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An Empirical Test Of Significance Of Performance Enhancing Inputs On Cocoa Yields In The Suaman District Ghana

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Abstract: Increase in Ghana's cocoa yield has often been attributed to fertilizer application and spraying. A hierarchical regression and curve estimation analysis of 200 farmers from the Suaman District has proven that increase in farm size with good management practices accounts for increase in cocoa yield than fertilizer application and spraying. Based on the findings it is recommended that to curtail the seasonal fluctuation of cocoa yield in Ghana much emphasis ought to be placed on high level of yield sustainability through the expansion of the area under cultivation.

I. INTRODUCTION

Ghana's cocoa industry has been the main stay of the Ghanaian economy for a long time and remains a considerable source of foreign exchange. Cocoa growing in Ghana started over hundred years ago where there was a remarkable spread of cocoa planting by African farmers which took Ghana to the leading position. Production expanded quickly and soon replaced oil palm as the major export commodity in the country (Lass, 1999). Although most cocoa production was carried out by peasant farmers on plots of less than three hectares, a small number of farmers appeared to have dominated the trade.

The government increased cocoa productivity from 300 kilograms per hectare to compete with Southeast Asian productivity of almost 1,000 kilograms per hectare where emphasis was placed on disease research, the use of fertilizers and pesticides. The results of these measures were seen in rising cocoa production in the early 1990s (Ministry of Finance, 1999). Ghana Cocoa Board starting from 2001, redesigned its extension policy for an effective farmers' education to enable them pursue good husbandry practices for increased yield per hectare. Cocoa Board subsequently encouraged the use of fertilizer application and improved planting materials (http://www.ghana business news .com)

A. OBJECTIVES

The main objective of this study is to find out whether the productivity enhancing inputs mainly fertilizer, spraying, seed and relevant socio-economic variables which include farm size, gender and education are responsible for increasing output at farm level**.**

The specific objectives of the study are,

- ✓ To estimate cocoa output function at farm level in terms of the productivity enhancing inputs using Suaman district as the case study.
- ✓ To determine the significant contribution of each input on cocoa yield.

B. JUSTIFICATION

In Ghana one of the major policy instrument aimed at stimulating cocoa production is the domestic cocoa producer price hence the setting of this price each year has become a key economic policy in the country. This notwithstanding, increase in cocoa yield since 1994 has been attributed to increase in fertilizer use and spraying Asenso-Okyere (2001). Much attention however, has not been paid to the contribution of other factors such as planting of new hybrid varieties, pruning and farm size. Chemical inputs usage has a significant impact on farm level output. However socio-economic factors such as farm size, education and gender also influence yield. It is therefore important to estimate and analyze the effects of both factors on farm level output.

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It is obvious that the production process is not adequately represented by a production function in which there are only three factors of production capital, labor and land. It is better represented by a production function where there are hundreds of resources or possible categories of inputs. For most goods, there are more than just two inputs. For example in agriculture, the amount of land, water, and fertilizer can all be varied to produce different amounts of a crop. In furtherance to this yield depends on the age of the cocoa tree, tree type, and level of inputs needed (Kumbhakar, 1994). There are therefore important issues that need to be addressed in order to explain Ghana's cocoa yield.

II. METHODOLOGY

A. STUDY AREA

The Suaman district lies in the mid-western part of the western region of Ghana between latitudes five degrees twenty-five minutes and six degrees fourteen minutes North(5° 25' N and 6° 14' N) and longitude two degrees thirty minutes and three degrees five minutes West (2° 30'W and 3° 05'W). The main occupation of the people in the district is farming with cocoa as a major crop. For the women petty trading is common. Generally, women who do not own cocoa farms help their husbands on their farms (http://www.aowinsuaman.ghanadistricts.gov.gh/). The district was selected because of its prominence in the production of cocoa.

B. DATA SOURCE AND SAMPLING PROCEDURE

Primary data obtained from the cocoa farmers was used for the study. The simple random sampling technique was used to select 200 farmers. Two hundred questionnaires were analyzed for the cocoa farmers. The data collected included the following input variables; fertilizer use, spraying, seed, weeding, pruning, cocoa output at farm level and other relevant socio economic variables.

C. EMPIRICAL APPROACH AND DATA ANALYSIS

The data collected were analyzed using various analytical techniques. Hierarchical linear Regression model was used to obtain the structural equation for cocoa output and each input at farm level as well as fitting a cocoa output response function using the ordinary least square estimation technique. A curve estimation analysis was also conducted.

