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Research Article

Technology Adoption Motivation Among Organic Cocoa Farmers in Southwest Nigeria

Lydia Olufunmilola Ogunya*

Department of Agricultural Economics, Obafemi Awolowo University, Ile-Ife, Nigeria

Abstract

The study assessed the level of organic farming among cocoa farmers; examined the factors influencing the decision to adoption; and intensity of use of organic farming adoption in Southwest, Nigeria. Using a multi-stage sampling technique, primary data were gathered from 300 organic cocoa growers in the study area. The data were analysed using the double hurdle model, which consists of two stages: the first stage determines the factors that influence the decision to adopt organic farming, and the second stage determines the factors that influence the intensity of use of organic farming. The decision to adopt organic farming practices among cocoa farmers was influenced positively and significantly by labour (mandays), credit accessibility and extension visit. However, farm size, farming experience were negative and significant at $p<0.01$. Intensity of use of organic farming adoption was positively influenced by three factors: labour (mandays), credit accessibility ($p<0.01$) and extension visits ($p<0.05$) and negatively influenced by farming experience ($p<0.05$). The study concluded that organic cocoa farming practices were influenced by various socio-economic and institutional factors, and that these practices had a positive impact on the efficiency and profitability of cocoa farmers. The study recommended that policies should be implemented to enhance the access to credit, extension services, labour and organic inputs for cocoa farmers, as well as to create awareness and incentives for organic farming in the region.

Keywords

Cocoa, Adoption, Intensity, Organic Farming Practice

1. Introduction

Cocoa (Theobroma cacao) is a valuable crop and a significant source of foreign exchange in Nigeria, along with other agricultural products. Nigeria currently ranks fourth in the world for cocoa production, producing about 12% of the total amount, behind only Cote d'Ivoire, Ghana, and Indonesia [3]. Over 328,000 tonnes of cocoa were produced in 2020, but Nigeria, like Cote D'Ivoire and Ghana, is still unable to fully benefit from the cocoa industry in order to diversify its economy [1].

Cocoa is mainly produced in south-western Nigeria, where almost all of the Southwest states are involved in cocoa production, except for Lagos. Ondo, Ogun, Oyo, and Ekiti account for roughly 60% of total cocoa production and at least 30% of total cocoa export in Nigeria [31]. Other states that produce cocoa include Cross River, Edo, Abia, Kwara, Kogi, Adamawa, and Akwa Ibom [36]. Among the fourteen (14) states notable for their cocoa production, which account for 370.01 metric tonnes, Ondo State contributes the most with 92.22 metric tonnes, equivalent to 25% of total production,

*Corresponding author: akanbilydia@gmail.com (Lydia Olufunmilola Ogunya)

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followed by Osun State with 74.10 metric tonnes. Imo State produced the least amount, 0.01 metric tonnes [3]. Despite its importance, the nation's cocoa production has been declining over time [30].

One of the major challenges facing cocoa production is the outbreak of plant pests and diseases such as cocoa pod borer, vascular streak dieback, and cocoa black pod disease [13]. These pests and diseases reduce the yield and quality of cocoa beans and affect the profitability of cocoa farmers. According to ICCO, the flow of cocoa beans produced in Nigeria has been inconsistent over the last three years, increasing from 200,000 metric tonnes in 2015/2016 to 245,000 metric tonnes in 2016/2017, followed by a 5% decline in 2017/2018 to 240,000 metric tonnes [17].

To reduce losses caused by insect pests and diseases, Nigerian cocoa farmers employ a variety of pesticides. However, pesticides are hazardous to the environment and the health of those who apply them [9, 20]. Pesticides promise effective pest control, but they also kill non-target plants and animals and pose risks to human health. Therefore, there is a need to develop and promote healthy, nutritious, and environmentally friendly technology for cocoa production.

