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Credit Access and Adoption of Cocoa Research Innovations in Ghana

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ABSTRACT
Even though the Cocoa Research Institute of Ghana (CRIG) has introduced a number of innovations to increase cocoa yield per hectare, rate of adoption has been very low. One of the reasons given for the low adoption is lack of access to credit. The main objective of the study was thus to find out the effect of access to credit and other farmer characteristics on the adoption of the CRIG recommended cocoa technologies. A sample of 600 cocoa farmers selected through a multistage sampling technique was used for the study. Cocoa extension officers were engaged to use questionnaires to gather data from cocoa farmers. The logistic regression model was used to estimate the impact of credit access and other factors on adoption of CRIG recommended technologies. Results of the study indicated that technology adoption is significantly influenced by credit access, primary education, hired labour, own labour, membership of association and frequency of extension advice. It is recommended that financial institutions should make credit accessible to cocoa farmers.
Key words: Credit Access, Adoption, Cocoa Research, Innovations, Technology

1. 0. INTRODUCTION

The cocoa industry contributes significantly to the economy of Ghana. The cocoa industry in Ghana is made up of cocoa bean production by smallholder farmers, collection and bagging of cocoa beans by licensed cocoa buying companies (LBCs), quality assurance by the Ghana Cocoa Board (COCOBOD) and haulage of cocoa beans by private hauliers. It also involves provision of warehousing and other logistics by COCOBOD and private individuals and companies and export of cocoa beans by COCOBOD. About 794,129 households are involved in cocoa production [Ghana Statistical Service (GSS) 2014]. Cocoa contributed about 32 per cent of the total export earnings in 2013 (ISSER 2014). The cocoa tree cover protects the environment and it has been identified to have medicinal value. Also, the cocoa sector contributes to educational development of the country as COCOBOD grants scholarships to brilliant children of cocoa farmers in senior high schools. In addition to these contributions, there have been a number of infrastructural developments such as provision of roads in the cocoa growing areas and hospitals from revenue obtained from the cocoa sector.

Even though the cocoa industry makes significant contribution to the Ghanaian economy, the sector is bedevilled with a number of challenges which resulted in Ghana losing its position as the world's largest exporter of cocoa to Cote d'Ivoire. Until 1978, Ghana was the largest exporter of cocoa beans (Awuah 2002). According to Dormon, Huis, Leeuwis, Obeng-Ofori and Sakyi-Dawson (2004), cocoa production levels declined to its lowest level of 160,000 metric tonnes in 1983. Since the mid 1980s, however, production levels have risen gradually due to a number of factors including improved technologies introduced by the Cocoa Research Institute of Ghana (CRIG). Laryea (1981) defines cocoa technology as the total stock of knowledge including traditional skills necessary for cocoa production, processing and marketing.

Commenting on yield of cocoa in Ghana, Dormon, et al (2004) stated that generally yields of cocoa are lower in Ghana than in other major producing countries and that whilst average cocoa yield per hectare in Malaysia and Cote d'Ivoire is 1,800 Kilograms and 800 kilogram respectively, it is only 360 kilograms per hectare in Ghana. Even though the innovations or technologies introduced by CRIG have potential of increasing yield per hectare adoption of the technologies has been low (Henderson and Jones 1990, Donkor et al 1991; MASDAR 1998).

Aneani, Anchirinah, Owusu-Ansah and Asamoah (2012) in their study of adoption of some cocoa production technologies by cocoa farmers in Ghana estimated adoption rates for control of capsids with insecticides, control of black pod disease with fungicides, weed control manually or with herbicides, planting hybrid cocoa varieties and fertilizer application as 10.3%, 7.5%, 3.7%, 44% and 33% respectively. They explained that factors such as access to credit, number of farms, gender, yield, the educational status of farmer, the age of farm, migration, and farm size were statistically recognized to influence the probability of adoption of CRIG recommended technologies. Earlier, MASDAR (1998) had reported that reasons given by farmers for their low adoption of the technologies involve lack of resources such as money and labour to apply the technologies.

Certain types of technologies are particularly difficult for smallholder farmers to finance. For example technologies that require large initial investments will require larger one-time loans which may be more difficult for smallholder farmers to access. Similarly, technologies that require many years to yield a benefit such as certain tree crops like cocoa are difficult for small farmers to finance.

The foregoing indicates that lack of access to credit is one of the major reasons provided for low adoption of CRIG recommended technologies. Credit Access can be defined as a transaction between two parties in which one, acting as a creditor or lender, supplies the other, the debtor or borrower, with money, goods, services or securities in return for the promise of future repayment (Kosgey, 2013). Access to credit (also known as financial inclusion) can be seen as the absence of both price and non-price barriers in the use of financial services (Nkuah, Tanyeh and Gaeten, 2013).

According to Hananu, Abdul-Hanan and Zakaria (2015) a household is said to have access to a type of credit if at least one of its members has a strictly positive credit limit for that type of credit which may be in cash or in kind. They continued that accessible credit enhances farmers' purchasing power to enable them acquire modern technologies for their farm production, however, access to credit seems to be limited among small holder farmers due to certain constraints. They observed that the decision to access agricultural credit is positively and significantly related to age, education, group membership and source of credit.

In Ghana and many developing countries, particularly in rural areas, access to financial services, including credit and formal savings mechanisms is limited. Even where financial services are available, they are often disadvantageous to small holder farmers.

