Productivity Growth, Technical Progress and Efficiency Change in African Agriculture

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Guy Blaise Nkamleu*

Abstract: The paper examines the economic performance of a large number of African countries using an international comparable data set and the latest technique for analysis. The paper focuses on growth in total factor productivity and its decomposition into technical change and efficiency change components. The analysis is undertaken using the data envelopment analysis (DEA). The present study uses data of 16 countries over the period 1970–2001. It was found that, globally, during that period, total factor productivity has experienced a positive evolution in sampled countries. This good performance of the agricultural sector was due to good progress in technical efficiency rather than technical progress. The region suffered a regression in productivity in the 1970s, and made some progress during the 1980s and 1990s. The study also highlights the fact that technical change has been the main constraint of achievement of high levels of total factor productivity during the reference period in sub-Saharan Africa. Contrariwise, in Maghreb countries, technological change has been the main driving force of productivity growth. Finally, the results indicate that institutional factors as well as agro-ecological factors are important determinants of agricultural productivity growth.

Résumé: L'article analyse la performance économique d'un grand nombre de pays africains, en se servant d'une série de données internationales comparables et de la toute dernière méthode d'analyse. Il se penche sur la croissance de la productivité globale des facteurs de production et sa décomposition en deux volets: évolution technique et évolution de l'efficience. L'analyse repose sur la méthode dite de *Data Envelopment Analysis* ou DEA (permettant de mesurer l'efficience à partir de données réelles). La présente étude utilise les données de 16 pays sur la période 1970–2001. Il en ressort que, d'une manière générale, la productivité globale des facteurs de production ont affiché une bonne

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évolution dans les pays de l'échantillon au cours de la période considérée. Cette bonne performance du secteur agricole était plutôt attribuable à une bonne progression de l'efficience technique et non à des progrès techniques. La productivité de la région a régressé dans les années 70, avant de remonter légèrement dans les années 80 et 90. L'étude souligne également que l'évolution technique a été le principal obstacle à la réalisation de niveaux élevés de productivité des facteurs en Afrique subsaharienne durant la période considérée. Par contre, dans les pays du Maghreb, l'évolution technologique a été le principal moteur de la croissance de la productivité. Enfin, les résultats indiquent que les facteurs institutionnels et agro-écologiques jouent un rôle déterminant dans la croissance de la productivité agricole.

1. Introduction

In many parts of Africa, the major challenge facing agriculture is how to increase farm production to meet changing food needs without degrading the natural resource base. The agricultural sector is the most important in African economies employing as much as 50–80 per cent of the
1 labour force (Johnson, 1990). About two-thirds of the 627 million people living in sub-Saharan Africa (SSA) depend on agriculture or agriculture-related activities for their livelihoods (Ehui and Pender, 2003). It is estimated that throughout the region, there are 236 million agricultural poor, which represents 60 per cent of the agricultural population and 80 per cent of the total number of poor in the region (Dixon *et al.*, 2001). Therefore, agriculture continues to remain important in rural SSA and indicators of rural well-being are closely related to agricultural performance.

In most African countries, because of its importance in overall GDP, export earnings and employment as well as its forward and backward linkages to the non-farm sector, growth in the agricultural sector will continue to be the cornerstone of poverty reduction. Increased agricultural productivity and growth, driven by technology and investments, has a powerful dynamic effect that benefits the poor throughout the economy: directly through increased agricultural income and employment, and indirectly through increased food availability and lower food prices as well as through the demand created by increased agricultural incomes for non-farm goods and services produced by the very large, employment intensive non-agricultural rural economy.

However, importation of food is still needed to curb the increasing gap between food demand and food production. As shown by several studies, one of the most critical problems in Africa today is how to increase agricultural production to meet increasing food demand arising from an increase in population pressure (Mensah, 1989; Timberlake, 1990; Pretty, 1995).

The decline in food and agricultural per capita production over the years has become synonymous with the region's stagnation, social decline and marginalization in the world. Unless renewed measures are taken by the governments and people of the region to dramatically increase agricultural production, there will be continued deterioration and stagnation.

Given its importance, there is genuine concern among policymakers and researchers about the poor performance of SSA's agricultural sector. Without exception, studies on developed countries' agriculture have shown substantial productivity increases, whereas the results for less developed countries have consistently shown productivity declines
2 (Lilyan and Perrin, 1997).

There is a substantial body of literature measuring agricultural productivity change in the developed countries (Kalirajan *et al*., 1996; Fare *et al*., 1994), while in sub-Saharan Africa, empirical studies to systematically characterize the agricultural productivity in the region are scarce.

