<u>Improved Technology and Land Productivity among Smallholder Cocoa Farmers in Ashanti Region, Ghana</u>

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Improved Technology and Land Productivity among Smallholder Cocoa Farmers in Ashanti Region, Ghana

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Abstract

The study assessed the effect of improved technology on land productivity of smallholder cocoa farmers in Ashanti Region, Ghana. With data from 366 smallholders cocoa farmers productivity was shown to be linearly related to and the use of improved cocoa technology in the study area. Both the decision to use improved technologies and the proportion of cocoa land allocated to cocoa production are all significant determinants of increased productivity. In addition, farm level factors characteristics as well as idiosyncrasies are shown to affect productivity. These including age, household size, participation in programs related to cocoa production, access to virgin lands, size of cocoa farm, labour resource use and nativity affect productivity at various levels of significance. Strategies to improve the productivity of the smallholder cocoa farmers must include the promotion of improved cocoa technologies as it evidently enhances productivity of the smallholders. These must not come alone but with appropriate training on their use.

1. Introduction

The cocoa sector in Ghana plays a significant role in the fight against poverty and the development of the economy of Ghana as a whole. The sector contributes over 37.8 percent of the overall foreign earnings which forms the bulk of revenue for the finance of infrastructure development and other public expenditure (Fosu, 1992; ISSER, 2006).

Cocoa production occupies over about 1.2 million hectares of land largely distributed among smallholders who manage plot(s) sizes of about 2 ha or less (MoF, 1998). The cocoa farmers include land owners, caretaker farmers, or share croppers who operate at very low levels of productivity (Appiah et al, 2000). Diseases and pests attack, declining soil fertility, poor agronomic practices, limited credit availability as well as inadequate infrastructure constitute major sources of constraints to productivity (COCOBOD, 1997; Boateng, 2003).

Until recently, the Ashanti zone played a lead role in cocoa production. The zone presently records the lowest of cocoa yield of about 256 kg/ha (Zeitlin, 2005). Efforts to improve the performance of the sector featured land area expansion with net negative effect on productivity (ISSER, 2006). The implementation of the Cocoa Sector Development Strategy (CSDS) in the 1990s saw the promotion of improved cocoa technologies. These are expected to enhance productivity among farmers (Asante, 2002). It is assumed that the effect of improved technology is channelled through the behavioural and decision making processes that subsequently, these translate into improved productivity among the smallholders (Wu, 2005).

This paper assessed the effect of improved technology on land productivity of smallholder cocoa farmers in Ashanti Region of Ghana. Section 2 presents the methodology of the study by describing the conceptual framework for productivity as well as the estimation procedure. Also is a description of the data and characteristics of the surveyed farmers. In Section 3 the results of the study are discussed. Section 4 presents the conclusion of the study with some recommendations to guide policy.

2. Methodology

2.1. Concept of Productivity

The production process of a farmer in the cocoa-based system can be described as a relation between the quantities of cocoa produced (Q) and respective inputs used (x). Based on the general form of the production relation, a productivity index can be computed as a measure of performance (Wu, 2005). Productivity can be referred to as cocoa output per unit of input used (Restuccia et al, 2003). It essentially refers to the average product per unit input and can be derived as follows;

$$Q_i = f\left(x_i\right) \tag{1.0}$$

$$P_i = \frac{Q_i}{x_i} = f\left(Q_i, x_i\right) \tag{2.0}$$

Given that a farmer uses a set of k different inputs to produce a certain quantity of output, productivity can be computed as Total Factor Productivity (TFP) or Partial Factor Productivity (PFP). TFP is derived as the ratio of the value of output to the total value of inputs. PFP on the other hand is constructed as the ratio of quantity of the produced to the quantity of a particular input.

$$P_i = \frac{Q_i}{\sum_{k=1}^{K} x_{k,i}} \tag{3.0}$$

$$P_{k,i} = \frac{Q_i}{x_{k,i}} \tag{4.0}$$

The choice of a particular productivity index is determined by the nature and the type of analysis to be conducted and the availability of information and standards of measurements (Brambilla and Porto, 2005; Rosenweig et. al., 1993). Scientists who employ TFP index argue that it accounts for the overall effect of the inputs in the production process. Productivity can subsequently be decomposed by components (Parente et al., 2000; Rosenweig and Binswanger, 1993).

The construction of TFP can however be erroneous and subject to criticisms in imperfect markets (Restuccia et. al, 2003; Brambilla and Porto, 2005). Assigning prices to family or communal labour in the cocoa-based system for instance does not truly reflect market conditions. If carefully constructed, PFP stands as a legitimate measure of the variations in output attributable to variations in factors of production (Alston et. al, 1994).

