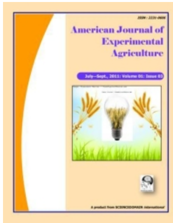

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Socioeconomic Factors Influencing Adoption of Codapec and Cocoa High-tech Technologies among Small Holder Farmers in Central Region of Ghana

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Authors' contributions

This work was carried out in collaboration between all the authors. Author RBA was involved in the design of the study protocol, survey instruments, data collection and entry as well as write-up of the introduction. Author JAD performed the statistical analyses and managed literature review as well as write-up of the materials and methods. Author FAF wrote the first draft of results and discussions of the manuscript. All authors read and approved the final manuscript.

Research Article

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ABSTRACT

Cocoa (*Theobroma cacao* Linn.) is single most important agricultural export crop 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, training, age of household head, household size and social capital as the key variables that positively influence decision of farmers to adopt Cocoa Pest and Disease

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Control (CODAPEC) and Cocoa High-Tech Technology packages. Very old cocoa farms contribute to the non-adoption of these technology packages by the farmers.

Keywords: Technology attributes; cocoa technologies; adoption; socioeconomic factors; tobit model.

1. INTRODUCTION

Cocoa (*Theobroma cacao* Linn.) is an important export crop for Ghana. The crop accounted for 35.1% of agricultural exports and 4.3% of Gross Domestic Product(GDP) in 2007 [29], contributed to about 63% of the foreign exchanges earnings from the agricultural sector and employed about 3.2 million workers including smallholder farm families, farm owners and service providers in Ghana [33]. Despite the enormous contribution of the cocoa sector to the Ghanaian economy, the sector has been smitten by a myriad of challenges over the years. For instance, the production level of 560,000 metric tonnes recorded in the 1965 declined to the lowest ever recorded of 154,000 metric tonnes in the 1980s [8].The premier position as number one producer and exporter of cocoa beans in the world has been lost to Cote d'Ivoire; whose annual average production as at 2009 was approximately 147,2000 metric tonnes [18].The average estimated productivity per hectare of 300-400kg in Ghana is very low as compared to countries like Cote d'Ivoire, Malaysia and Indonesia with estimated 800kg, 1800kg and 1000kg productivity per hectare respectively [6,7,39]. Moreover, it was estimated that over 25% of the cocoa-tree stocks were over 30 years old. In addition, the old cocoa farmers, whose average age is approximately 50 years, were unwilling to take risk by investing in yield improvement strategies due to perceived low returns [7].

Various reasons cited for the low productivity include low producer price, lack of access to credit or loan facilities, rapid deterioration of the forest environment, poor socioeconomic condition of rural farm communities and most importantly, the general poor maintenance culture especially the control pest and disease of cocoa [7,8,16,17,49]. Nevertheless, initial farm trials conducted by Ghana Cocoa Board indicated that Ghana has potential to achieve an average productivity of over 1500kg/ha if appropriate technologies and agronomic practices are adopted [5].

The Government of Ghana initiated two important cocoa technology-based intervention programmes, the Cocoa Pest and Disease Control and Cocoa High Technology (CODAPEC and Cocoa High-Tech) in 2001 to address some 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 [62]. The cocoa technologies (CODAPEC and Cocoa High-Tech technology) consist of discrete units of 25 attributes (Table 2) which mainly 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 partly due to the introduction of CODAPEC and Cocoa High-Tech technologies [25]. 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 [60]. The decision to use a technology is dependent on how the farmer perceives the technology [61]. Farmers in general may be aware of several constraints to farming which may be at variance with what the researchers perceive [40]. 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 [48]. Various reasons have been assigned to the low technology adoption among small holder famers. 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 [22,47].

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 [34]. Cruz [13] cited many factors that influence extent of adoption of on farm technologies. Notably among them are the attributes of a technology, the agent of change and the socio-economic, biological and physical environment. Many socioeconomic studies traditionally focused on technology adoption process at both individual farmers and aggregate levels [20,34]. However, this study examined the socioeconomic factors that influence adoption of Cocoa Technologies of smallholder cocoa farmers in Ghana.

