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Input Use Efficiency of Cocoa Production among Small Scale Farmers in Ondo State

T. M. Orisasona[1], O. Taiwo[1], E. E. O. Agbebaku[1], K. A. Oluyole[1*], O. A. Williams[1] and I. F. Abdulkarim[1]

[1]Department of Economics and Extension, Cocoa Research Institute of Nigeria, PMB 5244, Ibadan, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

The study is on the analysis of the input use efficiency of cocoa production among small scale farmers in Ondo State, Nigeria. The primary objective was to analyze the input use efficiency of cocoa production among small scale farmers in four Local Government Areas (LGAs) of Ondo State. Primary data were collected using the multistage sampling techniques with the aid of structured questionnaire. The descriptive and inferential (Cobb-douglasStochastic Frontier Model) statistical tool of analysis was used to analyze the 120 respondents collected. The result of the analysis shows that majority of the farmers are male and are between the age 41-50 years. Majority (76.7%) is married and most of them (44.2%) had formal education. Furthermore, the study reveals that most of the farmers (32.5%) had between 21-30 years of farming experience and had between 3-4 hectares of cocoa plantation. Inputs that are found to be statistically significant at 1% level of significance to cocoa production are labour, chemicals and farm tools as well as farm size. However, fertilizer was found significant but has an inverse relationship with cocoa production. The elasticity of production was found to be 1.2134 indicating that the farmers are under-utilizing the inputs necessary for cocoa production. It was recommended that the use of variable inputs should be increased for optimal level of cocoa output. Also, inputs should be made

**Corresponding author: E-mail: kayodeoluyole@yahoo.com;*

readily available to farmers by the government at a cheaper and accessible way and extension services from relevant agencies like ADP and the Cocoa Research Institute of Nigeria should be intensified.

Keywords: Efficiency; elasticity; cocoa; inputs; cobb-douglas.

1. INTRODUCTION

Nigeria's economy is incomplete without agriculture. In fact, before the commercial exploitation of petroleum in the 1970s, agriculture was the main stay of the country's economy. The pre-independence year witnessed the era of agricultural boom and it accounted for over ninety percent of the export trade [1]

Agriculture contributes about 63% to the Nigeria Gross Domestic Product (GDP) and over 70% of the country's population earned their living through agriculture [2]. Presently, however, because of the export product –oriented policy of the federal government with special focus on crude oil, the Nigerian agriculture is characterized by low farm income which results in poor savings and little improvements in yield [3] thereby reducing the livelihood of the small scale cocoa farmers. In view of the foregoing, it is imperative that the scarce resources or input used for cocoa production need to be efficiently utilized to generate maximum output. Hence, the need for efficient use of resources for cocoa production.

Productive efficiency means the attainment of production goal without waste, beginning with this idea of 'no waste', economist have built up a variety of theories of efficiency. However, the fundamental idea underlying all efficiency measures is that of the quantity of goods and services produced per unit of input use. Efficiency of a production system or unit also connotes comparism between observed and optimum values of its output and inputs. The comparism can be in form of the ratio of observed to maximum potential output obtained from a given input, or the ratio of minimum potential to observe input required in producing the given output or some combination of the two [4].

1.1 Theoretical Famework

Efficiency in economics according to the neo-classical economist is usually defined in terms of the optimally conditions associated with the competition norm, that is, for efficiency to exist, the marginal rates of substitution between any commodities or factors must be the same in all their different uses [5]. Concept of efficiency is often used synonymously with that of productivity, which relates output to inputs. In agriculture, the analysis is generally associated with the possibility of farms producing a certain optimal level of output from a given bundle of resources or certain level of output at least cost.

1.2 Measurement of Efficiency

Efficiency measurement has received considerable attention from both theoretical and applied economists. The measurement is important because this is the first step in a process that might lead to substantial resource savings. These resource savings are important for policy formulation and farm management. Farell [6] distinguished efficiency measurement into three: technical, allocative and economic efficiency. Technical efficiency is the ability of producing a given level of output with a minimum quantity of inputs. It is also the ability to achieve a given level of output, given a similar level of productive input; allocative efficiency refers to the optimal input proportions given relative prices. It is the extent to which farmers make efficient decisions by using inputs up to the level at which their marginal contributions to output value is equal to the factor cost while economic efficiency refers to the product of both technical and allocative efficiencies. Technical and allocative efficiencies are individually necessary condition and when they occur together, are sufficient conditions for achieving economic efficiency.