In light of the general objective of attaining regional self-sufficiency in agricultural products, governments and institutions have sought strategies that would lead to higher levels of production. A key factor for a sustained increase of agricultural production is improvement of productivity, which is carried out through technical change and/or efficiency change.

Many African farmers are still using low yielding agricultural technologies, which lead to low productivity and production. Another relevant question for agricultural policymakers is whether the agricultural sector can be made more efficient, by achieving more output with the current input level, or by achieving the current output with less input usage than is currently observed. An important step in answering these questions is to understand the pathway of productivity and its components.

The purpose of this study is to explore evolution of total factor productivity and its components in the African agricultural sector, using data envelopment analysis (DEA). The study used panel data on 16 selected countries of the region, and is intended to explain the relative performance of the agricultural sector across regions and countries.

2. Theoretical Framework: Malmquist Data Envelopment Analysis

Technical efficiency has received considerable attention in the economic literature in recent years. A variety of theoretical approaches, particularly yield gap and constraints methodologies, have been developed to investigate the failure of producers to achieve the same level of efficiency (Battese, 1992).

Over the past two decades, much progress has been made towards refining the frontier function methodology introduced by Farell in 1957 (Farell, 1957). Along with several methodological developments, there has been a considerable amount of empirical work, much of which use DEA and stochastic frontier production approaches (Lau and Yotopoulos, 1971; Bagi, 1982; Kopp and Diewert, 1982; Russell and Young, 1983; Taylor and Shonkwiler, 1984; Huang and Bagi, 1984; Dawson and Lingard,
3 1989; Ali and Chaudhry, 1990; Bravo-Ureta and Rieger, 1990; Defourny *et al*., 1992; N'gbo, 1994; Kalirajan and Shand, 2001; Bakhshoodeh and Thomson, 2001; Wilson *et al*., 2001).

More recently, a non-parametric method has been developed that calculates the total factor productivity index using an efficiency measure.
4 This approach when has panel data, uses DEA-like linear programs and Malmquist total factor productivity index to measure productivity change, and to decompose this productivity change into technical change and technical efficiency change.

In this paper, this method is employed. The method has the advantage that it is parameter free, we do not presuppose a parametric functional form. Specifying a functional form imposes restrictions on the structure of technology, which could give rise to specification error.

Malmquist productivity indexes were introduced by Caves *et al.* (1982), who first developed these measures for varying return to scale (VRS) technologies, assuming overall efficiency and a translog technology for output distance functions. Though the authors could not provide direct estimates of the Malmquist index (MI), they noticed that the geometric mean of two MI was equivalent to a scaled Tornqvist-Theil productivity index.

Subsequently, Fare *et al*. (1994) developed a non-parametric approach for estimating the Malmquist indexes, and showed that the component distance function could be derived using a DEA-like linear program method. Furthermore, they showed that the resulting total factor productivity indexes could be decomposed into efficiency change and technical change components. The method showed two main advantages. First, no assumption on the functional form of the underlying production technology was required. And second, unlike the Tornqvist TPF indexes, for the Malmquist indexes, data on output and input prices are not indispensable, hence making the method particularly suited for regions where price data are not readily available.

The Malmquist TFP index is defined using distance functions. Distance functions allow one to describe a multi-input multi-output production technology without the need to specify a behavioural objective such as cost minimization or profit maximization (Rao and Coelli, 1998). One may define input distance functions and output distance functions. An input distance function characterizes the production technology by looking at a minimal proportional contraction of the input vector, given an output vector. An output distance function considers a maximal proportional expansion of the output vector, given an input vector.

The output distance function is defined on the output set $P(x)$, as:

$$d_0(x, y) = min\{\theta : (y/\theta) \in P(x)\},$$

where the output set, $P(x)$ represents the set of all output vectors, y, which can be produced using the input vector x.

Extensive discussion on Malmquist indexes can be found in Fare *et al.* (1994). Here, we provide a brief summary of the discussion, and suggest interested readers to refer to the references above.

Even though the method is easily accommodated to the multi-output, multi-input case, for clarity purposes the exposition is limited to the single-output, single-input and output-oriented case. Following Fare *et al.* (1994), the MI TFP change between a base period (s) and a period t can be written as:

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

where the notation $d_0^s(y_t, x_t)$ represents the distance from the period t observation, to the period s technology. A value of 'm' greater than one will indicate positive TFP growth from period s to period t.