The statistical computer program used for the questionnaire data analysis and ordinary least square estimations was SPSS for Windows Version 16.0

D. MODEL SPECIFICATION

Where Q is output per farmer, X_i is the i^{th} performance enhancing input and the Z_j is the j^{th} Socio-economic input. Specifically:

$$Q = f(X_i Z_j) \quad \ldots\ldots 1$$

$$Q = f(X_1 X_2 X_3 Z_1 Z_2 Z_3) \quad \ldots\ldots 2$$

$$Q = b_0 + b_1 X_1 \quad \ldots\ldots 3$$

$$Q = b_0 + b_2 X_2 \quad \ldots\ldots 4$$

$$Q = b_0 + b_3 X_3 \quad \ldots\ldots 5$$

$$b_1 = \partial Q / \partial X_1 \quad \ldots\ldots 6$$

$$b_2 = \partial Q / \partial X_2 \quad \ldots\ldots 7$$

$$b_3 = \partial Q / \partial X_3 \quad \ldots\ldots 8$$

$$Q = b_0 + b_1 Z_1 \quad \ldots\ldots i$$

$$Q = b_0 + b_2 Z_2 \quad \ldots\ldots ii$$

$$Q = b_0 + b_3 Z_3 \quad \ldots\ldots iii$$

$$b_1 = \partial Q / \partial Z_1 \quad \ldots\ldots V$$

$$b_2 = \partial Q / \partial Z_2 \quad \ldots\ldots V\,i$$

$$b_3 = \partial Q / \partial Z_3 \quad \ldots\ldots V\,ii$$

Q= COB is output per farmer.

Performance enhancing inputs:

X_1= Fertilizer (FERT), measured in bags (50kg per bag)

X_2= Spraying (RAY), measured in litres of pesticide used and grams of fungicides used.

X_3= Variety of seed (DSD), measured as a dummy variable; 1 for hybrid variety and 0 for others

Socio-economic inputs:

Z_1= Farm Size (FZ), acreage of farm

Z_2= Gender (DGDR), measured as a dummy variable; 1 for male and 0 for female

Z_3= Education (DEDU), measured as a dummy variable; 1 for farmers who attained education above primary level and 0 for those who attained no education or attained it up to the primary level.

$\ln COB = \beta_0 + \beta_1 \ln FERT + \beta_2 \ln RAY + \beta_3 DSD + \beta_4 \ln FZ + \beta_5 DGDR + \beta_6 DEDU + U$

III. RESULTS

A. DEMOGRAPHIC CHARACTERISTICS OF FARMERS

Males and females are actively involved in cocoa farming. This characteristic was recognized in the study. Out

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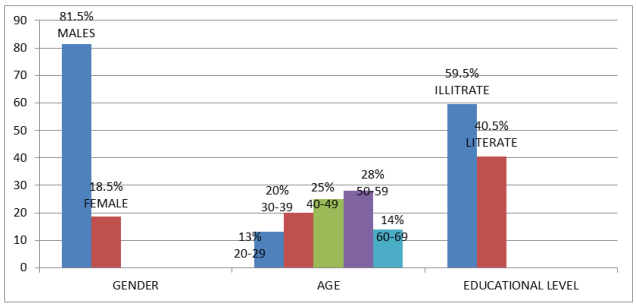
of the 200 farmers interviewed 163 were males and 37 females. As indicated in figure 1 below, the male figure represented 81.5% and the female figure represented 18.5%.This indicates that there are more male cocoa farmers than female cocoa farmers**.** This is true because most women are often involved in some other activities like trading in food crops. The Suaman district (the study area) is also very much endowed with food crop production such as maize, cassava and plantain. These are sold both at the district and regional markets. These activities turn to occupy the attention of women more than full time cocoa production activity. In addition cocoa production activity is much more rigorous and tedious and not many women can endure such hardship.

Education affects knowledge of innovations and attitudes to information which are necessary for farm work. The level of formal education was the benchmark used to define the level of literacy and illiteracy. Result in figure 1 indicates that the disparity between illiteracy and literacy is not that bad especially in the light of the fact that, decades past about 80% of the farmers were not educated.



Source: Field survey, 2014.

Figure 1: Demographic Characteristics of Farmers

Weeding and harvesting of pods are the major management requirements of cocoa production. Weeding, the commonest form of cultural practice was undertaken by all the cocoa farmers in the district. This was reflected in the number of times the cocoa farmers weed their various farms before the season ends. From figure 2, 77 % of the cocoa farmers weed their farms three times which is the ideal type in every crop year. Some farmers weed their farm as many as five times and beyond, before the end of the season especially farms under establishment.

