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COST EFFICIENCY OF COCOA FARMERS IN TWIFO HEMANG LOWER DENKYIRA AREA IN CENTRAL REGION OF GHANA

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Abstract

This study empirically examined cost efficiency of cocoa production in Twifo Hemang Lower Denkyira area in Central region of Ghana. Primary data was collected from 400 cocoa farmers in twenty (20) communities using interview guide and the cost efficiency of inputs in cocoa production was estimated using stochastic frontier production function. The empirical result of summation of the partial elasticities exhibited positive increasing returns to scale in the inputs use and the mean cost efficiency was 1.10 indicating that an average cocoa farms in the study area incurred costs that were about 10% above the minimum cost defined by the frontier .The findings show that cost efficiency of inputs use was fairly high. Hybrid varieties, level of education and age of tree, Farmer-based organization and extension contacts were found to be the main determinants of cost efficiency. This study recommends that Farmers should be encouraged to join farmer-based organization.

Introduction

Cocoa production has been a chief support to Ghana's economy through mainly its foreign exchange earnings, employment to thousands of rural dwellers and huge contribution to its Gross Domestic Product (GDP). Ghana cannot be mentioned without talking about its cocoa. Likewise, one cannot think of cocoa without thinking about Ghana. Notwithstanding the tremendous contribution of cocoa to the rural and the entire economy at large, the cocoa sector faces several challenges that limit not only the full potential of the sub-sector but also raises concerns about future sustainability of the cocoa sub-sector and the competitiveness of Ghana's cocoa farmers in an ever changing global economy.

Several researchers have found that Ghana's output growth in recent years in cocoa production has been as a result of increased land area frontier under cultivation. For instance nkamleu and ndoye (2003) reported that in Africa, growth in the cocoa sector has been achieved mainly by increasing the area cultivated rather than by improving yield that is the productive capacity of the cocoa plants. While recent household studies suggest dramatic output increases in the cocoa sector, longer-term analysis using data from the Food and Agriculture Organization (FAO) of the United Nations suggests that productivity may have declined marginally in the country: between 1991 and 2005: Ghana's cocoa output increased by six percent while the area expanded by seven percent, suggesting a decline in productivity of about one percent over the 14-year period (Binam, Gockowski and Nkamleu, 2008). These reinforce that increment in output in the Ghana's cocoa sector is attributable mainly to farmers merely expanding the area frontier of production rather than improvement in the yield capacity of the plant. Given the fixed and limited land area available, this approach of increasing output is very unsustainable and if an alternative approach is not sought for, the frontier will be reached and the forest cover completely wiped out.

However it is possible to increase agricultural production significantly, simply by improving the level of producer technical efficiency without additional investments (Dzene, 2010). Increasing productivity and efficiency requires a good knowledge of the current inherent efficiency or inefficiency and related factors. The studies to identify the factors of efficiency and to suggest the policy intervention to improve productivity and technical efficiency of cocoa production have been conducted in the past in Ghana as well as other countries (Aneani, Anchirinah, Owusu-Ansah and Asamoah, 2011; Binam *et al.*, 2008; Dzene, 2010; Kyei *et al.*, 2011). However, to the best of my knowledge, in the context of Ghana, there is no study so far assessing the cost efficiency of cocoa farms. This research work deals with cost efficiency of inputs use in cocoa production in Twifo Hemang Lower Denkyira area in Central region of Ghana.

METHODOLOGY

Sample Size

Primary data were used for this study and to get the sample size, a formula developed by Cochran (1963) was used.

$$n_o = \frac{Z^2 pg}{e^2}$$

Where n_0 is the sample size, Z^2 is the abscissa of the normal curve that cuts off an area α at the tails (1 - α equals the desired confidence level), e is the desired level of precision, p is the estimated proportion of an attribute that is present in the population, and q is 1-p. The value for Z is found in statistical tables which contain the area under the normal curve. We assume p=0.5 (maximum variability), 95% confidence level and ±5% precision.

$$n_0 = \frac{Z^2 pq}{e^2} = \frac{(1.96)^2 (0.5)(0.5)}{(0.05)^2} = 385 \text{ farmers}$$

The sample size of 385 was rounded up to 400 to take care of maximum error.