Organic technology is an intervention that promotes the intensive use of cocoa pods as fertilizers to replenish soil fertility, the use of neem extract on cocoa plantations, and the use of improved planting material to increase cocoa farm productivity [15, 19]. Organic production is a sustainable and environmentally friendly way of producing cocoa, which can improve the quality and profitability of the crop. Organic technology can also enhance the quality and marketability of cocoa beans and reduce the dependence on chemical inputs.

According to [25], cocoa farmers are willing to adopt organic production for a variety of reasons, such as lower production costs, higher returns, increased income, fewer potential risks, accessibility and reliability of production methods, maximum efficiency, and compliance with the standards of developed countries. Another significant benefit of organic farming for cocoa farmers is that it can result in a 10-30% increase in market premium. However, despite the advantages of organic farming, only a small fraction of Nigerian cocoa farmers has achieved organic certification status. According to Agbongiarhuoy and Fawole, out of the estimated 800,000 cocoa farmers in Nigeria, only 2000 have been certified as organic producers. This indicates a low level of adoption of organic farming practices among cocoa farmers in Nigeria [4].

Therefore, there is a need to determine the factors that influence the decision and intensity of organic farming adoption among cocoa farmers in Nigeria. This study aimed to fill this gap by conducting a baseline social and economic study of organic cocoa farmers in Southwest Nigeria, where most of the cocoa production takes place. The objective of the study was to assess the level and intensity of organic cocoa adoption; and identify the factors that influence them in the study area.

2. Methodology

2.1. Study Area

The study area for this research was Southwest Nigeria, a region that covers six states: Ekiti, Oyo, Ogun, Ondo, Lagos, and Osun. The region lies between latitude 6^0 and 8^0 North and longitude 2^0 and 6^0 East. The region is the main cocoa producing area in Nigeria, accounting for about 80% of the country's total cocoa output [5]. Cocoa is grown in 16 states across the federation, but Ondo State is the leading cocoa producer in Nigeria. The study area is dominated by smallholder farmers who cultivate one to five hectares of land per household. They intercrop cocoa with other crops for economic, social, environmental, and food security reasons.

2.2. Sampling Procedure and Sample Size

This study used a multi-stage sampling technique to select 300 organic cocoa growers from two states in Southwest Nigeria: Ondo and Osun. These states were purposively selected based on their high cocoa bean production and the presence of organic cocoa technology introduced by SARO Agro-Allied Nigeria. Within each state, six Local Government Areas (LGAs) were also purposively selected based on their high cocoa production and prevalence of organic cocoa farming. These LGAs were Ayedaade, Ife North, Ila, Ilesha West, Ife South, and Ife East in Osun State; and Akure North, Ile Oluji/Okeigbo, Idanre, Akure South, Ilaje, and Ondo West in Ondo State. From each LGA, five villages or towns engaged in organic farming practices were randomly selected. Finally, from each village or town, five organic cocoa farmers were randomly selected from the farmer records provided by SARO Agro-Allied Nigeria.

The study collected primary data from the selected organic cocoa farmers using a well-structured questionnaire. The questionnaire was pretested before the field survey to ensure its validity and reliability. The data were analysed using the double hurdle model, which is a statistical model that consists of two stages: the first stage determines whether or not a farmer adopts organic farming; and the second stage determines how much organic farming a farmer uses if they adopt it. The model also allows for the possibility that these two decisions are correlated by some factors. The study used this model to examine how various socio-economic and institutional factors affect both the adoption decision and the intensity of use of organic farming among cocoa farmers.

2.3. Theoretical Framework

2.3.1. Technology Adoption Index

This study used two methods to measure the adoption and intensity of organic farming practices among cocoa farmers. The first method was the adoption index, which calculated the proportion of organic farming practices used by each farmer out of the total recommended package of practices. The organic farming practices included: use of organic cocoa seeds, application of manure, compost, mulching, farm sanitation, regular weeding, application of organic fertilizer, application of natural pesticides, reduction of shade, removal of epiphytes and chupons, nitrogen fixing crops and breeding of resistant varieties. The adoption index ranged from 0 to 1, with 1 indicating the full use of all the recommended practices. The adoption index was computed using the following formula as adopted from:

$$AIi=\Sigma\{(ATi/RTi)\} \quad (1)$$

Where;

AIi is adoption index of ith farmer,

ATi is the number of practices used by i^{th} farmer,

RTi is the total number of recommended technology farmer ought to apply.