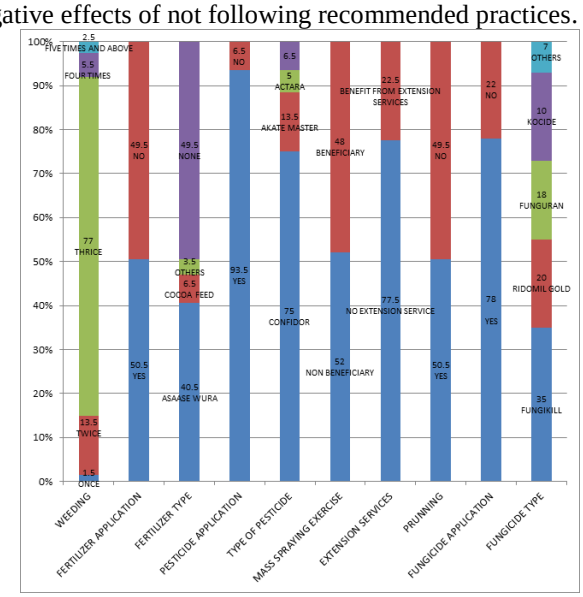
Fertilizers are nutrients that plants need to grow, produced in a form that they can digest when applied to the soil. Regarding fertilizer application in the study area, figure 2 depicted that 50.5% applied fertilizer while 49.5% did not. This gives a clear indication that in the district the variance between fertilizer application and non usage of it was quite insignificant. The type of fertilizer normally used in the district is Asaase Wura. Out of the 200 people who were interviewed 81 people used this type of fertilizer.

The use of chemical inputs is an important agricultural issue. They have played a significant role in increasing agricultural production in the developing world over the past decades, along with intensive agricultural practices (Pretty, 1995). From figure 2, farmers representing 93.5% and 78% undertook chemical control against insects and diseases respectively. Regarding the pesticide used in the district it was found out that, confidor was the most highly used to control insect infestation. This was followed by Akate Master and Actara which are part of pesticides recommended for pest control by the Cocoa Research Institute of Ghana. Another area which was also looked at was the mass spraying exercise. The Mass Spraying exercise is a pest and disease control programme by the Government of Ghana to control pest and fungal infections. The pest control is done in the dry season from August to October and December when their infestation is at its peak. November is skipped in order not to taint the cocoa beans since more cocoa are harvested at that time. The fungicide application is done at the onset of rains through to the end of the rainy season. Fungicide application is carried out in the rainy season since the humid condition aid the spread of Phythophtora pod rot disease. The pesticides and fungicides used are alternated every two years to prevent resistance. Out of the 200 respondent farmers, 104 of them representing 52% were beneficiaries of the mass spraying exercise. This was against 96 people representing 48% who were not beneficiaries. Several reasons were given by the non beneficiaries. Some were as result of the inadequacy of the pesticide and fungicides use.

Some farmers also applied fungicides on the cocoa pods to prevent and control fungal diseases in their farms. Out of the total farmers sampled, 78% applied different types of fungicides (Funguran, Fungikill, Ridomil Gold, Kocide and others) to control and prevent black pod disease which is a major treat to increased yields. Therefore controlling black pod infection which is the major fungal disease among others in Ghana means adding some output.

Pruning, the removal of excess branches and chupons is a major cultural practice that helps the cocoa tree to receive more sunlight and air there by reducing black pod infection was conducted by 50.5% of the sampled farmers. During pruning, already diseased and pest infected pods and branches are also removed to prevent the spread of the diseases. This helps to save pesticide cost, makes harvesting easier and less dangerous. It also helps farmers to harvest bigger pods with good quality beans.

Many farmers complained that extension officers did not visit them. Besides they find it difficult to understand the negative effects of not following recommended practices.



Source: Field Survey, 2014

Figure 2: Analysis of Ideal Practices of Sampled Farmers

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Dependent variable Ln COB				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Ln FERT	0.036116	0.057626	0.626730	0.5316
Ln RAY	0.195746	0.099892	1.959573	0.0515**
DSD	-0.086646	0.085126	-1.017865	0.3100
Ln FZ	0.662731	0.090911	7.289899	0.0000*
DGDR	0.085521	0.102640	0.833212	0.4058
DEDU	0.158259	0.083580	1.893510	0.0598**
CONSTANT	0.347563	0.166656	2.085506	0.0383**
F – ratio	11.6			0.00001*
R^2	0.265694			

** 1% Significant level ** 10 % Significant level*

Table 1: Regression Results of Farm Output of Cocoa

There was a positive relationship between the level of cocoa output and the quantity of fertilizer use in the district. The result indicates that when farmers apply fertilizers to their cocoa farms yield increases. Fertilizer did not significantly affect output. Regarding the positive relationship between fertilizer and farm level of cocoa output, a study by Benjamin (1995) highlighted on this in relation to the quality of the soil. Accordingly, Benjamin indicated that the effects of fertilizer use are determined by its interaction with soil quality such that fertilizer has a positive impact on output when soil quality is high.