Method of Sampling

A sample of 400 cocoa farmers was randomly selected using the multi-stage sampling approach. A list of names of farmers of the Licensed Buying Companies (LBC) served as the sampling frame from which the sample of farmers was selected. A three-stage sampling technique was used to the selection of sample of 400 farmers.

First of all, stratified sampling technique was used to divide the study area into two strata based on the demarcations of the two newly created districts namely, Twifo Atti Mokwaa district and Hemang Lower Denkyira district. In the second stage, simple random sampling was employed to obtain ten (10) cocoa communities from each district and finally twenty (20) farmers were identified randomly using, again, simple random sampling technique in each of the communities. The sample size per stratum was the same because the two zones had similar population strengths in terms of cocoa farmers. However, due to some irregularities in the data, 326 respondents were used for the efficiency analysis in the study.

Model Specification for Cost Function

The traditional production efficiency against a cost frontier is evaluated by the extent to which a farm's actual cost deviates from the efficient cost frontier. To analyze the data, both the statistical and tabular methods were employed. For the purpose of the statistical analysis, Battese and Coelli (1995) model was used to specify a stochastic frontier cost function with the behaviour inefficiency component and to estimate all parameters together in maximum likelihood estimation. If we wish to specify a stochastic frontier cost function, we simply alter the error term specification from (V_i - U_i) of the production function to (V_i + U_i). This model is implicitly expressed as:

$$In\ C_i = g\ (P_i,\ Y_i;\ \alpha) + (V_i + U_i) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

where C_i represents the total cost of production, g is a suitable functional form such as the Cobb-Douglas; P_i is the vector variable of input prices,. Y_i is the value of output, α is the parameter to be estimated. The systematic component V_i represents the random disturbance costs due to the factors outside the scope of farmers. It is assumed to be identically and normally distributed with mean zero and constant variance as N (0, σ^2v). Ui is the one-sided disturbance form used to represent cost inefficiency and is independent of Vi. Thus, $U_i = 0$ for a farm whose costs lie on the frontier, $U_i > 0$ for farms whose cost is above the frontier, $U_i < 0$ for farm identically and independently distributed as N (0, σ^2v). The two error terms are proceeded by positive signs because inefficiencies are always assumed to increase cost.

In this cost function the U_i now defines how far the firm operates above the cost frontier. If allocative efficiency is assumed, the U_i is closely related to the cost of technical inefficiency. If this assumption is not made, the interpretation of the U_i in a cost function is less clear, with both technical and allocative inefficiencies possibly involved. Thus we shall refer to efficiencies measured relative to a cost frontier as “cost” efficiencies in the remainder of this document. The exact interpretation of these cost efficiencies will depend upon the particular application.

Furthermore, the cost efficiency of an individual cocoa farm is defined in the terms of the ratio of the observed cost (C^b) to the corresponding minimum cost (C^{min}) given the available technology and is expressed as:

$$\text{Cost Efficiency } (C_{EE}) = \frac{c^b}{C^{min}} = \frac{g\ (Pi, Yi; \alpha) + (Vi + Ui)}{g\ (Pi, Yi; \alpha) + (Vi\ )} = \exp\ (U_i) \ldots\ldots\ldots\ldots\ldots (2)$$

where the observed cost (C^b) represents the actual production cost whereas the minimum cost (C^{min}) represents the frontier total production cost or the least total production cost level. C_{EE} takes the values between 1 or higher with 1 defining cost efficient farm (Ogundari *et al.*2006). The stochastic cost frontier model focused on the average performance, optimal and extreme performances of firm. The zone below the cost frontier is unattainable; therefore, all productive units are either on or above the frontier. Those on the frontier have the lowest or minimum cost of factors of production for a given level of output. The Cobb-Douglas cost frontier function for the cocoa farmers was specified and defined as follows:

$$C_i = \alpha_0 .\ P_1^{\alpha 1} .\ P_2^{\alpha 2} .\ P_3^{\alpha 3} .\ Y_i^{\alpha 4} .\ \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

