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ADOPTION OF FARM MANAGEMENT PRACTICES BY SMALLHOLDER COCOA FARMERS IN PRESTEA HUNI-VALLEY DISTRICT, GHANA

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ABSTRACT
As part of Ghana's quest to increase cocoa production, Cocoa Research Institute of Ghana has recommended farm management practices to help boost production levels. However, adoption of these management practices had been low, leading to yield levels below potential. This study investigates the adoption intensity and factors explaining the variation in adoption among smallholder cocoa farmers in Prestea Huni-Valley district of Ghana. A sample size of 180 cocoa farm households from eight communities were randomly selected and interviewed through a well-structured questionnaire. Majority (80%) of the sampled farmers have adopted four to six out of seven cocoa farm management practices identified. The Poison regression model was used to examine the determinants of intensity of adoption of the farm management practices. The results generally revealed that, marital status of the farmer, household size, educational attainment, membership of farmer-based organization and farmer receiving extension services are all significant variables explaining farmer's decision to adopt cocoa farm management practices. The study concludes by suggesting that farm level policies such as extension service delivery system should be strengthen in terms of staff and methodologies.

KEY WORDS
Cocoa, farm management practices, poison regression model, adoption, Prestea Huni-Valley, Ghana.

Cocoa is a critical cash export crop for producing countries and also a key import for consuming countries, which typically do not have suitable climates for cocoa production. The primary growing regions are Africa, Asia, and Latin America. The largest producing country by volume is Côte d'Ivoire, which produces 33% of global supply (WCF, 2014). Other major producing countries in Africa include Ghana, Nigeria and Cameroon which contribute 68%- of the global output while Asia, Indonesia, Malaysia, Papua New Guinea contribute 17% and Brazil, Ecuador and Columbia contributing the remaining 15% (WCF, 2014).

In Ghana, the contribution of cocoa industry has been very remarkable over the last decades. It has employed over 800,000 smallholder farm households in the provision of food, employment, income, tax revenue and foreign exchange earnings for the government. In 2014, the sector contributed about GH¢1.963 billion representing about 2.23% of Ghana's Gross Domestic Product (GSS, 2014).

Despite the significant roles of the sector, the crop production has been fluctuating over the last decade with a record breaking of 1,000,000 metric tons in 2012. However, between 2012/2013 and 2014/2015, production has decline tremendously. Growth in agricultural in general, and cocoa in particular over the years has come as a result of increase in land area under cultivation rather than improvement in yields. Studies in the Ghanaian cocoa industry have shown that cocoa farm yields are lower than their achievable yields. Ghana's average cocoa yield are well below that of the international yields as well as those observed in other cocoa producing countries. For instance, the average yield of cocoa in Ghana is about 400kg/ha (MoFA, 2011) whilst that of Malaysia and Cote D'Ivoire are 1800kg and 800kg per hectare respectively (Barietos et al., 2008). The low yields of the sector are attributed to poor farm maintenance such as pruning and weeding, high incidence of pests and diseases, depletion of soil nutrients, high cost of inputs among others. As result, the use of agrochemicals to provide nutrient for soil and control of pests and diseases as well as other farm management practices has become significant issues under investigation in the sector. Investments in research by Government of Ghana and other stakeholders through Cocoa Research Institute of Ghana (CRIG) has led to the development and diffusion of cocoa improved technology package. The Cocoa Research Institute of Ghana has been tailored to the development of improved farm practices to militate against problems in cocoa production such as pests and diseases, poor soil fertility and other poor agronomic practices. The improved farm practices recommended by CRIG includes spraying against insects called mirids or capsids, spraying against fungal called black pod, fertilizer application, weeding and pruning, planting of improved seed and planting of cocoa friendly timber trees.