In (1), the term outside the square brackets measures the Farrell efficiency change between period s and t, and the term inside measures technical change, which is the geometric mean of the shift in the technology between the two periods. Thus, the two terms in equation (1) are:

$$Efficiency\ change = \frac{d_0^s(y_t, x_t)}{d_0^s(y_s, x_s)}$$

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

The efficiency change component is equivalent to the ratio of the Farrell technical efficiency in period t to the Farrell technical efficiency in period s, under the constant return to scale ($EFFCH_{crs}$). This efficiency change component can be separated into a scale efficiency and pure technical efficiency change. The pure technical efficiency is obtained by re-computing efficiency change under the variable return to scale ($EFFCH_{vrs}$). The scale efficiency is therefore the ratio of efficiency under constant return to scale and the same efficiency under variable return to scale ($EFFCH_{crs}$/ $EFFCH_{vrs}$).

The overall index in (1) represents the productivity of the production point (y_t, x_t) relative to the point (y_s, x_s), and a value larger than one depicts positive TFP growth between periods s and t. Empirical applications require the computations of the four distance functions in (1). As suggested by Coelli (1996), the distance functions can be recovered by solving the following DEA-like linear programs:

$$\begin{aligned} [d_0^t(x_t, y_t)]^{-1} &= Max_{\phi,\lambda}\phi, \\ \textit{subject to} \quad & -\phi y_{it} + Y_t\lambda \geq 0 \\ & x_{it} - X_t\lambda \geq 0' \\ & \lambda \geq 0, \end{aligned}$$

$$\begin{aligned} [d_0^{t+1}(x_{t+1}, y_{t+1})]^{-1} &= Max_{\phi,\lambda}\phi, \\ \textit{subject to} \quad & -\phi y_{i,t+1} + Y_{t+1}\lambda \geq 0 \\ & x_{i,t+1} - X_{t+1}\lambda \geq 0' \\ & \lambda \geq 0, \end{aligned}$$

$$\begin{aligned} [d_0^t(x_{t+1}, y_{t+1})]^{-1} &= Max_{\phi,\lambda}\phi, \\ \textit{subject to} \quad & -\phi y_{i,t+1} + Y_t\lambda \geq 0 \\ & x_{i,t+1} - X_t\lambda \geq 0' \\ & \lambda \geq 0, \end{aligned}$$

$$\begin{aligned} [d_0^{t+1}(x_t, y_t)]^{-1} &= Max_{\phi,\lambda}\phi, \\ \textit{subject to} \quad & -\phi y_{it} + Y_{t+1}\lambda \geq 0 \\ & x_{it} - X_{t+1}\lambda \geq 0' \\ & \lambda \geq 0, \end{aligned}$$

5 where λ is a $N \times 1$ vector of constant and ϕ is a scalar with $1 <= \phi < \infty$. $\phi - 1$ is the proportional increase in outputs that could be achieved by the ith unit, with input quantities held constant.

The above programs must be solved for each country in the sample in each period, and an extra three programs for each country to construct the chained index. If we have T time periods, we must calculate $(3T - 2)$ LPs. Overall, for N firms and T periods, with the decomposition of the technical efficiency $N(4T - 2)$ LPs are solved (2016 LP in this case).

3. Data Specification

To estimate the Malmquist indexes of efficiency and total factor productivity, a panel data on 16 African countries from 1970 to 2001 was used. The countries concerned are listed in Table 1 below.

Data consisted of information on agricultural production and means of production in the study countries. Record of agricultural production index (base 1989–1991), rural population, number of tractors in use, fertilizer uses, agricultural areas were obtained from FAO statistic database.

Specification of output and input in the analysis was as follows:

Output

- Agricultural production: To construct the output series, we followed the methodology suggested in Rao and Coelli (1998). Output aggregated for the year 1990 was used to compute output series. These 1990 aggregated outputs were computed using international average prices

Table 1: Sample countries used in the analysis

	Colonial heritage	Location	Sahelian/ non-Sahelian	Have/Have not experience major civil war
Algeria	French	Maghreb	Sahelian	No
Burkina Faso	French	West Africa	Sahelian	No
Cameroon	French	West Africa[a]	Non-Sahelian	No
Côte d'Ivoire	French	West Africa	Non-Sahelian	No
Egypt	French	Maghreb	Sahelian	No
Ghana	British	West Africa	Non-Sahelian	No
Kenya	British	East Africa	Non-Sahelian	No
Malawi	British	Austral Africa	Non-Sahelian	No
Mali	French	West Africa	Sahelian	No
Morocco	French	Maghreb	Sahelian	No
Mozambique	Portugal	Austral Africa	Non-Sahelian	Yes
Nigeria	British	West Africa	Non-Sahelian	No
Senegal	French	West Africa	Sahelian	No
Tunisia	French	Maghreb	Sahelian	No
Uganda	British	East Africa	Non-Sahelian	Yes
Zimbabwe	British	Austral Africa	Non-Sahelian	No

[a] Although Cameroon is politically part of Central Africa, it is more common in scientific studies to consider it as part of West Africa.

