpha_5 \begin{pmatrix} Growth\ rate \\ of\ livestock \end{pmatrix}$$

We first compute TFP growth using Data Envelopment Analysis (DEA) procedure (Malmquist indexes). Recall that for the single-output, single-input and output-oriented case, the MI TFP change between the base period 's' and a period 't' can be written as (Nkamleu 2004):

$$m_0(y_s, x_s, y_t, x_t) = \frac{d_0^t(y_t, x_t)}{d_0^s(y_s, x_s)} \left[\frac{d_0^s(y_t, x_t)}{d_0^t(y_t, x_t)} \frac{d_0^s(y_s, x_s)}{d_0^t(y_s, x_s)} \right]^{1/2}, \quad (5)$$

This productivity change can later be decomposed into technical change and efficiency change.

Then, regressing $\dot{Q}_{it} - \dot{TFP}$ on the growth rate of inputs, using panel data random effect procedure, we obtain coefficients (α_i) which are interpreted as factor shares. For the polled and for each group of countries, a separated panel data random effect regression was ran to derive factor share for each of the period (1971-80, 1981-90, 1991-00 and 1971-00). Overall, 28 regressions were ran.

Results

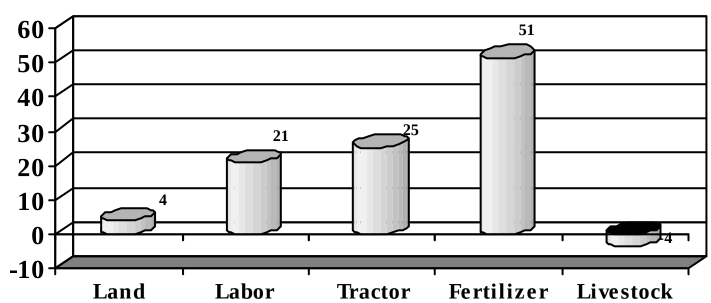
Table 1 reports the results of the output growth decomposition by decade, over the entire sample. Agricultural growth performance varies widely over time. Low during the seventies, the average annual growth rate grew to more than 3% in subsequent decades. The contribution of factor inputs (98%) has been on average larger than that of TFP (67%). Unaccounted factors which might include factors such as agro-climatic shocks, institutions and political instability, also contributed importantly to agricultural output growth (-65%). The weak performance of the TFP growth was mainly due to its negative evolution during the seventies and the overall failure to absorb the available technology (negative efficiency change). In the eighties and nineties, TFP growth rises sharply, while the contribution of factor inputs tended to decline. Busari et al, (2005), also found that TFP contribution to total economic growth was negative during the seventies in Africa. In sum, output growth decomposition shows that physical inputs or factor accumulation globally provides the most important component of output growth during the last three decades. Narrowing our focus within the contribution of each physical input (Figure 1) reveals that output growth due to fertilizer usage is the highest in Africa where it accounts for 51% of total agricultural output growth, following by the contribution of tractor (25%). The amount attributable to labor growth was 21% while land account only for 4% of total agricultural growth. The contribution of livestock has been constantly negative. In the time dimension, we observe more stability in the contribution of fertilizer, as well as in the contribution of livestock. Figure 2 reports results of the output growth decomposition per decade, and per geographical group. These results indicate that the strength of the contribution of growth determinants varies across regions, with some common characteristics. The contribution to output growth of TFP is constantly lower than contribution of total inputs. In some regions (North and West Africa), the contribution of TFP is close to the contribution of the physical inputs while in others, factor contribution far exceed TFP contribution. In all regions, it is apparent that fertilizer is the most important physical input contributor to agricultural growth. Suggesting that fertilizer is a good foundation, on which one can build strong equitable agricultural growth in Africa. We further investigated the impact of colonial inheritance and agro-climatic conditions on growth accounting parameters. We found that the contribution of physical inputs, particularly labor and tractor has been highest in French speaking countries, while TFP growth was more important in English countries than in French countries. Unaccounted factors (agro-climatic shocks, political instability…) have been a major constraint for agricultural production growth in French speaking countries, whereas in English countries, these factors have had no significant effects.

When comparing sahelian vs forest countries, it appears that agricultural growth attributable to factor accumulation was higher than TFP contribution in forest countries, while in sahelian countries, TFP contribute more than physical factor to agricultural growth. Unaccounted factors also impede agricultural growth in forest countries.

Table 1: African agricultural growth decomposition by decade

Source of growth (Percentage contribution to agricultural growth)				
	1971-80	1981-90	1991-00	All (1971-2000)
Total output growth per year (a)	100%	100%	100%	100%
Total growth due to factor inputs (b)	113.88%	48.33%	92.04%	98.41%
Yearly growth due to Land (c)	-13.51%	5.39%	3.06%	4.14%
Yearly growth due to Labor (d)	-14.77%	-34.76%	30.06%	21.04%
Yearly growth due to Tractor (e)	88.10%	13.12%	14.79%	25.44%
Yearly growth due to Fertilizer (f)	57.40%	67.82%	44.90%	51.31%
Yearly growth due to Livestock (g)	-3.34%	-3.23%	-0.77%	-3.54%
Yearly growth due to unaccounted factors (h)	31.23%	-34.47%	-83.39%	-65.35%
Yearly growth due to Total factor productivity change (i)	-45.11%	86.14%	91.36%	66.95%

Figure 1: Contribution of physical inputs in the agricultural growth 1971-00 (%)



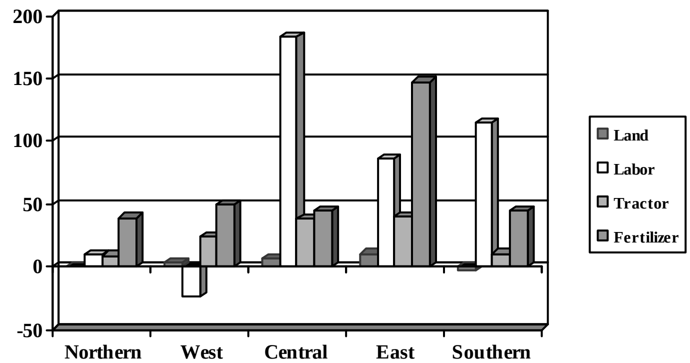


Figure 2: Contribution of physical inputs in the agricultural growth by region, 1971-00, (%).

Conclusions

One main finding in this paper is the quantification of the contribution of different inputs in the agricultural growth. One general conclusion is that the role and contribution of different inputs differ substantially between regions and countries, reflecting different country conditions, institutions and politico-historical factors. These regional differences show types and the extent of interventions needed to be put in place in each region for enhancing the agricultural growth of African agriculture. For some group of countries such as forest and French speaking countries, the agricultural growth attributable to factors such as labor, tractor and fertilizer was positive and high, while the contribution of livestock has been highly negative in English speaking and forest countries. In forest countries, livestock pest related problems might have played a negative role and pulled back the livestock sub-sector. Future strategies should be conscious of such constraints. The contribution of land also appears to be lower for Sahelian and French speaking countries. These results should be taken into account to build strategies to overcome the problem of agricultural growth in Africa. Efforts are needed not only from within the countries and regions, but also from the international community to ensure that the right mixture of policies is put in place to promote and sustain agricultural production in Africa.

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