2.0 OBJECTIVES OF THE STUDY

In the light of the above, the main objective of the study was to examine the impact of credit access on adoption of CRIG recommended technologies. The specific objectives of the study were:

i. to estimate the impact of credit access and other farmer characteristics on adoption of cocoa research innovations.
ii. to provide recommendation based on the outcome of the study.

3.0 HYPOTHESES

Based on the stated objectives the following hypotheses will be tested.

H_0 : There is no relationship between access to credit and adoption of cocoa research innovations.

H_2 : There is a positive relationship between credit access and adoption of cocoa research innovations.

4.0 REVIEW OF RELEVANT LITERATURE

4.1 Rate of Technology Adoption

Rogers (2003) believes that technology and innovation are often used interchangeably. He defined technology as a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving an outcome. He explained rate of adoption as the relative speed with which an innovation is adopted by members of a social system. He identified the variables that determine the rate of adoption as perceived attributes of innovation; types of innovation decision; communication channels; nature of social system and extent of change agent's promotion efforts.

Feder, Just and Zilberman (1985) observed that social scientists are interested in agricultural technology adoption because of its importance in increasing productivity and efficiency. They traced the commencement of technology adoption in developing countries to the period after the Green Revolution in Asian countries. They gave the factors which affect technology adoption as farm size, risk and uncertainty, human capital, labour availability, credit constraint, land tenure system, supply constraint and aggregate adoption over time.

4.2 Cocoa Industry of Ghana

4.2.1 Trends of Cocoa Output in Ghana

According to Acquaah (1999) cocoa was introduced to Ghana in the late 19th century and the production of the crop has undergone a series of major expansions and contractions. It is the belief of Ruf and Siswoputranto (1995) that cocoa production is influenced by environmental factors such as availability of forest land; ecological factors such as deforestation, outbreaks of disease, and geographic shifts in production; and economic and social factors such as migration. These factors, they explained, result in variability in output such that in periods of favourable weather conditions output increases. They identified four distinct phases with regard to cocoa production in Ghana. These phases are: introduction and exponential growth (1888–1937); stagnation followed by a brief but rapid growth following the country's independence (1938–64); near collapse (1965–82); and recovery and growth or expansion, starting with the introduction of the Economic Recovery Program (1983 to present). According to Vigneri and Santos (2008) growth in cocoa production became more pronounced starting in 2001, possibly driven by a combination of record-high world prices, increased share being passed onto farmers, and a set of interventions such as mass spraying programs and high-technology subsidy packages to promote the adoption of higher and more frequent applications of fertilizer rolled out by COCOBOD.

4.2.2 Cocoa Research Institute of Ghana

The Cocoa Research Institute of Ghana (CRIG) was set up in June 1938 as the Tafo Central Cocoa Research Station and was assigned clear goals within the Gold Coast Department of Agriculture to investigate the pest and disease problems of cocoa in order to maintain production in the Eastern Region. In 1944 the Research Station was upgraded to West Africa Cocoa Research Institute (WACRI) and the objectives were widened to include the disease and pest problems of cocoa in West Africa and also to investigate soil fertility and agricultural practices with a view to increasing yield. The name was changed to CRIG when Ghana attained independence in 1957 (Acquaah 1999).

CRIG has introduced a number of research innovations which farmers have to follow to achieve increase in output. These practices include maintenance of the farm by weeding at least twice in a year, pruning semi parasitic mistletoe plant from the cocoa trees and cutting down cocoa trees affected by swollen shoot virus disease. To improve soil fertility, the farmer has to apply fertilizer in prescribed quantities. The farmer has to spray fungicides in right quantities to control black pod disease and spray insecticides to control insects such as black ants, stem borers, mealy bugs, termites and red ants. Ripe cocoa should be harvested; fermentation should be between six and seven days and the cocoa beans should be turned twice on the third and fifth days before they are dried. The cocoa should be dried daily in the sun on raised mats and should be properly dried before they are put in sacks for sale. The activities to be performed by farmers and estimated man-days are presented in Table 1.

Table 1: Cocoa Technologies and Estimated Man Days Per Hectare

Activity	Man Days	Remarks
Land clearing	20-25	Depends on the nature of bush.
Felling and chopping	15-20	Depends on the nature of trees felled.
Stumping and debris gathering	15-20	Depends on the state of cleared area.
Holing for suckers	5	
Planting of suckers	10	
Holing for seedlings	5	
Planting of seeds/seedlings	10	
Brushing	15-20	
Capsid control	2	with 1 for water carrying
Black pod control	5	with 2 for water carrying but depends on farm performance.
Mistletoe Control	4	
Fertilizer application	4	
Plucking of Pods	5	But depends on the farm performance
Gathering and heaping of pods	4	But depends on farm performance
Breaking of pods	6	But depends on the farm performance
Carting of fermented beans	4	But depends on the farm performance
Drying of beans	3	But depends on the farm performance
Carting of dried beans	4	But depends on the farm performance

Source: Research Department, COCOBOD, Accra

The labour required for any particular activity by any farmer depends on some important factors. For instance, the land to be cleared for cocoa farm establishment may either be a virgin forest, which will be more involving and so demand more man-days compared to a secondary forest. In the case of virgin forest there will be more trees which need to be cleared and this will require more man hours. On the other hand if the land involves secondary forests they may contain few or no big trees to be felled and in effect require even less man-days. Also, the number of labourers required to harvest, gather and heap as well as break pods from a hectare of cocoa farm is largely dependent on the performance of the farm. If yield is high, the labour requirement is correspondingly high and vice versa (MMYE, 2007).

