Factors Influencing Participation of Cocoa Farmers in the Government Spraying Programme in Ghana

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Authors' contributions

This work was carried out in collaboration between both authors. Author ABT designed the study and performed the statistical analysis. Author AA-H wrote the first draft of the manuscript. All authors managed the literature searches. Both authors also read and approved the final manuscript.

Original Research Article

ABSTRACT

The study assessed the factors influencing participation of cocoa farmers in the government spraying programme in Ghana using cross-sectional data obtained by interviewing respondents with the aid of a questionnaire. A probit model was employed to analyse the determinants of farmer participation in the programme. The study revealed that participation in the spraying programme was higher for the following: male farmers, producers with more years of farming experience, farmers with more extension contacts, and respondents with smaller families. Furthermore, the interaction term for gender and farming experience showed that being an experienced male farmer decreased the probability of participation in the programme relative to an experienced female farmer. The study recommends the expansion of the government cocoa spraying programme to cover farmers who were unable to participate. In particular, addressing the factors inhibiting the participation of female farmers as well as improving extension service delivery to producers will enhance the effectiveness of the programme.

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1. INTRODUCTION

Ghana has become synonymous with cocoa due to her contribution to the production of the crop at the global stage. Currently, the country ranks second to Côte d'Ivoire as the leading producer of the crop. Cocoa production contributes immensely to the nation's gross domestic product and provides a source of livelihood for more than 800,000 farm families [1]. For instance, out of the share of Agriculture to Gross Domestic Product (GDP) in Ghana, cocoa contributed about 7.4% and 8.2% in 2009 and 2010 respectively, with potential growth rate averaging 5% annually [2]. Ghana is a major player in the global cocoa market. Cocoa has contributed to Ghana's development and poverty alleviation strategies since independence in 1957. However, production levels dwindled in the 1960-70s after several decades of being a global leader in the production of the crop. This resulted in a near breakdown of the cocoa sector in the 1980s. However, following reforms introduced by the government of Ghana in the mid-1980s, the cocoa sector began to revive in the 1990s. The country's cocoa output almost doubled between 2001 and 2003. [3] observed that the consistent gain in production falls short of cocoa output in the 1960s. The decline in production was due to low yields arising from pests and diseases infestation and non-adoption of research recommendations.

To curb the fall in production and increase the efficiency of the cocoa sector, the Government of Ghana in the early 1990s embarked on several cocoa sector policy reforms. The most dominant policy shift was the introduction of partial liberalisation in the cocoa sector that paved the way for licensed private buying companies alongside the state-owned Produce Buying Company (PBC) to buy cocoa internally from farmers. The government instituted a development strategy in 1999 to revamp the cocoa industry. Closely following the 1999 strategy was the approval of the Cocoa Sector Development Strategy aimed at revamping the cocoa sector to bring about rural development and poverty alleviation. The government set the target of increasing cocoa output from 335,000 tons to 500,000 tons by the year 2004/5 (https://www.odi.org/events/presentations/446.pdf). The target for 2009/10 was 700,000 tons. The goal was to maintain this production level thereafter. Associated with the Cocoa Sector Development Strategy is the cocoa diseases and pests control programme which provides free spraying of all cocoa farms in the country. According to the recommendation of the Cocoa Research Institute, cocoa farms require four spraying regimes per annum between July and November [4]. Apart from the free government spraying, cocoa farmers are required to supplement the government spraying with their personal spraying to ensure total crop protection.

Even though the government cocoa spraying programme is expected to benefit every cocoa farmer, there is evidence that some farmers are not able to participate. For example, [5] reported that 30 percent of cocoa producers in the Bibiani-Anhwiaso-Bekwai District of Ghana could not participate in the spraying programme. A major reason given for non-participation in the programme was inadequate number of spraying personnel. The non-participation of cocoa farmers in the spraying programme is a major concern to researchers, the Cocoa Research Institute and the Ministry of Food and Agriculture who are involved in promoting cocoa production in the country. While attention has often focused on developing new technologies, there is no concomitant attention to assess the barriers to participation and/or adoption of technologies. Information on the socio-economic determinants of participation in the cocoa spraying programme in Ghana is very limited despite the importance of cocoa to the Ghanaian economy and the significance of the spraying programme to the cocoa sector. It is in this light that we sought to bridge the knowledge gap by providing empirical evidence of the factors restricting farmers' participation in the government-sponsored spraying programme.