The theoretical discussion of efficiency started with Farell [6]. He suggested a method of measuring the technical efficiency. According to him, efficiency of a firm depends on two components; technical efficiency and allocative efficiency. These two measures are combined to provide measure of total economic efficiency. Farrell instructed his ideas using two inputs X_1 and X_2 to produce output Y under the assumption of constant return to scale.

The empirical studies on the measurement of technical and allocative efficiency in the

agricultural sector in the African context are still relatively new and very limited. However, efficiency studies have been carried out on specific crops in the agricultural sector of some countries within and outside Africa. Battese et al. [7] estimated a stochastic frontier production function for farms in India although the stochastic frontier was significantly different from the corresponding deterministic frontier; the hypothesis that the efficiency effects had half-normal distribution was rejected. Technical efficiency ranged from 0.66 to 0.91, with the mean technical efficiency estimated at 0.84. A study of wheat farmers in Pakistan by Battese [8] applied a single model for estimating technical efficiencies. The inefficiency variables were the age of the farmer, maximum year of schooling and ratio of adult males the total household size and were incorporated along with the production variable of land, labour, dummy variables for fertilizer, land preparation, number of ploughs and number of seeds. The study reveals that the technical inefficiencies were highly significant meaning that the traditional response function was inadequate for the analysis of wheat farmers displayed considerable variation over time within each district such that the mean technical efficiencies ranged from 57% to 79% in the four districts. Study carried out by Ajibefun et al. [9] investigated factors influencing the technical efficiency of smallholder farmers in Nigeria, using farm level data .The result indicated that the technical efficiency of the sampled farmers were significantly related to age, and farming experience of the farmers. However, the inefficiency of the farmers was not significantly related to the size of farming operations. The hypotheses of no technical inefficiency among the sampled farmers vary widely across farms ranging between 21.75% and 87.8%. Brato-Ureta and Pinbeiro [10], in a study carried out on the small scale food crops farmers in the Dominican republic, found out mean technical, allocative and economic efficiencies of the farmers in the study area were 70%, 44%and 31% respectively. The study further revealed that Return to scale (RTS) of the farmers equal to 0.78, which is an indication of decreasing return to scale.

A study of wheat farmers in Pakistan by Farell [6] applied a single model for estimating technical efficiencies. The inefficiency variables were as age of the farmer, maximum year of schooling and ratio of adult males the total household size and were incorporated along with the production variable of land, labour, dummy variables for fertilizer, land preparation, number of ploughs and number of seeds. The technical inefficiencies were highly significant meaning that the traditional response function was inadequate for the analysis of wheat farmers displayed considerable variation over time within each district such that the mean technical efficiencies ranged from 57% to 79% in the four districts. Ajibefun et al. [9] investigated factors influencing the technical efficiency of smallholder farmers in Nigeria, using farm level data. The result indicated that the technical efficiency of the sampled farmers were significantly related to age, and farming experience of the farmers. However, the inefficiency of the farmers was not significantly related to the size of farming operations. The hypotheses of no technical inefficiency among the sampled farmers vary widely across farms ranging between 21.75% and 87.8%.

Ondo State stand out as the largest cocoa producer compared to other States of the federation. Despite the vast hectares of land been used for cocoa farming, the efficiency level of the small scale cocoa farmers is evidently low due to mainly inefficient use of input for cocoa production. In order to overcome the low and declining level of Cocoa production, efforts at increasing Cocoa production must be intensified through efficient use of input. In achieving this, there is the need to ascertain the factors affecting the efficiency use of inputs for Cocoa production in the producing areas. Therefore, there is an urgent need to examine critically the factors affecting efficiency of inputs use by small holder farmers who constitutes a greater portion of cocoa farmers. Hence the questions:

i What are the socio economic characteristics of the farmers in the study area?
ii What are the factors affecting the input use efficiency production and return to scale for the Cocoa farmers?
iii Which production inputs contribute to the efficiency level attained in the production of Cocoa in the study area?

1.3 Objectives of the Study

The objective of the study is to describe the socio-economic characteristics of the cocoa farmers in the study area and to determine the inputs affecting the efficiency of cocoa production among the farmers as well as to determine the inputs that contribute to the efficiency level attained in the production of cocoa in the study area.

2. METHODOLOGY

2.1 Study Area

The study was carried out in Ondo State, Nigeria. The state is situated in the South-western geo – political zone of Nigeria. It lies in the tropical region of West Africa. It is located within longitude 4^0 3' - 6^0 East and 5^0 45' – 8^0 15' North of the equator.

