Effects of Access to Credit and Membership in Farmers' Cooperatives on Improved Technologies Adoption Categories in Cocoa-Based Farming Systems of Southwestern Nigeria

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Agricultural development through technical change of adoption of improved technologies remains a vital panacea to food insecurity and poverty among rural farmers. These improved technologies include improved seed varieties, fertilizer, recommended mixed cropping, recommended spacing, and pesticides. Therefore, this study investigated the effects of access to credit and membership in farmers' cooperatives on categories of adoption of these improved technologies in cocoa-based farming systems. A multistage sampling procedure was employed to obtain data from 200 respondents for the study. Data were analyzed using descriptive statistics, adoption index and multinomial logit regression model. Descriptive statistics revealed mean difference in some socioeconomic characteristics among categories of adopters in the study area such as household size (p<0.01), farming experience (p<0.01) and farm size (p<0.01). The average level of adoption of improved technologies in the study area was observed to be 49%. There are three categories of adopters in the study area with variations in their socio-economic characteristics. About 7.5 %, 41.5%, and 51% of the respondents were non-adopters, partial adopters, and full adopters of the improved technologies, respectively. Multinomial logit estimates revealed that gender, extension visit, farm size, and access to credit significantly influenced partial adoption of improved technologies. Education, extension visit, farm size, access to credit, and membership of association significantly influenced full adoption of improved technologies. The study concluded that cooperative membership has significant influence on full adoption of improved technologies, while access to credit has significant influence on both partial and full adoption of improved technologies. Therefore, the study recommends that an agricultural development programme that ensures efficient and effective access to credit should be established in the rural areas as well as encouraging formation and strengthen of a farmers' cooperatives for increased uptake of improved cocoa production technologies.

Key Words: Multinomial logit, improved technologies, cocoa, farming systems, adoption, membership, farmers cooperatives, credit

Introduction

Cocoa (Theobroma cacao) has earned more foreign exchange and offered employment to the populace. Also, it is an important source of raw materials to industries and revenue to cocoa producing States (Nkang et al., 2009). Apart from its contribution to the nation's economy, cocoa contains a group of compounds which has health benefits (Taubert et al., 2007). Despite its potentials, Mafimisebi et al. (2008) noted that the performance of Nigeria's cocoa economy has remained abysmally low. Cocoa production in Nigeria witnessed a downward trend from 1971 season, thereby reducing the country's market share to about 6% and relegating her to the position of fifth largest producer to date (Folayan et al., 2006). Amos (2007) described cocoa-based farming business as unsophisticated one due to low level of improved technologies application as a result of the current cocoa planting pattern. This sequel to the fact that most farmers consider cocoa a low input crop therefore, receives low technological input. In addition, Daramola et al. (2003) observed that many cocoa farms especially in Southwestern Nigeria are old thereby reducing cocoa production in that area. The ageing of cocoa farms was often ascribed to non-use of improved technologies for cocoa production (Aikpokpodion et al., 2005).

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Heikkila et al. (2012) opined that investment in improved technologies remains the fundamental way to increasing agricultural production either on small scale basis or large-scale basis. In accordance to this, research institutes across the nation are mandated to produce improved technologies consistent with natural resource management (Idachaba, 1998). However, the research institutes introduced some improved technologies to increasing cocoa production. These technologies embody improved seed technology and management practices of agro chemicals in terms of biological and chemical technologies. These include improved seed varieties, fertilizer, pesticides, recommended spacing, recommended crop combinations among others (CRIN, 2010). Despite the introduction of improved technologies through programmes and projects, farmers strictly adhere to use of old technologies and management practices (Ayanlaja, 2000). Consequently, the smallholder farmers obtain yields lower than potential yields obtainable.

However, the success of any agricultural technology depends on its dissemination among the farmers. An improvement would occur in the agricultural production, if improved technologies were adopted by the farmers (Ogunwale et al., 2006). The extent at which a technology improves agricultural production could be measured by the level of adoption of such technology (Iheanacho, 2006). In other words, adoption of improved technologies would lead to desired result in agricultural production when farmers fully comply with the recommendations of the technologies. A significant deviation from the recommended quantity of a particular input would result to low output. Thus, the variation in agricultural output can be attributed to difference in technology adoption rate among farmers or partial adoption of improved technologies. Partial adoption refers to incomplete adoption of the total technology package by the farmers, which may be due to socioeconomic factors or institutional factors such as age, farming experience, education, risk consideration, scarcity of funds, and lack of access to information (Bamire, 2002; Adebiyi and Okunlola, 2013).