Based CRIG's research findings, the government in 2001 initiated two programmes namely Cocoa High Technology (Cocoa Hi-Tech) and Cocoa Pest and Disease Control Programme (CODAPEC) to improve cocoa yield and for that matter impact on the socio-economic conditions of farmers. The "High Technology" of cocoa production is defined as the sustainable cocoa production by which the farmer increases and maintains productivity through soil fertility maintenance at levels that are economically viable, ecologically sound and culturally acceptable using efficient management resources (Appiah, 2004).

The Cocoa High Technology Programme (Hi-tech) programme emphasizes the use of fertilizer and proper farm management practices to achieve higher cocoa yield. However to enable maximum utilization of the fertilizer the programme holistically consists of other four components namely cultural maintenance, application of fungicides, application of insecticides and harvesting, fermentation and drying technologies in addition to the

fertilizer application component. Two main types of fertilizer formulations are used in the Hi-Tech Programme. These are granular fertilizers and liquid fertilizers.

The cocoa disease and pest control programme (CODAPEC) is a national pest and disease control programme initiated by the government in 2001 to address the decline in cocoa production. The programme aims at assisting farmers to maintain their farms and includes weeding twice or thrice in a year; general pruning and pruning of mistletoes and chuppons against diseases and pests twice or thrice in a year.

Teal and Vigneri (2004) in their report on Ghana Cocoa Farmers Survey 2004, observed that the 45% increase in cocoa output between 2001/2002 to 2003/2004 could be attributed to three factors namely increase in land use especially in the Western Region where the price of land has been relatively low, increase in non-labour inputs such as fertilizer and the number of persons engaged on the farm. They however suggested further research as to whether the long term growth prospects in the cocoa sector are dependent on lifting constraints on farmers' production possibilities or whether it simply reflects a short-term response to the windfall gains of strong cocoa prices. They also suggested re-sampling that would allow geographically representative cross-section of cocoa farmers. This they said is required for a full understanding of factors driving cocoa expansion in the sector as a whole. In a related study, Vigneri (2007) attributed the increase in cocoa output in Ghana between 2001 and 2003 to the increase in fertilizer use and a government sponsored mass-spraying exercise beginning 2001. She observed that farmers are progressively integrating fertilizer use and spraying practices into their own cultivation of cocoa crop. She indicated that two thirds of the increase in production was generated from extensive land margin while the other third was obtained by intensifying productivity of existing land under cultivation. The survey indicated that cocoa production is characterised by low technology cultivation which requires the use of working capital mainly to hire labour for clearing and weeding the land, to purchase the chemicals needed to spray cocoa farms for the control of pests and disease.

Even though CRIG recommended technologies have potential to greatly increase cocoa output in Ghana some farmers are not adopting the technologies. One of the reasons attributed to the low adoption rate is lack of access to credit because farmers do not have their own funds to plough back into the farming activities.

4.3. Importance of Agricultural Credit

Agricultural credit has been defined as the present and pro term transfer of purchasing power from a person who owns it to a person who wants it allowing the latter the opportunity to command another person's capital for agricultural purposes but with confidence in his willingness and ability to repay at a specified future date (Kuwornu, Ohene-Ntow & Asuming-Brempong, 2013). For small holder farmers to achieve higher productivity, timely access to short-term finance for input such as seeds, fertilizer, pesticides, herbicides, machines services, transport, labour and fuel is fundamental. Small holder farmers in developing countries however often face extreme barriers to finance (Grossman and Tarazi, 2014)

According to Lundstedt and Parssinen (2009) poor access to credit and high cost of credit constitute major constraints to farmers in Ghana. They believe that the seasonality of cocoa production implies that all input costs are incurred before the harvest and farmers sometimes need to borrow up to sixty percent of their harvest upfront since they are usually liquidity constrained and need credit. Wiredu, Mensah-Bonsu and Fosu (2011) also believe that agricultural finance is very crucial for farm business operation. They explained that credit, an important source of agricultural finance is shown to have no effect in productivity, and rather access to secondary income has positive effect on productivity. They further indicated that farmers rely on earnings from secondary income to finance the purchase of required inputs and also pay for hired labour.

Onumah, Williams, Quaye and Akuffobea (2014) identified sources of funds for cocoa farmers as rural banks, money lenders, family support, and personal savings. They realised that the most prominent sources of finance for cocoa farmers in the study area were mainly personal savings and that from family/friends. Cocoa producers in the study area did not have access to financial services especially those from financial institutions. Only about 20% had access to financial services provided by microfinance companies. The bulk of credit they received from financial institutions went into paying for labour services.

4.4 Credit Access and Technology Adoption

There have been a number of studies on credit access and technology adoption. Feder and Umali (1993) and Fernandez-Cornejo and McBrid (2002) reviewed factors that affect technology adoption and highlighted access to credit as the key determinant of adoption of most agricultural innovations. Similarly, the Ministry of Food and Agriculture (2010) reported that most small scale farmers in Ghana are unable to afford basic production technologies such as fertilizer and other agro chemicals resulting in low crop yields due to poverty and limited access to credit.

Nyemeck, Gockowski and Nkamleu (2007) explained that access to credit affects cocoa farmers' outcomes through different pathways. They identified the more prominent channel as through the alleviation of capital constraints on cocoa production: expenditures on cocoa inputs are incurred during the cocoa husbandry

process, whereas returns are received only after the cocoa are harvested and commercialized. They further explained that most cocoa farmers show a negative cash flow during the proceeding season. Therefore to finance the purchase of production inputs, the farmer must either dip into its savings or obtain credit. They concluded that access to credit can therefore significantly increase the ability of cocoa farmers with little or no savings to acquire agricultural inputs. Furthermore, easing potential capital constraint through credit reduces the opportunity costs of capital-intensive assets relative to family labour, thus encouraging the adoption of high yielding technologies.