(expressed in US dollars) derived using a Geary-Khamis method (see
6 Rao, 1993). The aggregates are based on the sum of price-weighted quantities of different agricultural commodities produced after deduction of quantities used as seed and feed weighted in a similar manner. The resulting aggregates represent, therefore, disposable production for any use, except as seed and feed. The 1990 output series were then extended to cover the study period 1970–2001, using the FAO production index number series.

Input

- Labour refers to the economically active population in agriculture for each year, in each country. The economically active population in agriculture is defined as all persons engaged or seeking employment in agriculture, forestry, hunting or fishing sector, whether as employers, own-account workers, salaried employees or unpaid workers.
- Agricultural land: the sum of area under *arable land* (land under temporary crops, temporary meadows for mowing or pasture, land under market and kitchen gardens and land temporarily fallow); *permanent crops* (land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee and rubber); and *permanent pastures* (land used permanently for herbaceous forage crops, either cultivated or growing wild).
- Fertilizer: The sum of nitrogen, potash and phosphate content of various fertilizers consumed, measured in thousands of metric tons in nutrient units.
- Tractors refer to total wheel and crawler tractors (excluding garden tractors) used for agricultural production.

4. Results

Mean overall technical efficiencies (Table 2), indicate an overall positive trend over time for the sample countries. However, countries did not have the same performance during the period. Some countries like Malawi and Côte d'Ivoire have experienced a big increase of overall technical efficiency during the period, while Burkina Faso experienced a negative trend. Recall that a value greater than unity represents an improvement of efficiency or productivity. Turning to the component
7 measures (*PechcY* and *SechCY*), it appears that both pure and scale technical efficiency have contributed to the growth of overall efficiency. This suggests that, in the achievement of high levels of technical performance over time, the technical efficiency is not a long-run constraint.

Table 2: Mean technical efficiencies change

Countries	Technical efficiency change *EffchC*	Pure technical efficiency change *PechC*	Scale efficiency change *SechC*
Algeria	1.012	1.019	0.994
Burkina Faso	0.982	1.000	0.982
Cameroon	1.000	1.000	1.000
Côte d'Ivoire	1.018	1.006	1.012
Egypt	1.000	1.000	1.000
Ghana	1.006	1.006	1.000
Kenya	1.009	1.000	1.009
Malawi	1.023	1.000	1.023
Mali	1.009	1.009	1.000
Morocco	1.000	0.997	1.004
Mozambique	1.002	1.022	0.981
Nigeria	1.000	1.000	1.000
Senegal	1.013	1.000	1.013
Tunisia	1.006	1.000	1.006
Uganda	1.000	1.000	1.000
Zimbabwe	1.009	1.001	1.009
Mean	1.006	1.004	1.002

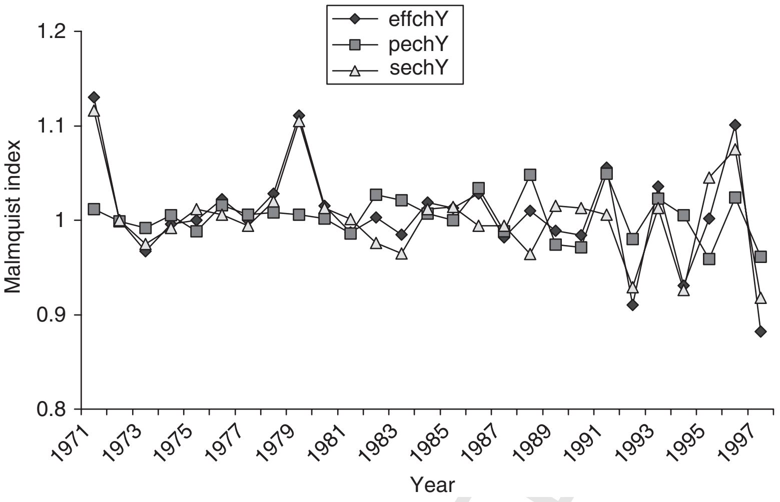
The positive evolution of the scale efficiency suggests that the agricultural sector succeeded in taking advantage of the growing size of the sector, while the improvement in pure technical efficiency over the study period is a significant finding and suggests that there was a learning process, as predicted by theories of intra-firm diffusion (Kalirajan and Shand, 2001).