Also, access to credit enhances farming households' ability to adopt improved technologies in order to achieve greater capacity and investment (Nwaru and Onuoha, 2010; Ammani, 2012). However, lack of agricultural credit is the major constraint to adoption of improved technologies. This could be attributed to problems of collateral as well as the risky nature of agricultural production. To overcome these constraints, several farmers are encouraged to form cooperatives in rural areas (Latynskiy and Berger, 2016). Farmers' Cooperatives are important institutional innovation that help to overcome the constraints that affect farmers' technology adoption (Abebaw and Haile, 2013). Cooperatives improve technology adoption by providing necessary information, credit and offering a better market price for their produce by pooling different resources such as credit, information, and labour among members (Verhofstadt and Maertens, 2014; Ma and Abdulai, 2016).

Consequently, this study investigates the effects of access to credit and membership in farmers' cooperative on improved technologies adoption categories in cocoa-based farming systems. Specifically, describes socio-economic characteristics of cocoa farmers; determines the rate of adoption of improved technologies among farmers within the cocoa-based farming system; determine the effects of access to credit and membership in farmer's cooperative on categories of adoption of improved technologies among farmers within the cocoa-based farming system.

Research Methodology

The Study Area

South west Nigeria has six States; Ekiti, Lagos, Ogun, Ondo, Osun and Oyo. Two States namely, Oyo and Osun States in South west Nigeria constitute the study area. Although there are different dialects even within the same state, it is a Yoruba speaking area. It has a population of 5,591,585 people (National Population Commission, 2007). It is characterized with two climatic seasons; rainy season and dry season. The favorable climate of the area encouraged about 70 percent of the inhabitants to engage in farming. Small scale farmers dominate in the study area. They grow both cash and food crops. The climate favoured the cultivation of crops like cocoa, maize, yam, cassava, millet, rice, plantain and cashew. The improved technologies considered in this study were introduced to study area through cocoa research institute of Nigeria (CRIN) (CRIN, 2010).

Sampling Procedure and Sample Size

A multistage sampling procedure was employed to obtain data for the study. The first stage involved the random selection of two States in Southwestern Nigeria (Osun and Oyo States). The second stage was the purposive selection of two Local Government Areas (LGAs) in each State. Ido and Ogo-oluwa LGAs were selected in Oyo State, while Atakumosa East and Ayedire LGAs were selected in Osun State. The selection was based on the predominance of cocoa farmers in the LGAs. The third stage was the random

selection of five villages from the list of cocoa growing villages in each of the four LGAs. The fourth stage involved the random selection of ten cocoa farmers in each village making a total sample of 200 cocoa farmers for the study.

Analytical Technique

Descriptive statistics (frequency and percentages) was used to describe the socio-economic characteristics of cocoa farmers.

Adoption Index

In this study, the technologies considered were improved seed varieties, fertilizer, pesticides, recommended spacing and recommended mixed cropping. For adoption of each technology, an adopter was coded as 1 while non-adopter was coded as 0. The adoption level (x) of a farmer was determined using the following formula:

$$AI_i = \sum \left(\frac{AT_i}{NT_i} \times 100 \right) \quad \dots \quad (1)$$

Where,

AI_i is the adoption Index of a farmer; AT_i is the number of technologies adopted by a farmer; and NT_i is the number of technologies introduced. A maximum adoption index obtainable is fixed at 100%. The mean adoption index would be calculated. To determine the mean adoption level, this study adopted this formula:

Average adoption level = $\Sigma fx/N$

Where f = frequency of each value observed; N = number of observations of the variable x. If a farmer's score is higher than the mean adoption index, he is a full adopter of improved technologies, if a farmer's score is less than the mean adoption index; he is a partial adopter of improved technologies. If farmer scores zero, then he is classified as non-adopters.

Multinomial Logistic Regression

This study used a Multinomial Logit (MNL) model to investigate the factors influencing a cocoa farmer being in a particular category of adoption in the study area. In the model, the dependent variable included three categories which were non-adoption, partial adoption and full adoption based on the adoption level generated from adoption index while the explanatory variables included different institutional and social-economic factors. Probability of adoption could be estimated if each farmer and technology can be classified based on some set of variables (Owombo and Idumah, 2015). This model was employed because it accommodates more than two categories in the dependent variable in the probability analysis. The estimated model is specified as follows:

$Y_i = \beta_0 + \beta_1 AGEHHED + \beta_2 FFEDU + \beta_3 LATEN + \beta_4 FAMEXP + \beta_5 HHSIZE + \beta_6 MEMBASS + \beta_7 ACCREDIT + \beta_8 GENHHED + \beta_9 FAMSIZE + \beta_{10} EXTENSN + e_i \quad \dots (2)$

Where,

Y_i is a single dependent variable with three categories (Category 1 is non-adopters (X=0); Category 2 is partial adopters (adoption index < mean adopter index); category 3 is full adopters (adoption index > mean adopter index)).