2.3.2. The Double Hurdle Model

The double hurdle model, which is a parametric generalization of the Tobit model that consists of two stages: the first stage determines whether or not a farmer adopts organic farming; and the second stage determines how much organic farming a farmer uses if they adopt it. The double hurdle model allows for the possibility that some factors may affect both stages in the same or opposite directions [16]. The first stage used a probit regression model to determine the probability that a farmer adopts organic farming technology [37]. The second stage used a Tobit regression model to determine the intensity of use of organic farming technology among the adopters. The factors that were hypothesized to influence both stages were: age of farmers, years of education, household size, years of organic cocoa farming experience, labour use, quantity of organic fertilizer used and contact with extension services by farmer. The models were specified as follows:

$$\text{Index equation } I^* = X_1 i\beta_1 + U_i,\ U_i \sim N(0,1) \quad (2)$$

Threshold Index Equation

$$y = 0 \text{ if } I < I^* \quad (3)$$

$$y = I \text{ if } I \geq I^* \quad (4)$$

I* is the latent discrete adoption choice variable that denotes binary censoring,

X_1i is vector of explanatory variables hypothesized to influence adoption choice and

B_1 is vector of parameters.

Ui is the standard error term and

I is the observed quantity of organic farming practice representing the respondent's participation decision (i.e. 1 means the respondent index is greater than grand mean, and 0 means otherwise).

$$Y_i=\beta_0+\beta_1 age+\beta_2 edu+\beta_3 housiz+\beta_4 yearsofexp+\beta_5 Labused+\beta_6 extvisit+\beta_7 qtyof\ orgfert+\beta_8 farmsize+Ui \quad (5)$$

Where, Y_i is the adoption index of cocoa farmer X_1 =age of farmers (years), X_2 =education as number of years spent in school (years), X_3 = household size (number of members) X_4 =years of organic cocoa experience (years), X_5 = labour used (mandays), X_6 = contact with extension agent per cropping season (number of visits) X_7 = quantity of organic fertilizer (kg/ha) X_8 = farm size (ha).

The second hurdle involved an outcome equation, which uses a truncated model to determine the extent of optimum intensity use of the organic farming technology. This stage uses observations only from organic cocoa farmers to determine the intensity of use. The truncated regression model, closely resembles Tobit's model. The double hurdle contains two equations written as:

$$D_i=Z_i\alpha+u_i \quad (6)$$

$$Y^*=X_i\beta+v_i \quad (7)$$

The log-likelihood function for the D-H model is given as:

$$LnL_{dh}= \sum In[\phi(Z_i{}'\beta\frac{1}{\sigma}\emptyset(\frac{y_i-x_i\beta}{\sigma}) + \sum In[1-\phi[x_i\alpha]\phi[\frac{Z_i\beta}{\sigma}]] \quad (8)$$

$$LR=-2[LogL_T-(LogL_p+ LogL_{TR})] \sim X^2_k \quad (9)$$

Where $LogL_T$= log-likelihood for the Tobit model, $LogL_p$= log- likelihood for the Probit model, $LogL_{TR}$= log-likelihood ratio for the Tobit model and k is the number of independent variables in the equations [16]. The tobit model will be used for the second model.

