

# Regional Level Total Factor Productivity Growth in Ghana Agriculture

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## Abstract

This paper examines the trends in major principal crop productivity growth in 10 regions in Ghana. A panel dataset is constructed for the period 2000-2009 from the Food and Agriculture Organization of the United Nations and Ministry of Food and Agriculture, Ghana database. A nonparametric data envelopment analysis (DEA) programming method is used to compute Malmquist productivity indices. These are decomposed into two component measures: efficiency change and technical change. The study examines the trends in regional level agricultural productivity growth in Ghana from 2000-2009 and for the sub-periods 2000-04 and 2005-09. The paper also indicates trends between the total factor productivity and partial productivity indices: labor productivity and land productivity. We find that the total productivity growth rate is higher in Northern region of Ghana followed by Eastern and Upper West regions. The overall contribution of technical change is greater than that of efficiency change to overall productivity changes in all the regions except Central, Eastern regions.

**Keywords:** Total factor productivity, Malmquist Index, Regional-wise, Ghana, Agricultural Production

## 1. Introduction

Ghana's agriculture sector is mainly rainfed and is the most dominant economic activity sector in the country especially for the rural households who engage with 87 per cent to 89 per cent, particularly in crop production (Xinshen Diao, 2010). However, the agricultural productivity growth is generally low mainly due to use of traditional farming systems and inconsistent nature of rainfall. Despite challenges to successful agricultural production, it is still the principal sector in the Ghanaian economy. Fifty per cent of the labor force is employed mainly as small landholders<sup>1</sup> contributing in 2009 about Gh¢ 11,342 million i.e., 31.8 per cent in agriculture<sup>2</sup> to the Gross Domestic Product (GDP)(GSS, 2011). Moreover, all export duty paid on agricultural commodities becomes a major source of government revenue (Seini 2002).

The productivity of agricultural growth in developing countries has long been recognized as the key sector to overall economic growth (Alene, 2010). Several studies have estimated the agricultural productivity growth on the global and cross-country, country-wise analysis while using Malmquist index method (e.g. Coelli and Rao, 2005; Fugli, 2008, 2010, 2012; Lio and Hu, 2008; Headey et. al. 2010). Although the Malmquist index approach has a advantage relating to the data and assumptions, recent empirical studies, Nin et al., 2003; Thirtle et al., 2003 has demonstrated that the traditional Malmquist index approach measures are based on an in appropriate representation of underlying technology that typically understate productivity. Other studies have focused on trends of agricultural productivity growth in developing countries because the contribution of agriculture production in general is the key to economic growth across the developing world (e.g., Avila and Evenson, 2010, Coelli and Rao, 2005; Fulginiti and Perrin, 1993, 1997, 1998; Headey et al., 2010; Nin et al., 2003; Trueblood and Coggins, 1997).

Particularly in African region several studies have examined the agricultural productivity (for e.g.

Block, 1994; Frisvold and Ingram, 1995; Fulginiti et al., 2004; Lusigi and Thirtle, 1997; Nin and Yu, 2008; Nkamleu, 2004; Thirtle et al., 1995). Due to the internal conflicts of civil wars in Africa region, the agricultural productivity growths are having very poor performance recorded during 1960's and 1970's on the previous studies (e.g. Block, 1994, 2010; Nkamleu, 2004; Thirtle et al., 1995; Trueblood and Coggins, 1997). After the mid 1980's the African agricultural productivity exhibits a remarkable recovery in the performance of

<sup>1</sup> According to Chamberlin, 2007 study, more than 70 percent of Ghanaian farmers are 3 ha. or smaller in size.

<sup>2</sup> The other sectors: contributed: industry 19.0 percent and services as 49.2 percent to the Gross Domestic Product (GDP).

agriculture (e.g. Block 1994, 2010; Fulginiti et al., 2004; Lusigi and Thirtle, 1997; Nin and Yu, 2008). After a long period of poor performance and declined agricultural productivity in sub-Saharan African regions, the studies Fulginiti et al. 2004; A. N. Pratt and Yu, 2008, 2011; Alene 2010, Block 1994, 2010 have provided evidences of recovery in the performance of sub-Saharan agricultural growth after 1980's. For instance, few studies like Thirtle et al (1995) study found that the agricultural protectionism had an important impact on TFP growth over 1971-1986 periods. Block (1994), in his paper exhibits a recovery of African agriculture total factor productivity in the 1980's mainly due to R& D and macroeconomic policy reform. Pratt and Yu, (2008, 2011) studies estimate the agricultural productivity growth in East and Southern Africa has benefitted from the completion of internal conflict, and West Africa has benefited from the devaluation of the CFA franc. However, in Alene, 2010, in his study claiming that the improving TFP growth was the result of mainly R & D in 1970's and slower growth rate was observed in 2000's is a result of less spending on R & D in 1980's and 1990's.