Examining the trend of efficiencies offers another important insight into the performance over time. The evolution trend of the technical efficiency and its component is shown in Figure 1. Scale efficiency has experienced big season-by-season fluctuations, inducing big fluctuations in the overall technical efficiency. This situation may be due to the large difference between countries in performing scale efficiency change (Table 2).

Turning to the Malmquist total factor productivity index, Table 3 includes mean values of measures of change in total factor productivity index and its components (efficiency change and technical change). Means are given for the sample as a whole as well as by country. Looking at the sample as a whole, the change in total factor productivity of the agricultural sector of the countries studied has been positive. On average, total factor productivity has increase by 0.1 per cent annually.

An important question is: what is the main cause of that gain of productivity? The agricultural sector can improve the level of total factor productivity either by improving technical efficiency and/or by improving

Figure 1: Evolution of technical change over time



technological level (shift in the production frontier). The component measures of total factor productivity, *EffchC*and *TechchC* show that efficiency has been the main contributor of the success of total factor productivity. The average technical efficiency change was 0.6 per cent per year, while the technical change was negative (−0.5 per cent per year).

Table 3: Mean total factor productivity change

Countries	Technical efficiency change *EffchC*	Technological change *TechchC*	Total factor productivity change *TfpchC*
Algeria	1.012	1.017	1.030
Burkina Faso	0.982	0.967	0.950
Cameroon	1.000	0.992	0.992
Côte d'Ivoire	1.018	0.993	1.011
Egypt	1.000	0.998	0.998
Ghana	1.006	0.992	0.998
Kenya	1.009	1.004	1.013
Malawi	1.023	1.002	1.024
Mali	1.009	0.981	0.989
Morocco	1.000	1.005	1.006
Mozambique	1.002	1.007	1.009
Nigeria	1.000	0.964	0.964
Senegal	1.013	0.987	1.000
Tunisia	1.006	1.008	1.014
Uganda	1.000	1.001	1.001
Zimbabwe	1.009	1.005	1.014
Mean	1.006	0.995	1.001

This suggests that, for the sampled countries, technical change has been the main constraint of achievement of high levels of total factor productivity during the reference period.

Also here, countries did not perform similarly. Countries, that had been good or average in increasing levels of technical efficiency, experienced poor technical change. This was the case in countries like Côte d'Ivoire and Senegal. Overall, 11 out of the 16 sampled countries had increased efficiency more than technology (Table 4). This is useful information and important in guiding efforts to increase agricultural production.

Figure 2 shows the trend over time. This trend is characterized by an important season-by-season variation of the two components of the total factor productivity index. The technical change component has had more fluctuation, suggesting that promotion of technical change has not been constant during the period.

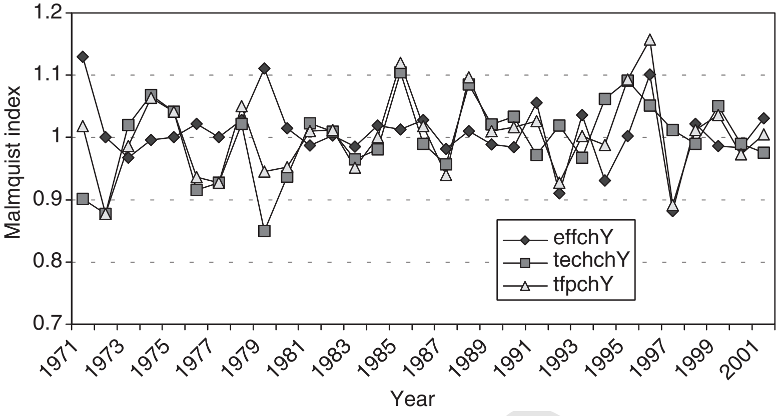
Figure 4 shows the rates of change in efficiency, technology and productivity, grouped by decade. It appears that, during the 1971–80 period, the region performed well in raising the efficiency of the agricultural sector. The average annual growth rate of technical efficiency during that period was 2.3 per cent, while the technical change was negative on average. The situation was reversed during the 1980s and the 1990s, with a good score on technical change and a regression of technical efficiency.