$$I= b_o + b_1X_1 + b_2X_2 + b_3X_3 + \ldots.. + b_nX_n = f(X_i) \quad (10)$$

and

$$y= g(I) \quad (11)$$

Specifically:

$$y = b_iX_i + e_i \quad (12)$$

$$y_1=x_1\alpha+\varepsilon_i \text{ (adoption equation)} \quad (13)$$

Where

y= level of technology adoption,

I=adoption index

I*=mean of adoption index

b_i= parameters of I,

e_i= random error term,

X_i = socioeconomic variables i (i= 1, 2, 3… n) (as indicated on 5)

In order to allow for ease of comparison Z_is = X_is and Xis are as defined for the Tobit model above. This is to allow for comparison of the Probit model and the Tobit model with the two-step process involving the double-hurdle models and to compare the significance of the variables in the first and the second hurdle of the double-hurdle models.

3. Result and Discussion

3.1. Socioeconomic Characteristics of Organic Cocoa Farmers

Table 1 summarizes the demographic characteristics of the farmers in the study area who were sampled.

Gender: The results show that men dominate organic cocoa production in the study area, as they constitute 81.67% of the farmers. This suggests that men are more actively involved in organic cocoa production than women, which could be attributed to cultural norms that allow men to own more land than women. This validates the findings of Olowa and Olowa, who discovered that men were more engaged in cocoa production [28, 31].

Marital Status: The results show that most of the cocoa farmers in the study area (85.7%) were married. This could mean that more family members could work on the farm, lowering labor costs. Djokoto et al., discovered that married farmers are more likely to have family members available for organic cocoa production than single farmers [12, 26, 33].

Age: The results show that the average age of cocoa farmers in the study area was approximately 52 years, implying that the average farmer in the study area is older. This may be as a result of recent migration, in which young people migrate to cities in search of greener pastures, leaving the elderly behind in rural areas.

The following points highlight some of the challenges and opportunities faced by the farmers, such as lack of access to credit, frequency of extension visits, and market premium for organic cocoa.

Access to credit: The results show that a large proportion of organic cocoa farmers (58.7%) do not have access to credit. Access to credit facilities is critical in organic cocoa technology because it facilitates the purchase of production inputs; therefore, insufficient access to credit may prevent farmers from adopting new technologies [24].

Frequency of extension Visits: The result shows that extension agents visited cocoa farmers two times per month on average. Extension agents visiting farmers could help them learn more about a new technology [18, 23]. Odukoya, also confirmed that frequent contact between cocoa farmers and extension agents improves production because of the information accessed and training program organized [25].

Market premium: One of the benefits of organic farming for cocoa farmers is that it can result in a 10-30% increase in market premium [25]. This can motivate farmers to adopt organic farming practices and increase their income and profitability.

Table 1. *Distribution of Socioeconomic Characteristics of Organic Cocoa Farmers.*

Variables	Frequency	Percentage	Maximum	Minimum	Mean	Standard deviation
Gender						
Female	55	18.33				
Male	245	245				
Marital Status						
Single	14	4.67				
Married	257	85.67				
Widowed	27	9.00				
Divorced	2	0.67				
Age						
≤30	18	6				
31-40	63	21.00				
41-50	79	26.33	20.00	85.00	51.61	14.39
51-60	68	22.67				
61-70	46	15.33				
Above 70	26	8.67				

Variables	Frequency	Percentage	Maximum	Minimum	Mean	Standard deviation
Household Size						
1-3	71	23.67				
4-6	126	42.00				
7-9	68	22.67	1.00	15.00	5.64	2.89
10-12	28	9.33				
13-15	7	2.33				
Years of Formal Education						
0	71	23.67				
1-6	98	32.67	0.00	24.00	7.30	5.24
7-12	102	34.00				
Above 12	29	9.66				
Years of farming experience						
≤2	49	16.33				
3-4	95	31.67				
5-6	85	28.33	2.00	54.00	25.14	13.75
7-8	34	11.33				
9-11	28	9.33				
Above 11	9	3.00				
Access to on farm organic demonstration						
NO	127	42.33				
YES	173	52.67				
Access to credit						
NO	124	41.33				
YES	176	58.67				
Frequency of extension Visits						
0	41.1	13.7				
1.0 -3.0	89.1	29.7				
4.0 – 6.0	41.1	13.7	0.00	13.00	2.15	0.63
7.0 – 9.0	18.0	6.0				
10.0 – 12.0	72.9	24.3				
Above 12.0	37.8	12.6				

