

**Socioeconomic Factors Influencing Adoption of CODAPEC and Cocoa High-Tech technologies among Smallholder Farmers in Central Region of Ghana**

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**Abstract**

Cocoa is single most important agricultural crop export and major source of foreign exchange to Ghana. This study examines the socioeconomic factors affecting adoption of CODAPEC and Cocoa High-Tech Technology packages introduced by Ghana government into cocoa production system to address the dwindling levels of productivity. The study employed a multi-stage random sampling technique to select 250 households from 25 communities in five of the eight cocoa districts in Central Region of Ghana. Tobit multivariate regression model was used to understand socioeconomic factors influencing farmers' decision to adopt these technologies. Results generally indicate experience, education level, training, age of household head, household size, social capital and the producer price are the key variables that positively influence decision of farmers to adopt CODAPEC and Cocoa High-Tech Technology packages. Lack of credit and very old cocoa farms contribute to the non-adoption of these technology packages by the farmers. The study recommends these socioeconomic variables for consideration in future cocoa policy formulation. Policy makers should seriously take into account the cost equation of what goes to cocoa production on the farm when fixing of the producer price of cocoa. Emphasis should be placed cocoa extension services to educate the farmer about the importance of the technology attributes so as to increase level of adoption.

**Keywords:** Technology attributes, Cocoa technologies, Adoption, Socioeconomic factors, Tobit model

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## 32 1.INTRODUCTION

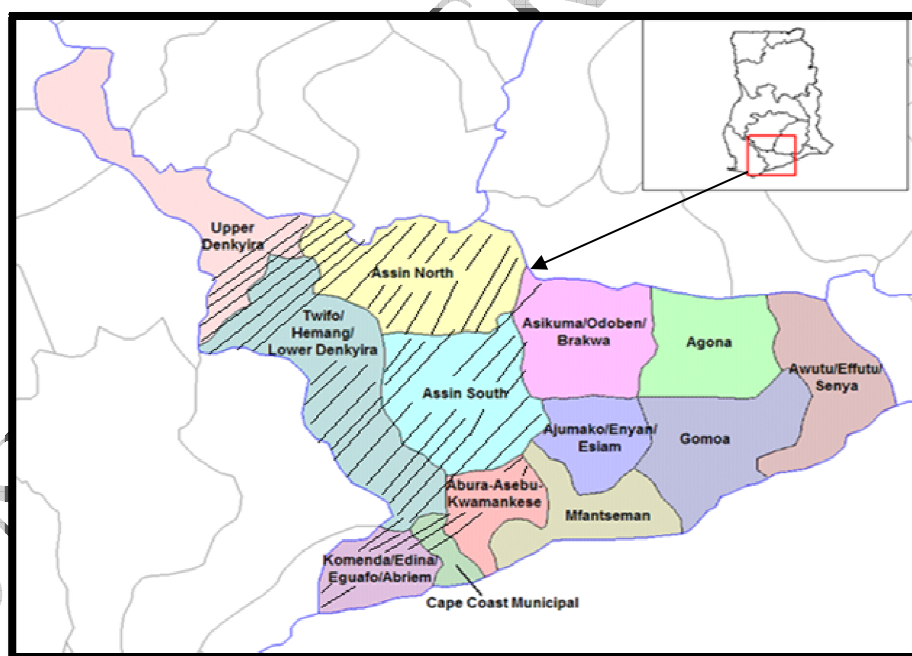
33 Cocoa (*Theobroma cacao* Linn.) is an important export crop for Ghana. The crop accounted for  
34 35.1% of agricultural exports and 4.3% of Gross Domestic Product(GDP) in 2007 (Institute of  
35 Statistical Social and Economic Research, 2008), contributed to about 63% of the foreign  
36 exchanges earnings from the agricultural sector and employed about 3.2 million workers  
37 including smallholder farm families, farm owners and service providers in Ghana (Lundstedt and  
38 Parssinen, 2009). Despite the enormous contribution of the cocoa sector to the Ghanaian  
39 economy, the sector has been smitten by a myriad of challenges over the years. For instance, the  
40 production level of 560,000 metric tonnes recorded in the 1965 declined to the lowest ever  
41 recorded of 154,000 metric tonnes in the 1980s (Appiah, 2004). The premier position as number  
42 one producer and exporter of cocoa beans in the world has been lost to Cote d'Ivoire; whose  
43 annual average production as at 2009 was approximately 1472 000 metric tonnes (Food and  
44 Agriculture Organisation, 2010).The estimated productivity per hectare of 300-400kg in Ghana  
45 is very low as compared to countries like Cote d'Ivoire, Malaysia and Indonesia with estimated  
46 800kg, 1800kg and 1000kg productivity per hectare respectively (Anon, 1995; Anim-Kwarpong  
47 and Frimpong, 2005; Ministry of Finance, 2002). Moreover, it was estimated that over 25% of  
48 the cocoa-tree stocks were over 30 years old. In addition, the old cocoa farmers, whose average  
49 age is approximately 50 years were unwilling to take risk by investing in yield improvement  
50 strategies due to perceived low returns (Anim-Kwarpong and Frimpong, 2005).Various reasons  
51 cited for the low productivity include low producer price, lack of access to credit or loan  
52 facilities, rapid deterioration of the forest environment, poor socioeconomic condition of rural  
53 farm communities and most importantly, the general poor maintenance culture especially the  
54 control pest and disease of cocoa (Appiah, 2004; Padi and Owusu, 1998; Anim-Kwarpong and  
55 Frimpong, 2005; Dormon et al., 2004; Dormon et al., 2007). Nevertheless, initial farm trials  
56 conducted by Ghana Cocoa Board indicated that Ghana has potential to achieve an average  
57 productivity of over 1500kg/ha if appropriate technologies and agronomic practices are adopted  
58 (Ampofo,1990). The Government of Ghana initiated two important cocoa technology-based  
59 intervention programmes, the Cocoa Pest and Disease Control and Cocoa High Technology  
60 (CODAPEC and Cocoa High-Tech) in 2001 to address the production challenges of the cocoa

