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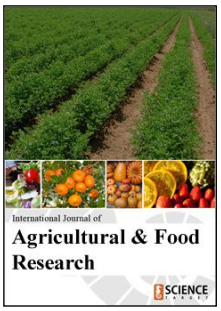

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Technical Efficiency of Cocoa Production in Southwest Nigeria

Popoola Olufemi A.[1], Ogunsola Grace O.[2] and Salman Kabir K.[1]
[1]Department of Agricultural Economics, University of Ibadan, Nigeria
[2]Department of Agricultural Economics and Extension, Bowen University, Iwo, Nigeria

Abstract. In this study, we investigate the profitability of cocoa enterprise, the technical efficiency, and drivers of efficiency among cocoa farmers, in southwest Nigeria. Data were collected through the use of well structured questionnaires administered to farmers in selected cocoa producing states. For enterprise profitability, the gross margin analysis was used while the Data Envelopment Analysis (DEA), a non-parametric approach, was used to analyse technical efficiency and the OLS regression to profile socio-economic variables that affect technical efficiency. A majority of farmers were male with a mean age of 55.01±16.74 years, mean household size of about 7.28±3.79 members and about thirty-five percent without any formal education. Over eighty percent had more than 10 years of cocoa farming experience with the average age of cocoa trees being 30.38 ±17.92 years. Cocoa was found to be a profitable enterprise, although returns in Ekiti state were higher. The majority of cocoa farmers were relatively technically efficient in their use of resources, with a mean technical efficiency of 0.8126. Farmers in Ekiti state are most technically efficient with a mean of 0.8922 followed by Ondo state with a mean of 0.8132 while Osun state has the least mean of 0.7323. Education was positively and significantly associated with efficiency, while area of land and age of cocoa trees negatively affects technical efficiency. This indicates that public investments in education have complementary and synergistic effects on improved cocoa technical efficiency, and younger cocoa trees should be planted by farmers in southwest Nigeria.

Keywords. *Cocoa production, Profitability, technical efficiency, DEA, Southwest*

*Correspondence:
adebolastephens@gmail.com

1. Introduction

The primacy of agriculture to African economies has never been in doubt. Its role in the provision of foreign exchange and development of economies cannot be overstated, as it remained for a long time the main machine for the earnings (Nkamleu, et al., 2010; Adeniyi and Ogunsola, 2014). However, agriculture remains in the hands of mainly small-scale farmers who use traditional methods and rudimentary tools of production, resulting in unsustainably low crop yields despite their high commercial and export potential. In Nigeria, the sector contributes 42.1% of the current GDP (Eleri et al., 2012). With more than half of Nigeria's population currently employed in the agricultural sector (Manyong et al., 2005), and with the vast majority of these individuals living in rural areas, the agricultural sector is key to Nigeria's economic development.

Cocoa plays a significant socio-economic role in Nigeria (Agbongiarhuoyi et al., 2013), as it accounts for about 2% of the national export earnings and over 200,000 rural households in 14 cocoa-producing states depend on cocoa for the majority of their cash income (NCDC, 2008). According to several authors (Arueya, 1989; Olubamiwa et al., 2000 and Hamzat et al., 2003), millions more are dependent on cocoa for their

livelihoods in different areas of the supply chain such as trade, transport, processing, and export of cocoa and its products.

It has been reported that in Africa, growth in the cocoa sector has been achieved by increasing the area cultivated rather than by improving yield (Nkamleu, et al., 2010). They further posited that cocoa productivity levels can be enhanced either by improving technical efficiency and/or by improving technological application. Gockowski et al. 2000 (Nkamleu and Ndoye, 2003) reported that cocoa cultivation is among the most significant causes of the near disappearance of the West African rainforest. A relevant question for agricultural policymakers is to pursue a strategy directed towards efficiency (Nkamleu, 2004; Nkamleu 2004b). The presence of shortfalls in technical efficiency means that output can be increased without requiring additional conventional inputs. If this is the case, then empirical measures of efficiency are necessary in order to determine the magnitude of the gain that could be obtained by improving performance with the same level of resource use.