The literature is replete with studies on the factors that determine participation in agricultural programmes (see for example, [6-8]. Many of these studies considered a broad range of factors such as gender, education, farm size, extension contact, household size, farm experience, age, distance and credit. However, the findings do not always agree. For instance, [9] found participation in an environmental programme in Greece to be higher for farmers with larger farm size. [10] however found participation to be higher for farmers having smaller farm sizes in a study in Belgium. According to [6], participation is higher for smaller farm owners while other researchers like

[11] and [12] do not find any association between participation and farm size.

Socio-economic factors such as gender, age, farming experience, occupation and group membership also affect participation in agricultural programmes. [8] underlined how these factors influence programme participation in Nigeria. The author indicated that gender, age, farming experience, occupational status and membership of cooperative societies influenced farmers' participation in agricultural programmes.

In another study, [7] examined the relationship between adoption of hybrid cocoa varieties and land productivity in Ghana and found several socio-economic factors affecting participation. Among the factors were age, household size, access to credit and extension, group membership, and application of fertilizer. Other factors such as sex and education did not significantly affect adoption.

[13] also examined factors affecting participation in agricultural projects in Ghana. The results of a probit analysis showed the factors influencing participation in agricultural projects to include educational level, access to credit and extension service.

Even though [14] examined socio-economic factors influencing participation, their study placed emphasised on programme effectiveness and constraints as the main determinants of farmers' participation in agricultural programmes. They found that the probability of participation in agricultural programme increased with household size and programme effectiveness but decreased with the level of constraints.

[15] replicated the use of the probit model to examine farmers' willingness to take part in a multi-stakeholder platform in Northern Ghana. The study showed the determinants of participation to include age, income and household size.

In a study to examine the adoption of some cocoa production technologies by farmers in Ghana using multinomial logistic regression analysis, [16] found adoption to be influenced by factors such as gender, farm size, yield, age of the farm, and access to credit.

The literature confirms that characteristics of farmers interplay in the participation in agricultural interventions. However, there remain gaps in knowledge regarding the direction of impact of the factors affecting participation in agricultural programmes such as the cocoa spraying programme in Ghana. Modelling participants' motivations underlying participation or uptake of programme interventions remains a challenge to research as indicated in some studies ([17-19]). Using the Bibiani-Anhwiaso-Bekwai District in Ghana as a case study, the study sought to investigate the factors influencing participation of cocoa farmers in the government spraying programme. The study contributes to our understanding of the factors affecting smallholder farmers' participation in programmes intended to enhance their productivity. It is our anticipation that the results of the study will contribute to addressing the problem of non-participation in the cocoa spraying programme and thereby improve the productivity of farmers.

The structure of the paper is as follows: section 1 covers the introduction. The methodology used, including the survey process and analytical framework is presented in section 2. We present the results and discussion of the major findings in section 3. Finally, the conclusions and recommendations are presented in section 4.

2. METHODOLOGY

2.1 Study Area and Data

The study was carried out in the Bibiani-Anhwiaso-Bekwai District, which is located in the Western Region of Ghana. The Western Region is the leading cocoa producing Region in the country and Bibiani-Anhwiaso-Bekwai is a leading cocoa producing district in the Western Region. The District has a forest vegetation type and the annual rainfall varies from 1200 mm to 1500 mm. The rainfall pattern is bimodal and very conducive for cocoa production. The bimodal rainfall pattern contrasts with the unimodal rainfall pattern in the savannah zones of the country where the long spell of dry season does not support cocoa cultivation.

A field survey was used to identify 80 cocoa farmers who were selected at random from four communities using semi-structured questionnaire. Random sampling was used to eliminate systematic bias. Demographic, socioeconomic and production data were collected. From the total sample of 80 respondents, 78 provided complete information and were included in the final analysis.