Very few studies were estimated particularly by regional and state level in their respective countries, some studies like Armagan et al., (2010) estimated TFP and their decomposition components for the crop production region-wise in Turkey during 10 year period covering 1994-2003; Shilpa, (2012) in her study estimates total factor productivity (TFP) in Indian agriculture at state-level by using non-parametric Sequential Malmquist TFP index. In Linh, (2009) study, he was used a panel data for 60 provinces in Vietnam during the period 1985-2000. For measuring the total factor productivity growth in Vietnamese agriculture by applied Malmquist Productivity index. Nicholas E. Rada et al., (2011), has used 1985-2005 Indonesian provincial panels for measuring the nation's agricultural productivity. However, Mao and Koo, (1997), study considered twenty-nine provinces in China and applied a data envelopment analysis (DEA) approach to analyze total factor productivity, efficiency and technology changes in Chinese agriculture production from 1984-1993. On the other hand, the agricultural total factor productivity studies by regional wise and district level for African countries are very less compared to the Asian studies. However, we find very few studies estimating agricultural total factor productivity growth for Africa by regional and district wise. For e.g. Conradie et al. (2009), his paper estimated the appropriate level of aggregation for the construction of total factor productivity indices in Western Cape agriculture for 31 magisterial districts from 1952 to 2002. In Fantu N B, (2012), in his paper examines the trends in total factor productivity and sources of growth in output during the 2004-05 to 2009-10 period, he has used two data sets and applied Cobb-Douglas production function and stochastic production frontier on zone level data covering the 2003-04 to 2008-09 period.

As of our knowledge it is the first study to examine the regional level Malmquist Index method to estimate Ghana's agricultural production. The main aim of this study is to use Malmquist index method in order to provide information on agricultural total factor productivity growth (efficiency and technical) from ten administrative regions in Ghana while covering the time period 2000-2009 and for the sub-periods 2000-04 and 2005-09.

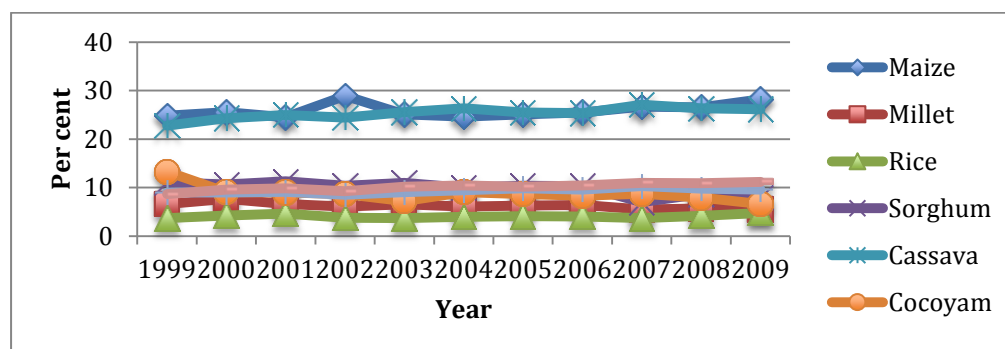
The paper is organized as follows: section 2 outlines the overview of Ghana agriculture; section 3 describes the nature and source of data. Section 4 describes the Malmquist indices, followed by section 5 that examines and discusses the results and finally section 6 concludes the major findings and conclusions of the study.

## 2. Overview of the Ghana Agriculture

Ghana is located on the southern coast of West Africa, between latitudes  $4^{\circ} 44'$  N and  $11^{\circ} 11'$  N and longitudes  $3^{\circ} 11'$  W and  $1^{\circ} 11'$  E with covering 238,533 km<sup>2</sup> of geographical land area in which, contributing agricultural land covers around 57 per cent. The agricultural farming system is mainly five different agro-ecological zones defined on the basis of climate. These are Rain Forest, Deciduous Forest, Transitional Zone, Northern Savanna (Guinea and Sudan Savanna) and Coastal Savanna (MOFA, 2011). Industrial crops are commonly monocropped while starchy and staple crops are often mixed cropped. Zone-wise, the northern savanna is mainly for the cereal staple and starchy crops are

cassava, cocoyam, yam, maize, rice, millet, sorghum, while cotton tobacco are also important crops. In the forest zone industrial crops are significant with cocoa, oil palm, coconut, coffee, cotton, kola, rubber are particularly important crops and the area under starchy and cereal staple crops are mainly inter-cropped mixtures of cassava, cocoyam, yam, maize and plantain. On the other hand, the area under middle belt is considered by sole and mixed cropping of maize, cocoyam, maize and legumes with industrial crops tobacco and cotton are being the principal cash crops. Area under rice crop is significant in all zones (MoFA, 1998, 2011).

Figure-1: Cropping pattern trends of principal agricultural crops in Ghana: 1999-2009



In the above figure 1 represents the cropping pattern changes of principal agricultural crops in Ghana during the period 1999-2009. The area under maize exhibits increasing trend from 24.82 percent in 1999 to 28.18 percent in 2009, and the area under cassava was observed increasing trend from 22.79 percent in 1999 to 26.17 percent in 2009 in the total cropped area throughout the time period under study. Moreover, these two crops are the dominant and cereal crops in Ghana. The cropping pattern shifts of area under yam exhibits increasing trend from 8.65 percent in 1999 to 11.20 percent in 2009, followed by plantain crop (9.01 percent in 1990 and 9.60 percent in 2009); and rice crop (3.74 percent in 1999 and 4.79 percent in 2009). However, the area under cereal crop millet shows a marginal decline from 6.62 percent in 1999 to 5.52 percent in 2009, while the other crops, the area under sorghum was observed drastic decline from 11.11 percent in 1999 to 7.89 percent in 2009, followed by cocoyam (13.25 percent in 1999 and 6.65 percent in 2009). Declining the area under cereal crops clearly projects that farmers are getting high prices in cash crops rather than cereal crops (MoFA, 2009)<sup>3</sup>. Perhaps, the area under cropping pattern shifts indicates that the changes will have a direct impact on crop production and labour productivity.