But $\varepsilon_i = V_i + U_i$

The linear transformation of (3) is achieved by taking the natural logarithm of both sides of the equation to obtain (4)

$$\text{In } C_i = \alpha_0 + \alpha_1 \text{InP}_1 + \alpha_2 \text{InP}_2 + \alpha_3 \text{InP}_3 + \alpha_4 \text{In } Y_i + V_i + U_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

The choice of the Cobb-Douglas is based on the fact that the methodology requires that the function be self dual as in the case of cost function which this analysis is based on. The cost inefficiency model for the study is specified as:

$$U_{it} = \chi_0 + \chi_1 \text{Exp}_i + \chi_2 \text{Ext}_i + \chi_3 \text{FBO}_i + \chi_4 \text{Age}_i + \chi_5 \text{Pri}_i + \chi_6 \text{M/JS}_i + \chi_7 \text{SVT}_i + \chi_8 \text{Ter}_i + \chi_9 \text{Hyb}_i + \chi_{10} \text{Hyb-loc}_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

where U*it* represents the cost inefficiency of i-th farmer; all these variables are expected to explain the technical efficiency levels in technology use in cocoa production in the study area and were fitted into a multiple regression equation.

Results and discussions

Effect of the inputs on cost of production

All the variables included in the cost function had positive correlation on total cost. With the exception of coefficient of the price of yield, the coefficients of all the other variables were statistically significant. This means that an increase in the cost of fertilizer, cost of pesticides and cost of labour will result in a significant increase in total cost. Maximum likelihood estimates (MLE) of the cost model is presented in Table 1.

Table 1: Cost Efficiency Model Estimation

Variables	Parameters	Coefficients	Standard error	t-ratio
Constant	α_0	-0.0677***	0.0148	-4.5774
InFertilizer cost	α_1	0.1452***	0.0231	6.2927
InLabour cost	α_2	0.7192***	0.0384	18.7451
InChemicals cost	α_3	0.1660***	0.0223	7.4370
InYield price	α_4	0.0139	0.0238	0.5848
Sigma-squared	Σ^2	0.1263	0.0268	4.7048

Gamma	Γ	0.8571	0.0227	37.7577

*** represents one percent (1%) level of significance

Source; Study results, 2014

The computed value of the scale return to scale is 1.0443. This indicates increasing return to scale and it means that increasing cost of all the variables by one percent (1%) caused 1.044 percent (1.044) in the total cost. Increasing any of the variables, that is, the cost of labour, cost of pesticide, cost of fertilizer or price of yield by one percent (1%) result in 0.7192%, 0.1660%, 0.1452% or 0.0139% in total cost respectively. It is worthwhile to reiterate that an increase in yield by one percent (1%) resulted in 0.0139% increase in total cost. In Paudel *et al.* (2009) research, increasing the yields of maize by one percent (1%) was found to elicit a 0.21% increase in total cost and is greater than the percentage increment in total cost when yield is increased by one percent (1%) in this study.

The huge effect of cost of labour on total cost of cocoa production to a large extent explains why a lot of the respondents in the study area are adopting labour serving technologies or inputs like herbicide weed control (87%) and use of prunners for pruning. These inputs greatly enhance labour productivity. The supply of labour may be less than labour demanded and this might be causing the rise in cost of labour. Also, it can be argued tentatively that other sectors of the rural economy (like in constructions to carry concrete, assisting in commercial cars etc) may pay higher for labour services than farming and arguably less laborious, and so individual prefer offering the labour services to the other sectors. As a result, farmers may be forced to pay higher price for the labour supply. Table 2 provides the results of the elasticities and return to scale of the cost model discussed above.