2.2 Empirical Model

Due to the binary nature of the dependent variable, that is participation in the cocoa spraying programme, we employed the probit model to analyse the data. The probit model is suitable for small datasets and has been widely applied to the estimation of participation models in the literature (for example, [8], [13-15].

As a binary situation, farmers either participate in the programme or otherwise. Therefore, if we denote participation in the spraying programme by y_i, then $y_i = 1$ if the farmer participated and $y_i = 0$ if the farmer did not participate. The predicted probabilities are then constrained to lie between 0 and 1. With the probit model only the values of 0 and 1 can be observed for y_i, but there is a latent variable y_i^* that determines y_i [20].

Following [21], the probit model can be written as:

$$E(y_i|x_i) = 1[F(\boldsymbol{\beta}'\boldsymbol{x_i})] + 0[1 - F(\boldsymbol{\beta}'\boldsymbol{x_i})] = F(\boldsymbol{\beta}'\boldsymbol{x_i}) = \Phi(\boldsymbol{\beta}'\boldsymbol{x_i}) \qquad (1)$$

where Φ is the cumulative distribution function of the standard normal distribution, $\boldsymbol{x_i}$ represents a vector of random explanatory variables and $\boldsymbol{\beta}$ is a vector of parameters to be estimated.

We specify the empirical model of the probit regression as follows:

$$y_i^* = \beta_0 + \sum_{j=1}^{8} \beta_{ji} x_{ji} + v_i \qquad (2)$$

where y_i^* is the latent variable representing farmers' participation in the spraying programme, x_1 to x_8 are the independent variables influencing participation namely gender, education, farm size, household size, farm income, farming experience, extension contact, and the interaction of gender and farming experience, respectively. v_i is a random disturbance term.

The latent variable (y_i^*) is related to the observable binary variable (y_i) through the expression:

$$y_i = \begin{cases} 1 \ if \ y_i^* > 0 \\ 0 \ if \ y_i^* \leq 0 \end{cases} \qquad (3)$$

Due to the non-linearity of the probit model, the parameters do not represent the marginal effects of the explanatory variables. The marginal effects are more informative and easy to understand and explain. The results of the marginal effects provide useful guidelines for decision-making by policymakers. The marginal effect is the differential of equation (1) with respect to x_i [21]:

$$\frac{\partial y_i}{\partial x_i} = \left[\frac{\lambda\boldsymbol{\beta}'\boldsymbol{x_i}}{(1+\lambda\boldsymbol{\beta}'\boldsymbol{x_i})^2}\right]\beta_i = F(\boldsymbol{\beta}'\boldsymbol{x_i})[1 - F(\boldsymbol{\beta}'\boldsymbol{x_i})]\beta_i = \phi(\boldsymbol{\beta}'\boldsymbol{x_i})\beta_i \qquad (4)$$

where ϕ denotes the probability density function of the standard normal distribution.

Our choice of variables for this study is based on intuition and literature ([13-15], [22], [23]) as these have been shown to play key roles in farmers' programme participation.

We present the definition of the explanatory variables used in the study and our *a priori* expectations of their relationship with the dependent variable in Table 1. A positive sign means that the variable in question is expected to increase the probability of participation in the spraying programme and vice versa.

We expect the gender of the farmer to have a positive relationship with participation implying that we expect male farmers to have higher participation in the programme compared to their female counterparts. This is due to the inherent bias against women farmers in most developing countries in terms of access to resources and participation in programmes.

Education increases farmers' awareness of the benefits of interventions and access to information. Hence, we expect the variable to have a positive impact on participation. However, participation is likely to decrease if educated farmers engage in off-farm activities due to their higher opportunity cost of labour. We therefore hypothesise an indeterminate sign for the education variable.

With respect to farm size, we hypothesise a positive relationship with participation in the cocoa mass spraying programme. This is because farmers with larger farm holdings are likely to be influential members of the society and thus more likely to be beneficiaries of government interventions. Similarly, we expect farm income to have a positive effect on participation because households with higher incomes are likely to be influential members in the society.