2. MATERIALS AND METHODS

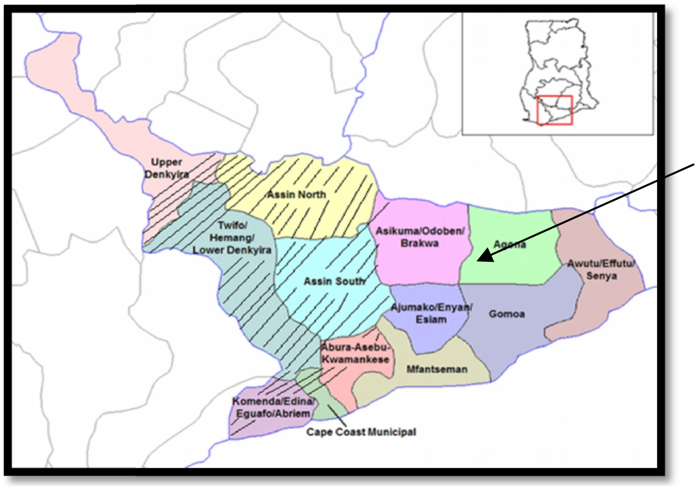
2.1 Data and the Study Area

A cross-sectional survey design was adopted for the study. On-farm level data collection was conducted from December 2009 to February, 2010 to collect data for the 2009 crop season 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 [51]. 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 (Fig. 1). At the second stage, five communities were randomly selected from each of the selected cocoa districts. A total of 250 small holder farm 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 [31]. The questionnaires are design to capture both demographic and socioeconomic data.

2.2 Theoretical and Conceptual Framework

The decision of farmers to adopt any novel technology has been suggested to be based on utility maximization [54]. The concept of utility maximization has therefore been used as theoretical or conceptual framework for adoption of many innovations or improved farm technologies [2,3,9]. 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 [3,23,52,59].



Key: Study area

Fig. 1. A map showing the five selected districts for the study in the Central Region of Ghana: - source (http://www.ghanadistricts, com/centralregion, 2009)

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 [57]. The household of cocoa farmers maximize utility over the set of attributes of CODAPEC and Cocoa High-Tech technology package. Following Mazvimavi and Twomlow [36] 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 [27,37]:

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

Where Y_t^* represents the latent unobserved component of the adoption of CODAPEC and Cocoa High-Tech technologies, β is a (k x 1) vector of unknown parameters, N is the number of observations which represents individual cocoa farmers who participated in the enumeration, X_t is a vector of the type (k x 1) denoting independent variables which capture socioeconomic characteristics of the cocoa farmers and μ_t is independent normally distributed error term with mean zero and constant variance σ^2 [37]. 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 [27]:

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

Adoption occurs when Y_t falls within 0<Y*<1 and Y*≥ 0; and non-adoption occurs when Y*≤ 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 of CODAPEC and Cocoa High-Tech technology is specified as:

$$Y_t = \beta_0 + \beta_1 X_1 + \beta_2 X_2 ....\beta_n X_n \tag{3}$$

Where the X(s) are the independent socioeconomic variables and β(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:

$$Adoption = \beta_0 + \beta_1 Experience + + \beta_2 AgeHH + \beta_3 Gender + \beta_4 HouseHoldS\,ize + \beta_5 FarmSize + \beta_6 Ageofthefa\,rm + \beta_7 SocialCapi\,tal + \beta_8 Training + \varepsilon \tag{4}$$

The detail information about the characteristics of dependent variables is provided in Table 1 and descriptive statistics for all the explanatory variable use in the model are presented in Table 2. 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, farmer may be able to make critical decision concerning adoption of new technology. Hence, experience is expected to be positively related to adoption [41].

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

AgeHH 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 [44]. Old age increases with conservativeness and negatively impact on adoption while young farmers tend to be more innovative and risk adverse [1,27,64]. Thus, the age of household head is negatively related to adoption [42,50]. Nevertheless, in this study we hypothesized that the age of household head was 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 over the years 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 [15,32,34,51].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 [45]. 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 studies to capture labour availability or endowment to a farm household. The fact that CODAPEC and Cocoa High-Tech technology is labour intensive or demanding, it is expected that farm households with large family sizes are likely to supply more labour and readily adopt this technology package [43].