**Table: 1 Annual growth rates of crop output and conventional inputs**

Particulars	Sub-Period 1 2000-04	Sub-Period 2 2005-2009	Overall 2000-09
<b><i>Output Indicator</i></b>			
Crop Output <sup>4</sup>	6.9	9.4	8.6
<b><i>Input Indicator</i></b>			
Agricultural Land (000' ha)	4.6	2.2	3.0
Livestock (000' No.) <sup>5</sup>	6.5	5.5	5.4
Tractors (No.)	3.7	1.6	2.3
Labour (000' No.)	5.7	4.1	4.6
Fertilizer (NPK) (MT)	11.7	9.4	9.8
<b><i>Climate Indicator</i></b>			
Rainfall (in mm)	-3.9	2.5	-0.0

Source: United Nations of Food and Agriculture Organization (FAO); Ministry of Food and Agriculture (MoFA), Ghana; Author Calculations.

Table 1 reports that the annual growth rates in various indicators of Ghanaian agriculture during the period 2000-09 and for the sub-periods 2000-04 and 2005-2009. Output indicator was observed increasing growth at a smaller rate of 6.9 percent in 2000-04 to 8.6 percent in 2000-09. While in the case of input indicators of sub-period 2 were exhibits declining growth during the period 2005-09. However, it may be one of the causes of declining agricultural productivity growth in the overall study period.

### 3. The method and source of data

In this study total factor productivity (TFP) is measured using the data envelopment analysis (DEA), a Malmquist index defined in Caves et al. (1982b) and describes in (Fare et. al., 1994; Coelli et al., 2005), decompose the Malmquist total factor productivity change measures into various components, including efficiency and technical change. The Malmquist index has been particularly popular because it does not require

<sup>3</sup> Agriculture in Ghana Facts and Figures (2009), Ministry of Food and Agriculture, p.g. 39. Table 7.3.

<sup>4</sup> Major principal crop production including cereals (maize, rice, sorghum, and millet) and starchy staples (cassava, cocoyam, yam, and plantain)

<sup>5</sup> Number of livestock defined as including (cattle, goats, pigs and sheep's)

agricultural input or output prices. Moreover, in the context of African agriculture the nonparametric model is perfectly fit because the market prices for the inputs are insufficiently reported to provide any meaningful information for land, labor, and livestock (Pratt and Yu, 2008).

### 3.1. The Malmquist TFP index

The Malmquist index is defined using distance functions, describe a multi-input, multi-output production technology without the need to specify a behavioral objective (such as cost minimization or profit maximization). According to the Färe et al., 1994, the output distance function is defined on the output set,  $S^t$  to define the output-based malmquist index of productivity change

$$S^t = \{(y^t): x^t \text{ can produce } y^t\} \text{ --- (1)}$$

The distance function, will take a value that is less than or equal to 1 if the output vector,  $y^t$ , is an element of the feasible production set,  $S^t$ . Furthermore, the distance function will take a value greater than one if  $y^t$  is located outside the feasible production set.

The Malmquist TFP index measures the TFP changes between two data points (for e.g. those of a particular regions in two adjacent time periods) by calculating the ratio of the distances of each data point relative to a common technology.

Following Färe et al. (1994) the Malmquist TFP index between period t and t+1 is given by

$$M_0(x^{t+1}, y^{t+1}, x^t, y^t) = \left[ \left( \frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \right) \left( \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^t, y^t)} \right) \right]^{\frac{1}{2}} \text{ --- (2)}$$

This index is estimated as the geometric mean of two Malmquist indexes the first is relative to period t+1, and the second is relative to period t.

Färe et al., 1994 showed that the Malmquist index could be decomposed into an efficiency change component and a technical change component

$$M_0(x^{t+1}, y^{t+1}, x^t, y^t) = \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \left[ \left( \frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^{t+1}, y^{t+1})} \right) \left( \frac{D_0^t(x^t, y^t)}{D_0^{t+1}(x^t, y^t)} \right) \right]^{\frac{1}{2}} \text{ --- (3)}$$

Where

$$\text{Efficiency change} = \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^t, y^t)} \text{ --- (4)}$$

$$\text{Technical change} = \left[ \left( \frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^{t+1}, y^{t+1})} \right) * \left( \frac{D_0^t(x^t, y^t)}{D_0^{t+1}(x^t, y^t)} \right) \right]^{1/2} \text{ --- (5)}$$

Above all a value of  $M_0$  greater than 1 will indicate positive TFP growth from period t+1 to period t while a value less than one indicates a TFP decline.

