Application of Frontier Production Model to Cocoa Farming in Surulere Local Government Area of Oyo State,Nigeria.

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Abstract

This study applied stochastic production to determine the technical efficiency of cocoa farmers in Oyo State, Nigeria. A total of seventy respondents was interviewed .Primary data was used with well structured questionnaire. The descriptive analysis showed that a large proportion (58.6%) of the cocoa farmers had formal (primary) education. It also revealed that farm size and family labour have positive and significant relationship with income of the farmers. The cost of chemical and implement have significant but negative relationship with income of the farmers. Inefficiency estimates showed that years of schooling and farming experience reduce the inefficiency of the farmers, while age of the farmers, family size and age of the farm increase the inefficiency of the farmers. The mean technical efficiency of the farmers is 54 per cent. The implication of this result is that any effort aimed at increasing years of schooling and farmers experience will increase the technical efficiency of the farmers. This study therefore recommends mass literacy campaign in the study area in order to increase the technical efficiency of the farmers.

Keywords: Application, Frontier, Production, Model, Cocoa, Farming,

Introduction

The cocoa tree known as *Theobroma Cacao* belongs to the family *stericuliniacea*. Cocoa has its gene centre in the upper Amazon region of the South America from where it spread to different parts of the world (Osun, 2001). It is generally believed that cocoa cultivation in Nigeria started about 1879 when a local chief established a plantation at Bonny in the defunct Eastern Nigeria. However, cultivation in the western Nigeria began afterwards. Production has been reducing in recent years as a result of old age of farmers and farms, inefficiency in the use of resources by farmers. The implication of this has been reduced cocoa production at a time when there are more processing industries and the increased demand for Nigerian cocoa as a result of world political instability and the growth in consumption of chocolate the world over.

Cocoa is a concentrated food with high nutritive value. It provides carbohydrate, protein, fat and minerals. Again it is usually used for making beverages, wine chocolate, cream and livestock feed. Nigeria was second largest cocoa producer in the world with about 97% of its total production from the south-western region . Recently, the trend seems to have changed in the negative with production declining rapidly. The yield of cocoa in Nigeria has declined to 250kg/ha from as high as 480kg/ha in 1965(Adegeye and Ajayi, 1996). The picture becomes clearer when this is compared with 400kg/ha in Ghana, 600kg/ha in Ivory Coast, and Malaysia 800kg/ha (Alabi, et al, 2004b). The fall in percentage share of cocoa output may be attributable to two reasons. First is the negligence of the agricultural sector by the past administrations due to the discovery of the petroleum resources that now accounts for the enormity of foreign exchange earnings. Second is the endemic problem in the cocoa industry. The impact of the declining production level is the fall in the income accruing to the farmers. Realization of the potentials of cocoa in the economy of the country, the government set up the defunct cocoa marketing board, which was program scraped as part of the Structural Adjustment (SAP) in 1986. The dissolution of the Commodity Board and the introduction of free market pricing system encouraged farmers who had hitherto abandoned their cocoa farms to embark on rehabilitation and establishing new holdings. Farmers enjoyed high farm-gate prices for their cocoa. Thus young men and women returned to cocoa farming again. This led to the injection of huge amount of money into the subsector. This had significant impact on the economy and socio-political stability of the producing region.

The era of commodity trade liberalization has also witnessed unprecedented drawbacks. It led to complete dismantling of all the infrastructures and administrative systems, which facilitated efficient

commodity trade. Although the farmers are still enjoying market determined prices for their commodity, they have lost all the subsidies and support from government as well as stable price development. The debilitating impacts started showing that production output are on the downward trend and government is paying lip service to ensure an upward upswing. The uncontrolled entry and exit of middlemen and exporters resulted to loss of money at the domestic market, and poor quality of produce and declining output. The trend must be reversed if farmers' output and thus their income are to be commensurate with the efforts the farmers put into cocoa production.

In general terms, Gockowski *et al*.(2000) and, Nkamleu and Ndoye (2003) established that in Africa, the cocoa sector thrives on increase in area cultivated rather than improving yield rather than improving technical efficiency. To reverse this trend, stakeholders of cocoa growing economies have resorted to introducing policy reforms into the industry to improve efficiency. Low production efficiency means that output can be increased without requiring additional conventional inputs and new technology. This implies that empirical measures of efficiency and technical progress is the rational strategy to adopt to improve performance significantly with a given technology, or in the presence of technological gaps. The general output of individual farmers therefore largely depends on the various inputs as well as other specific characteristics relevant for the estimation of inefficiency.

Agricultural productivity can be defined as the index of the ratio the value of total farm output to the total farm inputs used in farm production (Alabi, et al, 2004a). Resource productivity is definable in terms of individual resource inputs or a combination of them. Optimal productivity and efficiency are synonyms in this conclusion (Ajani and Olayemi, 2000). Many past analyses of efficiency in farming involve calculation of ratio of total output to input used or comparing the marginal value product with marginal input cost (Afolami, 2001). These measures can be very informative but can also be quite misleading, because each measure only considers a single input in isolation.