Akudugu (2012) stated that a small but growing empirical literature suggest that in rural areas of developing countries, credit constraints have significant adverse effects on farm output (Petrick, 2004), farm profit (Foltz 2004) and farm investments (Carter and Olinto, 2003). Akudugu (2012) continues that lack or inadequate credit access (capital Constraint) is a crucial militating factor against farmers in financing their operations and is one of the major underlying factors of low agricultural productivity in Ghana (Nani-Nutako, 1998). Similarly, Dzadze, Osei-Mensah, Aidoo and Nurah (2012) agree that credit is very important resource that allows farmers to expand their operations or adopt new technologies but unfortunately several factors are thought to limit smallholder farmers' access to credit.

Atta Junior, Osei and Petershie (2014) report that the provision of credit enables farmers to mobilize savings and promote investments so as bring about sustainable economic growth in the country; however, despite concerted effort by government, and more recently non-governmental organizations in promoting the cultivation of cocoa, its adoption remains low. They believe credit constraints are widely responsible for the low adoption of cocoa technologies due to its requirement for costly inputs.

According to Asamoah (2015) most of the technologies for cocoa production require the purchase and use of input such as mist blowers and fertilizers, however the bulk of cocoa farmers are peasant farmers who have limited resources and so majority of them are unable to adopt the innovative technologies as recommended. The major constraint has been identified as high cost of inputs and the lack of agricultural credit as well as high interest rate.

4.5 Credit Constraint and Technology Adoption

In an ideal world, people would be able to borrow or lend in smoothing out year to year fluctuations in income to produce a smooth consumption stream. The difficulty in obtaining credit is referred to as credit constraint. Eswaran and Kotwal (1990) opine that the provision of micro-credit to farmers is seen as an effective strategy for promoting the adoption of improved technologies. They believe that access to credit promotes the adoption of technologies through the relaxation of credit constraints as well as through boosting of household's risk-bearing ability. They further explained that the option of borrowing, a household can do away with risk-reducing but inefficient income diversification strategies and concentrate on more risky but efficient investments.

Smale (1995) observed that in addition to taste preference, on-farm storage constraints and risk aversion credit constraints are responsible for the low adoption of hybrid maize due to its requirement for costly seed. Supporting this view, Karlan, Osei, Osei-Akoto and Udry (2012), are of the opinion that investment decision of small scale farmers in developing countries are conditioned by their financial environment. They explained that binding credit market constraints and incomplete insurance can reduce investment in activities with high expected profits. They said farmers most often cited lack of capital as reason they had not intensified farm investment. They however learnt that capital constraint alone was not the problem and that risk is a key hindrance to investment and thus improved income and growth.

According to de Janvry and Sadoulet (1997), credit access will be effective for credit constrained farmers, that is, those with access to remunerative consumption, production and investment opportunities who are unable to pursue the opportunities for lack of financial resources. They explained that lack of access to credit may not necessarily imply an unmet credit need.

Simtowe, Zeller and Diagne (2009) also observed that credit constraint are found to have reducing effect on the amount of land allocated to hybrid maize and recommended that credit should be targeted at younger farmers that are credit constrained to enhance cultivation of hybrid maize.

Okpukpara (2010) believes that access to credit affects household welfare outcomes through two channels. He said first credit access alleviates the capital constraints on agricultural households. Access to credit also reduces the opportunity costs of capital-intensive assets relative to family labour, thus encouraging labour-saving technologies and raising labour productivity, a crucial factor for agricultural development, especially in many African countries (Delgado 1995; Zeller, Schriedner & Heidhues, 1997).

According to Diagne and Zeller (2001) rural households in developing countries lack adequate access to credit and this has negative consequences on aggregate household level outcomes including technology adoption, agricultural productivity, food security, nutrition, health and overall household welfare. They said access to credit affects household welfare outcomes through at least two channels. They gave the first channel as

alleviation of capital constraints on agricultural households. Explaining further, they indicated that expenditures on agricultural inputs must be incurred during the planting and growth periods of crops, while returns are received only after the harvest several months later. They said to finance the purchase of inputs, the farm household must either dip into savings or obtain credit, and hence access to credit can significantly increase the ability of poor household with no or little savings to acquire needed agricultural inputs. They also explained that access to credit reduces the opportunity costs of capital intensive relative to family labour, thus encouraging labour-saving technologies and raising labour productivity, a crucial factor for development, especially in many African countries.

Diagne et al (2001) further explained that the second channel, through which access to credit affects household welfare, is by increasing its risk-bearing ability and altering its risk coping strategy. They further indicated that just the knowledge that credit will be available to a potentially profitable but risky investment turn out badly will induce the household to bear additional risk. The household may therefore be willing to adopt more risky technologies

The liquidity problem faced by cocoa farmers in Ghana is amply explained by Vigneri and Santos (2009). They indicated that growing cocoa requires the availability of cash throughout the crop season to ensure all farming practices can be carried out on time. They observed that the use of chemicals for the control of pests and diseases and the application of fertilizer are crucial to take advantage of production potential of the crop. They further observed that cocoa farmers are unable to advance cash for the purchase of inputs or to hire additional non-family labour to work on the farm. Thus, cocoa farmers face serious liquidity constraints and with most of yearly income coming during the main harvest season, producers often find themselves short of cash by the time they reach the lean season, which falls in the middle of the crop year.