Source: Field survey, 2021

3.2. Factors Influencing Decision to Adopt Organic Cocoa Technology

This study used the double-hurdle model to identify the factors that influence the adoption and intensity of organic cocoa production among 300 farmers in Southwest Nigeria. The double-hurdle model consists of two stages: the first stage determines whether or not a farmer adopts organic farming; and the second stage determines how much organic farming a farmer uses if they adopt it. The model also allows for the possibility that some factors may affect both stages in the same or opposite directions. The table below shows the parameter estimates of the first stage (probit regression) and the second stage (tobit regression) models.

Table 2. *Estimates of double hurdle on organic cocoa adoption and intensity of organic cocoa technology.*

Variables	Probit		Tobit	
	Coefficients	**Marginal eff.**	**Coefficients**	**Marginal eff.**
Age	0.0028 (0.0102)	0.0007 (0.0009)	0.0008 (0.0011)	0.0006 (0.0009)
Education	0.0319 (0.0186)	0.3430 (0.2982)	-0.0029 (0.0024)	-0.0022 (0.0018)
House size	0.00742 (0.0371)	0.0007 (0.0035)	-0.0048 (0.0044)	-0.0036 (0.0033)
Labour (Mandays)	0.0036*** (0.0011)	2.27e-04*** (6.89e-05)	1.74e-04*** (5.31e-05)	1.31e-04*** (3.65e-05)
Farm size	-0.1572** (0.0649)	-0.0109** (0.0045)	-0.0067 (0.0039)	-0.0051 (0.0028)
Farming Experience	-0.0014** (0.0099)	-0.0019** (0.0010)	-0.0029** (0.0013)	-0.0022** (0.0009)
Credit Accessibility	0.7495*** (0.1894)	0.0744*** (0.0188)	0.0967*** (0.0261)	0.0724*** (0.0177)
Extension Visits	0.0557*** (0.0182)	0.0049*** (0.0016)	0.0046** (0.0022)	0.0035** (0.0015)
Constant	0.5163 (0.4929)		0.1406** (0.0681)	
Number of observations	300			
Log likelihood	25.0018			
Chi-square	74.32			
p-value	0.000			

Source: Data Analysis, 2020

The results show that the log likelihood (25.00) and chi-square (74.32) were significant at 1%, indicating the statistical significance of the fitted regression models. The results also show that the decision to adopt and the intensity of adoption of organic cocoa production were influenced by different factors and at different levels of significance.

In the first stage, the dependent variable was the decision to adopt organic cocoa production, while the explanatory variables were age, education, household size, labour, farm size, farming experience, credit accessibility, and extension visits. Out of these eight variables, five were statistically significant at acceptable levels.

Labour: The results show that labour had a positive and significant effect on the decision to adopt organic cocoa production at 1% level. This means that farmers who used more man-days of labour were more likely to adopt organic farming practices than farmers who used less labour. This could be because most farmers depend on hired labour for farm activities, especially for weeding and harvesting [14, 32]. Therefore, farmers who could afford to hire labour would tend to maximize their returns on investment in organic cocoa production and adopt improved technologies.

Farm Size: The results show that farm size had a negative and significant effect on the decision to adopt organic cocoa production at 5% level. This means that farmers with larger farm sizes were less likely to adopt organic farming practices than farmers with smaller farm sizes. This could be because farmers with larger farm sizes are less willing to bear the risk of trying new technologies or changing their existing practices [7, 21, 35].

