Journal of Research in Business, Economics and Management (JRBEM)
ISSN: 2395-2210

SCITECH
RESEARCH ORGANISATION

Volume 8, Issue 6

June 15, 2017

Journal of Research in Business, Economics and Management
www.scitecresearch.com

Total Factor Productivity and Sources of Long Term Growth in Togolese Agriculture

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Abstract

The paper attempts to measure the total factor productivity (TFP) in order to provide better empirical evidence on its contribution to Togolese agriculture growth. It applies the conventional growth accounting framework to the time series data at an aggregate level over the period 1970-2014. The determinants of TFP growth are then identified using the error correction modelling technique. The results confirm the general expectation from previous studies that TFP makes an important contribution to agricultural output growth even though it displays two main episodes, a deceleration during the state intervention period and an acceleration episode during the liberalization period. The paper highlights the fact that the agricultural research and extension policies play an important role in determining the TFP long term growth.

Keywords: Growth; Total Factor Productivity; Agriculture.

1. Introduction

It has long been recognized that agricultural growth is important for overall economic development (Suphannachart and. Warr, 2010). In developing countries, where the majority of poor people lives in rural areas and depends directly or indirectly on agriculture for their livelihood, sustaining agricultural growth is of critical importance. The diminishing returns on factor inputs, declining arable land, water supplies and natural resources, concern over climate change and environmental degradation and high fuel and fertilizer prices continue to pose challenges for agriculture.

In the Togo context, agriculture plays a crucial role in contributing to overall economic growth. It accounts for 40% of GDP, employs 70% of the labor force and contributes more than 35% to export revenue (MAEH, 2010). According to the simulations carried out in 2006 (DGSCN, 2006), in order to reduce the poverty by fifty percent, it would require to achieve an annual real economic growth rate of 6% per year. Another study carried out in 2009 by IFPRI (MAEH, 2010) showed that reducing by half the number of rural poor would require an annual growth of 9.6 per cent in the agricultural sector. According to the study's findings, additional annual growth of 1% in food crop production would reduce poverty at the national level by 4.6% with a stronger impact on the rural world. These findings show that agriculture remains the main source of poverty reduction, especially in rural areas. However, meeting the challenge of the target 9.6% of agricultural growth implies a technical change that affects remarkably the total productivity of the factors, both the productivity of labor and that of capital.

According to Solow theory of growth (1957), the three factors that affect the growth rate of output are labor volume, capital volume, and Total factor productivity. A fundamental theoretical question has often been whether growth was due to the increase of the volume of factors or to the TFP. As Mounier (1993) points out, the TFP has played a major role, and consequently the volume of factors a minor role in the dynamism of agriculture in developed countries. Growth in TFP, often referred to as "a third factor of production", would become the main explanatory factor for that agricultural economic growth. And according to Schumpeter's vision, technological progress is the main driver of the economic growth process of modern capitalist economies (Nkamleu, 2004).

In Africa, Ludena (2005) showed that to achieve the 6.2% of agricultural yield growth rate targeted by CAADP, the TFP is expected to grow by 4.4% annually, accounting for 71% of agricultural yield growth. These statistics show that in the coming years, agricultural growth in SSA will depend mainly on the TFP growth.

Despite the importance of the total factor productivity in agricultural sector, few studies have rigorously addressed the issue of TFP in Africa and in particular in Togo. Existing information on Togolese agricultural TFP is fragmented and appears in the international classifications carried out by Fuglie (2011) and Avila and Evenson (2010). In fact, these works are limited in scope because they do not enable the researcher to understand the measure and the determinants of agricultural TFP growth. In fact, for Togo, the classifications give rather inconsistent results. According to Fuglie (2011), the average growth rate of Togo's agricultural TFP over the period 1960-2000 is 0.70%, whereas it is 1.43% according to Avila and Evenson (2010). It is therefore important to undertake a study on the measurement of TFP in particular to identify policies that can boost its growth. Therefore, the present paper proposes to answer the following research questions:

What is the contribution of TFP to agricultural growth in Togo?

What are the sources of the long-term growth of the Togolese agricultural sector? In other words, what are the economic policies whose implementation would boost TFP growth in the Togolese agricultural sector?

The rest of this paper is organized as follows. Section 2 reviews the previous studies on the TFP measure and factors influencing it. Section 3 provides the methodology of the study. Section 4 presents and discusses the empirical results and section 5 concludes and gives the limitations of the study.

2. Literature Review

If the literature on agricultural growth is scarce, the one on the economic growth is abundant. Solow (1957) was the first to propose an accounting framework for growth analysis. In his analysis, he attributes TFP growth to the share of output growth not explained by the growth of inputs, namely capital, labor and land. The new theories of growth broaden the conceptual framework proposed by the theory of neoclassical growth. They present the determinants of long-term growth by focusing on externalities induced by the accumulation of factors such as capital in research and development (Romer, 1986), human capital (Lucas, 1988), stock (Barro and Sala-i-Martin, 1996), or the stock of foreign capital in research and development (Coe and Helpman, 1995).