Farrell (1957) proposed a method of measuring efficiency which could account for all factors of production simultaneously. He proposed measuring the technical efficiency of a firm in an industry by comparing its observed output to that output which could be produced by a fully-efficient firm, given the same bundle of inputs. Many subsequent papers have applied and extended Farrell's ideas. The literature may be roughly divided into groups, according to the method chosen to estimate the production of the fully-efficiency firm (which are now commonly referred to as frontier production function). Determination of the factors

affecting technical e fficiency dates back to the early1990s, and are evaluated by both parametric and non-parametric techniques. The non parametric technique constitutes Data Envelopment Analysis (DEA) and requires linear programming based on the input and output quantities [10]. The parametric technique is also based on the stochastic frontier analysis (SFA), which was first proposed by Aigner *et al*. (1977) and Meeusen and Van den Broeck (1977). The SFA uses assumptions on the distribution of an unobserved productivity component to separate productivity from the deterministic part of the production function and the random error. Estimating relative technical efficiencies of firms are thus based on information extracted from extreme observations from a body of data to determine the best practice production frontier to achieve the relative measure.

While some studies have applied stochastic frontier production in analysis technical efficiency of farmers in African settings, none of such studies model technical efficiency with farmers' socio-economic variables as determinants of technical efficiency. Hence, this study was designed to determine the technical efficiency of cocoa farmers in Surulere Local Government Area of Oyo State, through the application of stochastic frontier production model, taking socio-economic characteristics of farmers as determinants of technical efficiency.

Methodology

The study was carried out within Surulere Local Government Area of Oyo State. It was created out of defunct Ogbomoso Local Government in 1989.The headquarter is located at Iresaadu. The Local Government share boundaries with Ifelodun and Orolu Local Government Area of Osun State, Asa Local Government Area of Kwara State and Orire, Ogbomoso North and South Local Government Area of Oyo State. The vegetation is generally regarded as derived savannah vegetation zone and with a low-rain forest area. There are two main season in the area, dry and wet season. The wet season usually starts from the middle of April and ends towards October while dry season start from early November and ends in March. A fairly high and uniform temperature, moderate heavy seasonal rainfall and high relative humidity characterizes the climate. The mean annual temperature for the area is 26^0c while lowest temperature is experienced in March is 28.97^0c. Humidity is highest during the wet season especially between July to September and lowest in December and January. To obtain the relevant farm household data required for this study, farm survey was conducted. The main instrument for collecting the primary data is structured questionnaire. Data collected include socio-economic characteristics of the farmers such as age, educational level, sex, marital status, experiences, household size, and extension contact, production inputs, farm

output and their farm gate and market prices. Family and hired labour utilization profile, labour wage rates, hectare of the cocoa farm, cultivated rental values of land, crop yield and incomes. Three communities were randomly selected from the list of the communities in the Local Government Area due to the abundant of cocoa farmers in the area. Twenty five farmers were selected from each of two communities while twenty farmers were selected from the third community. A total of 70 cocoa farmers were interviewed with the aid of structured questionnaires which were coded and analysed using descriptive statistics and stochastic production frontier.

In this study, a variant of Battese Coelli (1995) model of stochastic production frontier was applied in the analysis of data to capture the technical efficiency of the farmers.

The empirical model of the stochastic production frontier was specified as:

$$\ln Q = a_0 + a_1 \ln X_1 + a_2 \ln X_2 + a_3 \ln X_3 + a_4 \ln X_4 + a_5 \ln X_5 + (V_i - U_i) \quad \ldots\ldots\ldots\ldots\ldots (1)$$

The subscript refer to the i-th farmer,

Where,

ln = Natural logarithms

Q = Total value of farm output (#)

X_1 = Land area under cultivation (ha)

X_2 = Total quantity of family labour (man-day)

X_3 = Total of hired labour (man-day)

X_4 = Expenses on chemical (#)

X_5 = Cost of farm implement (#)

V_i = a random error term with independent and identical normal distribution with mean zero and variance δ^2_v, intended to capture events like weather, etc.

U_i = Non-negative random variable called technical inefficiency effects associated with technical inefficiency of the farmers involved. It is assumed to arise from a normal distribution with mean u and variance δ_u^2, which truncated at zero. If Ui = O no allocative inefficiency occurs, the production lies on the stochastic frontier. If Ui> O, production lies below the frontier and is inefficient.

The average level of inefficiency measured by the mode of truncated normal distribution (i.e.U_i) is a function of socio-economic variables of the farmers and specified in the equation below,

$$U_i = a_0 + a_1 Z_1 + a_2 Z_2 + a_3 Z_3 + a_4 Z_4 + a_5 Z_5 \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Where,

Z_1 = Age of the farmer (years)

Z_2 = Years of the formal education (years)

Z_3 = Experience (years)

Z_4 = Household size

Z_5 = Age of the farm

a's and γ coefficients are unknown parameters to be estimated along with the various parameters which are expressed in term of $\delta_s^2 = \delta_v^2 + d^2 = \delta^2/\delta_s^2$

where the γ – parameter has value between zero and one. The parameters of stochastic frontier function model were obtained by Maximum Likelihood Estimation method, using the Computer Programme, Frontier Version 4.1 (Coelli, 1994), where equations 1 and 2 were simultaneously estimated.