Farming Experience: The results show that farming experience had a negative and significant effect on the decision to adopt organic cocoa production at 5% level. This means that farmers with more years of experience in cocoa production were less likely to adopt organic farming practices than farmers with fewer years of experience. This could be because farmers who are used to old technologies are more resistant to change or innovation [10].

Credit Accessibility: The results show that credit accessibility had a positive and significant effect on the decision to adopt organic cocoa production at 1% level. This means that farmers who had access to credit were more likely to adopt organic farming practices than farmers who did not have access to credit. This could be because credit enables farmers to purchase production inputs such as improved seeds, organic fertilizers, and natural pesticides [6, 8].

Extension Visits: The results show that extension visits had a positive and significant effect on the decision to adopt organic cocoa production at 10% level. This means that farmers who were visited by extension agents more frequently were more likely to adopt organic farming practices than farmers who were visited less frequently. This could be because extension agents provide information and training on new technologies and best practices [18, 25].

This study used the second stage of the double-hurdle model to identify the factors that influence the intensity of organic cocoa production among the farmers who adopted it. The intensity of organic cocoa production was measured by the adoption index, which ranged from 0 to 1, with 1 indicating the full use of all the recommended organic farming practices. The explanatory variables were age, education, household size, labour, farm size, farming experience, credit accessibility, and extension visits. Out of these eight variables, four were statistically significant at acceptable levels.

Labour: The results show that labour had a negative and significant effect on the intensity of organic cocoa production at 1% level. This means that farmers who used more man-days of labour also used fewer organic farming practices than farmers who used less labour. This could be because of the high cost of labour incurred in organic cocoa production, as labour demand is higher than labour supply in the rural areas where most of the cocoa production takes place [2, 11].

Farming Experience: The results show that farming experience had a negative and significant effect on the intensity of organic cocoa production at 5% level. This means that farmers with more years of experience in cocoa production also used fewer organic farming practices than farmers with fewer years of experience. This could be because of the lack of production efficiency and the inability to maximize production output due to limited resources and other constraints [22].

Credit Accessibility: The results show that credit accessibility had a positive and significant effect on the intensity of organic cocoa production at 1% level. This means that farmers who had access to credit also used more organic farming practices than farmers who did not have access to credit. This could be because credit enables farmers to purchase production inputs such as improved seeds, organic fertilizers, and natural pesticides [29, 34].

Extension Visits: The results show that extension visits had a positive and significant effect on the intensity of organic cocoa production at 5% level. This means that farmers who were visited by extension agents more frequently also used more organic farming practices than farmers who were visited less frequently. Isaac et al. and Odukoya, supported that extension agents provide information and training on new technologies and best practices [18, 25].

4. Conclusion

This study aimed to investigate the adoption and intensity of organic farming practices among cocoa farmers in Southwest Nigeria. The study used descriptive statistics and the double-hurdle model to analyze the primary data collected from 300 organic cocoa growers in the study area. The descriptive statistics, such as percentages, mean and frequencies, were used to summarize the socio-economic characteristics of the farmers, such as gender, age, education, household size, farm size, farming experience, credit accessibility, and extension visits. The double-hurdle model, which consists of two stages, was used to identify the factors that influence the decision and intensity of organic farming adoption among the farmers. The first stage determines whether or not a farmer adopts organic farming, and the second stage determines how much organic farming a farmer uses if they adopt it. The model also allows for the possibility that some factors may affect both stages in the same or opposite directions.

The results of the descriptive statistics showed that the majority of the farmers were male, married, literate, and had access to on farm organic demonstration. The results of the double-hurdle model showed that five factors had a significant effect on the decision to adopt organic farming practices: labour (man-days), farm size, farming experience, credit accessibility, and extension visits. The results also showed that four factors had a significant effect on the intensity of adoption of organic farming practices: labour (man-days), farming experience, credit accessibility, and extension visits.

Abbreviations

ICCO	International Cocoa Organization

Author Contributions

Lydia Olufunmilola Ogunya is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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