The definitions of independent variables are:

AGEHHED is age of the farmers (years), FFEDU is number of years of formal education (years) LATEN is land tenure status (Dummy variable 1= own land, 0= otherwise), FAMEXP is year of farming experience (years), HHSIZE is farm household size (#), MEMBASS is membership of farmers' association (dummy variable 0= non-member, 1= member), ACCREDIT is access to credit (1= accessible, 0= inaccessible), GENHHED is gender of house hold head (0= female, 1= male), FAMSIZE is farm size (ha), EXTENSN is extension visit (1= yes, 0= no), and e_i is random error term.

The inclusion of these variables in the model was based on a prior expectation on the variable used (Table 1). These explanatory variables are expected to influence the adoption of improved technologies.

The influence of age on adoption of improved technologies is controversial. In adoption studies, it is assumed that older people adopt new technologies due to many years of farming experience. On the other hand, because of the risk adverse nature of older farmers, they are more conservative than the younger ones to adopt new technology (Akinola et al., 2010). Education is assumed to have positive influence on the adoption of improved technologies because its ability to obtain process, understand and interpret the agricultural information coming to farmers from any direction (Bamire et al., 2002). Land tenure measured as dummy (1, if owned and 0, otherwise) refers to the rights a farmer has over his farmland. It is hypothesized that land-tenure status is positively related to new technologies (Bekele and Mekonnen, 2010).

Farming experience is the number of years a farmer started farming on his own. It has positive influence on improved technologies. Farmers with higher experience often have full information and better knowledge. Thus, they are able to evaluate the advantage of improved technologies (Ogundele and Okoruwa, 2006). Household size is the number of persons that pool resource together, live under the same roof and eat from the same pot related by blood or not. A large household size working on the farm reduces the expenditure on hired labour. Hence, it is

assumed to positively affect decision to adopt improved technologies (Akinola and Owombo, 2012). Membership of association such as cooperatives has been found to influence the adoption of agricultural technologies. Membership of association allows cross fertilization and fast transmission of ideas among farmers (Akinola et al., 2010). Access to credit is the capital that could be used in the production process or exchanged for productive assets. If the farmers have free access to credit facilities, they may be more interested in investing on improved technologies. Therefore, it is expected to influence adoption of technologies positively (Owombo et al., 2011). Gender is one of the factors influencing adoption of new technologies. It has been observed that male headed household invest in improved technologies

than the female headed household. (Lawal and Oluyole, 2008). Farm size has positive effect on adoption of most practices. The larger the farm size the greater the likelihood that a farmer will invest in improved technologies. Therefore, the size of the land will positively affect the decision to uptake improved production technologies (Akinola et al., 2011). Extension visits refer to the number of contact farmer had with extension agent to take advice in last cropping season. Extension visit implies easy exposure to new technologies. Therefore, extension contact is expected to have a positive influence on farmer's adoption of improved technologies. It is believed that frequent contacts will enhance the exposure of farmers to improved production technologies (Owombo et al., 2011).

Table1: Description of variables

Variables	Units	Expected signs
Age	Years	±
Education	Formal education =1 Informal=0	+
Land Tenure Status	Access; yes=1, no=0	±
Farming experience	Years	±
Farm house hold size	Number of members	±
Extension visit	Yes=1, No=0	+
Membership of association	Member=1, Non-member=0	+
Access to Credit	Access; yes=1, no=0	+
Farm size	Hectares	±
Gender of House hold Head	Female=0, Male= 1	±

Result and Discussion

Adoption categories of improved technologies

Figure 1 reveals the adoption categories of improved technologies in the study area. The average level of adoption in the study area was observed to be 0.49 indicating that farmers adopted 49% of the improved technologies. This implies that adoption of improved cocoa production technologies is still relatively low