Result and Discussion

Table 1 shows that the farmers are relatively young with average age of 49years; they are still in their active age. The breakdown of their education history shows that 58.6% of respondents had primary education, while 22.9% had secondary education. On the hand, 18% of respondents had no education which implies that they were illiterates. The mean years of farming experience of 27.44years implies that they have been involved in the farming system for long, a factor that would have helped them in evolving an adaptable farming system compatible to their environment. The household size of about eight can be an asset or liability depending on their prevailing circumstances. If the majority of the members of household are employable on the farms, they can be source of labour. If majority of the members of the household are dependant, they may affect the flow of investment capital to the farms. Farm size of 8.24hectare shows that they are large-scale farmers. The age of the farm of about 28years indicates that their cocoa farms are at optimal production age.

Table 1: Summary of socio-economic characteristics of the Respondents

Socio-economic characteristics	Mean
Age of the farmers	48.67years
Years of schooling	1.04
Farming experience	27.44years
Household size	7.69
Farm size	8.24ha
Age of the farm	27.78years
Annual farm income	#164142.86
Sex	49(70%) male 21(30) female
Marital status	59(84.3% married)11(15.7%unmarried)

Source: Computed from field data, 2012.

Table 2 shows that while farm size and family size are significant and positive determinants of income of cocoa farmers (P< 0.01), coat of chemical, fertilizer and cost of implement have negative but significant relationship with the income. Hired labour has positive but significant statistical relationship with output of the

farmers. The coefficient estimates in table 2, indicates that increase in farm size and family labour will result in increase income of the farmers, while increase in costs of chemical and implement will reduce the income of the farmers. The findings reported in table 2 also indicates that one unit increase in farm size, family labour and hired labour will lead to 361.5612, 8.3476 and 6.4909 respectively. It is glaring that a unit increases in output than any other inputs.

Inefficiency estimates indicate that age of farmers, household size, age of the farm have positive relationship with inefficiency of the farmers. It means that increase in the age of the farmers, age of the farms and household family size will reduce the efficiency of the farmers. Table 2 also shows that years of schooling and farming experience have negative relationship with technical inefficiency of the farmers. This means that educated farmers are less inefficient than uneducated ones, the experienced farmers are more efficient than inexperienced farmers. These findings are in consonance with the study of Ajibefun et al (2002a). They showed that years of schooling and experience have negative relationship with inefficiency of the farmers. Ajibefun et al (2002b) indicates that age of the farmers is positively related with technical inefficiency of the farmers. The value of gamma(γ) 0.8913, close to one , which indicates that the inefficiency effects are highly significant in the analysis of the income of cocoa production in the study area (if the gamma is zero, the variance of the inefficiency effect is zero and so the model reduces to traditional average response function in which the variables of age, year of schooling, farming experience, household size are included in the production function). The log likelihood function estimated to be -89.2207. This value represents the value that maximizes the joint densities in the estimated model.The findings reported in table 2 also shows that the technical efficiencies of the farmers ranges from 0.1092 to 0.9007 with mean of 0.5357 (on the scale of 1). It means that farmers on the average are 54% efficient in the use of combination of inputs available to them.

Table 2: Maximum Likelihood Estimates and inefficiency parameters of equation 1 and 2.

Variable	Coefficient	t-ratio
Inefficiency model		
Constant	5.2085	12.1458
Family Size	361.56	6.9561***
Family labour	8.3476	3.7472***
Hired labour	6.4909	1.2992
Expenses on Chemical	-0.1484	-4.5411***
Cost of implement	-3.7168	-3.3652***
Inefficiency Model		
Constant	7.1588	1.6817
Age	0.6643	2.7180***
Year of Education	-9.0205	-3.1431***
Year of Experience	-0.2485	-2.6504***
Family Size	0.5075	2.6810***
Age of the farm	7.6751	2.5832***
Variance Parameter		
Sigma squared	13.0552	2.6241***
Gamma	0.8913	18.1632
Likelihood	-89.2207	
Technical efficiency (Mean =0.5357)	Minimum=0.1092	Maximum=0.9007

Note: *** = 1% level of significance

Source: Computed from field survey data, 2012.

The study showed that farm size and family labour have positive significant relationship with income of the farmers while costs of chemical and implement have significant but negative relationship with income of the farmers. Inefficiency estimates shows that years of schooling and farming experience reduce inefficiency of the farmers, while age of the farmers, household size, and age of the farm increases inefficiency of the farmers. The mean technical efficiency is 54%.

Conclusion and Recommendation

The implication of this study is that any effort aimed at increasing years of schooling and farmers experience will increase the technical efficiency of the farmers. This study therefore recommends mass literacy campaign in the study area in order to increase the efficiency of the farmers.

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