Aryeetey (1992), in his study of the financial market in Ghana, concluded that credit from both formal and informal sectors towards financing small enterprises in Ghana which dominate national production after agriculture is very limited and is not relied upon by entrepreneurs. For policy purposes making credit available in both sectors must supersede all other considerations.

Responding to the needs of firms, the government or in collaboration with other development partners, has come out with several initiatives such as Youth in Agriculture Programme (YAP), Private Enterprise Export Development (PEED) Fund, and International Fund for Agricultural Development (IFAD), Funds for Small and Medium Enterprises Development (FUSMED) and Export Development and Investment Fund (EDIF). These interventions have been fraught with difficulties and so have not yielded the needed results.

To specifically address the problem of lack of access to credit to cocoa farmers in Ghana, a number of schemes have been tried among which are supply of inputs to cocoa farmers. To assess the effectiveness of this scheme, Bosompem, Ntifo-Siaw and Adjei-Kwarteng (2008) conducted a study on the Cocoa High Technology Programme (CHTP) using a survey of 200 randomly selected beneficiaries of a micro financing facility in four districts in the Eastern region of Ghana. The facility was to increase access by cocoa farmers to high yielding inputs and technologies. There was a partnership agreement between CRIG, the licensed cocoa buying companies (LBCs), the Cocoa research Institute (CRIG) and the Ministry of Food and Agriculture (MOFA). The LBCs received agro chemicals (the credit) from CRIG and forward them to their registered credible farmers. MOFA provides the necessary extension and monitoring support for beneficiary farmers on application of the technology. The credit is deducted from the sales of cocoa to the LBCs. Thus the LBCs bear the full credit risk. Their findings were that, farmers' yields significantly improved by 72% three years after the programme. However about 81% defaulted because beneficiary farmers diverted their produce to non-partner LBCs thereby preventing the LBCs which advanced the credit from making deductions for loan recovery.

In a similar study, Caria, Dzene, Opoku, Teal and Zeitlin (2009) conducted a study to assess the impact of an input (fertilizer, insecticides and fungicides) supply credit package run by the Cocoa Abrabopa Association (CAA). Under the programme farmer groups consisting of between 5 and 15 members are formed for the purpose of participation. These groups enter into a contract with the CAA in March each year and receive inputs to be applied beginning April and May. The harvest begins in October and although it continues into the following calendar year, CAA loans are due by December 15 by which time it is expected that farmers will have harvested approximately three quarters of their annual production. They sought to find answers to a number of questions including the following: is the limited use of fertilizer technology due to the fact that households are credit constrained and cannot access the financial capital to invest in this technology or is it due to lack of knowledge of either (or both) of how to apply the fertiliser and the gains available from doing so? Their findings indicated that the output of the farmers who accessed the facility increased by about 40% and loan recovery rate was about 90%. However there was a drop-out rate of about 30%.

The foregoing indicates that farmers are likely to adopt improved technology if they have access to credit. The study therefore seeks to provide empirical evidence of the impact of credit access on the adoption of CRIG recommended technologies by cocoa farmers.

5.0 METHODOLOGY

5.1 Research design

The survey method was used to collect primary data for the study. This method was used because of the wide area the study covered. Primary data was collected through the use of interview schedule. The questions covered personal, socioeconomic, institutional and other relevant variables.

5.2 Study areas

The study was conducted in five regions where cocoa is grown. The five regions are Eastern, Central, Brong Ahafo, Ashanti and Western. Volta region was left out because according to COCOBOD (2011) output of cocoa from that region is less than one percent of the total national output.

5.3 Study population

The population for the study was all cocoa farmers in Ghana. According to the report of the Ghana Statistical Service (2014), cocoa supports more than 794,129 smallholder households and the number of cocoa farmers in estimated at 350,000. These farmers are found in all the cocoa growing regions. They consisted of male and female, literate and non-literate farmers of diverse background and ages.

5.4 Sampling procedure

The multistage stratified sampling technique was used in selecting 600 farmers for the study. The first stage involved selection of districts and two districts from each region making a total of 10 districts were selected. The districts selected were Nkawie and Konongo in the Ashanti Region; Goaso and Dormaa in the Brong Ahafo Region; Assin Fosu and Twifo Praso in the Central Region; Koforidua and Asamankese in the Eastern Region; and Tarkwa and Sefwi Bekwai in the Western Region. The second stage involved the selection of villages or communities through random sampling and 10 districts were selected. The third stage involved the selection of farmers and six (6) farmers were selected from each district making a total of 600 farmers.

5.5 Survey instrument and procedures for data collection

The instrument for the study was interview schedule. The questions in the interview schedule were developed based on the kind of information that was required for the analysis. It contained both closed and open-ended questions. Some questions were on Likert scale to enable respondents rank certain items or variables. The interview schedule was divided into eight sections as follows: Section one dealt with farmer characteristics; section two considered farm characteristics; section three had questions on social participation; section four sought respondents' knowledge about cocoa research innovations; section five treated questions related to technology adoption; section six treated questions on measurement of intensity of technology adoption; section seven dealt with output of cocoa; and section eight dealt with credit access.

5.6 Pilot Study

Twenty (20) farmers purposively selected from the New Juabeng District were used for the pilot study. This district was selected due to its nearness to Akim Tafo where the Cocoa Research Institute of Ghana (CRIG) is located. The results of the pilot study led to a modification of a few questions to make them clearer.