and have not made enough anabasis in the study area. Non- adopters were 15 (7.5%), the presence of non-adopters could be ascribed to lack of information and encouragement from concerned organization. Partial adopters of improved technologies were 83 (41.5%), while full adopters of improved technologies were 102 (51.0%). Relative high numbers of full adopters could be attributed to effective extension service, high literacy level, and presence of social organization (Junge *et al*., 2009).
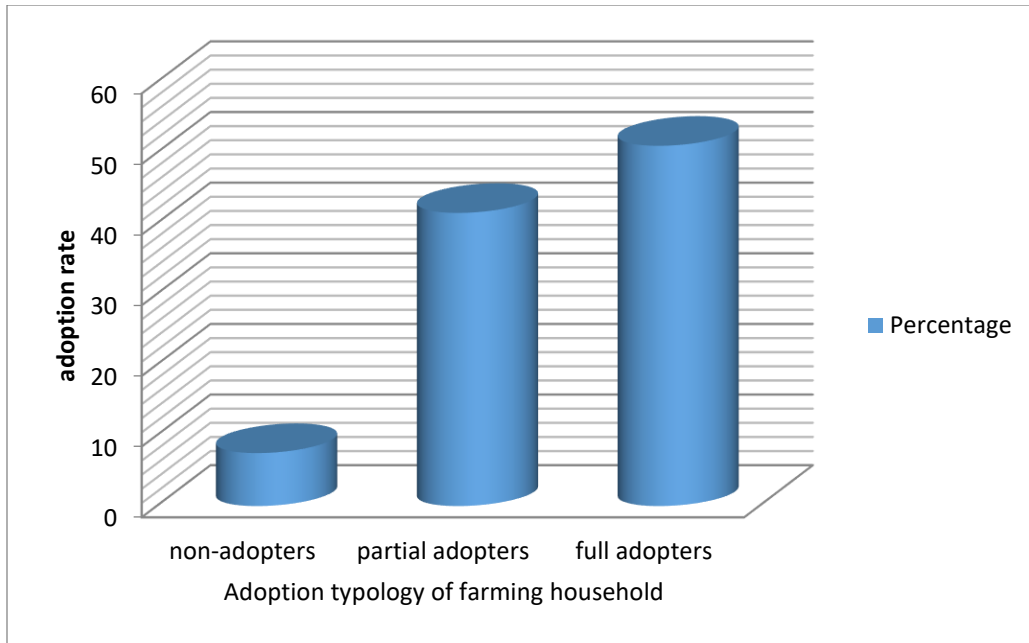
Figure 1: Adoption categories of improved technologies

Socio-economic and Demographic Characteristics of the Respondents

Table 2 reveals dissimilarities in the socio-economic and demographic characteristics among the categories of farmers in the study area. The mean age for non-adopters was 53.7(±14.8) years. The average ages of partial and full adopters were 52.8 (±14.5) and 51.8(±13.1) years, respectively. The average years of schooling among categories of farmers ranged from 6.3(±4.2) years to 7(±5.1) years with full adopters having the highest mean education 7(±5.1) years. Non-adopters have the highest mean household size of 10 (±3.3) persons, followed by partial adopters 9.5(±3.1) persons. Full adopters have the lowest household size of 9 (±3.0) persons. F-test value showed significant mean difference among categories of farmers for household size (P<0.1). The mean farming experience for non-adopters was 32.4(±10.8) years, partial adopters was 30.3(±10.2) years and full adopters was 27.8(±8.6) years. F-test value showed significant mean difference among the categories of farmers for farming experience (P<0.01). The mean farm size for non-adopters was 6.0 (±2.0) hectares. The average farm size ranged from 8.5(±2.8) to 9.5(±3.2) hectare among adopters of improved technologies. F-test value showed significant mean difference among categories of farmers for farm size (P<0.01). About 93.3 percent of the non-adopters, 72.3 percent of partial adopters, and 71.6 percent of full adopters were male. This study revealed that male dominates cocoa production in the study area. The result further revealed that full adopter had the highest access to credit (9.8 percent). Just 6.7 percent of non-adopters had access to credit. Membership of association was least among non-adopter as only 53.3 percent belongs to cooperative society. The non-adopters had least extension contact as just 20 percent had contact with extension officer.

Table 2: Socioeconomic characteristic of respondents

Variables	Non-adopters (n=15)	Partial adopters (n=83)		Full adopters (n=102)	F-test
Age (yrs)	53.7(14.8)	52.8 (14.5)	51.8(13.1)	0.200	
Years of schooling	6.3(4.2)	6.5(4.5)	7.0(5.1)	0.108	
Household size (#)	10(3.3)	9.5(3.1)	9.0(3.0)	1.963*	
Farming experience (yrs)	32.4(10.8)	30.3(10.2)	27.8(8.6)	4.844***	
Farm size (ha)	6.0 (2.0)	8.3 (2.8)	9.5(3.2)	3.285***	
Married (%)	100.0	88.0		89.2	
Male (%)	93.3	72.3		71.6	
Extension contact (%)	20.0	75.9		91.2	
Access to credit (%)	6.7	7.2		9.8	
Memberships of (%)	53.3	67.5		70.6	
Association					

Note: figures in parentheses are standard deviations, *** indicates significant at 1%, *indicates significant at 10%.