TFP is generally decomposed into embodied and disembodied technical change. Embodied technical change is referred to as change that is captured in factor inputs, such as improved seeds, breeds or a new type of machinery (Alston *et al*., 1998). Disembodied technical change is referred to as technological change that is not embodied in factor inputs but takes place like manna from heaven in the form of better methods and organization that improve the efficiency of factor inputs (Chen, 1997), such as more effective production methods that improve input usage. According to Schumpeter's vision, technological progress is the main driver of the economic growth process of modern capitalist economies (Nkamleu, 2004). Since the publication of the pioneering work of Schultz (1953), Solow (1957) and Griliches (1964), an abundant literature on the measurement and analysis of TFP has emerged.

In general, methods for measuring TFP used in empirical studies can be grouped into two main approaches. The frontier approach and the non-frontier approach known as the conventional approach. The first approach assumes output is efficiently produced on the production frontier while the latter assumes that the output can be produced off the production frontier. Both approaches can be classified as parametric and nonparametric. In contrast to the nonparametric approach, the parametric approach imposes a specific function. These methods of measuring TFP have been used by several authors.

Alene (2010) measured and compared the TFP of agriculture in Africa over the period 1970 2004 using the conventional approach and the frontier approach. The conventional method gives an average annual growth of 0.3% against 1.8% with the frontier approach.

Fulginiti et al. (2004) used the nonparametric method of a frontier production function covering the period 1960-1999 of 41 African countries. They found that agricultural TFP increased by 0.83% annually, although that of the 1985-1999 period was higher (1.90%). English-speaking countries posted stronger TFP growth than other countries. While the former Portuguese and Belgian colonies exhibited much weaker TFP.

NKamleu (2004) used the DEA approach to calculate the TFP of the agricultural sector of 8 Francophone African countries over the period 1970-2000. The results indicate that total factor productivity in the sampled countries was negative over the period. A decomposition of this measure shows that the low productivity performance is due to a technological delay, the evolution of the level of technical efficiency having been relatively satisfactory.

Nin-Pratt and Yu (2010) also computed the Malmquist index, which is a nonparametric approach to the boundary curve for a sample of 106 countries, including 26 sub-Saharan African countries for the period 1961-2006. It notes a real recovery in agricultural growth in the SSA countries from 1985 to 2006. This recovery was driven by improved technical efficiency due to economic policy reforms.

Other studies have analyzed the evolution of agricultural TFP in sub-Saharan Africa using one or the other of the above-mentioned measuring instruments. These are: Block, 1994, 2010; Frisvold and Ingram, 1995; Fulginiti et al., 2004; Lusigi and Thirtle, 1997; Nin and Yu, 2008.

Although these studies have covered different time periods, and different groups of SSA countries, they converge in terms of outcomes:

- Real productivity gains in the 1960s;
- Decline or zero growth of TFP in the agricultural sector in the 1970s, corresponding to a period of strong public intervention in the agricultural sector;
- Resumption of growth in the 1980s and 1990s with the reduction of public intervention in the agricultural sector.

Outside Africa, Latruffe (2010) summarized studies on TFP in the agricultural sector in the USA and the countries of the European Union. He notes that in the USA, TFP has increased in recent years as a result of technological progress, high level and experience of the agricultural workforce. The annual growth of TFP was in average 1.50% over the last century. Real wages per worker increased less rapidly than TFP. In fact, more than 50% of agricultural growth comes from TFP. With this contributory share of TFP, US agriculture has proved more efficiency than that of the European Union.

In China, Fan and Pardey (1997) showed that from 1965, TFP contributed to the growth of agriculture by 20%. This result was confirmed by Chen et al. (2005), who revealed that the main source of growth in Chinese agriculture remains TFP growth, which is itself affected by agricultural fiscal policy, expenditure on rural education, Infrastructure and R & D spending.

In Australia, Cox (1998) used the Malmquist index to assess the impact of public expenditures in agricultural research on the agricultural TFP. The results indicate that these expenditures contributed to the increase of TFP from 12 to 20%.

In Mexico Fernandez-Cornejo et al. (1997) also assessed the impact of research on the growth of TFP in Mexican agriculture. According to the results, the TFP of Mexican agriculture increases by 2.50% annually. A 1% increase in investment in research increases TFP by 0.13%. The 1% increase in TFP in US agriculture induces a 1.11% increase in TFP in Mexican agriculture, reflecting the effect of an international spillover effect.

From this overview of the empirical literature, we conclude that the key factors affecting TFP growth are: investment in research, infrastructure, farmers' education, climate, trade openness, reforms of agricultural policy and the international spillover effect.