5.7 Test of reliability and validity of instrument

To test the reliability of the questions in the interview schedule, the services of cocoa extension officers were solicited. They reviewed the questions to ascertain whether they would prompt the type of responses expected. After that a pilot study, the main study was carried out. The data from the pilot study was analysed using SPSS (Statistical Package for Social Sciences). A reliability coefficient of 0.90 was obtained which was good.

5.8 Administration of interview schedule for the main study

Extension officers employed by COCOBOD were used to interview the farmers. The extension officers were selected based on recommendation from officers from CRIG who had been working closely with these extension officers. The questions were asked in the local language and so there was the problem of exact translation of the scientific terminologies into the local language. However because cocoa extension officers were used they were able to explain things to the farmers.

5.9 Data analysis

The assistance of officers in the Ghana Statistical Service was solicited and the information in the completed interview schedules was captured with the use of software called Census and Survey Processing System (CS Pro). The information was then exported to the Stata software for analysis. The descriptive statistics such as mean and standard deviation were obtained using appropriate commands in the Stata software. Also regressions were run using the appropriate commands based on the models to be estimated.

5.9.1 Analytical Framework

Following Asamoah (2015), adoption in this study is defined as full utilisation of CRIG recommended technologies. Thus farmers were regarded as adopters if they utilised all the recommended technologies provided in Table 1.

In order to estimate the effect of credit access and other farmer characteristics on adoption, A, a logistic regression model was employed. An adoption (A) as in equation 1 was used as the general framework.

$A_i = 1$ if $A_i^* > 0$ and 0 if $A_i^* \leq 0$

$$A_i^* = \alpha' Z_i + \mu_i \quad \ldots (1)$$

Where A* is a latent variable that takes the value 1 if the farmer adopts a technology or an innovation and zero, otherwise. Z is a vector of household or farmer characteristics.

The logistic regression model was used because it is capable of handling dependent variables with more than two categories (Aneani et al, 2014; Salasya, Mwangi, Mwanbu & Diallo 2007; Adenkule & Henson 2007).

5.9.2 Empirical model

The model estimated using logistic regression is as follows:

$$Adopt = \beta_0 + \beta_1 credit + \beta_2 hhsize + \beta_3 farmsize + \beta_4 Primedu + \beta_5 Midedu + \beta_6 Secedu + \beta_7 Tertedu + \beta_8 Age + \beta_9 hirelab + \beta_{10} Nonhiredlab + \beta_{11} ownlabour + \beta_{12} memasso + \beta_{13} freqadvice + \varepsilon \quad (2)$$

The expected signs of the coefficients are:

$B_1 > 0$; $\beta_2 > 0$; $\beta_3 > 0$; $\beta_4 > 0$; $\beta_5 > 0$; $\beta_6 > 0$; $\beta_7 > 0$; $\beta_8 < 0$; $\beta_9 > 0$; $\beta_{10} > 0$; $\beta_{11} > 0$; $\beta_{12} > 0$; $\beta_{13} > 0$

Where:

Adopt is level of adoption of cocoa research innovations; *credit* is access to credit; *hhsize* is household size; *farmsize* is the size of the farm; *Primedu* refers to primary education; *Midedu* is junior secondary/middle school education; *Secedu* is secondary education, *Tertedu* is tertiary education, *Age* is farmer's age; *hirelab* is hired labour; *Nonhiredlab* is non-hired labour such as spouse labour and reciprocal labour; and *ownlabour* refers to farmer's own labour, *memasso* refers to membership of an association, *freqadvice* refers to frequency of extension service advice and ε is the error term.

In all there were 600 respondents made up of 467 males and 133 females for the study.

Table 2: Descriptive Statistics for Variables

Variable	Description	Obs.	Mean	S. dev	Min	Max
Adopt	Level of Adoption	195	0.68	0.47	0	1
Credit	Credit Access(1/0)	174	1.29	0.46	0	1
Hhsize	Household size	600	4.53	0.73	2	7
Farmsize	Farm size in Acres	600	4.90	1.15	2	10
Noedu	No formal Education (1/0)	130	0.22	0.41	0	1
Primedu	Primary education(1/0)	116	0.19	0.39	0	1
Midedu	JSS/Middle School(1/0)	302	0.50	0.50	0	1
Secedu	SSS/Technical/ Trg. Coll(1/0)	48	0.08	0.27	0	1
Tertedul	Tertiary (1/0)	4	0.01	0.081	0	1
Age	Age in years	600	50.12	11.4	22	72
Hirelab	Hired labour	600	3.74	1.41	0	9
NonhiredLab	Non-Hired Labour	600	2.93	2.30	0	8
Ownlab	Own labour(1/0)	600	0.66	0.47	0	1
Memasso	Membership of Association	600	0.57	0.49	0	1
Frqadvice	Frequency of extension advice	600	0.74	0.47	0	20

Source: Own Survey Data

Note: No education is used as the reference category for education.

Descriptive statistics of the variables used in the model are provided in Table 2. They show details of number of observations, mean, standard deviation, minimum and maximum values.

Adoption

As explained earlier, adoption in this study refers to full utilisation of CRIG recommended cocoa technologies. Out of the 600 respondents 195 indicated that they adopted the technologies. This gives an adoption rate of 32.5 per cent.