Amidst rapid globalization and food security issues, it has become expedient for Nigeria to foster growth through the comparative advantage they have in the production of these commodity export crops to generate foreign exchange and promote economic growth with particular interest in cocoa. It is within the context of globalization and economic challenges that the quest for increased cocoa production is needed so as to meet up with income and development needs. The cocoa market liberalization (1986) resulted in the numerous traders and marketers involved in the value chain. Subsequent to the launch of the Structural Adjustment Programme (SAP) in 1986 and overall economic liberalization policy, cocoa production is still primarily managed by smallholders with a low use of both inputs and product enhancing agricultural techniques (Idowu et al., 2007).

Cocoa is mainly exported as beans with processing activities being limited within the country. Cocoa, being the main agricultural export in Nigeria (IFPRI, 2010), has been observed to have low and declining yields, inconsistent production patterns, disease incidence, pest attack, and little agricultural mechanization Nwachukwu et al. (2010). The main challenges faced by the cocoa sector are the decreasing level of labor force and the ageing of trees resulting in low yields (Cadoni, 2013). Additionally, the ageing of cocoa producing trees also plays a role in the decrease of productivity. Particularly, 60 percent of cocoa farms are over 40 years old, thus hampering productivity. When compared to other cocoa producing countries, Nigeria presents yields among the lowest, together with Ghana and Cameroon, while Cote d'Ivoire is the best performing country in West Africa in terms of yields, and Indonesia is the best performer in terms of yield at the global level (FAOSTAT, 2012).

Given that these farmers are resource-constrained, key questions arise: (i) Are the resources and inputs used in the production of cocoa returning the optimum levels of output? (ii) How efficiently can these limited resources be employed to obtain the maximum level of cocoa output?, and (iii) What are the drivers of technical efficiency in the area under study? Assessing the profitability of cocoa enterprise and the technical efficiency is the appropriate way to identify if resources are being put to their best use. Producers need to be aware early enough of the drivers of technical efficiency for the enterprises they are involved in. In this paper, we apply the DEA approach to investigate technical efficiency of cocoa farms in south west Nigeria.

Objectives

The major objective of this study was to establish the profitability of cocoa enterprise and the technical efficiency of farmers in south-west Nigeria.

The specific objectives were:

(i) To determine the profitability of cocoa enterprise

(ii) To establish the technical efficiency of cocoa-producing farms

(iii) To establish the determinants of the efficiency of producers.

Rationale of the Study

Determining the technical efficiency status of cocoa farmers is very important for policy purposes. In an economy where technologies are lacking, technical efficiency studies show the possibility of raising productivity by improving efficiency in the use of existing resources. It also helps to determine the under utilization or over utilization of factor inputs. Most empirical literature dealing with farm technical efficiency, at least in Nigeria, have been concerned with measurement of technical efficiency by using production function, profit function, or stochastic production frontier model as analytical techniques (Adepoju, 2008; Omonona et al., 2010). The application of DEA is still scarce in Nigeria. Only a few studies have employed it (Yusuf and Malomo, 2007); Ajao, (2011); Jatto et al., (2012) but none have applied it to cocoa-based production systems. This study intends to depart from the more common analytical approaches by using the DEA approach to estimate the technical efficiency of cocoa farmers in the Southwest area of the country. In this way, the hope is that the study will constitute a unique contribution to available literature on the empirical measurement of efficiency in Nigeria.

Agricultural development of a country or region is closely related with production of the crops. It is generally accepted that Nigerian agriculture has suffered as a result of the resource curse effect of oil and inappropriate policies and institutions. The Nigerian government has made concerted efforts to increase production and productivity levels through a number of programs, some of which are the National Special Programme on Food Security (NSPFS), National Economic Empowerment and Development Strategy (NEEDS), National Agricultural Land Development Authority (NALDA), and Agricultural Development Project (ADP) among others. The most recent is the Agricultural Transformation Agenda. Despite all the policies and laudable programs with challenging themes, Nigeria is yet to achieve food security. This study seeks to provide empirical findings on the resource use efficiency of cocoa so as to formulate development plans and provide an opportunity to ascertain the ground reality regarding the real cause of backwardness in cocoa production in Nigeria.