3. Methodology

This section is subdivided into four subsections. The first explains the TFP measurement methodology used for the study. The second describes the model of the determinants of TFP. The third section describes the method of estimating the determinants model and finally the fourth section specifies the nature and sources of the data.

3.1 Method of TFP measurement

The method used is growth accounting. The competitive equilibrium conditions which are the underlying assumptions of the growth accounting approach are reasonable for the case of Togolese agriculture. The agricultural sector is well characterized by a perfectly competitive market in the sense that there are a large number of farmers who minimize cost and take prices as given.

It begins with a basic production function which establishes a relation between output and inputs and formulated as follows:

$$Q_t = A_t F(L_t, N_t, K_t) \quad (1)$$

where Q_t = real output at time t

L_t = labour quantity at time t

N_t = land quantity at time t

K_t = capital quantity at time t

A_t = level of efficiency at time t

Totally differentiating equation (1) with respect to time gives:

$$\frac{dQ_t}{dt} = \frac{dA_t}{dt}F(L_t, N_t, K_t) + A_t\frac{\partial F}{\partial L_t}\frac{dL_t}{dt} + A_t\frac{\partial F}{\partial N_t}\frac{dN_t}{dt} + A_t\frac{\partial F}{\partial K_t}\frac{dK_t}{dt} \quad (2)$$

Dividing both sides by Q_t gives:

$$\frac{dQ_t}{dt}\frac{1}{Q_t} = \frac{dA_t}{dt}\frac{1}{A_t} + \frac{\partial F}{\partial L_t}\frac{dL_t}{dt}\frac{1}{F(.)} + \frac{\partial F}{\partial N_t}\frac{dN_t}{dt}\frac{1}{F(.)} + \frac{\partial F}{\partial K_t}\frac{dK_t}{dt}\frac{1}{F(.)} \quad (3)$$

Rearranging equation (3) gives:

$$\frac{dQ_t}{dt}\frac{1}{Q_t} = \frac{dA_t}{dt}\frac{1}{A_t} + A_t\frac{\partial F}{\partial L_t}\frac{dL_t}{dt}\frac{1}{L_t}\frac{L_t}{Q_t} + A_t\frac{\partial F}{\partial N_t}\frac{dN_t}{dt}\frac{1}{N_t}\frac{N_t}{Q_t} + A_t\frac{\partial F}{\partial K_t}\frac{dK_t}{dt}\frac{1}{K_t}\frac{K_t}{Q_t} \quad (4)$$

$$\hat{Q}_t = \hat{A}_t + PM_L\left(\frac{L_t}{Q_t}\right)\hat{L}_t + PM_N\left(\frac{N_t}{Q_t}\right)\hat{N}_t + PM_K\left(\frac{K_t}{Q_t}\right)\hat{K}_t \quad (5)$$

$$\hat{Q}_t = \hat{A}_t + S_L\hat{L}_t + S_N\hat{N}_t + S_K\hat{K}_t \quad (6)$$

where $S_L = wL/Q$ stands for the share of labour income in the value of total output;

$S_N = r\,N/Q$ stands for the share of land income in the value of total output;

$S_K = iK/Q$ stands for the share of capital income in the value of total output;

Equation (6) indicates that output growth can be decomposed into the growth rate of the efficiency level and the growth rate of labour, land and capital, weighted by their output elasticities or factor income shares. The first component is the shift in the production function (representing technical change) and the latter is the movement along the production function (representing input growth and input substitution). Rearranging equation (6), the estimation of TFP growth ( ) $TFPG_t$ can be expressed as the residual part of output growth that cannot be explained by the combined growth of physical inputs as follows:

$$\hat{A}_t = \hat{Q}_t - S_L\hat{L}_t - S_N\hat{N}_t - S_K\hat{K}_t \quad (7)$$

Since the differentiation is applicable only to continuous variables, the growth rate terms in the above equations refer to an instantaneous rate of change. However, in practice, discrete data, especially annual data, are normally used in empirical work. Hence, the discrete annual data can be applied to approximate equation (7) by taking the average of two consecutive periods:

$$TCPGF_t = lnPGF_t - lnPGF_{t-1} = (lnQ_t - lnQ_{t-1}) - \frac{1}{2}(S_{Lt} + S_{Lt-1})(lnL_t - lnL_{t-1}) - \frac{1}{2}(S_{Nt} + S_{Nt-1})(lnN_t - lnN_{t-1}) - \frac{1}{2}(S_{Kt} + S_{Kt-1})(lnK_t - lnK_{t-1}) \quad (8)$$

Equation (8), although apparently simple, has the disadvantage of requiring data relate to the calculation of elasticities (Si), that is, the units of factor income in total income. In rural areas, some inputs such as land are weakly exchanged, and their quality varies from one region to another. The heterogeneous and weakly tradable characteristics of these inputs make them difficult to determine their price. To solve this problem, some studies have proposed to estimate the distance function as the Malmquist index which measures TFP from input and output quantity data only (Nkamleu, 2004, Nin-Pratt et al. 2008) The disadvantage of this method is that it is sensitive to the number of outputs and inputs (Lusigi et al., 1997). Coelli and Rao (2005) have pointed out that shadow prices derived from the estimation of this model, vary over time and are equivalent to zero for several key factors such as land and labor, which is not plausible. These difficulties led Avila and Evenson (2010) to use the elasticities of Brazil and India for African countries; As for us, we calculated these elasticities by using data from local sources (agricultural census reports, annual reports from the extension service, field observations, etc.). This has the advantage of providing more realistic data.