2.2. Determinant of Land Productivity

The cocoa farmers in their rural communities are assumed for be facing imperfect markets with distorted prices. Estimating PFP provides a more plausible description of performance in the production system. By derivation, the PFP for land (land productivity) can be expressed as relationship between land productivity and the proportions of inputs per unit area.

$$P_{land,i} = \frac{Q_i}{x_{land,i}} = \beta_0 + \beta_{land} x_{land,i}^{-1} + \frac{\sum_{k=1}^{K} \beta_{x,k} X_{k,i}}{x_{land,i}} + \mu_i \tag{5.0}$$

The βs in the productivity model represent the marginal effects of the proportion of inputs used on productivity. Introducing variables to capture idiosyncratic management competence ($H_{h,i}$) and the adoption behaviour ($W_{w,i}$) of farmers, the land equation is re-expressed as,

$$P_{land,i} = \frac{Q_i}{x_{land,i}} = \beta_0 + \sum_{k=1}^{K} \beta_{h,k} H_{h,i} + \sum_{k=1}^{K} \beta_{w,k} W_{w,i} + \beta_{land} x_{land,i}^{-1} + \frac{\sum_{k=1}^{K} \beta_{x,k} X_{k,i}}{x_{land,i}} + \mu_{land,i} \qquad (6.0)$$

Equation 6.0 suggests that all the variables except land have positive effect on land productivity. Such that a unit increase in a variable will results in a certain unit(s) increase in productivity as shown by the βs. A positive relationship is also expected between the use of improved technology and productivity. By definition, farmer who uses an item in package of improved technologies is referred to as an adopter. Adoption is also measured as the proportion of resource allocated to improved technology.

2.3. Data

The study is based on a survey conducted as part of activities under the Ghana Sustainable and Competitive Cocoa System (GSCCS) project in 2005. It covered a cross-section of smallholder cocoa farmers in Ashanti Region. Cocoa producing community in the region represented the basic sample unit.

In all data from a total of 366 interviewed cocoa farmers was used for the analysis. These were selected by a systematic sampling procedure at the regional and community levels. At the regional level, 61 communities were randomly selected from the list of cocoa producing communities obtained from the extension service department in the region. Within each of the selected communities, 6 smallholder cocoa farmers were again randomly selected.

2.4. Characteristics of Smallholder Cocoa Farmers

In Table 1, the characteristics of the respondents are disaggregated by adoption status. Male cocoa farmers dominate the sample and constitute about 84 percent of the total sample. On the average a cocoa farmers is about 57 years and controls about 10 persons in the household. At the time of the survey, about half of the sampled cocoa farmers were settler farmers.

In addition to age, the proportion of farmers with formal education and the years of experience of the farmers suggest a rich store of knowledge among the farmers. This is further highlighted by proportion who are members of farmer association, access to information and extension as well participation in cocoa related programs.

Table 1: Characteristics of Sampled Households

Characteristics	Adopters	Non-adopters	Total
Sample (N)	235	131	366
Socio-demographic factors			
Proportion of male (%)	83	85	84
Proportion of female (%)	17	15	16
Age	56	57	57
Household size	10	10	10
Natives (%)	55	40	49
Education and experience			
Proportion educated (%)	83	77	81
Years of education	8	7	8
Years of experience	32	33	32
Institutional factors			
Membership of association (%)	81	78	80
Access to information on cocoa (%)	95	92	94
Participation in cocoa programs (%)	61	63	62
Access to extension service (%)	74	69	72
Access to credit (%)	21	32	25
Access to Amenity (%)	100	66	87
Secondary income (%)	73	34	59

Source: GSCCS survey, 2005

Access to credit is limited among the adopters and non-adopters. However access to other social amenities is higher among the adopters. Moreover the majority of the adopters are engaged in secondary income generating activities.

Table 2: Cocoa Production Parameters

Characteristics	Adopters	Non-adopters	Total
Plots (N)	4	3.5	4
Cocoa plots (N)	2.5	2	2
Cocoa Area (ha)	6.7	6.6	6.7
Area of Improved (%)	17	0	11
Labour (man-days)	242	191	223
Yield (ton/ha)	1.50	0.98	1.32

Source: GSCCS survey, 2005

There is minimal variation in the number of land holdings (cocoa plots and total plot) and cocoa plot sizes across the adopter category. On the average, the adopters allocate about 17 percent of their cocoa land to improved cocoa technologies. The yields obtain by adopters are significantly higher than the yields from the non-adopters (Table 2).