Following Färe et al. 1994, the required distance measures for the Malmquist TFP index using DEA- like linear programs with the suitable panel data are available. We need to compute four distance functions to measure the total factor productivity change between two periods t and t+1. Färe et al. 1994 assume a constant returns to scale (CRS) technology in their analysis and It requires solving for each region in each pair of adjacent year by using the following linear programming problems.

$$\begin{aligned} [d_0^t(y_t, x_t)]^{-1} &= \max_{\phi, \lambda} \phi, \\ \text{st} \quad &-\phi y_{it} + Y_t \lambda \geq 0, \quad x_{it} - X_t \lambda \geq 0, \quad \lambda \geq 0 \end{aligned} \text{ --- (6)}$$

$$\begin{aligned} [d_0^s(y_s, x_s)]^{-1} &= \max_{\phi, \lambda} \phi, \\ \text{st} \quad &-\phi y_{is} + Y_s \lambda \geq 0, \quad x_{is} - X_s \lambda \geq 0, \quad \lambda \geq 0 \end{aligned} \text{ --- (7)}$$

$$\begin{aligned} [d_0^t(y_s, x_s)]^{-1} &= \max_{\phi, \lambda} \phi, \\ \text{st} \quad &-\phi y_{is} + Y_t \lambda \geq 0, \quad x_{is} - X_t \lambda \geq 0, \quad \lambda \geq 0 \end{aligned} \text{ --- (8)}$$

$$\begin{aligned} [d_0^s(y_t, x_t)]^{-1} &= \max_{\phi, \lambda} \phi, \\ \text{st} \quad &-\phi y_{it} + Y_s \lambda \geq 0, \quad x_{it} - X_s \lambda \geq 0, \quad \lambda \geq 0 \end{aligned} \text{ --- (9)}$$

Where  $y_{it}$  is Mx1 vector of output quantities for the  $i^{\text{th}}$  region in the  $t^{\text{th}}$  period;  $x_{it}$  is a K x 1 vector of input quantities for the  $i^{\text{th}}$  region in the  $t^{\text{th}}$  period;  $y_t$  is a M x N matrix of output quantities for all N regions in the  $t^{\text{th}}$  period;  $x_t$  is a K x N matrix of input quantities for all N regions in the  $t^{\text{th}}$  period;  $\lambda$  is a Nx1 vector of weights; and  $\phi$  is a scalar, reflecting the degree to which the output vector can be expanded (Coelli and Rao, 2005). These four LP's for the Malmquist index were calculated using the software DEAP 2.1 (Coelli, 1996).

### 3.2. Nature of Data Source

The output and input data were used for this study was taken from the internationally authenticated sources FAO

CountrySTAT (Ghana)<sup>6</sup>, FAO AGROSTAT<sup>7</sup> and Ghana's Ministry of Food and Agriculture (MoFA)<sup>8</sup>. For this paper we have attempted to estimate the regional level TFP growth indices. For this purpose we have focused on major principal crop production including cereals (maize, rice, sorghum, and millet) and starchy staples (cassava, cocoyam, yam, and plantain). In this regard, please note that only regional level data is available and that has been duly consulted. As mentioned, the time period under study is 2000-2009.

For this study we have considered one output variable and six inputs variables. The output variable is derived by aggregating detailed output quantity data on eight major agricultural commodities: maize, millet, rice, sorghum, cassava, cocoyam, plantain and yam from the respective regions: Ashanti, Brong Ahafo, Central, Eastern, Greater Accra, Northern, Upper East, Upper West, Volta and Western in Ghana. These aggregates are constructed using real average rural wholesale price in Ghanaian Cedi (GH¢) for 2002 constant prices. On the other hand, the input variables land, labor, fertilizer, tractors, livestock and rainfall were considered for this study. In detailed, 1) the variable agricultural land is measured area under covered crops in harvested in thousand hectares; 2) the variable labor is defined the economically active population in agriculture includes all economically active persons in agriculture in thousand number; 3) the majority of rural households keep some sort of livestock, livestock farming is adjunct to crop farming. Number of livestock defined as including (cattle, goats, pigs and sheeps)<sup>9</sup>; 4) the variable total number of tractors is used as machinery used in agricultural farming; 5) the variable fertilizer defined as the sum of nitrogen (N), phosphate (P<sub>2</sub>O<sub>5</sub>) and potassium (K<sub>2</sub>O) in thousands of metric tonnes, which we followed the previous studies (Coelli and Rao 2005, Hayami and Ruttan 1970); and finally we have included one climate variable rainfall based on Ajao, 2011 paper. However, rainfall has one of the important sources of water source of crop farming, considered average rainfall in millimeters by region-wise.

Regional input variable data for tractors, fertilizer, livestock and labor is not available and therefore such a data for the time period under study has been extrapolated from national level data on tractors, fertilizer, livestock and labor. This data was collected from the FAOSTAT-Agriculture, Food and Agriculture Organization (FAO).