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 [64].

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 [7].

SocialCapital 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 [10,11,12,21]. All the parameters of the model (4) were estimated in Eviews-7 for windows [28] with Tobit link function using QML (Quasi-Maximum Likelihood) (Huber/White) robust standard errors and Newton-Raphson optimization algorithm.

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

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
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 0 = female	+	76 24	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.	hectares	+		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. This is measured as membership to social organisation, clubs, marketing companies e.t.c	1=Yes 0= No	+	27 73	0.27	0.44
Training	Training will enhance the farmer readiness to adopt the technology. This is estimated as whether the farmer has received some form of training on the technology package.	1= Yes 0 = No	+	28 72	0.28	0.45

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 (Frequency)	Non-adopters (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
Application of Insecticide	Spraying of *Akate* 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

3. RESULTS AND DISCUSSION

Virtually all the 250 cocoa farmers interviewed used solar energy to dry the cocoa beans and 238 adhered strictly to 5-7 days recommended duration for fermentation of the cocoa beans (Table 2). Cultural maintenance component of the technology package registered high level of adopters with exception of use drainage system and general sanitation practised such as the 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 household heads 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 recoded 135 adopters. The top two most popular fungicides amongst 250 cocoa farm household interviewed were "Ridomil" and "Nordox", which registered 161and 149 adopters respectively. Table 3 summarizes the results of the parameter estimates of Tobit regression analysis. 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 farm size which was considered not to be significant (Table 3).

In this study, it was hypothesized that experience is positively associated with adoption of CODAPEC and Cocoa High-Tech technology. As expected, the adoption of CODAPEC and Cocoa High-Tech technology was positively and significantly (P<0.001) correlated with experience. The finding is in line with previous studies on different technology packages [3,36,46]. The average number of years a farmer has been engaged in the cultivation of cocoa in the communities investigated in the Central Region of Ghana was approximately 21.7 years.

This suggests that farmers have a rich experience of cocoa growing activities under various policy initiatives of past Government in Ghana. As a result, it is not surprising that experience exerted strong influence on adoption of CODAPEC and Cocoa High-Tech technology. Experienced farmers are less risk averse and willing to adopt an innovative technology that is perceived to come with high financial rewards and improve their lot. In addition, experience equipped the farmers with sound agronomic competencies and skills that enhance adoption of new technology [41,53,56].

Training was hypothesized to be positively associated with adoption of CODAPEC and Cocoa High-Tech technology. Nevertheless, education level of the household head and training on on-farm application CODAPEC and Cocoa High-Tech technology were found to be significant (P<0.0001) and positively correlated with adoption. These results are consistent with other adoption studies on different technologies and crops [1,14,41,47]. Training facilitates good performance and sharpened the skills of the farmers which invariable enhance adoption of new innovative technology [38]. Education expands individual scope of inference and paradigm, whereas training re-enforces individual's experience and up-grade the skills for effective implementation of any novel technology. Education enhances individual farmer's ability to access and process agricultural information, and the application of information in improving on-farm activities [25]. The training on how to use a new technology is directly embodied or dependent on efficient and effective extension education [2]. 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 apt to adopt new technology due to their longer planning and lower risk aversion characteristics [1].

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

Variable	Coefficient estimate	Standard error	z-Statistic	Prob.
Experience	0.014421	0.000707	20.38702***	0.0001
Training	0.005397	0.013783	9.391570***	0.0001
Age of the house head	0.003070	0.000453	6.776071***	0.0001
Gender	0.047662	0.013346	3.571221***	0.0004
Household size	0.002584	0.001255	2.058103**	0.0396
Farm size	0.001194	0.001214	0.983045^{NS}	0.3256
Age of the farm	-0.001630	0.000286	-5.696863***	0.0001
Social capital	0.031957	0.013783	2.318547**	0.0204

*Log likelihood function = 241.5998; Average log likelihood =0.966399 , LR chi2 (8) =316.54***; Pseudo R2= 0.7656 Note: ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. NS: not significant*.