sector. The programmes also have both social and economic objectives that seek to improve upon the income and living standards of farm families, maximise foreign exchange contribution to the economy of Ghana, reduce poverty amongst cocoa farmers and to encourage the youth to go into cocoa farming (Vigneri, 2008). The cocoa technologies (CODAPEC and Cocoa High-Tech technology) consist of discrete units of 25 attributes (see Table 1) which targeted the reduction or elimination of the two major cocoa pests namely, capsids and black pod disease in Ghana. COCOBOD has reported an unprecedented historical cocoa production level of 1,004,194 metric tonnes in 2011 due to the introduction of CODAPEC and Cocoa High-Tech technologies (Ghana Cocoa Board, 2011). However, very little information was provided to understand the socioeconomic drivers influencing the adoption of CODAPEC and Cocoa High-Tech technologies by farmers. The extent of adoption, adjustment or rejection depends on farmer's behaviour (Valera and Plopino, 1987). The decision to use a technology is dependent on how the farmer perceives the technology (Van de Ban and Hawkin, 1988). Farmers in general may be aware of several constraints to farming which may be at variance with what the researchers perceive (Mutsaers et al., 1997). Smallholder farmers possess a body of indigenous knowledge about the socioeconomic and biophysical environment which are hardly incorporated into development and design of appropriate technologies (Oweremadu et al., 2007). Various reasons need to be assigned to technology adoption among smallholder farmers which is generally very low (ICRAF, 1997). High adoption rates of proven technology among farmers have been associated with proper and effective diagnosis of problems of farmers, involvement in the programme design and encouragement to innovate (Franzel et al. 2001; Oweremadu and Matthew-Njoku, 2007). The understanding of socioeconomic and biophysical dynamics or interaction that contributes to variation in adoption of technologies by smallholder farmers will unravel the key factors that influence their decisions making process (Matata et al., 2010). Cruz (1987) cited many factors that influence extent of adoption of on farm technologies. Notably among them are the attributes of technology, the agent of change, socio-economic, biological and the physical environment. Many socioeconomic studies traditionally focused on technology adoption process at both individual farmers and aggregate levels (Feder et al., 1982; Matata et al., 2010). However, this study examined the socioeconomic factors that influence adoption of Cocoa Technologies in smallholder cocoa farmers in Ghana.

## 2. MATERIALS AND METHODS

### 2.1 Data and the study area

A cross-sectional survey design was adopted for the study and it was conducted from December 2009 to February, 2010 to collect on farm-level cross-section data for the 2010 crop year from five selected cocoa districts in Central Region of Ghana. A multi-stage random sampling technique was employed to locate the districts, farming communities and farm household (Rahman, 2003). At the first stage, five out of the eight cocoa districts were selected randomly. These were; Cape Coast, Twifo Praso, Twifo Nyinase, Assin Foso and Assin Breku (Figure 1). At the second stage, five communities were randomly selected from each of the selected cocoa districts. A total of 250 households from the selected 25 communities (ten from each community) were selected randomly at the final stage of sampling to be involved in the study. The data were gathered through administering of questionnaires (Kumepkor, 2002).