#### 4. Results and Discussions

This section represents TFP indices computed assuming constant returns to scale. Using principal agricultural output on the basis of contemporaneous technology<sup>10</sup>. Most of the previous studies adopt the constant returns to scale frontier as a benchmarking technology. There are several studies that find constant returns to scale in developing countries and increasing returns to scale in developed countries (for e.g. Avila and Evenson, (2010); Hayami and Ruttan (1985), Headey et al., (2010); Khaldi (1975), Coelli and Rao, (2005); Fugli, (2010); Fulginiti and Perrin (1998); Nin et al., (2003); Trueblood and Coggins, (1997)).

This section table 1 exhibits the average total factor productivity growth rates by regional level in Ghana. The trends in the agricultural total factor productivity growth are analyzed for the entire time period 2000-2009 and for the sub-periods 2000-04 and 2005-09. TFP growth rate for Ghana is estimated to be 2.9 per cent during the first period 2000-04 and then declines to -12.7 per cent during 2005-2009, the average TFP growth period being 0.7 per cent per annum for the entire time period. The average efficiency growth shows slight improvement in both sub periods but when it comes to the overall period the efficiency growth exhibits negative improvement in Ghana. The other decomposition component technical change shows improving growth in first sub period and then the second sub period would exhibit negative technical growth, while the overall period of the annual technical growth exhibits improving trends. It might be the reason for farmers are gradually trying to attempt to adopt mechanization for their crop farming (MoFA, 2009).

**Table 2: Regional-wise annual total factor productivity growth rates (%)**

Region	Year	Efficiency Change	Technical Change	Total Factor Productivity (TFP) Change
Ashanti	2000-04	1.5	6.4	7.8
	2005-09	3.2	-6.6	-3.5
	<b>2000-09</b>	<b>0.3</b>	<b>1.2</b>	<b>1.5</b>

<sup>6</sup> <http://faostat.fao.org/site/567/default.aspx#ancor>

<sup>7</sup> <http://www.countrystat.org/home.aspx?c=GHA&tr=25>

<sup>8</sup> <http://mofa.gov.gh/site/>

<sup>9</sup> Livestock conversion factors taken from Y Hayami and V WRuttan, 1970

<sup>10</sup> The software used is Tim Coelli's DEAP version 2.1

Brong Ahafo	2000-04	7.6	3.2	10.8
	2005-09	-5.5	-4.9	-10.4
	<b>2000-09</b>	<b>-1.2</b>	<b>5.6</b>	<b>4.4</b>
Central	2000-04	9.6	-3.6	6.1
	2005-09	-2.8	-12.2	-12.8
	<b>2000-09</b>	<b>3.9</b>	<b>-1.4</b>	<b>2.5</b>
Eastern	2000-04	10.6	-6.6	4.0
	2005-09	0.5	-6.8	-6.3
	<b>2000-09</b>	<b>2.1</b>	<b>0.0</b>	<b>2.0</b>
Greater Accra	2000-04	-1.6	14.5	1.4
	2005-09	-5.7	-9.9	-11.1
	<b>2000-09</b>	<b>1.1</b>	<b>3.7</b>	<b>0.5</b>
Northern	2000-04	-7.2	11.9	4.8
	2005-09	4.6	-10.9	-15.9
	<b>2000-09</b>	<b>0.0</b>	<b>2.4</b>	<b>2.4</b>
Upper Eastern	2000-04	-3.9	2.9	-1.0
	2005-09	-4.4	-11.3	-15.7
	<b>2000-09</b>	<b>-1.9</b>	<b>2.2</b>	<b>0.3</b>
Upper Western	2000-04	-5.5	-4.1	5.5
	2005-09	-4.3	3.6	-0.7
	<b>2000-09</b>	<b>-0.5</b>	<b>2.9</b>	<b>2.4</b>
Volta	2000-04	2.6	4.4	7.0
	2005-09	-1.0	-9.8	-10.8
	<b>2000-09</b>	<b>-0.5</b>	<b>4.5</b>	<b>4.0</b>
Western	2000-04	-13.6	21.6	7.9
	2005-09	-7.4	-5.7	-13.1
	<b>2000-09</b>	<b>-2.1</b>	<b>3.7</b>	<b>1.7</b>
Ghana	2000-04	0.1	2.7	2.9
	2005-09	0.1	-12.8	-12.7
	<b>2000-09</b>	<b>-0.8</b>	<b>1.5</b>	<b>0.7</b>

Note: Average annual growth rates computed through geometric mean

By the regional level analysis of total factor productivity growth have categorized into four ways: negative; marginal and small (0-2 %); medium (2-5%) and large (> 5%) for clear understanding of the results. The decomposition components of technical change and efficiency change have performed into

three modes: increasing, declining or no change. However, the rates of technical progress, which factors provide more to the agricultural productivity change (see table 2). For the overall time period 2000-2009, it is found that all regions in Ghana show improvement in productivity growth. There are medium productivity gains occurring in Brong Ahafo, Central, Greater Accra, Upper East, Upper West and Volta.