Age of the household head can be negatively related to adoption (1,31,64] or positively be associated with adoption [3,41,63]. Gender was represented or captured as social role in the study was observed to be positively and significantly (*P*=0.0004) related to adoption of CODAPEC and Cocoa High-Tech technology. This is obvious cocoa industry in Ghana is male dominated sector of the economy. In this work, the result indicated that the age of the household head significantly (P<0.001) and positively influenced adoption of CODAPEC and Cocoa High-Tech technology. This result corroborates with findings of other studies [3,63].

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 2). Results presented in Table 3 shows a significant (*P*=0.0396) positive association between household size and adoption of. 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. [41] and Rajasekharan and Veeraputhran [55].

Farm size was observed to be positively related to adoption of CODAPEC and Cocoa High-Tech technology. However, this relationship was not statistically significant (P= 0.3256). In this work, the average age of the cocoa farms in the study area is approximately 18 years (Table 1). The age of the cocoa farm was negatively and significantly (P<0.001) related to adoption of this technology. This is an indication that farmers prefer to employ this technology on young cocoa farms that have high financial returns or benefits. The productivity of cocoa farms decline with passing of age. The age of the cocoa farm is one of the factors the cocoa farmers consider in adopting any capital intensive technology. In general, farmers are reluctant to spend money on old farms because of low yields which normally does not commensurate with capital expenditure. The CODAPEC and Cocoa High-Tech technology are high inputs driven technology with corresponding high cost of expenditure.

The study assumed that there is high probability for a cocoa farmer belonging to societies such as clubs; produce buying cooperative organization and religious society to adopt CODAPEC and Cocoa High-Tech technology. Social capital was therefore hypothesized to be positively associated with adoption. However, as expected social capital was significantly (P<0.05) and positively related to adoption. This finding confirms the results of Kassie et al. [30] and Adesina et al. [1]. Farmers who aggregate in groups through cooperatives societies as a way 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 [11]. 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 practices and distributions of cocoa farm inputs is through Cocoa Produce Buying Organisations or Cooperative Societies.

4. CONCLUSIONS AND RECOMMENDATIONS

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 farm size, experience, age, household size, gender, age of the farm, social capital and training are variables that strongly and significantly influence adoption of CODAPEC and Cocoa High-Tech technology.

Institutional extension support to reduce the risk faced by farmers in adopting aspects of the technological package is important since it will reduces the need for detailed information prior to adoption. That is, to overcome non-adoption because of onerous information demands the CODAPEC and Cocoa High-Tech technology, state support is useful. Currently, the policy direction is the incorporation of pluralism in cocoa extension where there is public-private partnership in extension delivery. The authors recommend strengthening of extension outfit of COCOBOD to lead in the training of farmers on latest agronomic practises since the farmers are not in position to pay for extension services.

Experienced, aged and successful farmers should be retrained to act as resource persons since experience and age positively affect adoption of CODAPEC and Cocoa High-Tech technology. The success stories of such farmers can entice the youth to go into cocoa farming. This will go a long to enhance cocoa production levels per unit area comparable to those in Asia and other parts of Africa.

One of the findings of the study is that farmers with very old cocoa farms feel very reluctant to adopt the CODAPEC and Cocoa High-Tech technology. There is the need to focus education of farmers on capability of the technologies in improving the productivity of old cocoa farms. Abandoned old cocoa farms are sources of pest and disease for new farms and have implications for overall success of the programmes. Consequently, the initial policy directive of CODAPEC to offer free mass spray to all cocoa farmers in all the cocoa growing districts in Ghana should be pursued. It will be reasonable for the government to expand the technology package to cover the entire cocoa growing districts in the country to boost production.

The role of produce buying companies, cooperative organisation, and clubs etc in disseminating information on this novel technology cannot be overemphasized. This is measured or captured in this paper as social capital. The involvement of social capital in the training of farmers and as conduit for disseminating information or implementing government policy objectives on CODEPEC and Cocoa High-Tech technology will facilitate or enhance the adoption of this technology.

The incorporation of these socioeconomic variables in policy formulation will increase adoption level and productivity of cocoa farms in Ghana. However, it will be appropriate to conduct further studies to find out the rationale behind this observed behaviour.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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