Review of Productivity and Efficiency Measures

Several scholars have employed different measures over the years to quantify agricultural productivity. Kendall (1939) introduced the *Kendall's ranking coefficient* and was employed by Stamp (1958). In 1964, the *Index of Productivity Coefficient of Agriculture* was devised by Enyedi. Following this, J.L. Buck developed a new technique, which related to grain equivalents per head of production known as the *Grain equivalents index*. This was further modified by E.de Vries in 1967 (Quoted in Singh and Dhillion, 2000). Bhatia introduced a *Productivity evaluation index* in 1967. He considered that all physical and human factors join in to produce the agricultural crops. Sapre and Deshpande (1964) have introduced a *Weighted rank index* for measuring agricultural productivity. *Agricultural productivity coefficient index* was introduced by Shafi in 1984 by using calorie values relating to each crop. In 1972, Jasbir Singh attempted to introduce a new technique for calculating agricultural efficiency by expressing the per unit area carrying capacity. Hussain also developed a technique to measure agricultural productivity in 1976 (Hussain, 1976). He converted agricultural production into monetary values of a regional unit in production. Kawagoe and others have used a method of *Production function approach* for measuring agricultural productivity among different countries (Kawagoe et al. 1985). In 2005, Vanloon, Patil, and Hugar developed an indicator for measuring crop productivity by using primary product yield or conventional yield. Despite the uniqueness of these measures, they failed to take account of measurement errors, and there are no statistical tests to validate the results.

Apart from these methodologies, measures of agricultural productivity can be divided into partial or total measures depending on the number of inputs under consideration. The

partial measure of productivity is the Single Factor Productivity (SFP) which comprises the Labour Productivity (LP) and the Land Productivity (LP) (Zepeda, 2001; Wiebe et al., 2003). These measures do not take into account the role of other inputs in any observed output changes (production) (Zepeda 2001), as it is only a measure of the output quantity to the quantity of a single input used (Singh and Dhillion, 2000; Diewert and Nakamura, 2005). As a result of this shortcoming, a total measure of productivity was developed. Total factor productivity (TFP) is defined as the ratio of a measure of total output quantity to a measure of the quantity of total inputs used (Zepeda, 2001; Wiebe et al., 2003). This measure imposes several strong assumptions about technology, and a major drawback is that statistical methods cannot be used to evaluate their reliability. Empirical studies that have employed TFP include; Rahji, 2007; Adepoju and Salman, (2013).

After these measures were developed, it became imperative for developing countries to increase the quantity and quality of inputs in agriculture with large evidence from literature. Given the level and quality of inputs available, how well farmers are able to utilize these inputs is an important determinant of the quantity of output they are able to produce. Also, it is possible to increase output even given current levels and quality of inputs by increasing overall economic efficiency of farmers (Bravo-Ureta and Pinheiro, 1997). Efficiency in agricultural production is generally estimated using both parametric, such stochastic frontier analysis (SFA), and nonparametric approaches, such as Data Envelopment Analysis (DEA). Parametric methods assume that the functional form of the production function is known. The parametric/econometric model has the advantage of permitting hypothesis testing and calculation of confidence intervals to test the reliability of the estimations. If the functional form is more flexible, a further advantage is that fewer restrictive assumptions about technology are imposed. A disadvantage of the econometric model is that it requires more data than the other models. The most common specifications are the stochastic frontier models proposed by Aigner et al., (1977) and Meeusen and van den Broeck, (1977). This measure has been extensively specified in Nigeria for a wide variety of crops (Ajibefun, 1998; Fasoranti, 2006; Amos, et al., 2004; Adejoh, 2009; Ojo et al., 2009).

Data envelopment analysis models are the most commonly used forms of non-parametric models (Ajibefun 1998, 2008). Coelli (1995) among others indicated that the non-parametric approaches do not assume a specific functional form to specify relationship between inputs and outputs (Saradifis, 2002). This implies that one can avoid unnecessary restrictions about functional form that can affect the analysis and distort efficiency measures as mentioned in Fraser and Cordina, (1999). Second, it does not require the distributional assumption of the inefficiency term. Another advantage is that is that it does not impose restrictive assumptions on production technology. Some empirical studies that have employed a DEA model in Nigeria are Yusuf and Malomo, (2007) and Jatto et al., (2012).

Following the aforementioned advantages, this study employed the input-oriented variable returns to scale (VRS) DEA model to estimate the technical efficiency of cocoa production in southwest, Nigeria.

2. Methodology

Study Area

The study area is southwest Nigeria. This is because the main cocoa producing states are located in this region (NBS, 2012).