Table 3: Categorization of regions as per TFP, Technical and Efficiency growth rates (%)

Particulars	2000-04	2005-09	2000-09
<b>Total Factor Productivity</b>			
Negative	UEAS,	ASH, BRO, CEN, EAS, GACC, NOR, UEAS, UWES, VOL, WES,	
Marginal and Small (0-2%)	GACC,		NOR, ASH, EAS, WES
Medium (2-5%)	EAS, NOR		BRO, CEN, GACC, UEAS, UWES, VOL,
Large (>5%)	ASH, BRO, CEN, UWES, VOL, WES		
<b>Efficiency Change</b>			
Declining	GACC, NOR, UEAS, UWES, WES	BRO, CEN, GACC, UEAS, UWES, VOL, WES	BRO, UEAS, UWES, VOL, WES
No Change			NOR
Increasing	ASH, BRO, CEN, EAS, VOL	ASH, EAS, NOR,	ASH, CEN, EAS, GACC,
<b>Technical Change</b>			
Declining	CEN, EAS, UWES	ASH, BRO, CEN, EAS, GACC, NOR, UEAS, VOL, WES	CEN
No Change			EAS
Increasing	ASH, BRO, GACC, NOR, UEAS, VOL, WES	UWES	ASH, BRO, GACC, NOR, UEAS, UWES, VOL, WES

While the regions Northern, Ashanti, Eastern and Western exhibit marginal and small productivity improvements. During the sub-period 2000-04, the regions Upper East shows a decline in productivity, whereas the other regions showing productivity improvement. Marginal and small TFP increases are observed in Greater Accra; medium TFP increases in Eastern and Northern. The regions of Ashanti, Brong Ahafo, Central, Upper west, Volta and Western exhibits large productivity growth. During the second sub-period 2005-2009, a weakening in productivity is observed in all the regions Ashanti, Brong Ahafo, Central, Eastern, Greater Accra, Northern, Upper Eastern, Upper Western, Volta and Western.

In the overall period 2000-09, efficiency change is reported to decline in Central region out of all ten regions. The Eastern region reports no change in efficiency indicates frontier region. Ashanti, Brong Ahafo, Great Accra, Northern, Upper East, Upper West, Volta and Western accounts increase in efficiency. The first sub period 2000-04, the change of efficiency growth is observed declining in Greater Accra, Northern, Upper East, Upper West and Western regions. The non-frontier regions of Ashanti, Brong Ahafo, Central, Eastern and Volta show improvements in efficiency. On the other hand, the second sub period 2005-09, the efficiency growth is improved in Ashanti, Eastern and Northern regions but in the other regions Brong Ahafo, Central, Greater Accra, Upper East, Upper West, Volta, Western have show declining efficiency. The contribution of technical change is improved in Ashanti, Brong Ahafo, Greater Accra, Northern, Upper East, Upper West, Volta and Western regions but it is declined growth in Central region. However, the frontier Eastern region has stagnation in the technical growth. In the first sub-period 2000-04, the technical change exhibits declining growth in the regions Central, Eastern, Upper Western. The regions Ashanti, Brong Ahafo, Greater Accra, Northern, Upper East, Volta and Western shows improving technical performance. In

the second sub period 2005-09, out of ten regions the only region Upper West shows the improving technical performance and the of the regions exhibits declining trends. The overall contribution of technical change is greater than that of efficiency change to overall productivity changes in all the regions except Central, Eastern regions.

In this section Figure 2 shows cumulative Total Factor Productivity indices from 2001 to 2009 for the different regions. From the figure it is clear that all the regions in Ghana doesn't have continuous cumulative growth by 2009. The cumulative trends of all regions are almost showing fluctuation productivity growth. The Northern region has the highest cumulative productivity growth (1.9) in 2005 and after that it reaches to 1.2 in 2009, followed by the other regions Brong Ahafo, 1.68 in 2005 and 0.94 in 2009; Volta 1.67 in 2005 and 1.10 in 2009;

Upper Eastern and Greater Accra regions are having the similar cumulative productivity growths. On the other hand, the regions Ashanti, Upper

Western and Eastern are having the similar cumulative productivity growth like 1.28 to 1.30 per cent by 2005 and thereafter all these three regions, the productivity growth are went down to 0.74 to 0.90 by 2009. While in the case of country Ghana, the cumulative productivity growth rate having the same kind of variation growth like as regions.

Figure 2: Regional-wise Total Factor Productivity Growth in Agriculture (cumulative TFP Indices)