Table 1. Definition and expected signs of the variables in the probit model

Variable	Definition/measurement	Sign
Participation in programme	Dummy: 1 if farmer participated; 0 for otherwise	
Gender	Sex of farmer: 1 if male; 0 for otherwise	+
Education	Dummy: 1 if educated; 0 for otherwise	+/-
Farm size	Farm size in acres	+
Farm income	Farm income in Ghana Cedis	+
Extension contact	Number of extension visits per annum	+
Household size	Total number of household members	+/-
Farming experience	Years of farming experience	+

Extension agents are channels for information flow to farmers so we expect extension contact to have a positive impact on participation in the cocoa spraying programme. Communities without extension agents are less likely to be involved in the programme just as farmers who are unable to access extension service. We expect household size to exert either positive or negative influence on participation. This is because we anticipate that larger households may have social influence that is likely to aid their accessibility to the spraying personnel. However, labour-constrained small households may be desperate to get their farms sprayed and may therefore be more eager to search for spraying personnel. Finally, we expect farmers who are more experienced in cocoa production to be more knowledgeable about farming and more familiar with extension agents and the spraying personnel, which are likely to facilitate their participation in the spraying programme.

3. RESULTS AND DISCUSSION

We present the results of the study together with the discussion of the relevant findings in the following section. Table 2 presents the descriptive statistics of the respondents according to their participation status: the mean, standard deviation and the test of the mean difference of the variables use in the model.

From the results, gender, educational status, farm size and farming experience did not exhibit any significant difference between the participants and non-participants. Overall, about 69 percent of respondents participated in the programme, with 82 percent being male farmers.

With respect to gender, even though the results of the *t*-test did not show any significant difference between programme participants and non-participants, it highlights the perceived marginalisation of women farmers in developing countries with regard to access to production resources and participation in development programmes due to their low social and political power ([24-25]).

About 88% of the respondents had been to school and obtained some level of formal education. We recorded education as a dummy variable and therefore were unable to give sufficient information about the levels of educational attainment. The average years of farming experience among the respondents was 15 with average farm size equal to 8 acres and household size averaging 10 members. Furthermore, the average income from cocoa production was GH¢1937 while 36% of the respondents made contact with an extension agent during the farming season. Even though farm income was a little higher for non-participants, the mean difference was not significant.

Table 2. Descriptive statistics of respondents according to participation status

Variable	Mean	Std. Dev.	Participants (N = 54)	Non-Participants (N = 24)	*t*-test
Gender	0.82	0.39	0.83	0.79	-0.44
Education	0.88	0.32	0.89	0.86	-0.18
Farm size	7.76	5.76	7.70	7.73	-0.03
Farm income	1937	2029	1874	2078	0.41
Extension contact	0.36	0.81	0.50	0.04	-2.39**
Household size	9.99	2.94	9.48	11.1	2.34**
Farming experience	15.3	7.72	15.6	14.6	-0.51

*** Significant at 5% level*

Contact with extension agents was higher for programme participants, and the mean difference was statistically significant, implying that the variable is likely to play an influential role in farmers' participation in the spraying programme. The number of household members was higher for non-participants and the mean difference was statistically significant. Hence, household size is likely to influence participation in the spraying programme.

3.1 Factors Determining Participation in the Spraying Programme

We present the factors influencing participation of cocoa farmers in the government-sponsored spraying programme (estimated by the probit model) in Table 3.

The Wald chi-square value of 16.98 for the model is statistically significant at 5% indicating that the independent variables jointly explain the probability of participating in the spraying programme. Four out of the seven explanatory variables were significant determinants of participation with three of the variables confirming our *a priori* expectations. Specifically our results showed that gender, extension contact, household size and years of farming experience significantly influenced farmers' participation in the cocoa spraying programme. Our aim was to help stakeholders understand the degree to which the estimated coefficients from the probit model affect participation in the cocoa spraying programme. Hence, besides the estimation of the probability of participation, we also estimated the marginal effects of the coefficients and discussed the significant variables.