As expected, spraying impacted positively on output. This explains the fact that spraying is done to protect the cocoa tree against pest and diseases which in effect leads to increase in yield. Spraying was significant. This shows that spraying was critical in determining the level of output in the study area. Output increased by 0.0515 as a result of a unit increase in spraying. The positive significance of spraying which depicted the relationship between spraying and farm level output of cocoa was explained in a related study by Mathews (1999). He also identified effective spraying and pruning as major reason for a positive relationship between spraying and output.

The negative effect of seed on output suggests that yields vary over the lifespan of the tree, rising as it matures, then stabilizing and eventually falling. The negative relationship between seed and the level of output is comparable to the result of a study undertaken by Appiah (2001).The result showed a negative relationship between seed variety and output implying that the productivity of new varieties is not conditional on input use, meaning yields decline mainly at high levels of age of the cocoa tree.

From the result gender impacted positively on output such that when there are more males into cocoa farming, output will increase. 1% increase in male cocoa farmers is associated with 0.085521 % increase in output. The positive relationship between gender and farm level output of cocoa is similar to a work done by Asfaw and Admassie (2004) which generally hypothesized that male-headed farmers are more likely to get information about new technologies and take risks than female-headed ones in cocoa farming activity.

Education is positively significant as expected implying that there is a positive relationship between the level of output of cocoa and education. This explains the fact that when education is high, yield will also be high. Moreover when education is low yield will decrease. A unit increase in education is associated with 0.158259 increases in output.

Farm size was found to significantly affect the production level of cocoa in the study area. This is so because the more the acreage of a farm, the more will be the output from the farm especially if the farm is given the desired agronomic management practices thus highlighting on a positive relationship between output and farm size.

This indicates that farm size had the potential to contribute more to yield than any of the above mentioned variables. The relative importance of these factors in contributing to output was also identified by ranking the factors based on the magnitude of their absolute t-values. Base on this ranking it was observed that among the independent variables, the t- statistic value for farm size was approximately 7.3 which is the highest. Farm size, therefore appears to be relatively more important in terms of its contribution to output (Mwakalobo, 2000).The coefficient of farm size was 0.662731. This means that 1% increase in farm size is associated with 0.66% increase in output.

The statistical reliability of the estimates of the parameters of the model is explained in terms of the coefficient of determination, the standard error and the F-ratio. The R^2 of 0.26 shows that 26% of the variation in the farm level output of cocoa was accounted for by the performance enhancing inputs and socio-economic variables. The F- value of 11.6 indicates that the overall equation is significant at 1% error level. From the results the low standard errors of the estimates is an indication of a high statistical reliability of the estimates.

Dependent variable COB				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Fertilizer	.021	.053	.403	.688
Dependent variable Cocoa output				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Spraying	.126	.134	.945	.346
Dependent variable Cocoa output				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Seed variety	. -.315	.304	-1.035	.302
Dependent variable Cocoa output				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Farm size	.964	.117	8.217	.000*

** 1% Significant level*

Table 2: Hierarchical Regression Results of the Selected Inputs

Analysis of the individual input contribution to cocoa yield by hierarchical regression showed that farm size was the only variable that contributed significantly to output.

Farm size was found to significantly affect cocoa yield in the study area. The coefficient of farm size was 0.96. This means that 1% increase in farm size is associated with 0.96% increase in output.

IV. CURVE FIT TEST FOR COCOA YIELD AND THE SELECTED INPUTS

A curve fit test was conducted to evaluate the correlation between cocoa yield and the selected inputs and also assessed the impact of the inputs on cocoa yield.

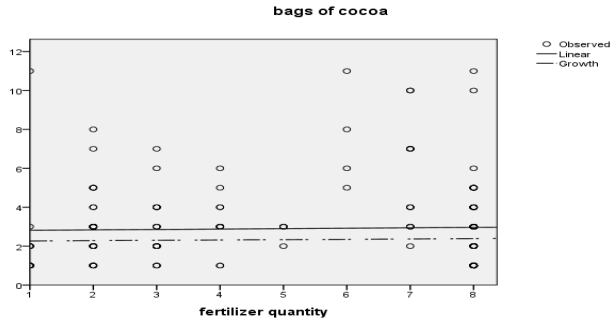

Figure 3: Curve Fit Test for the use of fertilizer by the sampled farmers

Figure 3, indicates that the influences of fertilizer on cocoa yield in the study area is at a fairly stable rate. This was revealed by the line of growth representing the impact of fertilizer to yield to be below the line of observation.