Ondo State is well endowed with abundant human and natural resources and has an estimated land area of about 15,500 square kilometers. The state is bounded on the north by Ekiti and Kogi States, on the west by Ogun and Osun States, on the east by Edo and Delta States, and to the south by the Bight of Benin and the Atlantic Ocean. The state is made up of eighteen local government areas and lies between latitudes $5^{o}45^{l}$ and $7^{o}52^{l}$N and longitudes $4^{o}20^{l}$ and $6^{o}05^{l}$ E. The estimated population of the state was 3,441,024 (NPC, 2006). Agriculture is the main occupation of the

people of the state. This state is the leading cocoa producing state in Nigeria. Cassava, yams, and palm produce are other crops grown in the state. Ondo State is rated as the largest cocoa producing state in Nigeria (Oluyole, 2005; ICCO, 2009).

Osun state is rich in human and material resources. It covers an area of approximately 14,875 square kilometres. It lies between 04 00E and 05 ◦ 5 and latitude 05 ◦ 55 8N and 08 ◦ 07W. It is bounded by Ogun, Kwara, Oyo, Ondo, and Ekiti states in the south, north, west and east respectively. The state lies in the tropical rainforest. The state has a population of 3,423, 535 (NPC, 2006). The state is made up of 30 local government areas. Agriculture is practiced both at commercial and subsistence scales. Cocoa is the main export crop grown in the state and it is second only to Ondo in terms of cocoa production. Other crops include yam, maize, and cassava.

Ekiti State is situated entirely within the tropics. It is located between longitudes 4^0 5^1 and 5^0 45^1 East of the Greenwish meridian and latitudes 7^0 15^1 and 8^0 5^1 north of the equator. It lies south of Kwara and Kogi State, East of Osun State, and is bounded by Ondo State in the East and in the south with a total land area of 5886.890 square kilometers. Ekiti State has 16 local government councils. The estimated population of the state was 2,384,212 (NPC, 2006). Agriculture is the main occupation of the people, and it is the major source of income for many in the state. Major crops grown are cocoa, oilpalm, cassava, maize and cowpea.

Sources and Type of Data

Data were collected from primary sources. The primary data were collected with the aid of a well-structured questionnaire, containing information such as the socio economic characteristics of the respondents (age, level of education, household size, etc.) and information on farm characteristics such as farm size, farm experience, inputs, and quantity of output used by the farmer were collected.

Sampling Technique and Sample Size

A multistage sampling technique was employed for the study. The first stage involved the purposive selection of three cocoa growing states, namely Ondo, Osun, and Ekiti, from the six states that make up the southwest zone of Nigeria. The second stage involved the random selection of some major cocoa producing local government areas (LGAs). In Ondo state, Ile-Oluji/Oke Igbo, Owo, and Idanre LGAs were selected. In Osun state, Aiyedaade, Irewole, Isokan, and Atakumosa west LGAs were selected. Finally, in Ekiti state, Ise Orun, Gbonyin, Ekiti East, and Ikole LGAs were selected. The third stage involved the random selection of villages from each of the LGAs, and finally, cocoa farming households were selected in proportion to the number of cocoa farming households in each village. Being the highest cocoa growing state (ICCO, 2009), a total of 282 questionnaires were administered in Ondo state while 125 and 106 were administered in Osun and Ekiti states, respectively. In all, 513 cocoa farmers were sampled for the study.

Analytical Technique

Descriptive statistics were used to describe the socioeconomic and farm characteristics of cocoa farmers in the selected states. This was done using frequencies, percentages, mean, and standard deviation.

The Profitability of Cocoa Production

The profitability of cocoa production was estimated using the budgetary analysis. The budgetary analysis involves the deduction of the total variable costs (in Naira) from the total revenue of cocoa beans (in Naira) to obtain the gross margin for each cocoa farm in selected states. The total variable costs of production are the cost of labor, fertilizers, agro-chemicals, and other miscellaneous expenses.