Ondo State covers an area 14,600 km with a population of 5,640,000 based on the 2006 National Population Commission head count estimates. Farming is the major occupation of the people. About 80% of the population earns their livelihood from smallholding agricultural production systems. Although Ondo State is an oil producing state, agriculture contributes the largest percentage of the revenue generated by the state. Annual temperature average 25°C with a relatively high humidity and rainfall density of about 2000 mm which make the state to be an agrarian environment suitable for farming.

The Local Government Areas of Ondo State which are predominantly known for high production of cocoa beans are Idanre, Owo, Ile Oluji/Okelgbo and Odigbo. This study was thus conducted in Idanre, Owo, Akure South, and Akure North local Government areas of Ondo State, Nigeria.

2.2 Sources of Data and Sampling Technique

Primary data was used in the study. The primary data were collected through the use of well-structured questionnaire, which were administered at the farm level among the cocoa farmers in the study area.

The multi-stage sampling technique was used in the collection of data. The first stage involve the selection of the State. Secondly, four local government Areas, namely Idanre, Owo, Akure South and Akure North local Government Areas of Ondo State were selected using purposive sampling method due to their popularity in cocoa production in the state. The third stage involves the random selection of five villages from each of the four Local Government Areas. Specifically, in Akure South Local Government the villages selected were Irese, Oda, Ijoka, Olokuta and Aponmu. In Idanre Local Government, villages enumerated are Owena, Alade, Atoshin, Itaolorun, and Ayede. In Akure North Local Government the villages that were covered are Iju, Itaogbolu, Obaile, Igoba, and Olorunda. In Owo Local Government the villages that were randomly selected are Uso, ipele, Isinada, Iyere, Emureile. The fourth stage is the random selection of five cocoa farmers in each of the villages thus a total of 120 respondents (i.e. Cocoa farmers) were selected and analyzed.

2.3 Data Analysis

Descriptive statistics and stochastic frontier model were the analytical tools used for the analysis of the data collected. The descriptive statistics was used in the analysis of the socio economic characteristics of the farmers while the stochastic frontier model was used in estimating the efficiency of cocoa production among the farmers as well as to determine the inputs that contribute to the efficiency level attained in the production of Cocoa in the study area.

2.4 Estimation of the Stochastic Frontier β Production Function

Stochastic frontier production function was used to analyze the production efficiency of cocoa farmers in the study area .The Cobb-Douglas function was fitted to the stochastic frontier production and estimated. This functional form has been used consistently in related to efficiency studies carried out independently by Ayanwale [11,12]. The linear transformation is achieved by taking the natural logarithm of the equation and it is given below.

$$lnY_i = \beta_o + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + e_i$$

Where,

i = ith farmer among the sampled Cocoa farmers
Y= Output of Cocoa beans in metric tonnes per year
X_1 = Total quantity of fertilizer used in kg
X_2= Total amounts of family and hired labour used in mandays
X_3 = Total quantity of drugs and chemicals used in litres
X_4= farm tools including cutlass, sickle
X_5 =Total land size used for Cocoa production in hectares
β = Parameter to be estimated (I =0,1,2,3,4,5)
e = Vi-Ui or the Composite error term, where,
V = Random noise term assumed to be distributed as N(0)

U = Farm specific (Technical) inefficiency effect, which is assumed to be a truncated half normal distribution with mean and variance

The component of the error term, U_i represents the systematic effect that is not explained by the production function and is therefore attributed to the households technical inefficiency. This inefficient effect term is one sided, since if U=0, the household would be lying on the production frontier, obtaining maximum production given the level of inefficiency. The inefficiency effect term is usually assumed to follow a "half normal" distribution form, that is, identically and independently distributed N (0). The components of the error terms are guided by different assumption about their distribution. The random error represents random variation in the economic environment facing the production unit.

3. RESULTS AND DISCUSSION

3.1 The Socio Economic Characteristics of the Respondents

Farming is a profession which requires agility and strength found common at the youthful age. Table 1 presents the distribution of the respondents by their age. Results on Table 1 shows that farmers between ages 41-50 year accounted for 25.8% of the respondents. Farmers below the age of 30 years constituted only 14.2% while those above 60 years of age formed 12.5% of the total respondents' .This shows that middle age people dominate cocoa production in the study area.