Key: Study area 

**Figure 1.** Showing the five selected Districts for the study in the Central Region of Ghana

Source (<http://www.ghanadistricts.com/centralregion>, 2009)

## 2.2 Theoretical and conceptual framework

The decision of farmers to adopt any novel technology has been suggested to be based on utility maximization (Rahm and Huffman, 1984). The concept of utility maximization has therefore been used as theoretical or conceptual framework for adoption of many innovation or improved farm technologies (Adesina and Zinnah, 1993; Adesina and Baidu-Forson, 1995; Baidu-Forson, 1999). The decision of farmers to adopt a technology is seen as single unit of package, that is whether to adopt or not to adopt. The dichotomous nature of such decisions usually implies that the empirical model be specified as binary dependent variable model (Herath and Takeya, 2003; Adesina and Baidu-Forson, 1995; Rahman, 2003; Udoh et al., 2008). In the case of CODAPEC and Cocoa High-Tech technologies, the package consists of discrete units of 25 attributes, which most farmers adopt some and leave out others. As a result, the adoption level is expressed as a ratio of number of attributes adopted to the total attributes of the package. The dependent variable is therefore censored and continuous with lower limit designated as zero and the upper limit as one. Additionally, the intensity of adoption demanded that the model be specified as Tobit since binary dependent choice models often throw away some of the useful information concerning dependent variable (Tobin, 1958). The household of cocoa farmers maximize utility over the set of attributes of CODAPEC and Cocoa High-Tech technology package. Following Mazvimavi and Twomlow (2009) analytical framework or procedure, the adoption of CODAPEC and Cocoa High-Tech technologies is specified as Tobit model. The stochastic model of adoption within Tobit modelling framework is presented as follows (McDonald and Moffitt, 1980; Gould et al., 1989):

$$Y_t^* = \beta X_t + \mu_t \quad (t = 1, 2, \dots, N) \quad (1)$$

Where  $Y_t^*$  represents the latent unobserved component of the adoption of CODAPEC and Cocoa High-Tech technologies,  $\beta$  is a  $(k \times 1)$  vector of unknown parameters,  $N$  is the number of observations which representing individual cocoa farmers participated in the enumeration,  $X_t$  is a vector of the type  $(k \times 1)$  denoting independent variables which capture socioeconomic characteristics of the cocoa farmers and  $\mu_t$  is independent normally distributed error term with

mean zero and constant variance  $\sigma^2$  (McDonald Moffitt,1980). The observed component of dependent variable could therefore be denoted as  $Y_t$  this captures the aggregate levels of the total attributes of CODAPEC and Cocoa High-Tech technologies adopted by the cocoa farmers.

The conditional terms or probability of adoption are defined as follows (Gould et al., 1989):

$$Y_t = \begin{cases} 0 & \text{if } Y^* \leq 0 \\ Y^* & \text{if } 0 < Y^* < 1 \\ 1 & \text{if } Y^* \geq 1 \end{cases} \quad (t= 1, \dots, N) \quad (2)$$

Adoption occurs when  $Y_t$  falls within  $0 < Y^* < 1$  and  $Y^* \geq 0$ ; and non-adoption occurs when  $Y^* \leq 0$

The highest threshold or upper limit of  $Y_t$  is 1 and the lowest limit in this case is 0.

Thus, the final operational multivariate Tobit analysis of socioeconomic factors affecting adoption CODAPEC and Cocoa High-Tech technology is specified as

$$Y_t = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n \quad (3)$$

Where the  $X(s)$  are the independent socioeconomic variables and  $\beta(s)$  denote parameter estimates

### 2.3 The empirical model

The empirical model of adoption CODAPEC and Cocoa High-Tech technology to be estimated may be specified as

$$\begin{aligned} \text{Adoption} = & \beta_0 + \beta_1 \text{Experience} + \beta_2 \text{Education} + \beta_3 \text{AgeHH} + \beta_4 \text{Gender} + \\ & \beta_5 \text{HouseHoldSize} + \beta_6 \text{FarmSize} + \beta_7 \text{Ageofthefarm} + \beta_8 \text{SocialCapital} + \\ & \beta_9 \text{Credit} + \beta_{10} \text{Training} + \beta_{11} \text{Price} + \varepsilon \end{aligned} \quad (4)$$

The detail information about the characteristics of dependent variables is provided in Table 2 and descriptive statistics for all the explanatory variable use in the model are presented in Table 1. Quantitative dependent variable ( $Y_t$ ), which describes adoption decision of individual farmer consists of 25 metrics of attributes (Table 2). Each attribute of the farmers' adoption was allotted a value of 1 and the total was expressed as the ratio of the overall attributes. For instance, a

farmer who adopts 6 attributes of the technology was awarded 6, and  $Y_t$  (adoption) at this instance is 0.24.