3.2 Estimation of TFP Determinants Model

3.2.1 Theorical framework

The productivity analysis is based on the concept of the production function (Griliches, 1964). Let consider a simple production function:

$$Q = f(X, Z) \quad (9)$$

where Q = output, X = conventional inputs - labour, land and capital, Z = unconventional inputs, such as research, extension, infrastructure, weather, etc. By definition, TFP is viewed as an index of aggregate output relative to an index of aggregate conventional input,

$$TFP = Q/X \tag{10}$$

In other words, TFP is defined as output per unit of all conventional inputs combined. Accordingly, TFP is measured as the residual part of the movement in output left unexplained by major factor inputs (Solow, 1957).

To examine factors affecting TFP, the simple production function implies:

$$TFP = (Z) \tag{11}$$

meaning that TFP is a function of unconventional inputs. There are several factors captured in the unconventional inputs (Z), which can be categorized into 3 main groups: 1) pure technical change 2) efficiency gain and 3) economies of scale (Coelli *et al*., 2005). The potential determinants of TFP are therefore the factors that affect these three components of productivity and are the sources of long-term growth in agriculture. These include: investment in research, extension, infrastructure, training or education, climate, etc. (Suphannachart and Warr, 2010).

3.2.2 Empirical Framework

In empirical form, the TFP determinants model is express as follows:

$$TFP = f(PEXR, IRSE, PEXE, INFRA, EDUC, OPEN, NAT, LIB1, LIB2, CLIMAT) \tag{12}$$

By differentiating, equation (12) becomes:

$$TFP = \beta_0 + \beta_1 PEXR + IRSE + \beta_3 PEXE + \beta_4 INFRA + \beta_5 EDUC + \beta_6 OPEN + \beta_7 NAT + \beta_8 LIB1 + \beta_9 LIB2 + \beta_{10} CLIMAT + \varepsilon \tag{13}$$

Where β_i stands for the coefficient of variable i.

PEXR (+) = Public expenditures in agricultural research;

IRSE (+) = International research spillovers effects stands for the amount that is invested by some neighboring counties which have relationship in research area with Togo.

PEXE (+) = Public expenditures in extension service;

INFRA (+) = amount of kilometer of rural roads;

EDUC (+) = Percentage of farmers alphabetised or instructed;

OPEN (+) = Trade openness stands for percentage of import+Export of agricultural products to agricultural GDP;

NAT (+) = rate of adoption of new agricultural technologies (share of areas which received improved seeds);

LIB1 (+/-) = Liberalization of the food sector in 1986;

LIB2 (+/-) = liberalization of export crops sector in 1996;

CLIMAT (+/-) = Annual rainfall .

Public Expenditures in Agricultural Research: Is recognized, within-country, as a prime potential source of technical change that raises productivity and sustains output growth (Ruttan, 2002; Latruffe, 2010, Huffman et al, 2005). It increases the stock of knowledge, which either facilitates the use of existing knowledge or generates new technology. Hence, an increase in research expenditure within Togolese agricultural is expected to raise TFP.

International Research Spillovers: Are potentially important sources of productivity growth. But they have often been ignored in the literature on the impact of agricultural research, resulting in an omitted variable bias (Alston (2010) et Fuglie (2011). The model incorporates foreign research on crops and livestock that are relevant for Togo and it is expected to increase domestic TFP.

Agricultural Extension: Involves a dissemination of research results to farmers through information distribution, training and demonstration. It may also indirectly influence the agricultural research process by conveying feedback from farmers to researchers that may improve future research. Effective agricultural extension should improve productivity.

Infrastructure: Is considered a fixed factor that contributes positively to agricultural growth and productivity (Rosegrant and Evenson, 1995). It is typically not included among the conventional inputs in growth accounting and its effect on agricultural growth is thereby captured in the residual TFP.

Farmer Education: It strengthens the managerial capacity of farmers and thus increases their technical efficiency (Coelli and Rao, 2005).

Trade Openness: Helps achieve economies of scale by expanding market size through export. Economies of scale bring about real cost reductions, thereby increasing productivity. It also enhances market competition through import and export. Competition influences technological development, thereby increasing TFP. More open economies and international trade are generally found to be favourable to TFP (Urata et Yokota, 1994; Cardi, 2003).