Furthermore, this corroborates the findings of Oluyole [17], but in contrast with his findings of Oluyole and Sanusi [14] which shows that majority of cocoa farmers in Oyo State are old probably due to more encouragement of youth in Agriculture in Ondo State as compared to Oyo State. This should influence positively both on the productivity and efficiency of Cocoa Production in the study area. Analysis on Table 1 further shows the distribution of respondents according to the sex of the household heads. The result revealed that only 6.7% of the respondents are female cocoa farmers in the study area. This tends to show that any likely increase in efficiency of cocoa production would be as a result of the predominant involvement of male farmers who are most likely to be more agile than their female counterparts. The result is also in line with most studies on the socio economic characteristics of cocoa farmers as found by Oluyole et al. [13,14], also those of Aneani et al. [15]. The study also reveals on Table 1 that 76.7% of the respondents are married, while 6.6% are either divorced or widowed. This results shows that there are more married farmers involved in cocoa production in the study area. Since most of respondents are married, it implies that there are many hands to help household heads to increase the efficiency of cocoa production in the study area.

Table 1. Socio-economic characteristics of the respondents

Age	Frequency	Percentage
Below 30	17	14.2
31-40	31	25.8
41-50	29	24.2
51-60	28	23.3
Above 60	15	12.5
Total	**120**	**100.0**
Sex		
Male	112	93.3
Female	8	6.7
Total	**120**	**100.0**
Marital status		
Single	20	16.7
Married	92	76.7
Divorce	7	5.8
Widowed	1	0.8
Total	**120**	**100.0**
Year of education group		
1 – 6 years	13	10.8
7 – 12 years	53	44.2
13 – 15 years	16	13.3
16 – 18 years	28	23.3
Above 18 years	10	8.3
Total	**120**	**100.0**

Sources: Field Survey, 2009

Education is an important factor which influence farm productivity; it determines the farmers' access to information and adoption of new farming innovation, skills and technology. Furthermore, Table 1 presents the distribution of sampled farmers by their educational level. The Table shows that 44.2% of the respondents had 7-12 years of formal education while 23.3% of the respondents had formal education of between 16 and 18 years. Meanwhile, 10.8% of respondents in the study area had formal education of between 1 year and 6 years indicating that majority of the farmers are literate and hence the ability to adopt new innovation that can bring about increase in input use efficiency, the result also corroborates with the study of Oluyole [16].

3.2 Farming Experience of the Respondents

Analysis on Table 2 reveals that 32.5% of the respondents had farming experience of between 21 and 30 years. Also, about 30.8% of the respondents had 11 to 20 years of farming experience. While less than one percent of the respondents have between 1 to 10 years. Only 4.2% of the respondents indicated above 50 years of farming experience in the study area, this also corroborates with the study carried out by Oluyole and Sanusi [14] where about 80 percent of the farmers had between 10-40 years in farming experience. Evidence thus suggest that majority of the respondents had lengthy farming experience and should be able to make the right decision on the use of input to increase their efficiency status in cocoa production. The table further reveals the major occupation of the respondents in the study area, that 78.3% of the respondents took farming as their main occupation while only 17.5% of the respondents engaged in marketing. This result shows that farming was a major occupation of the respondents. This suggests a relative availability of the respondents in the farm business. Hence, more hours and energy is expended towards the success of their farming operation.

Analysis on Table 2 further shows the hectares of farm land cultivated by cocoa farmers which is known to have a direct relationship with output. Most increase in food production has always results from increase in hectare of land cultivated. The analysis shows that 28.3% of the respondents owned 3 to 4 hectares of cocoa plantation while 26.7% had 5 to 6 hectares and only 7.5% of the farmers had 1 to 2 hectares of cocoa farm lands implying that most of the farmers cultivate large hectare of cocoa on the average. Furthermore, the analysis shows that 28.3% of the respondents obtained their inputs from the Agricultural Development Programme (ADP) while majority (55%) of the respondents sourced their inputs from the Open market. Also 14% procured their farm inputs from cooperative societies. This indicates that respondents sourced for inputs mostly from the Open Market in the study area. This tends to suggest that inputs for Cocoa production are readily available in the open market as well as in the Agricultural Development Program (ADP) offices in the study area. However, there is the possibility of not getting good quality varieties of cocoa from the open market.

Analysis on Table 2 also shows the types of inputs respondents readily apply on the farm.32.5% of the respondents constituting the majority apply fertilizer while 18.3% use agro chemicals on their farms. 14.2% uses both fertilizer and agro-chemical/improved seedlings indicating that the farmers adopt new innovation to some levels.