*Experience* is measured as the number of years the individual household head has been engaged in cocoa cultivation. Experience enhances skills and facilitates the capacity to address technical or practical problems related to agronomic principles on the field. With increasing experience, a farmer may be able to make critical decision concerning adoption of new technology. Hence, experience is expected to be positively related to adoption (Nkamleu and Adesina, 2000).

*Education* is estimated in this study as number of years of schooling. Education enlightens and increases the level of cosmopolitaness of an individual. In addition, education increases the capacity of farmers to be creative, innovative and less conservative to change. Educated farmers are more likely to adopt new technology (Rahm and Singh, 1988; Nkamleu and Adesina, 2000). Therefore education was expected to be positively related to adoption.

*Training* gives insight to functioning of new technology and technical ramifications as well as the challenges expected to be encountered upon application of the said technology. Training and education are intimately connected. Training increases the level of competency of farmer which invariably will aid adoption. Training is therefore expected to be positively related to adoption.

*Age<sub>HH</sub>* measures the age of the de facto household head in the model. Age has been used extensively as explanatory variable in many adoption studies but its influence on adoption is indeterminate and depends on many factors. Older farmers are more experience and have accumulated more capital as results they are more likely to invest in innovation (Nkamleu et al., 1998). Old age also increase with conservativeness and negatively impact on adoption while young farmers tend to be more innovative and risk adverse (Adesina et al., 2000; Zhang et al. 2012; Gould et al., 1989). The age of household head is negatively related adoption (Nkamleu and Adesina, 2000; Polson and Spencer, 1991). In this study, the age of household head is we hypothesized to be positively related to adoption. This is because older farmers are perceived to be more experienced and have witnessed the benefits of various government interventions in the cocoa subsector in Ghana.

*Gender* is a dummy variable for sex measured as 1 for male and 0 for female. It is used to in the model to capture social role rather than sex of individual farmer. Male cocoa farmers are often more resource endowed than females. In tropical Africa and for that matter Ghana, social roles play significant impact on resource endowment and distribution within the family especially in

the rural farming communities. Females are usually resources constraints be it land or other assets by virtue of the inheritance system. Moreover, in most agrarian societies of Africa, women are generally marginalised in terms of access to information, external inputs as well as income (Lebbie, 2004; Matungul et al., 2001; Quisumbing et al., 1995; Dey, 1981). This state of affairs is more pronounced in male dominated cocoa sector in Ghana. In addition, a gender role affects labour allocation and job description. Gender could be negatively or positively related to adoption depending on the nature or the characteristics of the technology in question (Ntege-Nanyeenya et al., 1997). However, it is hypothesized that gender is positively related to adoption. The *HouseHoldSize* is the household size, which measures the number of individual in the family who eat from the same cooking pot. This variable is normally used in adoption analyses to capture labour availability or endowment to a farm household. Since CODAPEC and Cocoa High-Tech technology is more labour intensive, it is expected that household with large family size will supply more labour would readily adopt the technology (Nkamleu, 2007).

*FarmSize* is the farm size which measures the total land area under cocoa cultivation. Cocoa farmers with large farm sizes are usually wealthy and there is more likelihood that they would readily adopt any high inputs innovation such as CODAPEC and Cocoa High-Tech technology. Secondly, large farm size would facilitate easy realization of the benefits due economy of scale. Thus, farm size is hypothesized to be positively related to adoption (Zhang et al., 2012).

*Ageofthefarm* is a variable which captures the age of the cocoa farm. The age of the cocoa farm is negatively related to adoption of CODAPEC and Cocoa High-Tech technology. This is because most farmers often feel reluctant to spend money on inputs for old cocoa farms due to perceived low returns (Anim-Kwarpong and Frimpong, 2005).

*Credit* is a dummy variable used in the model to measure access to monetary help from financial institution or government. Lack of credit is given 1 and 0 otherwise. Lack of credit is one of the major factors which hamper the adoption of any high input innovative technology. It is therefore assumed to affect adoption negatively (Uaiene et al., 2009; Feder et al., 1985).