Credit access

It is a summary of the responses of farmers with regards to the funding of their operations from borrowing either from financial institutions or non-bank financial institutions. About Seventy one (71) per cent of the respondents had no access to credit. This implies only 29 per cent of the respondents had access to credit. The result is consistent with other studies (Asamoah 2015; Akudugu 2012 & Dabone et al 2014) which recorded low access to credit.

Household size

This refers to members of household who performed certain activities on the cocoa farm. The study indicated that the size of the household ranges from 2 to 7 and the average was 4.53 (approximately 5 people). 46.2 per cent of the respondents had household size of five (5). This finding is consistent with what is contained in the Round Five (5) of the Ghana Living Standard Survey (2008).

Farm size

In Ghana most cocoa farmers are small holders who use family lands or lease them. The farm sizes are therefore not big. About 57.8% of the farmers had farm sizes between 2 and 10 acres and the average farm size was 4.9 acres. The farm sizes conform to the general characteristics of cocoa farmers who are basically small holders. The farmers do not usually have large plantations. In the past the government used to have large plantations but these were sold to individual farmers and companies.

Level of education

Level of education was categorised into no education, primary education, middle school/junior secondary school education, senior secondary school education and tertiary education. The majority of the farmers (50.3%) had middle school or junior secondary school education. Those who had tertiary education were less than 1%.

Age of the farmer

The age of the farmer determines whether the farmer is a youth or an aged. It is generally believed that the youth are more energetic and as such are able to perform more strenuous work. The majority (53%) of the farmers were between the ages 41 and 50 years and the average age was 50.12 years. This suggests that most of the farmers are of middle age. This finding almost agreed with the finding of Boahene (1995) who had the average age of farmers as 53 years.

Hired labour

This refers to labourers who are paid to work on the farm. They may be casual labourers or permanent labourers. Most farmers usually hired about 4 labourers.

Non-hired labour

Non-hired labour refers to the engagement of services of people who are not paid any wage on the farm. They usually include friends or members of a cooperative group who visit the farms of members on rotational basis to assist each of the members in the group perform certain activities such as weeding, plucking of cocoa and breaking the pods. About 28.67% of the respondents engaged 3 non-hired labourers each on their farms.

Own labour

Own labour refers to the man-hours the farmer himself uses on his farm. The study shows that about 66.2% of the respondents used their own labour. The finding exhibits the general characteristic of small holder farmers who perform activities on their farms themselves because of lack of funds to hire labourers and also due to the fact that they consider farming to be their occupation.

Membership of association

A greater percentage of the respondents (57.17%) indicated that they belonged to cocoa producer association such as the Cocoa Abrabopa Association or Kuapa Kookoo Farmers Association. In such associations members are taught how to cultivate cocoa and discuss pertinent issues bordering on the production of cocoa.

Frequency of Extension advice

Frequency of extension advice refers to the number of times farmers were visited in a year. About 33.5% of the respondents indicated that they were visited at least once a year by extension officers. These extension officers were from the Ministry of Food and Agriculture or COCOBOD. They usually provided

advisory services on how to handle a particular problem such as fertilizer application or proper management of disease and pests on the farm.

6.0. RESULTS AND DISCUSSIONS

Results for the logistic regression have been presented in Table 3. Discussions on the various independent variables used in the model are presented.

Credit Access

The coefficient of credit access is 1.4849 and is significant at 1%. This means a unit increase in credit access will result in 1.4849 increases in the log-odds of adoption, holding other variables constant. This suggests that Credit access has a positive impact on the adoption of cocoa research innovation and confirms the stated hypothesis. By this finding therefore, respondents who received credit have higher probability of adoption of cocoa research innovation than those who did not receive credit. This result agrees with most studies (Boahene, 1995; Donkoh, 2006; Akudugu 2012; Dadze et al 2015; Atta Junior et al, 2014 & Asamoah, 2015) reviewed. Even though the percentage of respondents who accessed credit was small, the finding is significant and confirms the findings of other researchers that credit constraint is an important determinant of technology adoption.

Respondents whose facilities were declined indicated that they were declined principally because they did not have collateral to back their request. Other respondents also indicated that they did not apply for loans at all because the loans were not available; interest rates were too high when they were available; bank loans are too risky; and they did not meet the criteria set up by the banks.

Table 3: Logit Regression results for Determinants of Adoption

Variable	Coef.	Std. Err.	z	P>z	[95% Conf	Interval]
Credit	1.484939	0.2216511	6.7	0.000	1.050511	1.919367
HHsize	0.216247	0.1438078	1.5	0.133	-0.06561	0.498105
Farmsize	0.053714	0.0956954	0.56	0.575	-0.13385	0.241274
Primedu	1.066202	0.3640034	2.93	0.003	0.352769	1.779636
Midedu	0.307824	0.2632686	1.17	0.242	-0.20817	0.823821
Secedu	0.043742	0.4138313	0.11	0.916	-0.76735	0.854836
Tertedu	14.51362	453.6198	0.03	0.974	-874.565	903.5922
Age	-0.00591	0.009683	-0.61	0.541	-0.02489	0.013066
Hiredlab	0.304678	0.0745331	4.09	0.000	0.158596	0.45076
Nonhiredlab	-0.08284	0.0752201	-1.1	0.271	-0.23027	0.06459
ownlab	1.0787	0.2444039	4.41	0.000	0.599677	1.557723
memasso	1.525625	0.2362827	6.46	0.000	1.06252	1.988731
Frqadvice	0.203259	0.0858189	2.37	0.018	0.035057	0.371461
Constant	-4.05702	1.071353	-3.79	0.000	-6.15683	-1.9572

Source: Regression results based on Own Survey Data
Notes:
Dependent Variable = Adoption
Number of observations 600; Wald chi square (12) = 18.11; Pseudo R^2 = 0.3347; Prob > chi square = 0.2017

Household Size

The coefficient of household size was 0.2162 and significant at 10 per cent. Thus an increase in the size of household by one is expected to increase the log-odds of adoption by 0.2162, other things being equal. The results show that there is a positive relationship between household size and adoption of cocoa research innovations and agrees with the stated hypothesis. This finding corroborates those of Manyong and Houndekon (1997).