Despite the dissemination and the diffusion of CRIG-recommended improve farm practices to farmers, adoption of these farm practices over the years have been very low (Danso-Abbeam et al, 2014, Aneani et al, 2011). The main objective of this study was to determine adoption intensity and the factors explaining the variation in adoption among smallholder cocoa farmers in the Prestea-Hunni-valley district of Ghana. Information on the current adoption intensities of farm management practices as well as factors explaining variation in the adoption of these farm practices are very important in designing farm level policies. Better understanding of these will help Ghana in her quest to boost cocoa production through increase in yield rather than expansion under area cultivated.

METHODOLOGY OF RESEARCH

Study Area, Sampling Technique and Data Collection. The Prestea Huni-Valley District was created in 2008 and inaugurated on 29th February 2008.The district has a total population of 159,304 (Ghana Statistical Service, 2010) and located east of Tarkwa and lies within the south western equatorial zone. The district has a total land size of approximately 1376 sq km. The main socioeconomic activities in the district are farming, mining, trading and logging. The main crops grown in the district are cocoa (*Theobroma cacao*), oil palm (*Elaesis guineenssis*), plantain (*Musa spp*), maize (*Zea mays*), yam (*Dioscorea* spp), rice (*Oryza sativa*) and cassava (*Manihot esculenta*).

The study used cross-sectional data from eight communities randomly selected from the Prestea Hunni-Vally district, Ghana. To aid the process of sampling cocoa farm households from the communities, a list of cocoa farmers were obtained from the local offices of Ghana COCOBOD. The number of households selected from each community was based on the number of cocoa farms in each community. A total of 180 households were randomly selected from the eight communities. A well-structured questionnaire was administered through interview schedule to capture data on demographic and farm-specific characteristics as well as the use of farm management practices on the farm households.

Theoretical Framework. Generally, a farmer who adopts improves farm management practices is expected to have higher output than the one who did not adopt farm management practices. Further, it is also expected that the greater the number of management practices a farmer adopts, the higher his output, all things been equal. The outcome of cocoa farm management adoption can be modeled under the framework of utility maximization. Consider the i^{th} cocoa farm household facing a decision on whether or not to adopt cocoa farm management practices. Let $P^{\bullet}$ denote the difference between the benefit the farm household derives from adopting cocoa farm management practice (U_{iA}) and benefit from non-adoption of cocoa farm management practice (U_{iO}). Considering the axiom of rationality and profit maximization, the farm household will adopt cocoa farm technology package if $P^{\bullet} = U_{iA} - U_{io} > 0$. Thus, a farmer will adopts any of the farm management practice if and only if the net benefit is positive.

Following Cameron and Trivdi (1990) and Green (2008), the adoption of cocoa farm management practices could be modeled in the econometric context of Poison regression model. This is because the dependent variable (number of improved management farm practices) is a count data, hence, Poison is well suited for the study. It is employed for the estimation of farmer's decision on how many cocoa improved farm management practices a farmer adopts.

The probability of adopting *k* practices given *n* independent farm management practices is represented by the binomial distribution:

$$P(Y = K) = \binom{n}{k} P^{k}(1-P)^{n-k} \quad (1),$$

where: $\binom{n}{k} = \frac{n}{k!(n-k)}!$ and P is the probability of adopting k practices.

Statistical theory states that a repetition of a series of binomial choices, from the random utility formulation, asymptotically converges to a Poisson distribution as n becomes large and P becomes small. Thus;

$$Lim_{1-\infty} \binom{n}{k} pk(1-p)^{n-k} = \frac{e^{-\lambda} u^{k}}{k!} \quad (2),$$

where: $p = u/n$ and u is the mean of the distribution such as the mean number of farm management practices adopted by farm household. This formulation allows modeling of the probability that a farmer adopts a number of farm management practices k given a parameter u, the sample mean. The cocoa farmer makes series of discrete farm management decisions that sums across an aggregation of choices to a Poisson distribution. The Poisson regression model is the development of the Poisson distribution presented in [1] to a non-linear regression model of the effect of independent variables x_i on a scalar dependent variable Y. The density function for the Poisson regression is given by:

$$f(Y/x_i) = \frac{e^{-u_i} u^{Y}}{Y!} \text{ and } Y = 0,1,2,3...... \quad (3),$$

where: $f(Y)$ represents the probability that the dependent variable Y takes non-negative integer values, $Y!$ denotes Y factorial and u is the mean of distribution such as the mean number of cocoa farm management practices adopted by a farm household. The mean parameters of the function of the regressors x_i and a parameter vector β is given by:

$$E(Y/x_i) = u = \exp(x, \beta) \qquad Y = 0,1,2,3,..... \quad (4),$$

and x_i are variables hypothesized to affect the adoption of the farm management practices.