Table 4: Comparison between technical efficiency change and technological change

Countries	*EffchC* > *TechchC*	*TechchC* > *EffchC*
Algeria		*
Burkina Faso	*	
Cameroon	*	
Côte d'Ivoire	*	
Egypt	*	
Ghana	*	
Kenya	*	
Malawi	*	
Mali	*	
Morocco		*
Mozambique		*
Nigeria	*	
Senegal	*	
Tunisia		*
Uganda		*
Zimbabwe	*	
Mean	*	

* =Yes

Figure 2: Evolution of total factor productivity change over time



The results presented so far do support the notion that there is a difference between countries in performing efficiency and productivity change. It was therefore interesting to investigate the relationship between those changes and countries' particularities. We investigated what potential institutional and socio-political factors have affected the agricultural productivity performance in Africa. The relationship between total factor productivity and some measurable factors that may supposedly impact the productivity were investigated. The factors considered included:

Figure 3: Cumulative performance of agricultural sector in sample
8 **countries**

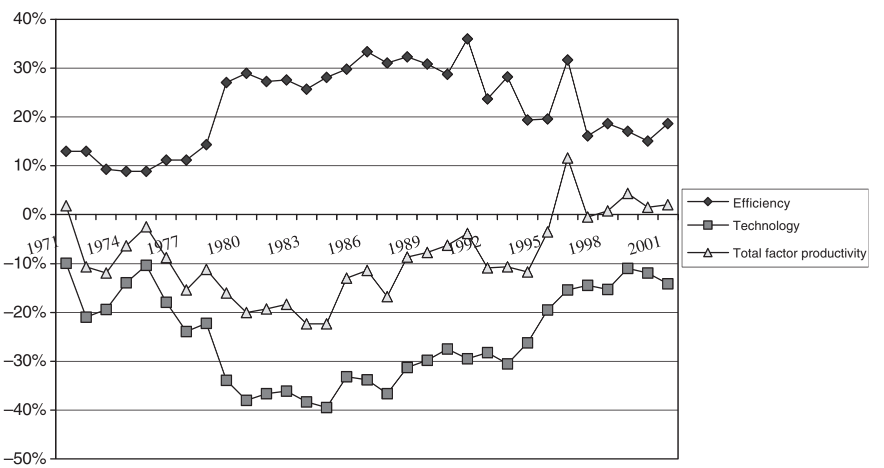
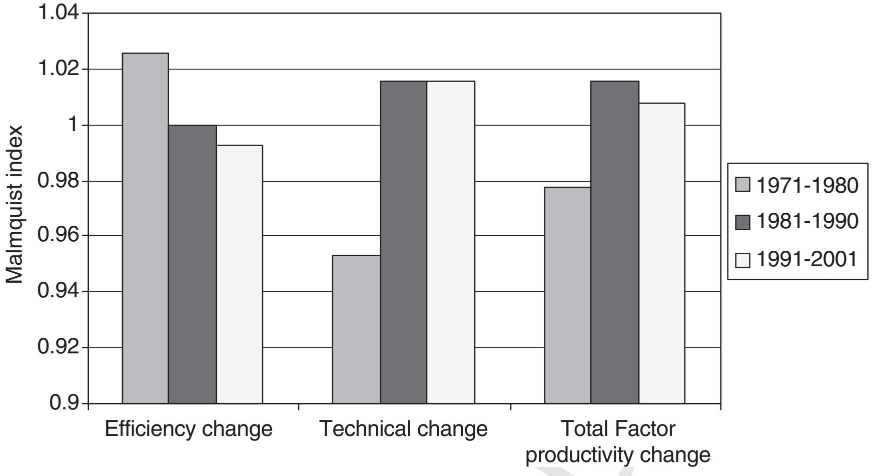


Figure 4: Decade average efficiency and productivity change



- Colonial heritage: countries were grouped according to their colonial heritage.
- Political right and civil liberties: indexes of political freedom that 'freedom house' has published for each sampled country was used. Each year, since 1972, based on a series of checklists relating to political rights and civil liberties, freedom house has rated each country as 'free', 'partly free' or 'not free'.
- Geographical location: It is expected that due to a difference in natural resource endowment, geographical location could impact the performance of the agricultural sector.
- Conflict: A dummy variable was used to characterize countries that have experienced a major civil war. Two countries were identified in this category (Mozambique and Uganda). However, it is recognized that this categorization is disputable, since the boundary between minor and major conflict has a subjective flavour.