Farm Size

There was a positive relationship between the farm size and adoption of cocoa research innovation. The coefficient for farm size was 0.0537 and significant at 10 per cent. This indicates that an increase in the farm size

by an acre is likely to result in an increase in the log-odds of adoption by 0.0537. The positive relationship between farm size and adoption confirms the stated hypothesis and the finding of Norris and Batie (1987), Kebede, Gunjal and Coffin (1990) Polson and Spencer (1991).

Education

As explained earlier, education was divided into no education, primary education, junior secondary or middle school, secondary or technical education and tertiary education with no education as the reference category. It was primary education which was significant at 1 per cent with a coefficient of 1.0662. This indicated that primary education has a positive impact on farmers' decision to adopt cocoa research innovation. Thus, respondents with primary education have a higher probability of adoption of cocoa research innovations than those with no formal education. The positive relationship between education and adoption agrees with the stated hypothesis and the findings of Boahene (1995); Legese, Langyintuo, Mwangi, Jaleta and Rovere (2009); Langyintuo and Mekuria (2005); Ben-Houssa (2011) and Aneani et al (2012).

Age of the farmer

The coefficient of the age variable is given as -0.00591. This means for a one year increase in the age of the farmer, we expect a 0.00591 decrease in the log-odds of adoption, holding other variables constant. Thus an increase in the age of the farmer reduces the probability of adoption of cocoa research innovation. This result agrees with most studies reviewed (Donkoh, 2006; Abera, 2008) and consistent with the stated hypothesis. As farmers grow older, they tend to be more conservative and risk averse compared to younger farmers. Young farmers who are vibrant, energetic and innovative may be prepared to allocate resources to new technologies, other things being equal.

Hired Labour

Hired labour had a coefficient of 0.0347 and was significant at 5%. This implies an increase in the number of hired labour by one will other things being equal, lead to a 0.0347 increase in the log-odds of adoption. This may be due to the fact that hired labourers provided the needed manpower required for the use of modern method of cocoa production as recommended under the high technology package. The finding is in conformity with the stated hypothesis and with Boahene's (1995) position that hired labour is a significant variable that determines the adoption of technology.

Non-Hired Labour

The coefficient for non-hired labour was -0.0828 and was significant at 5%. This means an increase in non-hired labour by one will lead to a reduction in the log-odds of adoption by 0.0828. There was therefore a negative relationship between non-hired labour and decision to adopt cocoa research innovations. It is worth recapping that non-hired labour included spouse labour and reciprocal labour. This finding is contrary to the stated hypothesis and the finding of Boahene (1995) who observed a positive relationship between adoption of hybrid cocoa and farmers' access to cooperative labour. The possible reason for this finding may be that the non-hired labour did not have the required skills for the job.

Own labour

The coefficient of own labour is 1.0787 and significant at 1%. The result indicates that a unit increase in own labour will lead to 1.0787 increase in the log-odds of adoption of cocoa research innovations, other things being equal. This suggested a positive relationship between own labour and adoption of cocoa research innovations. The finding confirms the stated hypothesis and agrees with Hicks and Johnson (1974) who believe that own labour leads to greater adoption of labour intensive rice varieties in Taiwan.

Membership of an Association

The coefficient for membership of an association is 1.5256 and significant at 1 per cent. This indicates that a unit increase in membership will lead to a 1.5256 increase in the log-odds of adoption of cocoa research innovations, other things being equal. Thus, there is a positive relationship between membership of an association and adoption of cocoa research innovations, a confirmation of the stated hypothesis. This finding agrees with that of Opoku, Dzene, Caria, Teal and Zeitlin (2009).

Frequency of Extension Advice

Results of the study indicated that there was a positive relationship between frequency of extension advice and the level of adoption of cocoa research innovations. The coefficient of frequency of extension advice was 0.2033 implying a unit increase in extension advice will lead to a in the log-odds of adoption of cocoa research innovations, other things being equal. This finding confirms the stated hypothesis and agrees with Baah, Anchirinah and Amon-Armah (2011) that there is a positive relationship between extension advice and adoption of technology.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The study dealt with the effect of credit access and other framer characteristics on adoption of CRIG recommended technologies. The logistic regression model was used for the study. Results of the study indicate

that credit access had a positive sign and significantly affected adoption of cocoa research innovations. With exception of age which had a negative coefficient, hired labour, own labour, membership of association and frequency of extension advice all had positive coefficients and significantly affected adoption of cocoa research innovations. Based on the outcome of the study, it is recommended that:

- Financial institutions should be encouraged by Bank of Ghana to make credit accessible to cocoa farmers. This can be done by enforcing the tax incentives to financial institutions which lend to the agricultural sector.
- Financial institutions should find innovative ways to secure facilities extended to cocoa farmers and should not always insist on tangible collateral such as landed properties.
- Farmers should be encouraged to join associations so that they can benefit from loans under group schemes.
- Credit to cocoa farmers should mostly be in the form of inputs to ensure that they are used for the intended purposes.

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