*Social Capital* is a measure of membership to social organisation such as cooperative society, unions and church. Social capital increases the capacity of an individual to access information about current innovation and its benefit from other members. It also increases individual farmer's awareness and as a result increases the likelihood for adoption of new technology (Foster and

227   Rosenzweig, 1995; Conley and Udry, 2010; Bandiera and Rasul, 2003; Caviglia and Kahn,  
228   2001).

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229 **Table 1.** Description of the summary statistics and hypothesized direction of influence of the variables specified in the model  
 230

| Independent variables | Description/Rational                                                                                                                                                              | Measure                | Expected effect | Mean  | Standard deviation |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------|-------|--------------------|
| Experience            | Experience farmers are less risk averse and more the likely to adopt new technology. This is captured as years of farming                                                         | Years                  | +               | 21.72 | 8.48               |
| Education             | Educated farmers are more enlightening, cosmopolite and less conservative to change. This is measured as number of years spent at school                                          | Years                  | +               | 0.61  | 0.49               |
| Age                   | Older farmers are more experience and more risk darling and likely to adopt new technology. This is the age of the male, de facto or de jury household head (Male or Female).     | Years                  | +               | 50.87 | 11.41              |
| Gender                | Male farmers in this part of Ghana are resource endowed by virtue of their culture setting and more apt to adopt all the technology attributes. Males are heads of the household. | 1 = Male<br>0 = female | +               | 0.76  | 0.43               |
| Household size        | Large household increase availability of labour and hence adoption level. Household size in this case is number of individuals eating from the same cooking pot.                  | Number                 | +               | 7.23  | 7.21               |
| Farm Size             | Farmers with large farm size are likely to adopt new technology due to significant realization of the benefits.                                                                   | m <sup>2</sup>         | +               | 9.03  | 6.48               |
| Age of the Farm       | Productivity of old farms are very low hence farmers do not see the benefit to invest ,hence low adoption levels                                                                  | Years                  | -               | 18.13 | 9.71               |
| Social Capital        | Membership to societies enhance their social net work and access to information and more likely to innovate or adopt a new technology                                             | 1=Yes<br>0= No         | +               | 0.27  | 0.44               |
| Credit                | Lack of credit will constraint the farmers ability to implement all the attributes of the technological package                                                                   | 1= No<br>0= Yes        | -               | 0.05  | 0.22               |
| Price                 | High cocoa producing price will motivate the farmers to implement or adopt the CODAPEC and Cocoa High-Tech technologies                                                           | 1= Yes<br>0= No        | +               | 0.02  | 0.15               |
| Training              | Training will enhance the farmer readiness to adopt the technology                                                                                                                | 1= Yes<br>0= No        | +               | 0.28  | 0.45               |

*Price* is a dummy variable used in the model to evaluate the perception of the farmers as to how cocoa producer price affects adoption. High producer price will motivate farmers to adopt intensive inputs based technology (see Arslan, 2008; Anim-Kwapong and Frimpong, 2005). The expectation that the producer price will go up in the near future = 1 and otherwise = 0. Hence, price is positively related to adoption option. All the parameters of the model (4) were estimated in Eviews-7 for windows (IHS Inc., 2011) with Tobit link function using QML (Quasi-Maximum Likelihood) (Huber/White) robust standard errors and covariance, and the Newton-Raphson optimization algorithm.

### 3. RESULTS AND DISCUSSION

Virtually all the 250 cocoa farmers interviewed used solar energy to dry the cocoa beans and adhered strictly to 5-7 days recommended duration for fermentation of the cocoa beans (see Table 2). Cultural maintenance component of the technology package registered high level of adopters with exception of use drainage system and general sanitation practise such use of deep pit to bury dead husks and pods. However, the use of “Assasewura fertilizer” brand seems to be more popular amongst the cocoa farmers. Out of 250 house head interviewed 246 reported using “Assasewura fertilizer” and 208 employed broadcast method for the application of the fertilizer. The application of fertiliser at the onset of the rain season featured more prominent among the cocoa farmers. cursory look at the results of cocoa health and protection management component of CODAPEC and Cocoa High-Tech technology, 213 farmers adopted the use of insecticide “Akate master” as against 201 in “Confidor”. However, these two aforementioned insecticides registered the highest number of adopters as compared to “Actara” which recorded 135 adopters. The top two most popular fungicides amongst 250 cocoa farm household interviewed were “Ridomil” and “Nordox”, which registered 161 and 149 adopters respectively. Table 3 summarizes the results of the parameter estimates of Tobit regression analyses. On the whole, most socioeconomics variables considered as factors influencing adoption of CODAPEC and Cocoa High-Tech technology in the analysis were observed to be highly significant, with the exception of gender which was considered not be significant (Table 3). In this study, it was hypothesized that experience is positively associated with adoption of CODAPEC and Cocoa High-Tech technology.