A Tobit model of the determinants of efficiency and productivity was run (Table 5). Apart from the factors mentioned above, the illiteracy rate, the proportion of irrigated agricultural land, and the agricultural land in each country were also included in the model. Two major results came out of these estimations:

1. The illiteracy rate is negatively related to productivity growth. Countries with a high proportion of illiterates were also those performing weakly in productivity growth, suggesting that fighting illiteracy is another means to push agricultural productivity.

Table 5: Tobit model of the determinants of total factor productivity change in sampled countries

Variable	Efficiency change		Technical change		Total factor productivity change	
	Coefficient	*t*-statistics	Coefficient	*t*-statistics	Coefficient	*t*-statistics
Constant	1.012	20.10**	1.0054	16.15**	1.0098	12.98***
% of irrigated land	−0.0253	−0.86	−0.0154	−0.42	−0.0391	−0.86
Illiteracy rate	0.0002	0.50	−0.0016*	−2.61**	−0.0015	−2.01**
Agricultural area	5.3E–08	0.12	6.9E–08	0.13	1.5E–07	0.22
Dummy for politically not-free countries	−0.0043	−0.36	0.0066	0.44	−0.0009	−0.05
Dummy for politically free countries	−0.0118	−0.43	0.0050	0.15	−0.0096	−0.23
Dummy for Sahelian countries	−0.0140	−0.57	0.0337	1.12	0.0256	0.68
Dummy for former French colonies	−0.0002	−0.01	0.0701	1.15	0.0865	1.14
Dummy for former British colonies	−0.0046	−0.12	0.0572	1.22	0.0662	1.13
Dummy for countries which experienced major war	−0.0186	−0.68	0.1082	3.21**	0.0935	2.22**
Dummy for Maghreb countries	0.0142	0.44	−0.0087	−0.22	0.0007	0.01
Dummy for West African countries	−0.0153	−0.62	0.0068	0.23	−0.0061	−0.16
σ	0.1260	30.89**	0.1557	30.89**	0.1946	30.89***
	Log likelihood = 311.41		Log likelihood = 210.37		Log likelihood = 103.92	
	Total sample = 477		Total sample = 477		Total sample = 477	

* = significant at 0.10; ** = significant at 0.05; *** = significant at 0.01.

2. Surprisingly countries that have experienced a major civil war had also a better performance of productivity growth rate. This can be explained by very few countries in this category (Uganda and Mozambique), and it should also be noted that the recovery process after war is usually a period of high investment in technology.

The results of the Tobit models were not very informative, since many of the explanatory variables are country specific and do not change through time, thus they do not affect changes in efficiency and productivity through time. Therefore, we found it more informative to look at simple cross-tabulation.

Table 6 reports the performance of the agricultural sector according to colonial heritage. It is evident that there are substantial differences between groups. Former French colonies had the poorest performance, averaging −0.001 per cent annually. Whereas former British colonies came with a positive average productivity gain of 0.2 per cent.

Table 6: Average 1970–2001 total factor productivity gain by colonial heritage

Countries	Technical efficiency change *EffchC*	Technological change *TechchC*	Total factor productivity change *TfpchC*
Former French colonies			
Algeria	1.012	1.017	1.030
Burkina Faso	0.982	0.967	0.950
Cameroon	1.000	0.992	0.992
Côte d'Ivoire	1.018	0.993	1.011
Egypt	1.000	0.998	0.998
Mali	1.009	0.981	0.989
Morocco	1.000	1.005	1.006
Senegal	1.013	0.987	1.000
Tunisia	1.006	1.008	1.014
Average	1.004	0.994	0.999
Former British colonies			
Ghana	1.006	0.992	0.998
Kenya	1.009	1.004	1.013
Malawi	1.023	1.002	1.024
Nigeria	1.000	0.964	0.964
Uganda	1.000	1.001	1.001
Zimbabwe	1.009	1.005	1.014
Average	1.008	0.994	1.002
Former Portuguese colony			
Mozambique	1.002	1.007	1.009
Overall average	1.006	0.995	1.001

Table 7: Country average level of selected efficiency-changing variable

Countries	Technical efficiency change *EffchC*	Technological change *TechchC*	Total factor productivity change *TfpchC*
Political freedom			
Not free	0.9991	1.0003	0.9993
Free/partly free	1.0037	0.9955	0.9992
Geographical location			
Sahelian countries	1.0032	0.9946	0.9978
Non-Sahelian countries	1.0074	0.9954	1.0028
Malghreb countries	1.0047	1.0071	1.0119
Sub-Saharan countries	1.0059	0.9911	0.9969
West African countries	1.0039	0.9821	0.9859
Non-West African countries	1.0069	1.0052	1.0122
Countries that have experienced a major war			
War	1.0011	1.0039	1.0050
Non-war	1.0062	0.9938	0.9999

When looking at the impact of political freedom (Table 7), it appears that the incidence of civil liberties did not make a substantial difference. Countries ranked as free and those ranked as non-free performed similarly.