The coefficient for gender is positive and statistically significant at 10% with a marginal effect of 63.5%. From the result, men had a higher probability of participation compared to women. This observation is consistent with [19] and [26]. The reason for this finding is that in a typical rural setting, household heads are usually males who are the decision-makers in terms of access to resources and participation in programmes. Women often need the permission of their husbands to participate in programmes thus constraining their participation rates.

Contact with extension agents had a positively significant effect on participation. This means that as the number of contacts with extension agents increases, the likelihood to participate in the programme increases. An additional contact with extension agent increases participation in the spraying programme by 30.2%. The result is in line with our *a priori* expectation. The implementation of agricultural projects and programmes of the Government of Ghana is usually through the Agricultural Extension Services Directorate of the Ministry of Food and Agriculture (MoFA). MoFA also collaborates with other institutions as well as farmer groups to extend services to farmers. Extension agents therefore facilitate access to agricultural interventions and services such as the cocoa spraying programme.

Table 3. Maximum likelihood estimates of the probit participation model

Variable	Coefficient	Std. Errors	P >	z		Marginal effect
Gender of farmer	2.203*	1.230	0.073	0.635
Educational level	-0.423	0.654	0.518	-0.122
Household size	-0.168**	0.071	0.017	-0.048
Farm size	-0.013	0.032	0.696	-0.004
Farm income	-0.142	0.239	0.553	-0.041
Extension contact	1.047**	0.471	0.026	0.302
Farming experience	0.114*	0.061	0.060	0.033
Gender × Experience	-0.118*	0.070	0.093	-0.034
Constant	1.454	1.802	0.420	-
Log-likelihood	-39.7			
Wald chi2 (8)	17.0**			
Pseudo R2	0.18			
Percentage correctly classified	74.4.			

* Significant at 10 percent level; ** Significant at 5 percent level

Household size was significant at 5% but with -4.8% marginal effect. Farmers with larger households are therefore 4.8% less likely to participate in the spraying programme for every additional member added to the farm household. This is because larger households may be less labour-constrained which may lead to less urgency in following up the spraying personnel. Larger households may also be preoccupied with meeting the family basic needs such as food, clothing and shelter, such that they may have little or no time left to follow up spraying personnel.

Farming experience was a significant factor influencing participation in the spraying programme and had a marginal effect of 3.3%. This implies that an additional year of farming experience leads to a 3.3% increase in the likelihood to participate in the spraying programme. Our result in this regard is plausible and expected. More experienced household heads have over time, developed some understanding of programmes that can help raise farm yields and become more acquainted with extension agents which may enhance their participation in programmes [27].

The interaction between gender and farming experience was negative and significant at the 10 percent level even though the influence of the individual variables on participation was positive. The interaction between the two variables showed that female farmers with experience in cocoa farming were 3.4% more likely to participate in the mass spraying programme compared to their male counterparts. The introduction of the interaction term is thus useful as it provides additional information on how the variables in the model influence programme participation.

4. CONCLUSION AND RECOMMENDA-TIONS

The study adopted the binary probit model to estimate the determinants of farmers' participation in the government cocoa spraying programme in Ghana. Eighty (80) cocoa farmers were selected from four communities in the Bibiani-Anhwiaso-Bekwai District of Ghana for the study. The respondents were randomly selected and interviewed with the aid of a questionnaire. Our results revealed that farmer characteristics including gender of the farmer, contact with extension agents, household size and farming experience had significant influence on participation in the government cocoa spraying programme. We therefore propose the following recommendations to enhance participation in the programme.

First, there is the need to eliminate the gender inequality in access to and participation in the government-sponsored spraying programme. Women's participation in agricultural programmes have been shown by this and other research findings to be lower than men and effort to enhance women's participation will go a long way to increase cocoa output in Ghana.

Furthermore, scaling up extension service delivery to farmers will enhance participation in the spraying programme as shown by the significant effect of extension contact on programme participation. In particular, the use of mass extension methods requires emphasis as a panacea to the limited number of extension agents in the country. For example, mass communication through radio, television and communication vans are potential means to reach farmers in remote areas. In addition, there is the need to strengthen farmer-based groups to serve as channels for the dissemination of extension services to farmers which may facilitate the participation of members in the spraying programme.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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