The formula is given as:

$$GM_i = \sum_{i=1}^{n} P_i Y_i - C_i$$

where

GM_i = Gross margin of farm *i*

P_i = Farm gate price per kg of cocoa beans of farm *i*

Y_i = Total quantity in kg of cocoa beans of farm *i*

C_i = Total variable costs incurred on farm *i*

i…n = Total number of cocoa farms

Data Envelopment Analysis - Model Specification

In this paper, we used the DEA method to investigate the production efficiency of the sampled cocoa farms. There are a number of multiple-input single-output production units (the cocoa farms) to be evaluated, which are taken as DMUs. Each DMU consumes varying amounts of inputs to produce different level of cocoa bean production. In this study, input-oriented measures were chosen to reflect local reality where a decrease in scarce resources (input) use is relevant.

Let us suppose that there are k = 1…, K DMUs, which in the context of our empirical application are cocoa farmers. Each DMU produces m = 1 . . . M outputs using inputs that are both under and beyond a farmer's control. Let us further assume that there are data available on K inputs and M outputs for each of N exploitations. The K x N input matrix X and the M x N output matrix Y represent the data for all the firms. An intuitive way to introduce the DEA is via the ratio form. For each farm we would like to obtain a measure of the ratio of all outputs over all inputs. According to Charnes et al., (1978), the optimal weights are obtained by solving following mathematical programming problem:

$$Max_{u,v}\theta = \left(\frac{u'y_i}{v'x_i}\right)$$

Subject to $u'y_i/v'x_i \leq 1$, (where i = 1, 2… N)

u,v ≥ 0

Where: $u'y_i/v'x_i$ is the scoring function, u is an M×1 vector of output weights, v is an K×1 vector of input weights, x_i is the input weights and y_i is the output weights.

The efficiency measure for the *i-th* DMU is maximized, subject to the constraints that all efficiency measures must be less than or equal to one. One problem with this particular ratio formulation is that it has an infinite number of solutions. To avoid this, Charnes et al. (1978) proposed the use of a CRS (constant return to scale) equivalent Duality Linear Program which is defined as the following:

$Max_{\mu,v}(\mu' y_i)$

Subject to $v'x_i = 1$

$\mu' y_i - v'x_i \leq 1$, (where j = 1,2,….,N), μ,v ≥ 0 Where θ is a scalar and λ is a vector of constants, *xi* and *yi*, are column vectors with the input and output data for the i-th farm. *X* is a K by N matrix and *Y* is a M by N matrix with respectively all input and output data for all N farms in the sample. The value θ is a score always lying between zero and one with a value of one indicating that the farm lies on the frontier and is efficient. An implicit assumption of the model described above is that returns to scale are constant and thus farms are operating at an optimal scale (Fraser and Cordina, 1999). However, DEA model computes for a Variable Returns to Scale (VRS) by adding the convexity constraint: N1′ λ = 1, to the CCR model (2) above. Without this convexity constraint, the DEA model will describe a CRS situation.

θ is the pure technical efficiency score (TE_{VRS}), having a value 0 ≤ θ ≤ 1. If the θ value is equal to one, the farm is on the frontier.

Ordinary Least Square Regression (OLS)

The OLS regression was used to examine factors affecting the technical efficiency of cocoa farmers.

The general model is given as:

$Y_i = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 \ldots\ldots + \beta_9X_9 + u_i$

Y = Technical efficiency scores; X_1 = Age of farmer (years); X_2 = Household size; X_3 = years of schooling (years); X_4 = Area of land cultivated (acres); X_5 = access to extension services (1 = have access, 0 otherwise); X_6 = Distance to market (kilometres); X_7 = Age of cocoa trees (years); X_8 = Ondo farmer (1= yes, 0 = No); X_9 = Ekiti farmer (1= Ekiti state farmer; 0 = Osun state farmer)