According to Wooldridge (2003), Green (2003) and Cameron and Trivedi (1990), since the dependent variable of a Poison regression model is a count data, the interpretation of the coefficient is as follows: a unit change in the explanatory variable is expected to change the dependent variable by the coefficient of the respective independent variable, given that the other independent variables in the model are held constant.

Empirical Model Specification:

Intensity of Adoption. The intensity of adoption in this study was calculated by the expression below:

$$I = \left[\frac{n}{N} \times 100 \right] \qquad (5),$$

where: $I, n \; and \; N$ denotes intensity of adoption, number of cocoa farmers that adopted a particular farm management practice and the number of farmers in the sample respectively. The intensity of adoption is a representation of the percentage of cocoa farm households that have adopted farm management practices in the Prestea-Hunni Valley district of Ghana.

Factors Influencing Adoption of Cocoa Farm Management Practices. The empirical Poison regression model used to examine factors influencing the adoption of improved cocoa farm management practices can be specified as:

$$A_i = \beta_0 + \sum_{i=1}^{8} \beta_j x_i + \varepsilon_i \qquad (6),$$

where: A_i denotes adoption (number of cocoa farm management practices adopted by a farmer). x_i represents age, sex, marital status, educational attainment, Household size, farmer experience, extension visits, and FBO membership. The measurements and the *a priori* expectations of the variables used in the empirical Poison regression model are presented in table 1.

Table 1 - Description, Measurement and a priori Expectations of Factors Affecting Farmer's Decision to Adopt Cocoa Farm Management Practices

Variable Description	Measurement	A priori Expectation
Age of the farmer	Years	+
Sex	Dummy: 1 if male, 0 otherwise	+/-
Marital status	Dummy: 1 if married, 0 otherwise	+/-
Educational attainment	Years of formal education	+
Household Size	Number of people	-
Farming Experience	Years	+
Extension visit	Dummy: 1 if a farmer has receive extension service, 0 otherwise	+
Farmer-based Organization	Dummy: 1 if a farmer belongs to any FBO; 0 otherwise	+

RESULTS AND DISCUSSIONS

Demographic Characteristics of Farm Households. Summary statistics on demographic characteristics of the sampled farmers in the study area are presented in table 2 below. From the descriptive statistics, majority (73.34%) of the farmers in the study area are within the age bracket 31 – 60 indicating that majority are in their active and productive age with the mean age of 44 years. Female respondents constitute about 43% while male respondents constitute only 57%. About 61% of the farmers in the data set are married while about 39% are not married. The mean household size is 8 per respondents household. Majority (about 71%) of farmers had attained formal education, thus, primary, junior high and senior high.

Adoption Rates of Cocoa Farm Management Practices. Table 3 presents a summary of the adoption pattern of cocoa farm management practices under consideration in this study. The data set reveals that 92.78%, 21.11%, and 18.89% have adopted pruning, hybrid seeds and timber planting in their cocoa farms respectively. Again, adoption rates for the control of black pod diseases with fungicides, control of capsids with insecticides, fertilizer application and land and water management are 72.22%, 98.89%, 55.56% and 3.33% respectively. The relatively high rates of insecticides and fungicides application somehow confirms the results obtained by Danso-Abbeam et al (2014) who reported that the application rates of fungicides and insecticides by smallholder cocoa farmers in Sefwi-Wiawso Municipality of Ghana are 64% and 60% respectively.