New Agricultural Technologies: The adoption of new agricultural technologies, including improved seeds, is an indicator of technological progress.

Climate: Is considered as variable explaining changes in TFP under the conventional TFP decomposition framework (Evenson, 2001). Good weather like more rainfall or less occurrence of drought or flooding should raise TFP relative to the opposite.

Liberalization of Agricultural Markets: Is characterized by a disengagement of the State and the deregulation of agricultural markets. The expected effect is ambiguous: the removal of distortions by creating competitive conditions with remunerative prices encourages farmers to adopt new technologies. However, it also means the removal of subsidies and hence increases in the price of inputs (fertilizers, pesticides and seeds).

3.3 Estimation of the Model

The Error Correction Mechanism (ECM) in Banerjee form (Banerjee et al., 1993) is used for two reasons:

- Due to the sample size that is less than 200 (45 observations). Indeed, Banerjee and al (1993) showed using the Monte Carlo simulation that this method based on the "one-step Hendry" approach is clearly preferable to the "two-step" method of Engle and Granger recognized as generating highly biased estimators when the sample size is less than 200 observations.

- Because it enables to explore both the short and long term determinants of the growth of the TFP.

The equation (13) rewritten in the Banerjee error correction model form is as follows (equation 13):

$$D(lnTFP) = \alpha_0 + \alpha_1 D(PEXR) + \alpha_2 D(IRSE) + \alpha_3 D(PEXE) + \alpha_4 D(lnINFRA) + \alpha_5 D(EDUC) + \alpha_6 D(OPEN) + \alpha_7 D(NAT) + \alpha_8 PEXR(-1) + \alpha_9 IRSE(-1) + \alpha_{10} PEXE(-1) + \alpha_{11} lnINFRA(-1) + \alpha_{12} EDUC(-1) + \alpha_{13} OPEN(-1) + \alpha_{14} NAT(-1) + \alpha_{15} LIB1 + \alpha_{16} LIB2 + \alpha_{17} CLIMAT + \alpha_{18} lnTFP(-1) + \delta \quad (13)$$

Where α stands for the vector of coefficients to be estimated. Ln stands for the natural logarithm . With the theorical

signs as follows :

$\alpha_1>0$, $\alpha_2>0$, $\alpha_3>0$, $\alpha_4>0$, $\alpha_5>0$, $\alpha_6>0$, $\alpha_7>0$, $\alpha_8>0$, $\alpha_9>0$, $\alpha_{10}>0$, $\alpha_{11}>0$,

$\alpha_{12}>0$, $\alpha_{13}>0$, $\alpha_{14}>0$, $\alpha_{15}>0$, $\alpha_{16}>0$, $\alpha_{17}>0$, $\alpha_{18}>0$

In this expression, the coefficients α_1 to α_7 characterize the short-term dynamics, while the coefficients α_8 to α_{17} capture the long-run equilibrium behavior of the TFP growth. The coefficient α_{18} stands for the error correction coefficient.

The Error Correction mechanism will be estimated by the Ordinary Least Squares (OLS) method and the long-run and short-run coefficients will be identified separately.

3.4 Data

The output and input data are time-series at an aggregate level, covering 45 years from 1970 to 2014. Definitions and sources of data for the TFP measurement are summarized in Table 1 and those for the TFP determinants are shown in Table 2.

Table 1: Summary of Data Used in TFP Measurement, 1970-2014		
Variables	**Definitions**	**Sources**
Agricultural output	GDP at 1990 prices (value added)	DGSCN/FAO
Agricultural labor	Number of persons employed in agriculture aged 15 and over	DGSCN/FAO and (ADI)
Agricultural land - Crop land - Livestock land	Land used in crop production - Grass area for livestock	DSID/UEMOA/FAO
Agricultural capital	Net capital stock at 1990 prices	DGSCN/FAO
Agricultural wage	Imputed wage of all workers measured as private workers wage adjusted to account for self-employed and unpaid family labour	MAEH (surveys) DGSCN (SAM 2000) DSID/FAO
Land rent	Actual and imputed rent	MAEH (General Census) ; ICAT (Annual reports) ; DSID/FAO
Factor income share	Value of factor income divided by GDP at factor cost	DGSCN (GDP at factor cost)