Table 1

Socio-economic Characteristics of Cocoa Farmers

Characteristic	Pooled (N=513)	Ondo (N=282)	Osun (N= 125)	Ekiti (N= 106)
Gender				
Male	470(91.7)	245(86.9)	123(98.4)	103(97.2)
Female	43(8.2)	37(13.1)	2(1.6)	3(2.8)
Age (years)				
<=20	2(0.4)	2(0.7)	-	-
21-40	122(23.8)	72(25.5)	41(32.8)	9(8.5)
41-60	215(41.9)	113(40.1)	50(40.0)	52(49.1)
61 and above	174(33.9)	95(33.7)	34(27.2)	45(42.5)
Mean±SD	55.01±16.74	54.95±17.79	51.83±16.82	58.91±12.61
Educational level				
No formal education	184(35.9)	84(29.8)	36(28.8)	64(60.4)
Primary education	126(24.6)	76(27.0)	34(27.2)	16(15.1)
Secondary education	146(28.5)	91(32.3)	39(31.2)	16(15.1)
Tertiary education	55(11.2)	31(10.9)	16(12.8)	10(9.4)
Household size				
1-3	43(8.4)	31(11.0)	10(8.0)	2(1.9)
4-6	218(42.5)	124(44.0)	51(40.8)	43(40.6)
7-9	151(29.4)	71(25.2)	35(28.0)	45(42.5)
>=10	101(19.7)	56(19.9)	29(23.2)	16(15.1)
Mean±SD	7.28±3.79	7.15±3.88	7.60±4.51	7.23±2.38
Farming experience (years)				
0-10	60(11.7)	40(14.2)	19(15.2)	1(0.9)
11-20	120(23.4)	76(27.0)	40(32.0)	4(3.8)
21-30	102(19.9)	66(23.4)	23(18.4)	13(12.3)
31-40	74(14.4)	39(13.8)	11(8.8)	24(22.6)
>40	157(30.6)	61(21.6)	32(25.6)	64(60.4)
Mean ± SD	32.26±18.032	28.44±16.60	29.28±18.67	46.06±13.92
Age of cocoa trees (years)				
0-10	80(15.6)	47(16.7)	31(24.8)	2(1.9)
11-20	118(23.0)	76(27)	39(31.2)	3(2.8)
21-30	103(20.1)	65(23.0)	21(16.8)	17(16.0)
31-40	71(13.8)	36(12.8)	12(9.6)	23(21.7)
>40	141(27.5)	58(20.6)	22(17.6)	61(57.5)
Mean ± SD	30.38 ±17.92	27.34±16.33	24.85±18.13	45±13.68
Access to extension services				
Access	131(25.5)	50(17.7)	58(46.4)	23(21.7)
No access	382(74.5)	232(82.3)	67(53.6)	83(78.3)

*Figures in parenthesis are percentages

3. Results and Discussion

Socio-economic Characteristics

The socio-economic characteristics of cocoa farmers in southwest Nigeria is presented in Table 1.

As typical in African farm households, males constitute over 85% of the household heads across the states considered. This further buttress the fact that Nigerian agriculture is still male dominated, implying that men have more access to the resources and information required to produce crops more efficiently than their female counterparts (Fasoranti, 2006; Otitoju and Arene, 2010). The majority of the farmers are 40 years and older, constituting over sixty-five percent among sampled house-holds with a greater proportion of older farmers residing in Ekiti state. The mean age of cocoa farmers was 55.01±16.74 years. It is evident

that most cocoa farmers are aged. This would likely affect the efficiency of the farmers in these states. Several studies have reported that the aging of the farming population is a source of concern for production efficiency (Ajibefun, 1998; Amos et al., 2004; Ogundari, 2006; Ojo et al., 2009; Ogunniyi, 2011). About sixty percent of cocoa farmers in Ekiti state have no formal education while a greater percentage of farmers had at least primary education in Ondo (70.9%) and Osun states (71.2%). This reveals the poor literacy level of the farmers in Ekiti state, but about one-third of farmers in Ondo and Osun states still have no formal education. There is a need for increased literacy among heads of household and also access to education beyond the primary level. Nonetheless, about 90 percent have household sizes that are more than six across the three states with a mean of about 7.28±3.79. This implies that households are excessively large in size, which could serve as a source of family labor. Over eighty percent had more than 10 years of cocoa farming experience with the average age of cocoa trees being 30.38 ±17.92 years. However, access to extension services remains a challenge, as over fifty percent do not have access in the three states although about forty-six percent had access to extension services in Osun state.

Profitability of Cocoa Production

The result shows that the average cost incurred on labor was highest in Ondo state and lowest in Ekiti state. The cost on hired labor constituted the highest proportion of the total cost of cocoa production in all three states, but the proportion of labor cost in Osun state was the highest. It therefore implies that labor, to a large extent, determines the viability and profitability of cocoa production as shown in Table 2. The gross margin per acre was highest in Ekiti state followed by Ondo state, while the least was Osun state. However, based on this finding, cocoa production remains a profitable enterprise.