3. Results and Discussion

Table 3 presents results from 2 land productivity models. In model 1, the use of improved cocoa technology features as a dummy variable. Here adoption=1 if a person uses at least 1 item in the technology package. In model 2, adoption is measured in terms of the proportion of cocoa land allocated to improved technology.

In addition to the improved technology, productivity is shown to be affected by age, household size, participation in programs related to cocoa production, access to virgin lands, size of cocoa farm and labour resource use. All these variables except access to virgin lands significantly affected productivity in model 2. Also in model 1 nativity is shown to affect productivity at 10 percent level of significance.

Age as a proxy for experience is shown to have positive effect on the productivity of the smallholder cocoa farmers in both models. The smallholder farmers with an average of 32 years of experience in cocoa production are expected to have accumulated enough knowledge to improve on their production operations. Lessons learnt from the past serve as a useful source of information for decisions in the present and the future.

Table 3: Land Productivity Models

	Model 1			**Model 2**		
Variables	**Coeff.**	**Std. Err.**	**P>|z|**	**Coeff.**	**Std. Err.**	**P>|z|**
Male	0.0349692	0.1811		0.0022071	0.1852198	
Age	0.0140037	0.00581	*	0.0140512	0.0059534	*
Education	0.2303958	0.18779		0.2321938	0.1934819	
Household size	0.0292778	0.01167	*	0.0303969	0.011963	*
Native	-0.2193688	0.12404	**	0.1680315	0.1270924	
Cocoa program	0.4002927	0.12505	*	0.4085176	0.1280049	*
Virgin land	0.3938548	0.13652	*	0.1857144	0.1348046	
Cocoa size	-0.0400813	0.0055	*	-0.0413546	0.0056434	*
Labour	0.0010797	0.00032	*	0.0013073	0.0003209	*
Adoption	0.6239551	0.13313	*			
Extent of adoption				0.7503129	0.3462342	*

***5 percent significance level **10 percent significance level**

Large household sizes are shown to affect productivity in the positive direction. Large household sizes guarantee the availability of labour during the peak of production when hired labour is in scarcity. The implication is that farmers are able to undertake all the necessary field operations during the critical periods of production. This thus translates into higher levels of productivity.

As mentioned earlier, nativity is shown to significantly affect productivity only in model 1. The results suggest that the non-natives farmers are more productive relative to the natives. Native farmers are assumed to have several communal responsibilities and also posses numerous land holdings. They are therefore unable to effectively supervise activities on their cocoa fields, hence record low levels of productivity. The reverse is true for the non-natives. They have less land holding and minimum obligations at the communal level. They are able to effectively supervise their field activities consequently resulting in high levels of productivity.

Participation in cocoa related programs was also used as a proxy to access to extension service. This obviously have positive significant effect on productivity. Adequate knowledge and exposure to the operations of the cocoa based system provides an environment for effectiveness and enhanced productivity. With the appropriate knowledge farmers are able to undertake timely operations that required for high levels of productivity.

Access to virgin forest significantly affects productivity in model 1 but in model 2. It is indeed common knowledge that virgin forests have high nutrimental potential. Farmers who have established their cocoa farms on such lands are expected to record up to sometime higher levels of productivity.

The results show an inverse relationship between land productivity and land area under cocoa and thus support the popular arguments in literature (Wu, 2005; Kimhi, 2003; Van den Ban and Hawkins, 1996). In both models, a unit increase in land area under cocoa is shown to cause about 0.04 unit decline in land productivity.

Also in both models, the man-days of labour employed significantly affect land productivity in the positive direction. As mentioned earlier, access to adequate amount of labour resource enables the farmers to undertake timely field operations that translate into higher levels of productivity.

Both models show that improved cocoa technologies significantly affect the land productivity in the positive direction. If a farmers decides to use at least one item in the package of improved cocoa technology is expected to increase productivity by 0.62 units. In similar manner, if a farmer increases the proportion of cocoa land allocated to improved technology by a unit, productivity is expected to increase by 0.75 units.

Conclusion and Recommendations

The results from the study indicate confirms the expectation about the effect of improved technologies on the performance of cropping systems. The decision to use improved technologies and the proportion of cocoa land allocated to cocoa production are all significant determinants of increased productivity.

It is also worth noting that apart from farm level factors, productivity is also affected by idiosyncrasies. These including age, household size, participation in programs related to cocoa production, access to virgin lands, size of cocoa farm, labour resource use and nativity significantly affect productivity.

Strategies to improve the productivity of the smallholder cocoa farmers must include the promotion of improved cocoa technologies as it evidently enhances productivity of the smallholders. These must not come alone but with appropriate training on their use.

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APPENDIX A Productivity Models