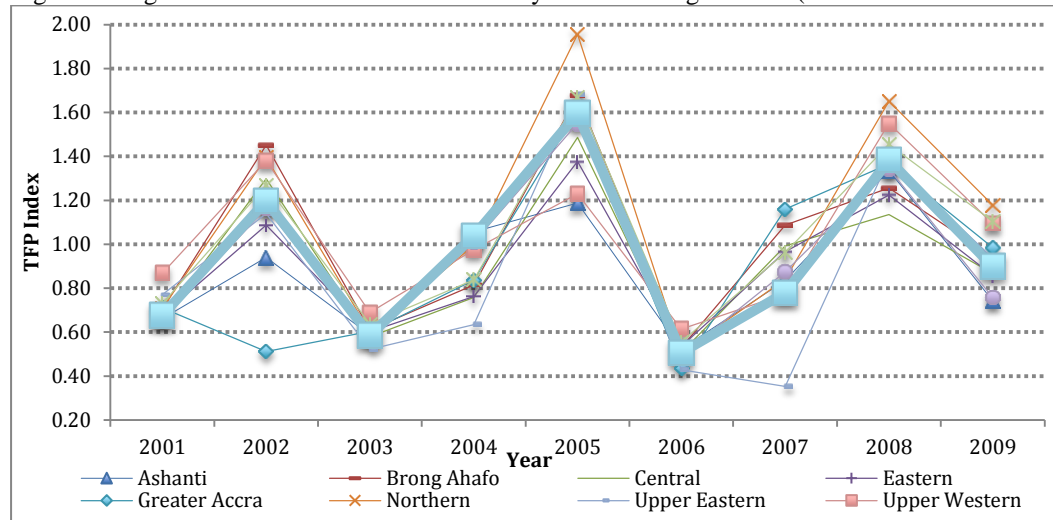


Table 3 provides details on the total factor productivity (TFP) index and its decomposition for 10 regions in Ghana over the period of 2000-2009. Northern region in Ghana were much better than the other regions improving their agricultural productivity (1.02) and efficiency (1.02) followed by the Eastern and Upper West regions, but the level of agricultural productivity is still less in these two regions. Interestingly the regions Central, Western, Volta and Greater Accra are improving their efficiency change but not the agricultural productivity growth. However, Brong Ahafo and Upper East regions have no efficiency change (1.0) during the selected time period but the agricultural productivity growth as same like as Greater Accra. The only region Ashanti was not improved neither their agricultural productivity change nor efficiency change. On the other hand, according to the Ministry of Food and Agriculture Ghana, 2011, the main agricultural farming system in Ghana is traditional farming. The hoe and cutlass are the main farming tools for agricultural farming. In addition, there is a little mechanized farming, but bullock farming is practiced in some places, especially in the Northern region. Due to this reason the performance of technical growth is almost insignificant in all regions except the Northern region (0.99). The overall performance of total factor productivity was not improved (0.955) but the change of efficiency exhibiting as a significant.

Table 4: Regional-wise Malmquist TFP indices and their decomposition

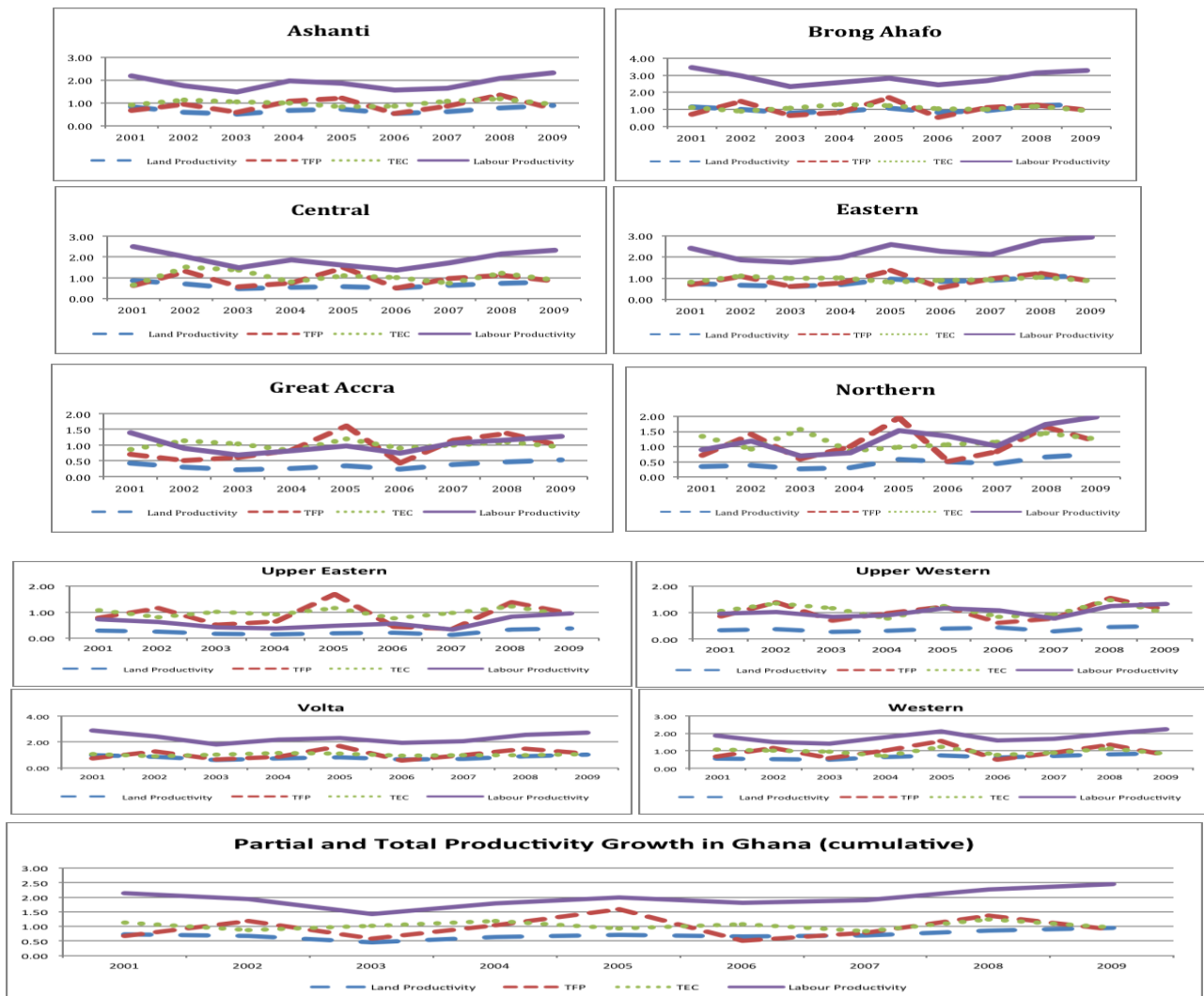
Region	Efficiency Change	Technical Change	Pure Technical Efficiency Change	Scale Efficiency Change	Total Factor Productivity	Rank based on TFP
Ashanti	0.996	0.942	0.993	1.004	0.938	9
Brong Ahafo	1.000	0.955	1.000	1.000	0.955	4
Central	1.007	0.933	1.004	1.002	0.939	8
<b>Eastern</b>	<b>1.011</b>	<b>0.959</b>	<b>1.001</b>	<b>1.010</b>	<b>0.970</b>	<b>2</b>
Greater Accra	1.018	0.933	1.000	1.018	0.950	6
<b>Northern</b>	<b>1.024</b>	<b>0.992</b>	<b>0.953</b>	<b>1.075</b>	<b>1.015</b>	<b>1</b>
Upper East	1.000	0.950	0.950	1.053	0.950	5
<b>Upper West</b>	<b>1.026</b>	<b>0.940</b>	<b>0.965</b>	<b>1.064</b>	<b>0.964</b>	<b>3</b>
Volta	1.004	0.933	1.001	1.003	0.936	10
Western	1.007	0.933	1.007	1.000	0.939	7
<b>Overall</b>	<b>1.009</b>	<b>0.947</b>	<b>0.987</b>	<b>1.023</b>	<b>0.955</b>	