Technical Efficiency of Cocoa Production

The distribution of farmers' production efficiency is presented in Tables 3. Over half of the cocoa farmers (54.6 %) had efficiency scores between 0.80 and 1.00.

Table 2

Profitability of Cocoa Enterprise

Item	Pooled	Ondo	Osun	Ekiti
Cocoa beans output (kg)/yr	1456.10	1337.53	1078.27	2217.07
Price/ kg	384.87	401.66	376.56	350.00
Value of output (₦)	560409.207	537232.30	406033.35	775974.5
Variable costs	(₦)	(₦)	(₦)	(₦)
Weeding	36762.39	42660.42	41602.50	17094.34
Spraying	29277.48	35120.18	27321.85	18905.66
Harvesting	22201.23	22849.56	21642.54	21400.00
Packing/pod breaking	15522.89	14608.00	5945.65	17773.58
Irrigation	1146.48	20000	6035.71	-
Pruning	1651.06	7515.46	5945.65	-
Drying	8437.43	12526.07	5988.64	8405.66
Hired labour	88926.06	110132.84	157654.55	19474.38
Labour	N 92502.96	96792.62	91180.00	82650.94
Agrochemicals	32423.13	44125.59	21906.00	13692.45
Implements (hoes and cutlasses)	58.99	53.61	-	142.90
Total costs	169599.797	212405.80	111167.35	96484.85
Profit/yr	390809.41	324826.50	294866.00	679489.65

Table 3

Summary of Technical Efficiency of Production

Efficiency scores	Frequency	Percentage (%)
<0.5	7	1.4
0.5-0.59	69	13.5
0.60-0.69	76	14.8
0.70-0.79	81	15.8
0.80-0.89	65	12.7
0.90-1.00	215	41.9
Total	513	100
Mean	0.8126	

This rather high degree of efficiency indicates that little marketable cocoa bean output is sacrificed to resource waste. The mean production efficiency is 0.8126, implying that on an average cocoa farm, the observed output is 18.7 percent less than the maximum output, which can potentially be achieved from the existing level of input. It accounts for the level of inefficiency for an average cocoa farm in south-west Nigeria.

More than half of the cocoa farmers in Ekiti state operated at efficiency scores between 0.90 and 1.00 followed by Ondo state (42.9%), while cocoa farmers in Osun state had the least number in that interval (25.6%). On average, the level of inefficiency in cocoa production is highest in Osun state (26.8%) followed by Ondo state (18.7%), while Ekiti state had the least (10.8%). This level of inefficiency depicts that farmers in the respective states produce less than the maximum output at the given level of input utilization.

Slacks

Input Slacks

Input slack or input excess is a problem that arises when there is a possibility of reducing the amount of any of the input used by a farmer and still producing the same amount of output. Where there is the presence of input and/or output slacks, farmers fail to be on the efficient point of the production frontier due to excess input use and/or failure to optimize production outputs by the farmer (Yusuf and Malomo, 2007).

Table 5 presents the input and output slacks of cocoa farmers. On average, Ondo state had the highest proportion of input slacks: land size[1] (6.29), labour[2] (38.97), and agrochemicals[3] (51.91) followed by Osun state: land size (2.63), labor (14.69), and agrochemicals (39.84); and the least were farmers in Ekiti state: land size (0.698), labor (10.69), and agrochemicals (25.04). This implies that inputs are not optimally utilized by cocoa farmers, and they are said to be radially inefficient in inputs usage by the given units. Farmers can become fully efficient by reducing the excess farm resources being under utilized by the given units and still producing the same level of outputs. From the result, cocoa farmers in Ekiti state utilize inputs most efficiently, having the least among the states. The area cultivated for cocoa farming was the most utilized input followed by labor while agrochemicals are the most underutilized.

Output Slack

Output slack is a problem that arises when there is the possibility of increasing the amount of any of the production output by a farmer without any corresponding change in the amount of input use. From Table 5, the quantity of cocoa beans produced in Ondo state had a slack of 67.46 kg, 25.72kg in Osun state while Ekiti state had no output slack. This implies that farmers in Ondo state especially do not optimally produce cocoa beans by the estimated unit, as farmers obtain a smaller quantity of cocoa beans than technically possible compared to those in Osun and Ekiti states.

In summary, there is a more feasible process in which cocoa farmers could operate, such as having a greater opportunity to minimize inputs use to produce the current level of output and maximize output without any corresponding increase in use of farm resources. This will make farmers operate at an efficient point on the production frontier.