When comparing sub-regions, we found that forest countries per-
9 formed better than Sahelian countries (Table 8). Forest countries had a positive evolution of the productivity, while the Sahelian countries had a negative evolution. An important fact to notice is that despite their overall weak performance, Sahelian countries succeeded well in raising their efficiency level ($EFFCH = 1.0032$); their overall weak performance is attributable to the failure to raise the technological level in the agricultural sector. The mean technical change for Sahelian countries was negative (-0.54 per cent).

Table 7 also shows that Maghreb countries had a better performance as compared to sub-Saharan countries. An important fact to also notice is that despite their overall weak performance, sub-Saharan countries raised their efficiency level ($EFFCH = 1.0059$), better than Maghreb countries (1.0047). This suggests that, in the achievement of high levels of growth over time, the technical efficiency component is not a long-run constraint for sub-Saharan countries. The principal difficulty appears in improving technology. Technical change was the main constraint for achieving high levels of total factor productivity during the reference period in SSA. Contrariwise, in Maghreb countries, technical change has been the main driving force of productivity growth.

Lastly, it is noticeable that compared to other regions, West Africa is the weakest.

5. Conclusion

Despite the importance of the agricultural sector in Africa, food importation is still needed to curb the increasing gap between the demand and food production. As shown by several studies, one of the most critical problems in Africa today is how to increase the agricultural production to face the augmenting population pressure. It has been estimated that, to meet this challenge, sub-Saharan agriculture must grow at a minimum average annual growth rate of about 4 per cent (Nkamleu and Adesina, 2000).

In this paper, the relative performance of the agricultural sector was gauged using DEA. From a panel data set of 16 countries, including a 32-year period from 1970 to 2001, mathematical programming methods were used to measure Malmquist indexes of total factor productivity. It was found that, during that period, the total factor productivity experienced a positive evolution in the sampled countries. A decomposition of these measures suggests that, most of the good performance of factors productivity is attributable to technical efficiency change rather than to technical change.

This suggests that, in the achievement of high levels of agricultural production, the principal difficulty appears in raising technology, that is, a shift in the production frontier. This provides support to the early work of Schultz (1964) on efficiency, which demonstrated that despite constraints faced by smallholder farmers in SSA, they are technically efficient in their production.

It was found that the region suffered a regression in productivity in the 1970s, and made some progress during the 1980s and 1990s.

The relationship between efficiency/productivity and some institutional and geographical factors was investigated to look for potential determinants. It appears that ex-British colonies experienced the highest growth rate as compared to ex-French colonies.

It was also found that the agro-ecological and geographical location has an impact on the performance of agricultural sector. It was shown that Maghreb countries succeeded in raising their productivity better than sub-Saharan countries. West African countries appeared as the worst performers in the region. In addition, it was found that Sahelian countries failed to raise their agricultural productivity as compared to forest countries where a positive evolution was detected.

These results have important implications for policy targeting. The principal difficulty in the long run lies in the slow or negative rate of increase in technical change. This indicates that there is a growing urgency for sustained improvements of technology, which require a more active role for the public sector and international agencies in research and extension activities in collaboration with farmers to raise the technology level significantly over time. In this regard, the emphasis everywhere should be on the communication of the research results to farmers in a usable form and the establishment of national, regional and international means to enhance research-extension-farmer linkages and the efficiency and relevance of technology generation and transfer.

However, a productivity and technical efficiency gap still exists between countries, and there is scope to narrow this by identifying the less competitive countries and deeply investigate the reasons for their relatively poor performance. A mix of physical factors and socio-cultural attributes will be responsible for constraining productivity of the agricultural sector of many countries. Appropriate policy programs targeted at the less performing countries should enable the gap to be narrowed.

Efforts are needed not only from within the region but also from the international community to ensure that the right mixture of policies is put in place to promote and sustain agricultural production.

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