Figure 3 shows the cumulative trends in partial productivity indices and total factor productivity. Two partial productivity indices are used the agricultural land productivity as a fraction of output over agricultural land, and the labor productivity. During the period 2001-2009 in Ghana the partial productivity indices of labor



productivity, TFP and efficiency change follow similar trends throughout period. But the labor productivity shows higher than the total productivity growth. The labor productivity trend clearly exhibit that the contribution of employment is still more in agricultural sector in Ghana. On the other side, by regional wise partial and total productivity indices describe the cumulative trends, shows that the labor productivity, total factor productivity, and efficiency change follow similar trends. The labor productivity shows higher cumulative growth than the TFP in Ashanti, Brong Ahafo, Central, Eastern, Volta and Western. But the other regions Greater Accra, Northern, Upper Eastern and Upper Western the labor productivity trend is closely follow to the total factor productivity (TFP) growth and some years it shows less than TFP during the period. Interestingly, the land productivity growth shows improving trend during the time period in all regions. It indicates that the improving land productivity leads to enhance the productivity growth and agricultural employment.

Figure 3: Region-wise partial and total productivity growth in Ghana (cumulative)



### 5. Major findings and conclusions

This study presents major findings on trends in regional level agricultural productivity growth in Ghana during the period 2000-2009 and for the sub-periods 2000-04 and 2004-09. The results show an annual growth in TFP of Ghana is estimated to be 2.9 per cent (similarly matched with Block, 2010) during the first period 2000-04 estimations and then declines to -12.7 per cent during 2005-2009, the average TFP growth period being 0.7 per cent per annum for the entire time period. By regional wise, The Northern region has the highest cumulative productivity growth (1.9) in 2005 and after that it reaches to 1.2 in 2009.

In addition, the Malmquist total factor productivity index shows higher productivity in Northern regions followed by the other regions Eastern and Upper West. The reason for this can be that in the North the area

under agricultural land is higher in comparison to other regions. The cumulative trends in partial productivity indices of the labor productivity show higher than the total productivity growth during the period 2000-09. The labor productivity trend clearly exhibit that the contribution of employment is still more in agricultural sector in Ghana. By regional level, the labor productivity shows higher cumulative growth than the TFP in Ashanti, Brong Ahafo, Central, Eastern, Volta and Western. But in other regions Greater Accra, Northern, Upper Eastern and Upper Western, the labor productivity trend is less than and closely follow to the total factor productivity growth during the study period. Increasing land productivity growth indicates that improving land productivity enhances the productivity growth and creates more agricultural employment opportunities.

Efficiency change is reported to decline in Central region out of all ten regions. The frontier Eastern region reports no change in efficiency. Ashanthe, Brong Ahafo, Great Accra, Northern, Upper East, Upper West, Volta and Western accounts increase in efficiency during the period 2000-09. It is a matter of serious concern that the overall contribution of technical change is greater than that of efficiency change to overall productivity changes in all the regions except Central, Eastern regions. This implies huge potential increase in production even with existing technology. It is important to reverse this efficiency decline that appears in many regions and achieve a faster and large scale diffusion of technical innovations across regions.

Finally, government should take some necessary steps to focus on improving crop productivity and also it is necessary to provide farmers timely and extensive services and support so that crop farming can be made more efficient.

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