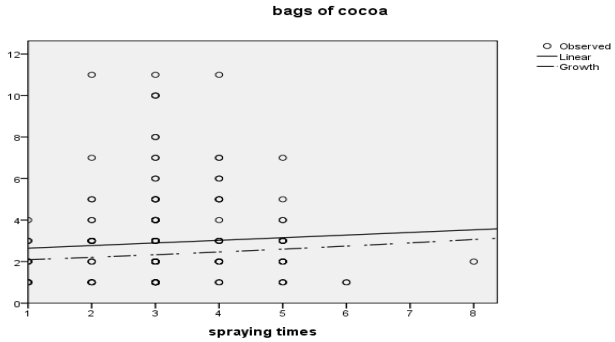

Figure 4: Curve Fit Test of Spraying by Sampled Cocoa Farmers

Figure 4 above revealed a positive relationship between spraying and cocoa yield. Its contribution to yield was relatively higher than fertilizer. Just like fertilizer, spraying did not significantly affect cocoa yield in the study area. This was revealed by the line of growth representing the contribution of spraying to yield to be below the line of observation.

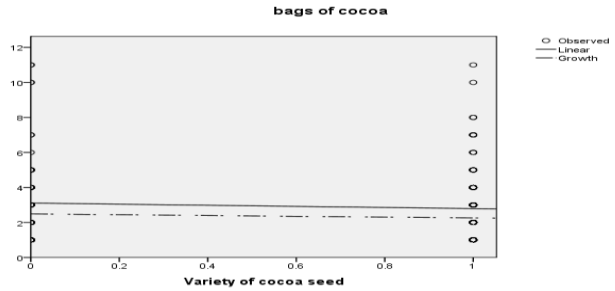

Figure 5: Curve Fit Test for Variety of Seed Used by Cocoa Farmers

In figure 5 above, seed did not influence yield. The line of growth and the line of observation for seed depicted a downward trend showing the negative relationship between seed and cocoa yield.

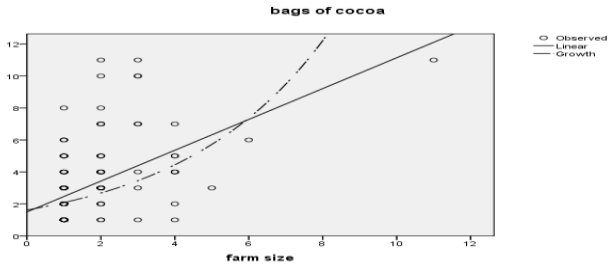

Figure 6: Curve Fit Test of Farm Sizes of Sampled Cocoa Farmers

From figure 6 above, farm size significantly influences yield. This depicts that when farm size is increased by some percentage, cocoa yield will increase by a greater percentage. This was revealed by the line of growth representing the contribution of farm size to yield to be above the the line of observation. After an initial below optimum contribution of farm size to yield it began to rise above the optimum levels.

The direction, form and strength of the relationship between cocoa yield and the selected inputs significantly correlated positively with farm size. This analysis confirmed the results of the hierarchical regression.

V. CONCLUSION AND POLICY RECOMMENDATION

The study presented a cross sectional analysis of the determinants of cocoa output. Performance enhancing inputs and socio-economic inputs were the factors reviewed. The findings of the study indicate that, in ranking the factors according to their relative contribution to yield, farm size contributed significantly to cocoa yield than any other factor. The study therefore recommends that, in a bid to increase output, government would have to ensure effective cocoa farm management and efficient extension supervision. This could be achieved by expanding the area under cultivation and intensifying production on existing acreage.

The fluctuation of Ghana's cocoa output has been a major challenge Ghana's cocoa industry is grappling with. This has created huge vacuum on the sustainability of Ghana's cocoa output. Over the years much attention has been paid to fertilizer application and spraying yet the problem of fluctuation and the sustainability challenge still persist. Indeed fertilizer application and spraying, contribute to yield, however, the study has proven that cocoa in Ghana needs more land for production, together with good farm management than fertilizer application and spraying. This implies that Ghana's cocoa sustainability largely depends on the size of the farm than any other factor.

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