Source : The author

DGSCN : Direction Générale de la Statistique et de la Comptabilité Nationale

ICAT : Institut de Conseil et d’Appui Technique

DSID : Direction de la Statistique, de l’Informatique et de la Documentation

MAEH : Ministère de l’Agriculture, de l’Elevage et de l’Hydraulique

Table 2: Summary of the Data Used in TFP Determinants Model, 1970-2014			
Variables ***Dependent variable***	**Abbreviations**	**Definitions**	**Sources**
Total factor productivity index	TFP	TFP index is calculated using the year 1990 as reference.	Authors' calculation based on the growth accounting method
Explanatory Variables			
1. Public Expenditures used in agricultural Research	PEXR	Amount of expenditures to GDP used in agricultural research	MAEH, ADI, FAO
2. International Research Spillover Effect	IRSE	Amount of expenditures to GDP spent by Nigeria, Benin and Ghana in agricultural research	IFPRI, ADI
3. Public Expenditures used in Extension services	PEXE	Amount of the expenditures to GDP used in agricultural extension services	MAEH
4. Infrastructures	INFRA	length of rural roads, unpaved roads and asphalt (km)	MAEH
5. Education	EDUC	Percentage of farmers alphabetized or instructed	ADI, ICAT
6. Trade openness	OPEN	percentage of import+Export of agricultural products to agricultural GDP	ADI/WB; DGSCN
7. New agricultural Technologies	NAT	share of areas which received improved seeds	ICAT, DSID reports
8. Liberalization of foods sector	LIB1	Dummy variable takes value 1 from 1986 to 2014 and 0 otherwise	-
9. Liberalization of export crops sectors	LIB2	Dummy variable takes value 1 from 1996 to 2014 and 0 otherwise	-
10. Climate	CLIMAT	Dummy variable takes value 1 if the amount of rainfall ranges from 500 to 1500 mm and 0 otherwise.	National Meteorology

Source : Auteur

ADI, African Development Indicators

4. Results and discussion

4.1 Analysis of the episodes of agricultural TFP growth in Togo

Figure 1 depicts the episodes of Togo's agricultural TFP growth over the 1970-14 period. It appears that the evolution of TFP growth can be divided into three episodes of growth: the first episode goes from 1970 to 1985; the second episode from 1986 to 2000 and the third episode from 2000 to 2014.

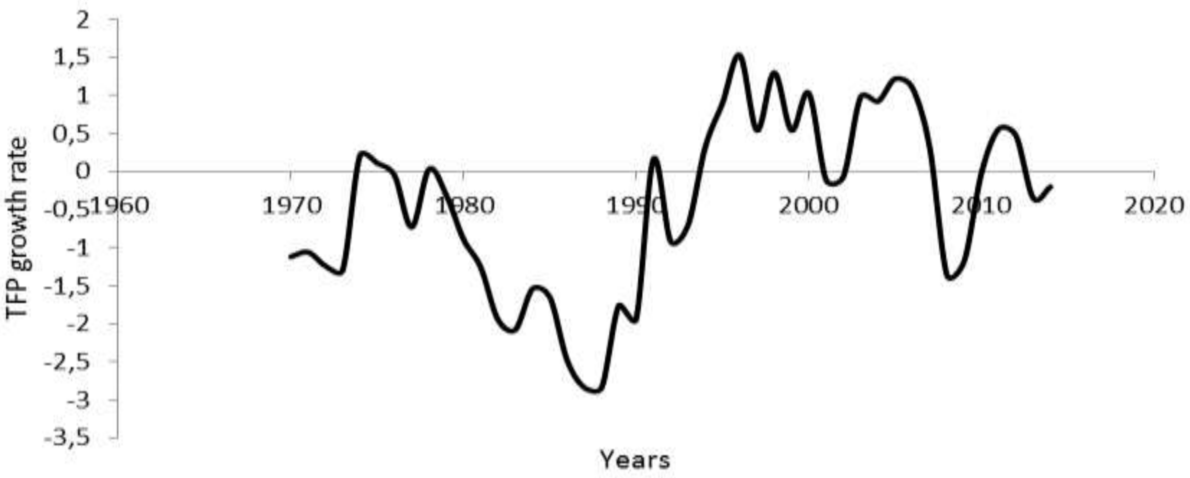

Figure 1: Evolution of agricultural TFP growth rate

4.1.1 Growth of TFP from 1970 to 1985

The first episode from 1970 to 1985 is characterized by a negative growth of TFP. This period of deceleration of growth coincides with the period of strong public intervention, which results in a high taxation of agriculture. Taxation of agriculture during this period was achieved through the establishment of marketing boards for cereal products (Togograin in 1974, and export products (OPAT in 1975). Through these offices, the public authorities have used levies from agriculture to finance the other sectors of the economy, particularly the industrial sector. This transfer of income from agriculture to other sectors has adversely affected overall factor productivity through a detrimental effect on agricultural investment.

4.1.2 Growth of the TFP from 1986 to 2000

The period from 1986 to 2000 is characterized by a recovery in TFP growth. This recovery could be explained by the implementation of agricultural policy reforms which have undergone structural adjustment programs. Due to the fact that these adjustment programs have been to correct market distortions and to provide right prices to farmers, they have contributed to increased efficiency in the use of agricultural resources. As a result of the abolition of the Togograin monopoly in 1986 and OPAT in 1995, prices of agricultural products have become market signals. Therefore, the incentives created by prices have increased investment and hence agricultural production.