**Table 2.** Distribution of Adopters and Non adopters of the CODAPEC and Cocoa High-Tech technology packages used as an index for dependent variable in Tobit model (N=250).

| Technology Package      | Description of Technology attributes                                | Adopters<br>(Frequency) | Non-adopters<br>(Frequency) |
|-------------------------|---------------------------------------------------------------------|-------------------------|-----------------------------|
| Cultural Maintenance    | Removal of basal chupons and overhead canopies                      | 247                     | 3                           |
|                         | Weeding of the cocoa farm regularly                                 | 242                     | 8                           |
|                         | Removal of dead husks and pods                                      | 233                     | 17                          |
|                         | Maintaining some trees in cocoa farm                                | 213                     | 37                          |
|                         | Removal of all hosts on the farm                                    | 184                     | 66                          |
|                         | Drainage                                                            | 69                      | 181                         |
|                         | Use of deep pit to bury dead husks and pods                         | 50                      | 200                         |
| Fertilizer              | Use of Assasewura fertilizer(NPK/ 10:10:10)                         | 246                     | 4                           |
|                         | Use of Sedalco (NPK/ 6:0:20 + TE (trace elements)                   | 99                      | 151                         |
|                         | Use of Cocoafeed (NPK/ 0:30:20)                                     | 64                      | 186                         |
|                         | Application of the fertilizer at the beginning of the rainy seasons | 230                     | 20                          |
|                         | Broadcasting method                                                 | 208                     | 42                          |
|                         | Ring application method                                             | 62                      | 188                         |
| Fungicide               | Use of Ridomil(6% metalaxyl-M and 60% copper (1) oxide)             | 161                     | 89                          |
|                         | Use of Nordox(Cuprous oxide)                                        | 149                     | 1                           |
|                         | Use of Champion(Cupric hydroxide)                                   | 76                      | 174                         |
|                         | Use of Funguran(Cupric hydroxide)                                   | 62                      | 188                         |
|                         | Use of Kocide 101(Cupric hydroxide)                                 | 47                      | 207                         |
|                         | Use of Gold 66(Cuprous oxide + mefenoxam)                           | 12                      | 238                         |
| Fermentation and Drying | Use of sun drying of cocoa beans                                    | 250                     | 0                           |
|                         | Use of less than 5 days for fermentation                            | 12                      | 238                         |
|                         | Use of 5-7 days for fermentation                                    | 238                     | 12                          |

264 **Table 2. (Continued)**

265

| Technology Package         | Description of Technology attributes                         | Adopters<br>(Frequency) | Non-adopters<br>(Frequency) |
|----------------------------|--------------------------------------------------------------|-------------------------|-----------------------------|
| Application of Insecticide | Spraying of <i>Akate</i> master(Bifenthrin)                  | 213                     | 37                          |
|                            | Spraying of Confidor(Imidacloprid)                           | 201                     | 49                          |
|                            | Spraying of Actara(Thiamethoxam)                             | 135                     | 115                         |
|                            | Spraying of 2-tankful of Chemical and water mixture per acre | 127                     | 123                         |

266 .As expected, the adoption of CODAPEC and Cocoa High-Tech technology was positively and  
267 significantly ( $P<0.001$ ) correlated with experience. The finding is in line with previous studies  
268 on different technology packages (Adesina and Baidu-Forson, 1995; Mazvimavi and Twomlow,  
269 2009; Okoedo-Okojie and Onemolease, 2009). The average number of years a farmer has been  
270 engaged in the cultivation of cocoa in the communities investigated in the Central Region of  
271 Ghana was approximately 21.7 years. This suggests that farmers have a rich experience of cocoa  
272 growing activities under various policy initiatives of past Government in Ghana. As a result, it is  
273 not surprising that experience exerted strong influence on adoption of CODAPEC and Cocoa  
274 High-Tech technology. Experienced farmers are less risk averse and willing to adopt an  
275 innovative technology that is perceived to come with high financial rewards and improve their  
276 lot. In addition, experience equipped the farmers with sound agronomic competencies and skills  
277 that enhance adoption of new technology (Namwata et al., 2010; Tiarniyu et al., 2009; Rahman,  
278 2008). Education and training are two socioeconomic variables that are known to exert  
279 tremendous influence on individual behavioural patterns relating to decision making and choices,  
280 thus these two variables have direct intimate association with adoption process.