Table 2 - Distribution of Respondents by Demographic Characteristics

Variable	Frequency	Percentage	Mean	Minimum	Maximum
Age			44.44	22	72
> 30	22	12.22			
31 - 40	49	27.22			
41 - 50	51	28.34			
51 - 60	32	17.78			
> 60	26	14.44			
Sex					
Male	102	56.67			
Female	78	43.33			
Marital Status					
Married	109	60.56			
Single	71	39.44			
Household Size			8	2	16
< 5	45	25			
6 - 10	93	51.67			
11- 15	29	16.11			
> 15	13	7.22			
Educational Attainment			8	0	14
No Formal Education	53	29.44			
Primary	17	9.44			
Junior High School	47	26.11			
Senior High School	63	35.01			

Source: Field Survey, 2015.

Table 3 - Adoption rates of Cocoa Technology Packages

Farm Management Practices	Users		Non-Users	
	Frequency	%	Frequency	%
Pruning	162	92.78	13	7.22
Hybrid seeds	38	21.11	142	78.81
Timber planting	34	18.89	146	81.11
Fungicides Application	130	72.22	50	27.78
Insecticides Application	178	98.89	2	1.11
Fertilizer Application	100	55.56	80	44.44
Land and Water Management	6	3.33	174	96.67

Source: Field Survey, 2014.

However, it is in sharp contrast to that of Aneani et al (2011) who reported adoption rates of 7.5% and 10.3% for fungicides and insecticides respectively. The high adoption rates of fungicides and insecticides could be attributed to high incidence of capsids and black pod diseases in the study area (personal communication with some farmers). The high rates (92.78%) of pruning is an indication of farmer's acknowledgement of the significance of adequate sunshine and aeration in their cocoa farms to prevent black pod diseases. The surest way to have enough sunshine and aeration is through pruning. The essential of pruning is to give the cocoa tree a structure to help maximize its productive capacity.

Intensity of Cocoa Farm Technology. The improved cocoa farm management practices that is expected to be adopted by farmers in other to enhance production include; pruning, planting of hybrid seeds, planting of recommended timber trees, fungicides application, insecticides application, fertilizer application and land and water management practices.

From table 4, the number of improved cocoa farm management practices adopted by all sampled farmers range from 1 – 7. Thus, every farmer in the data set adopted at least one cocoa farm management practice. About 17% of the sampled farmers adopted 1 -3 cocoa farm management practices whilst about 80% have adopted between 4 and 6 management practices. However, only five farmers representing 2.78% have adopted all the management practices. Farmers attributed their inability to adopt all management practices to reasons such as lack of funds to purchase inputs (example, fertilizer, fungicides and insecticides), lack of access to credit facilities and inadequate knowledge in the application of some of the practices. Whilst some farmers believe that their lands are fertile enough and therefore needs to fertilization, others also believe investment in fertilizer will yield inadequate returns comparing the cost of fertilizer and its application to the value of the crops at the end of the season. Hence, their unwillingness to apply fertilizer on their farms.

Table 4 - Intensity of Cocoa Farm Management Practices

Number of Farm Management Practices	Frequency	%
0	0	0
1	8	4.44
2	6	3.33
3	16	8.89
4	47	26.11
5	61	33.89
6	37	20.56
7	5	2.78
Total	180	100

Source: Field Survey, 2015.

Determinants of Intensity of Adoption of Cocoa Farm Management Practices. Table 5 presents the estimates for the Poison Regression model. Socio-economic variables in the model include; Age, Sex, Marital status, Level of education, FBO membership, Extension visit and Household size. Overall significance of the Poisson model as reported by the Wald Chi-squared value is satisfactory (35.81) indicating that the model had good explanatory power. Out of the eight explanatory variables, level of education, marital status, household size, FBO membership and extension visit were all found to be significant.

The coefficient of household is positive and significant at 1%. Thus, farmers with large household sizes are likely to adopt more farm management practices than those with small household sizes. This could partially be attributed to the fact that farmers with larger household sizes may have advantage of enjoying free labour (family labour) than those with smaller household sizes, and hence, are likely to adopt more of the management practices. The marginal effects indicate that adding one extra person to a farm household has the probability of increasing adoption by 0.08 units. The results are in sharp contrast to a negative relationship between household size and adoption reported by Nkamleu et al (2007).