Table 2: Partial Elasticity and Returns to Scale of Production (Cost Model)

Variables	Elasticities
Fertilizer cost	0.1452
Labour cost	0.7192
pesticide cost	0.1660
Yield price	0.0139
Returns to scale	1.0443

Source: Study results, 2014

Levels of Cost Efficiency of Inputs Use in Cocoa Production

The coefficient of gamma was high (0.8570) and significant, indicating the appropriateness of the model. The coefficient of gamma of 0.8750 means that 85.71% variations in the observed cost from the frontier cost are mainly due to cost inefficiency whilst a 14.29% is explained by factors beyond the control of the farmer like weather conditions, statistical errors, data collection errors. The cost efficiency score of the respondents ranges from 1.03 to 1.45. The mean cost efficiency was 1.10 meaning that an average cocoa farms in the study area incurred costs that were about 10% above the minimum cost defined by the frontier. That is, over 10% of the cocoa farms costs were wasted in comparison to the best practice firms producing the same output and facing the same technology.

Table 3: Frequency distribution of Cost Efficiency Estimates

Efficiencies level (%)	Frequency	Percent	Cumulative Percent
1.01-1.05	94	28.9	28.9
1.06-1.10	135	41.5	70.3
1.11-1.15	48	14.6	85.0
1.16-1.20	21	6.5	91.5
1.21-1.25	12	3.7	95.1
1.26-1.30	8	2.4	97.6
>1.30	8	2.4	100.0
Total	326	100.0	

Source: Study results, 2014

The frequency distribution of results of the data analysis of the level of cost efficiency of inputs use by respondents is presented in Table 3 above. The results show that the vast majority of the cocoa farmers were fairly cost efficient. From the above table, 70.3% of the respondents incurred at most 10% more than the minimum cost defined by the frontier. The research by Ojo *et al.* (2008) in Niger state, Nigeria on cost efficiency in small scale irrigated tomato production had a similar mean cost efficiency estimate. The researchers revealed that the mean cost efficiency of the respondents is 1.09 indicating that they were relatively efficient in allocating their scarce resources. Ogundari *et al*. (2006), while analyzing the small scale maize production in Nigeria, obtained the result that a relatively larger proportion of farms were fairly efficient to minimize the resource wastage associated with the production process.

Determinants of cost efficiency

The results of the analysis of the determinants of cost inefficiency are as shown in Table 4. Except the variables; experience of farmer and planting of mixture of hybrid and local; all the other variables had significant effects on cost efficiency of inputs use in cocoa production in the study area.

Table 4: Estimated Parameters of the Cost Inefficiency Effects model

Variables	Parameter	Coefficient	Standard-error	t-ratio
Constant	χ_0	-0.9452***	0.2915	-3.2429
Experience	χ_1	-0.0032	0.0036	-0.8820
Extension contacts per yr	χ_2	0.0715**	0.0290	2.4610
Farmer based organisation	χ_3	-1.3254***	0.4160	-3.1863
Age of tree	χ_4	0.0219***	0.0052	4.2478
Primary	χ_5	0.3251**	0.1112	2.9228
MSL/JSS	χ_6	-0.3765**	0.1320	-2.8514
Sec/Voc	χ_7	-0.8674**	0.3311	-2.6201
Tertiary	χ_8	-0.5095**	0.2324	-2.1928

Hybrid	χ_9	-0.4039**	0.1490	-2.7114
Hybrid-local	χ_{10}	-0.0296	0.0789	-0.3757

Note:*, **, *** indicate significance at 10 per cent, 5 per cent and 1 per cent levels, respectively

Source: Study result, 2014

Farmer based organisation had the highest significant impact on cost efficiency. There was negative correlation between farmer based organisation and cost inefficiency. Farmer-based-organisation significantly enhanced the cost efficiency of inputs use in cocoa production in the study area. In other words, farmers that were members of farmer-based-organisation were much more efficient in the management of the cost of production. Most of the farmer based organisations took advantage of the number of inputs they can purchase for its members to bargain for cheaper prices of inputs for their members and also organises training services for their members. Again members of farmer-based-organisation help themselves to undertake farm operations popularly referred to in 'nnoboa' in Twi. These forms of assistance the farmers enjoy from farmer-based-organisation enhanced their cost efficiency of inputs use.