4.1.3 TFP growth from 2001 to 2014

The third episode of growth is characterized by instability in the evolution of TFP. This instability of growth is due to internal shocks (unfavorable weather conditions) and external shocks, in particular to the instability of the supply policy and the distribution of inputs, namely fertilizers, pesticides and seeds.

4.2 Analysis of the shares of the production factors in the value added

The analysis in Table 3 identifies the contributive shares of each input in agricultural value added. The TFP corresponds to the residual obtained by deducting the weighted contribution of the three factors of production, namely labor, capital and land from agricultural value added. The analysis of Table 3 shows that Togolese agriculture has remained extensive with a high intensity of labor and land use. However, the contribution of TFP to the growth of agricultural value added has shown a spectacular positive evolution over the years. From 7% between 1986 and 2000, the share increased to 19% between 2000 and 2014 which corresponds to 1.8% growth of TFP. Due to the current dynamic, it is possible to envisage an agricultural growth in the coming years, driven by the TFP namely the technical progress.

The TFP growth corresponding to the component of growth in agricultural value added that is not attributed to the accumulation of factors of production, we are now concerned with the sources TFP growth.

Table 3: Decomposition of Annual Growth of Agricultural Value Added					
	Value added growth	Labor share	Capital share	Land share	TFP share
1970-1985	1,22	0,51	0,15	0,42	0,14(11%)
1986-2000	3,52	1,37	0,30	1,60	0,25 (7%)
2000-2014	2,86	1,33	0,35	0,65	0,53 (19%)

Source : Author calculation based on national and FAO data

4.3 Assessment of the determinants of agricultural TFP growth

To assess the determinants of TFP growth, an error correction model is estimated. For this purpose it appears necessary to test the degree of integration of the series before estimating the error correction model.

4.3.1. Unit root test on the series of variables

Table 4 shows the results of the unit root tests. The ADF test and the Perron test do not reject the existence of a unit root for series taken in level. The series of variables are therefore not stationary. On the other hand, the ADF tests performed for the series in their first difference show that the statistic t is different from zero at the 1% threshold. The series of variables are therefore stationary in their first difference where they are integrated in first odre (I (1)).

Table 4 : Results of the Unit Root Test			
	Level: ADF statistics	**Level: Perron statistics**	**First difference : ADF statistic**
TFP	-1.62 [2]	-3.12 [2]	-9.43 [1]
PEXR	-2.21 [5]	-1.31 [2]	-13.24 [1]
IRSE	-1.72 [3]	-3.01 [4]	-8.35 [1]
PEXE	-1.38 [5]	-2.15 [3]	-7.20 [1]
Ln INFRA	-1.95 [4]	-2.12 [2]	-10.51 [1]
EDUC	-1.60 [4]	-2.701 [2]	-7.92 [1]
OPEN	-2.51 [1]	-2.23 [1]	-21.26 [0]
-2.24 [5]	-1.27 [2]	-1.31 [2]	-13.15 [1]

Source: Author calculation using data from national and FAO databases.

The values in parenthesis are the number of lags required to obtain a white noise. The critical values of Mackinnon for ADF test are (-3,52) at 1% ; (-2,94) at 5% and (-2,68) at 10%. The critical values of Perron are (-5, 07) at 1% , and (-4,22) at 5%.

4.3.2. Analysis of the Results of the Error Correction Model Estimation

The results yielded from the Banerjee error correction model estimation shows the short-run equilibrium and the long-run equilibrium outcomes.

Statistically, the model is globally significant (the probability associated with the F statistic is zero). And the fit, that is, the predictive power (R^2 adjusted) is at an acceptable level. It indicates that 54% of changes in TFP growth are explained by the variables included in the model. The results also indicate no autocorrelation (DW = 2.21) with the existence of an autoregressive process. The coefficient of the error correction term (Ln TFP (-1)) is significant at 1% with a negative sign in line with expectations. This sign indicates that the rate of adjustment of TFP due to exogenous shocks causes the system to deviate from the long-term equilibrium. The disequilibrium thus created is rapidly corrected and the exogenous shocks dissipated within a year.

On the economic side, in the short term, two variables significantly affect the growth of TFP. These include public expenditures allocated to agricultural research and the adoption rate of improved seeds.

In the long run, there are more factors that affect the growth of TFP. These are the PEXR, PEXE, NAT, LIB1, LIB2 and CLIMAT variables.

It appears that a 1% increase in the share of public agricultural expenditures allocated to research at time t-1 results in an increase in TFP growth of 0.58% at time t. This long-term outcome leads to reconsider the conclusions that can be drawn from the short-term outcome and to consider other ways of public expenditures on agricultural research transmit ion. Indeed, in the short term, the impact of PEXR is likely to be captured by the variable NAT corresponding to the improved seed adoption rate, as both variables show a correlation coefficient of 0.48. Over time, the impact of PEXR accumulates and becomes visible as it is transmitted along the technical route not only through seeds but to all factors that enter into the process of agricultural production.