281 Education and training were hypothesized to be positively associated with adoption of  
282 CODAPEC and Cocoa High-Tech technology. Nevertheless, education level of the household  
283 head and training on on-farm application CODAPEC and Cocoa High-Tech technology were  
284 found to be significant( $P<0.001$ ) and positively correlated with adoption. These results are  
285 consistent with other adoption studies on different technologies and crops (Namwata et al., 2010;  
286 Daramola, 1989; Adesina et al., 2000; Onweremadu and Mathews-Njoku, 2007). Trainings  
287 facilitate good performance and sharpen the skills of the farmers which invariable enhance  
288 adoption of new innovative technology (Meenambigai and Seetharaman, 2003). Education  
289 expands individual scope of inference and paradigm, whereas training re-enforces individual's  
290 experience and up-grade the skills for effective implementation of any novel technology.  
291 Education enhances individual farmer's ability to access and process agricultural information,  
292 and the application of information in improving on-farm activities (Huffman, 2001). The training  
293 on how to use a new technology is directly embodied or dependent on efficient and effective  
294 extension education (Adesina and Zinnah, 1993).

295 **Table 3.** Results of parameter estimates of Tobit model of factors influencing farmers' decision to adopt CODAPEC and Cocoa High-  
 296 Tech technology in Ghana

| Variable              | Coefficient estimate | Standard error | z-Statistic  | Prob.  |
|-----------------------|----------------------|----------------|--------------|--------|
| Experience            | 0.009812             | 0.000768       | 12.77896***  | 0.0000 |
| Education             | 0.016165             | 0.003970       | 4.071270***  | 0.0000 |
| Training              | 0.049109             | 0.007986       | 6.149033***  | 0.0000 |
| Age of the house head | 0.002359             | 0.000521       | 4.530594***  | 0.0000 |
| Gender                | 0.016702             | 0.011910       | 1.402402     | 0.1608 |
| Household size        | 0.001187             | 0.000710       | 1.670671*    | 0.0948 |
| Farm size             | 0.003024             | 0.001154       | 2.621228***  | 0.0088 |
| Age of the farm       | -0.001816            | 0.000543       | -3.344270*** | 0.0008 |
| Social capital        | 0.020687             | 0.009322       | 2.219235**   | 0.0265 |
| Credit                | -0.037187            | 0.011444       | -3.249390*** | 0.0012 |
| Price                 | 0.073597             | 0.011279       | 6.525242***  | 0.0000 |

297 Log likelihood function = 311.0304; Average log likelihood = 1.244121

298 Note: \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

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In fact, there was mass training of cocoa farmers to facilitate the implementation CODAPEC and Cocoa High-Tech technology through extension division of Ghana Cocoa Marketing Board and with additional campaign through the print and electronic media in the country.

Age of the house heads either male, de facto or de jury had strong influence on the adoption of innovative and proven technologies in agriculture. Age as a factor of influencing adoption depends on other latent characteristics of the individual farmers. Young farmers tend to be more innovative and more ready to adopt new technology due to their longer planning and lower risk aversion characteristics (Adesina et al., 2000). Age of the household head can be negatively related to adoption (Nkamleu and Adesina, 2000; Kassie et al., 2009; Zhang et al., 2012) or positively be associated with adoption (Wu et al., 2010; Namwata et al., 2010; Adesina and Baidu-Forson, 1995). In this work, age of the household head was found to have significantly ( $P<0.001$ ) related to adoption positively. This corroborates the results of study conducted by Wu et al. (2010) and Adesina and Baidu-Forson (1995). The household size of the farming community is important socioeconomic variable which measures labour endowment in traditional agricultural production. One of the major constraints in cocoa production in Ghana is labour availability to perform certain on-farm task. Cocoa farmers relied on the household members to perform certain labour intensive tasks. This has serious negative impact on adoption of any novel technology which requires intensive-labour technique. For instance in this study under cultural practices (Table 2) out of 250 household interviewed only 69 adopted construction of drainage on their farm because of labour intensive nature of this work. Furthermore, most farmers prefer broadcasting application of fertilizer to ring method of application because of high labour requirement of the later (Table 1). Results presented in Table 3 shows a significant ( $P= 0.0948$ ) positive association between household size and adoption of CODAPEC and Cocoa High-Tech technology. Farmers with large household size are most likely to adopt the technology. The positive association between household size and adoption of new technology is not uncommon. Similar finding has been reported by Namwata et al. (2010) and Rajasekharan and Veeraputhran (2002). Farm size was observed in this study to be positively and significantly ( $P<0.01$ ) related to adoption of CODAPEC and Cocoa High-Tech technology. This is in line with findings of other studies (Kassie et al., 2009; Hussain et al., 2011; Zhang et al., 2012). In general, farmers with large cocoa farms are expected to be wealthy and influential and for that matter likely to adopt an innovative technology (Agbamu, 1993). The premise is that wealthy