[1] Land size measured in acres
[2] Labour in man-day
[3] Agrochemicals used were ridomil and gamalin measured in litres

Table 4

Distribution of Technical Efficiency among Cocoa Farmers in Southwest Nigeria

Efficiency scores	Ondo (N= 282)		Osun (N= 125)		Ekiti (N= 106)	
	Freq	%	Freq	%	Freq	%
<0.5	5	1.8	2	1.6	-	-
0.5-0.59	38	13.5	31	24.8	-	-
0.60-0.69	42	14.9	31	24.8	3	2.8
0.70-0.79	47	16.7	19	15.2	15	14.2
0.80-0.89	29	10.3	10	8.0	26	24.5
0.90-1.00	121	42.9	32	25.6	62	58.5
Mean	0.8132		0.7323		0.8922	
Standard deviation	0.1668		0.1659		0.0880	
Minimum	0.4727		0.4903		0.6510	
Maximum	1.0000		1.000		1.0000	

Table 5

Distribution of Input and Output Slacks

Inputs/Output	Ondo	Osun	Ekiti
Land(*i*)	6.29	2.63	0.698
Labour (*i*)	38.97	14.69	10.69
Agrochemical(*i*)	51.91	39.84	25.04
Cocoa Beans (*o*)	67.46	25.72	0.00

Note: '*i*' and '*o*' represents input and output respectively

Table 6

Determinants of Technical Efficiency among Cocoa Farmers in Southwest Nigeria

Variables	Coefficient	Standard Error
Age	0.00022	0.00045
Household size	-0.001489	0.00167
Years of schooling	0.0786**	0.0380
Land area	-0.04610***	0.00517
Access to extension services	0.01754	0.01419
Distance to market	0.00104	0.00132
Age of cocoa trees	-0.1031**	0.0421
Ondo	0.02741*	0.01530
Ekiti	0.10065***	0.02049
Constant	0.76458***	0.28125
F – statistic	16.25	
Prob > F	0.0000	
R-squared	0.6252	
Adj R-squared	0.6211	

Note- ***, **, * represent 1%, 5% and 10% significant levels respectively

Factors Affecting Technical Efficiency of Cocoa Production in Southwest Nigeria

There is a positive and significant relationship between technical efficiency and the farmer's years of education (p<0.05). This implies that as the years of education of the farmer increases, the technical efficiency significantly increases. It is believed that educated farmers will adopt progressive farming practices and new technologies which will enhance efficiency (Adeyemo et al., 2010; Oluwatosin, 2011). Land area cultivated has a negative and significant relationship with technical efficiency (p<0.01). This implies that as the area of land cultivated increases, technical efficiency decreases. This could be due to the fact that increase in cocoa production in Nigeria has only been achieved by increasing land area and not increasing yield and efficiency. Also, Masterson, (2007) posited that this inverse relationship could be attributed to the higher labor intensities on small farms due to lack of off-farm employment opportunities since labor remains the most important factor in smallholder agriculture in Nigeria (Adewuyi, 2002). The age of cocoa trees shows a negative and significant relationship (p<0.05). This implies that the older the cocoa trees, the lower the efficiency. This corroborates the assertion made by Cadoni, (2013) that the majority of cocoa trees are ageing with resultant negative effects on the yield. The dummy coefficient for location of cocoa farms in Ondo and Ekiti states are positive. Results

shows that farmers located in Ekiti state (p<0.01) are significantly more technically efficient than those in Ondo state (p<0.10).

4. Conclusion and Recommendations

In this paper, we examined the profitability and applied the DEA approach to investigate the technical efficiency of cocoa production in southwest Nigeria. The results show that cocoa enterprise was found to be profitable, and in terms of technical efficiency, cocoa farmers in the region were relatively production efficient. Ekiti state has the highest mean efficiency relative to Ondo state and Osun state. The study further revealed that years of schooling has a positive influence on the technical efficiency of farmers while area of land cultivated and age of cocoa trees has a negative influence. The study recommends that since cocoa farmers are not realizing their full production potential, there is a need for sustained improvements on performance through enhanced roles by the government in educating farmers and planting of younger trees to replace aging ones, which will significantly raise technical efficiency.

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