Table 2. Distribution of respondents by farming experience

Farming experience	Frequency	Percentage
1 – 10 years	1	0.8
11 – 20 years	37	30.8
21 – 30 years	39	32.5
31 – 40 years	28	23.3
41 – 8.350 years	10	8.3
Above 50 years	5	4.2
Total	**120**	**100.0**
Sources of Inputs		
Agricultural Development Program me	34	28.3
Open Market	66	55.0
Agricultural Cooperative	17	14.0
Others	3	2.5
Total	**120**	**100.0**
Majors Occupation		
Farming	95	79.2
Marketing	21	17.5
Craftsmanship	1	0.8
Farming and craftsmanship	3	2.5
Total	**120**	**100.0**
Total area of land cultivated (Ha)		
1 – 2	9	7.5
3 – 4	34	28.3
5 – 6	32	26.7
7 – 8	23	19.2
9 – 10	22	18.3
Total	**120**	**100.0**

Sources: Field Survey, 2009

3.3 Determinants of the Input Efficiency of Cocoa Production of Cocoa Farmers in Ondo State, Nigeria

Analysis in Table 3 shows the frontier production function analysis of the inputs use for Cocoa production in Ondo State. The analysis shows a sigma square of 0.9450, this indicate that 94% of the variables included in the analysis jointly explain the output of cocoa in the study area

hence the OLS model is of a good fit for the analysis.

The analysis further shows that fertilizer input is statistically significant at 10% and it is inversely related to cocoa output. However labour, chemicals, farm tools and farm size are positively related to cocoa output and are highly significant at 1% level of significance thus it shows how critical they are in the production of cocoa in Ondo State this is in line with the study carried out by Oluyole [16] in Taraba State where the cost of labour and chemicals were found to be critical cost in cocoa production.

Table 3. Determinant of the input efficiency of cocoa production of cocoa farmers in Ondo State, Nigeria

Variables	OLS Co-efficient	MLE Co-efficient
Constant	0.2659	0.2713
	(0.9407)***	(0.2762)***
Qty of fertilizer (Kg)	-01710	-0.1804
	(-0.1716)*	(-0.1519)
Labour (mandays)	0.3065	0.3064
	(0.3462)***	(0.6229)***
Quantity of chemical (litre)	0.2909	0.2726
	(0.2694)***	(0.2508)**
farm tools	0.1856	0.1856
	(0.3516)***	(0.4515)***
Farm size (ha)	0.6014	0.5995
	(0.2275)**	(0.6267)***
Sigma Square δ^2	*0.9450*	*0.9272*
Log Likelihood	*-0.2565*	*(-0.2009)*
Gamma λ -	*0.4998, LR test -*	*(0.1461)*

** = significant at 10%, ** = significant at 5%, *** = significant at 1%*

The elasticity of production is the summation of the coefficient in the analysis which also indicates the proportionate change in output as a result of 1% increase in variable input shows an elasticity value of 1.2134 which implies that a 100% increase in the variable input considered for cocoa production will bring about 121% increase in output, therefore the cocoa farmer in the study area are operating on an increasing rate of return to scale. In terms of stages of production, these inputs falls within the rational stage (stage 11), therefore, the cocoa farmers should rather continue to increase the use of variable inputs that will eventually bring about an increase in output of cocoa thereby increasing farmers income and hence the livelihood of the farmers. This further indicates that the farmers are either underutilizing there inputs for production or they do not have enough access to inputs that can bring about higher cocoa production.

4. SUMMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

The study looked at the analysis of input use efficiency of cocoa production in Ondo State. The result of the analysis shows that majority of the farmers are male and are between the ages of 41-50 years. Majority (76.7%) is married and most of them (44.2%) had formal education. Furthermore, the study reveals that most of the farmers (28.3%) has between 21-30 years of farming experience and has between 3-4 hectares of cocoa plantation. Whereas most farmers obtain their inputs from the open market, some equally obtain their inputs from the Agricultural Development Programme (ADP). Inputs that are found to be statistically significant to cocoa production are labour, chemicals, farm tools as well as farm size. However, fertilizer was found significant but has an inverse relationship with cocoa production.

The elasticity of production was found to be 1.2134 which shows that it is greater than one indicating that the farmers are under-utilizing the inputs necessary for cocoa production. It indicates that a 1% increase in input use would lead to more than 1% proportionate change in the output of cocoa. This implies an increasing return to scale in variable inputs use among the farmers because a 100% increase in the input use will result to about 121% increase in output of cocoa.

Based on the result of this research, the following policy measures will assist cocoa farmers.

1. The use of variable inputs considered for production should be increased for optimal level of output of cocoa such as labour, chemical and farm tool.
2. Inputs should be made readily available to farmers by the government in a more cheaper and accessible way so as to increase the use of inputs for higher cocoa production.
3 Extension services from relevant agencies like ADP and Cocoa Research Institute of Nigeria should be intensified since most farmers are between their active age and

with formal education hence their high tendency to adopt new innovations, particularly as to where they acquire their inputs for cocoa production.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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