farmers have large disposable incomes which might increase the likelihood of adoption of any high input technology. Furthermore, it has been suggested that farmers with large farm size release significant benefit from adopting technology that will increase productivity or yields and hence will respond positively to adoption (Mazvimavi and Twomlow, 2009). The average age of the cocoa farms in the study area was approximately 18 years (Table 2). The age of the cocoa farm was negative and significantly ( $P<0.001$ ) associated with adoption of this technology. Which indications that farmers prefer to use this technology on young cocoa farms that have high returns and benefits. In addition, farmers with very old farms are not adopting CODAPEC and Cocoa High-Tech technology. The productivity of cocoa farms goes down with passing years. The age of the cocoa farm is one of the determinant factors the farmers consider in adopting any capital investment related technology. Most farmers are reluctant in spending money on old farms because of low yields which normal does not commensurate with capital expenditure. The CODAPEC and Cocoa High-Tech technology are high inputs driven technology and require high cost of expenditure hence the expected outcome. The study assumed that there is high probability for a farmer in societies such as clubs; produce buying cooperative organization and religious society are likely to adopt CODAPEC and Cocoa High-Tech technology. Social capital was therefore hypothesized to be positively associated with adoption. As expected, there was a significant ( $P<0.05$ ) positive association between social capital and adoption. This finding collaborates the results of Kassie et al. (2009) and Adesina et al. (2000). Farmers who aggregate in groups through cooperatives societies as way a of selling cocoa beans in Ghana tend to have access to information. High social capital and membership of farmers' organisations or societies enhance accessibility to information (Caviglia and Kahn, 2001). Social links increase the likelihood of the farmer becoming aware of the importance of CODAPEC and Cocoa High-Tech technology and subsequently adopting it. In Ghana, most focal point for disseminating information on agronomic practises and distributions of cocoa farm inputs is through Cocoa Produce Buying Organisations or Cooperative Societies. Lack of credit or accessibility to credit was negative and significantly ( $P<0.001$ ) associated with adoption CODAPEC and Cocoa High-Tech technology (Table 3). This is not surprising looking at the inputs requirement of the attributes of the technology, which invariable place demands on some form of monetary expenditure. Hence, lack of credit impacted negatively on adoption CODAPEC and Cocoa High-Tech technology. Inaccessibility to credit facilities is often cited as

one of the major reasons why technology failed to be adopted by rural communities (Feder et al., 1985). Accessibility to credit on time is very crucial to cocoa farmers since most of the on-farm activities are time bound. Most commercial banks prefer to give loans to cocoa farmers at the peak of harvesting rather than the crucial moments when cultural activities are being performed on the farms. Most banks opine that during the harvesting they assured of getting their loans back. Agriculture sector is perceived to be too risky to grant loans to in Ghana. The cocoa producer price is a major fiscal policy which is determined by Ministry Finance and Economic Planning with approval from the parliament as integral part of the annual budget in Ghana. The price policy has behavioural inducement effect on the cocoa farmers. It has been suggested that cocoa farmers respond to producer price by changing the intensity with which they perform agronomic and cultural practices on farms (Anim-Kwapong and Frimpong, 2005). The quantum of the producer price is believed to be high enough to cover the cost of on-farm activities in particular maintenance of the farm, harvesting and drying. In this work, the cocoa producer price was significant and positively associated with adoption of CODAPEC and Cocoa High-Tech technology. However, Dormon et al. (2004) cited amongst other things the non-adoption of CODAPEC and Cocoa High-Tech technology is mainly due to high cost of inputs, low returns on investment due to low producer price and inadequate capital as well as difficulty in accessing credit. This is an indication that given high producer price and realization of accompanying monetary gain will motivate more cocoa farmers to adopt this novel technology to boost cocoa production in the country.

#### 4. CONCLUSIONS

The paper reported on the socioeconomic factors that influence adoption CODAPEC and Cocoa High-Tech technology, a social intervention which seek to boost the productivity of cocoa in Ghana. The empirical analyses showed that with exception of gender, experience, education, age, household size, farm size, age of the farm, social capital, credit, price, training significantly influence adoption of CODAPEC and Cocoa High-Tech technology. One of the findings of the study is that farmers with very old cocoa farms feel very reluctant to adopt the technology. The incorporation of these socioeconomic variables in policy formulation will increase adoption level and productivity of cocoa farms in the Ghana. It will be appropriate to conduct further studies to find out the ration behind this observed behaviour. Policy makers should seriously take into

account the cost equation of what goes to cocoa production on the farm when fixing of the producer price of cocoa. Finally, much emphasis should be placed on training through extension services to educate the farmer about the importance of the technology attributes, if adoption level were to be increased.

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