The positive and significance of education variable suggests that as more farmers become educated, it will help to increase the intensity of adoption of cocoa farm management practices, holding all variables constant. This is probably because educated farmers can easily access and comprehend information regarding their farming business. Literate farmers can easily absorbed information from mass and print media, hence, easily adopt innovations and new ideas faster than their illiterate counterparts. The marginal effects of a unit increase (1 year) of the number of years spent in acquiring formal education is likely to increase adoption intensity by 0.04 units. The results of this study are not different from the works of Al-Karableih et al (2009) and Odoemenem and Obinne 2010.

The adoption intensity was also greater for farmers without spouses than those with spouses. This is contrary to our apriori expectations. However, we can ascribe this observation to a simple logic that farmers with no spouse may have no family (not necessarily) and therefore will have few mouths to feed. This means that he/she may have few items to compete with his/her resources and hence may have enough to invest than those with spouses and may have family to cater for.

From the study, the potential increase in yield resulting from adoption of cocoa farm management practices is also a function of farmers belonging to a farmer-based organization (FBO). The coefficient of FBO variable is positive and significant at 1%. Farmer-based organizations creates opportunity for farmers to interact and learn from each other which help them to understand the ins and outs of a new production technology which increases the speed of adoption. The results indicates that a farmer being a member of FBO is likely to increase his/her adoption intensity by 0.76 units.

Table 5 - Poison Regression Estimates of Cocoa Farmers Intensity of Adoption of Farm Management Practices

Variables	Coefficient	Standard Error	Marginal Effects
Age	-0.0038879	0.028648	-0.0175997
Sex	-0.0122612	0.0474657	-0.0555592
Household size	0.0183427***	0.006525	0.0830346
Educational Attainment	0.0088513**	0.0039727	0.0400686
Experience	0.003488	0.0026571	0.0015791
Marital status	-0.1238504***	0.0460945	0.5715073
FBO Membership	0.163933***	0.0448399	0.7591484
Extension services	0.032372*	0.0177004	0.146543
Log likelihood	-298.07		
Wald Chi-square(8)	35.81***		
Sample size	180		

*Note: ***, **, * represent 1%, 5% and 10% level of significance. Dependent variable: Number of Production technologies adopted by Farm household. Marginal effects are calculated at the means of the independent variables.*

Extension contacts as expected, increases the adoption intensity of cocoa farm management practices. Extension contact was positive and significant at 10%, implying that exposing famers to extension services will help to increase adoption intensity. The results indicate that each time a farmer is expose to extension services, it increases adoption intensity by a margin of 0.15 units. The importance of extension delivery services explaining the adoption of farm management practices has been documented in many studies such as Ransom et al (2003) and Doss and Morris (2001).

CONCLUSION AND RECOMMENDATIONS

The study had focused on cocoa farm management practices adopted by farm households in Prestea Hunny-Valley district of Ghana using Poison Regression Model to identify factors explaining variation in farmer's intensity of adoption. The study estimated the respective adoption rates of 92.78%, 21.11%, 18.89%, 72.22%, 98.89%, 55.56% and 3.33% for pruning, planting of improved seeds/seedlings, planting of recommended timber trees, fungicides application, insecticides application, fertilizer application and land and water management. Majority (80%) of the sampled farmers have adopted 4-6 of the cocoa farm management practices. However, only 2.78% of the sampled farmers have adopted all the seven management practices. Factors such as household size, educational attainment, marital status, FBO membership and extension services were statistically identified to explain variation in the intensities of adoption of cocoa farm management practices. The results suggest that, to increase cocoa production in Ghana, farm level policies oriented towards increase in farm management practices is imperative. For instance, extension service delivery can be strengthen in terms of staff and other methods of delivery such as the mass media.

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