Effects of access to credit and membership in farmers' cooperative on adoption of improved technologies

Table 3 reveals the effects of access to credit and membership in farmers' cooperative on adoption of improved technologies. Log likelihood function and Chi-squared were -113.477 and 123.00, respectively. The log likelihood of Chi-squared was significant (P=0.0000) suggesting strong explanatory power. This shows that the entire model is best fit and significant at one percent. The base category was the non-adoption. The coefficients of gender, extension visit, farm size, and access to credit were positive and significantly influenced choice of partial adoption of improved technologies, while the coefficients of education, extension visit, farm size, access to credit, and membership of association were positive and significantly influenced choice of full adoption of improved technologies. The gender of household head had a significant influence on partial adoption category (p<0.1). This implies that male headed households had a higher probability of being a partial adopter of improved technologies. This conforms to the findings of Asfaw and Admassie (2004) and Odendo et al. (2009). Farm size significantly influenced both partial adoption and full adoption categories, respectively (p<0.05). This indicates that an increase in farm size increases the probability of being a partial adopter and full adopter of improved technologies, respectively. Education positively influenced full adoption category at (P<0.1). This suggests that an increase in education level of the farmers increase the probability of being full adopter of improved technologies. This agrees with findings of Mbaga-Semgalawe and Folmer (2000). Farmers' organization significantly influenced full adoption category (p<0.1). This indicates that membership in cooperative society increase the probability of being a full adopter of improved technologies. This conforms to findings of Nchinda et al. (2010). Access to credit positively influenced both partial adoption (P<0.01) and full adoption category (p<0.05), respectively. This concurs with the findings of Feleke and Zegeye (2006). Extension visit positively influenced partial adoption and full ad option categories (p<0.05), respectively. Land ownership significantly influenced partial adoption category (P<0.1). This implies that ownership of land increases the probability of being a partial adopter of improved technologies by the farmers. This concurs with studies such as FAO (2001).

Table 3: Multinomial Logit estimates of improved technologies adoption

Variables	Partial adoption	Full adoption
Gender	3.115*	0.284
	(0.054)	(0.454)
Age	0.106	-0.05
	(0.804)	(0.704)
Household size	-0.091	- 0.034
	(0.557)	(0.268)
Education	0.012	0.062*
	(0.917)	(0.069)
Farm size	0.511**	0.069**
	(0.027)	(0.017)
Association	1.314	0.659*
	(0.157)	(0.057)
Credit	4.317***	2.181**
	(0.0)	(0.046)
Land tenure	10.125*	1.106
	(0.072)	(0.353)
Farming experience	-0.094	-0.015
	(0.222)	(0.283)
Extension	0.0051**	0.0543**
	(0.0115)	(0.013)
Numbers of observation	200	
Log likelihood	-113.477	
LR chi-square (18)	123.00	
Pro> Chi square	0.0000	
Pseudo R^2	0.3515	

Base outcome or categories is non-adoption figures in parenthesis ( ) represent P-values, ***= significant at 1%, **= significant at 5%, *= significant at 10%.

Conclusion

There are three categories of adopters in the study area with variations in their socio-economic characteristics. The categories are non-adopter, partial adopters, and full adopters based on the extent of adoption of improved technologies by individual farmers. Non-adopters were relatively older than other categories of adopters, with significant differences between their years of schooling and farm sizes. Full adopters have larger farms and spent more years in school than categories of adopters. The significant difference among categories of farmers' farm size and years of schooling gives the full adopters opportunity to understand and try new improved technologies. Majority of the sampled farmers have organized social groups with limited access to formal credit. The major channels which improved technologies were disseminated were through extension agents to farmers in their various associations. Improved technologies have not made enough anabasis in the study area as its adoption is relatively low. Education, extension visit, farm size, access to credit, and

membership of association significantly influenced full adoption of improved technologies. All these significant variables should be taken into consideration in an effort to increase the uptake of improved technologies. The study concluded that access to credit has significant influence on both partial and full adoption. Therefore, farmers in rural areas of Nigeria should be encouraged to form cooperatives so they could pool resources together in order to access improved agricultural technologies. Therefore, an agricultural development programme that ensures efficient and effective access to credit should be established in the rural areas as well as strengthen of a social group would encourage the farmers to increase their uptake of improved cocoa production technologies.

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