Furthermore, as expected, the age of tree was positively related to cost inefficiency of production. This implies that as the age of trees increases, the cost inefficiency of production of the farmer increases. This may be due to the reduction in yield of the plant as the plants grow beyond some years of production.

Kalirajan (1981) stressed the need for policy makers in a South Indian state to focus on extension work in order to increase rice production and reduce inefficiency. Owen (2001) showed that access to agricultural extension services, defined as receiving one or two visits per agricultural year, raises the value of crop production by about 15%. Contrary to these and other literatures, the result of the empirical analysis showed that there was positive correlation between cost inefficiency and the number of contact made with extension agents per cocoa season. This implies that farmers who had more contacts with extension agents were rather more cost inefficient.

On education, the coefficient estimate of primary education was positively related to cost inefficiency while the coefficients of middle school/junior secondary school leavers, secondary/vocational leavers and tertiary institution were negatively related to cost inefficiency. However, all the variables were significant. This means that formal education above primary level improved cost efficiency. Pudasaini (1983) documented that education contributed to agricultural production in Nepal through both worker and allocative effects. The author also found that even though education enhances agricultural production mainly by improving farmers' decision making ability, the way in which it is done differs from environment to environment.

Interestingly, the coefficient estimate of secondary/technical/vocational level of education was greater than that of tertiary level of education. Kumbhakar *et al.* (2000) argues that a producer may be technically efficient, but yet cost inefficient because he fails to choose correct input combination. For Weirs (1999), at least four years of primary schooling are required to have a significant effect upon farm productivity. On the contrary, Adesina and Djato (1996), also found that there is no difference in either relative technical, allocative or economic efficiencies between educated (defined as those who had at least one year of formal schooling) and non-educated farmers and recommended that rural development efforts should not be biased towards "educated" farmers as "non-educated" farmers are just as efficient.

The number of years of farming or farming experience had negative effect on cost inefficiency. Farming experience improved the cost efficiency of inputs use in cocoa production insignificantly. This may be because increased years of farming establishes important acquaintance and acquire relevant skill which helps reduce cost and increases cost efficiency. For instance, because farmers operate in market of imperfect information, farmers over time can establish acquaintance with inputs seller who may sell inputs to these farmers at relatively low cost and learn over time the right quantities of inputs to use. This can reduce cost inefficiency of production since the cost of a factor is a product of quantities of the input used and the price per unit of the input.

Lastly, the planting of mixture of hybrid and local cocoa varieties on the cocoa farm had a negative correlation with the cost inefficiency and this implies that cost efficiency of farmer increases though insignificantly by planting a mixture of hybrid and local varieties. However, growing hybrid varieties only significantly improved cost efficiency of inputs use in cocoa production in the study area. This can be ascribed to the fact that the hybrid varieties respond more positively to application of inputs because the hybrids had been genetic improved

Conclusions and Recommendations

From the analysis and findings of this study, the following conclusions were made. Cost of fertilizer, cost of pesticide and cost of labour affect the cost of cocoa production. Labour cost affected total cost more than all the other variables included in the cost function of the study. Secondly, Farmer-based organisation, MSL/JSS, Secondary/technical/Vocational levels and tertiary of formal education, planting of hybrid, age of cocoa trees and extension contacts were also the major determinants of cost efficiency of inputs use in cocoa production in the study area.

Based on the findings, this study recommends that since farmer-based-organisation correlates positively to cost efficiency, Farmers should be encouraged to join farmer-based organization.

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