A comparison of short- and long-term NAT impact coefficients indicates that, other things being equal, a 1% increase in the adoption rate of improved seed results in an increase in TFP growth of 1, 9% and 3.2% respectively in the short and long term. This result is not surprising since it tends to simply highlight the effect of Learning by doing that goes through a trial error process. This means that time enabled farmers to master technical route associated with the adoption of improved seeds. This control leads to an improvement in the productivity of all the factors used in the production process, namely labor, capital and land.

Another salient result is the effect of public expenditures on extension (PEXE). All other things being equal, a 1% increase in the share of extension expenditures leads to an increase in TFP growth of 37%, at least 10 times the short-term impact! This result tends to show that the effects of extension are cumulative and can only be assessed over time.

It should be noted that the non-significant impact of the EDUC variable on TFP growth is surprising because it is not consistent with most results obtained by endogenous growth theorists (Lucas, 1988; Romer, 1990) about the role played by human capital on growth. To address this issue, we determined the correlation coefficient between the variables PEXE and EDUC. The coefficient correlation which level is 0.36 shows that the impact of functional education or literacy would have been captured by the impact of extension.

Another interesting result is the positive impact of the liberalization of food and cash crops on the growth of TFP. This result was not expected because some studies have shown that public intervention through the correction of negative externalities and market imperfections contribute to raise the TFP (Rosegrant and Evenson, 1995). As mentioned above, the liberalization of food and cash crops consisted in the implementation of a package of measures, namely the removal of the subsidies on agricultural inputs and the dismantling of marketing boards. While measures such as the removal of subsidies on inputs have had a depressive effect on their consumption, the effect of price liberalization by getting better prices to producers appears to have resulted in a productivity gain over the loss of productivity due to the removal of subsidies.

Finally, the result obtained with the CLIMAT variable is in line with expectations. Indeed, since Togolese agriculture is dependent to climate, the improvement of the productivity of labor, capital and land are intrinsically linked to rainfall. Since rainfall is a variable that cannot be controlled by the farmer, this result seems to suggest the need to move towards a policy of good water control, notably through the setting up of an efficient irrigation system, a guarantee of sustained agricultural growth.

Table 5: Estimation Results of Long and Short Run Model

Explanatory variable : D (LnTFP)	
D(PEXR)	0,032 (1,45)
D(IRSE)	0,005 (0,29)
D(PEXE)	0,030** (3,16)
D(Ln INFRA)	0,017 (0,021)

D(EDUC)	0,009 (0,25)
D(OPEN)	0,012 (1.10)
D(NAT)	0,019*** (4,07)
LnTFP (-1)	-0,750*** (-4,81)
PEXR (-1)	0,580*** (4,23)
IRSE (-1)	0,260 (0,78)
PEXE (-1)	0,370** (3,36)
Ln INFRA (-1)	1,220 (1,02)
EDUC (-1)	0,530** (2,06)
OPEN (-1)	0,390 (1,09)
NAT (-1)	0,320** (1,13)
LIB1	0,210*** (4,54)
LIB2	0,180*** (3,79)
CLIMAT	0,630*** (5,27)
Constant	-7,210*** (3,98)
Number of observations	45
AR (1)	-0,52
R^2 adjusted	0,54
P (F)	0.00
DW	2.25

5. Conclusion, Limitations and Suggestion For Future Research

This paper attempted to evaluate the contribution of total factor productivity (TFP) to agricultural growth and the sources of growth of the Togolese agricultural sector. Time series covering the period 1970-2014 from national sources and FAO have been mobilized. The growth accounting method was used to estimate TFP growth and an error correction mechanism to estimate the model of the determinants of long-term agricultural growth.

The results confirm the general expectation from previous studies that TFP makes an important contribution to agricultural output growth and experienced two main episodes, a deceleration during the state intervention period and an acceleration episode during the liberalization period. The paper then highlights the fact that the agricultural research and extension policies play an important role in determining the TFP long term growth. The paper is an advocacy for increasing more public investment in research, extension and in water management.

One limitation of this research is to assume a perfectly competitive market where producers maximize profit and employ each input where its marginal product equals its real factor price. The competitive equilibrium conditions which are the underlying assumptions of the growth accounting approach may be not relevant for the case of Togolese agricultural sector. Another limitation regards the indicator used to appreciate the international spillover effect. The amount of expenditures to GDP spent by Nigeria, Benin and Ghana in agricultural research may not be relevant. For future research, it is suggested to rather use the funding of organizations like IITA, WECARD, and IFPRI who intervene directly in agricultural research in Togo.

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