

DETERMINANTS OF THE INTENSITY OF ADOPTION OF COCOA REHABILITATION TECHNIQUES AMONG FARMERS IN NIGERIA

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Abstract. This study examines the determinants of the intensity of cocoa rehabilitation techniques adoption (CRTs) in Ondo State, Nigeria. Cross-sectional data were obtained from 150 cocoa farmers selected through a multistage sampling procedure and analyzed using descriptive statistics and ordered logit regression. The results reveal that most farmers operated at a moderate level of CRT adoption, with an average age of 51 years, household size of 10, and mean cocoa tree age of 19 years. The ordered logit results indicated that tertiary education, the interaction between education and farming experience, widespread adoption index, yield percentage, and farmers' age significantly increased the likelihood of higher adoption intensity. In contrast, the area covered by rehabilitation and farm size exerted significant negative influences, suggesting that scale-related constraints hinder intensive adoption. The findings highlight the central role of human capital, social diffusion, and productivity incentives in promoting rehabilitation efforts. The study recommends strengthening farmer education and extension training, fostering peer-to-peer learning platforms, and providing targeted support for farmers managing large rehabilitation areas. Enhancing community awareness and integrating yield improvement programs with rehabilitation initiatives are also essential for accelerating sustainable cocoa recovery in the region.

Keywords: cocoa rehabilitation, adoption intensity, ordered logit, diffusion, Nigeria

INTRODUCTION

The cocoa tree (*Theobroma cacao* L.) is an important economic crop and grows in some parts of the world, including the West African countries. African countries produce 75% of world's cocoa, with Cote d'Ivoire and Ghana leading the production table (FAO, 2023). Globally, Nigeria was once the leading cocoa producer, but has recently fallen to fourth position (Etaware, 2022; Oginni et al., 2024). The cocoa sector has contributed tremendously to foreign exchange earnings and employment through its value chain across the globe (Nwankwo et al., 2024). However, the sector has also been overwhelmed by several challenges in recent times, linked to aging and pest-related issues (Bryant and Mitchell, 2021; Eberhard et al., 2022; Esan et al., 2025; Kongor et al., 2024). These challenges have become a major threat to the livelihoods of millions of smallholder farmers who rely on cocoa farming, with many farmers in rural areas depending on cocoa production for their livelihood (Waarts et al., 2019). Cocoa output is declining particularly in the cocoa-producing states in Nigeria, which is due to inadequate farm management relating to lack of farm maintenance and environmental challenges.

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Cocoa is cultivated in eighteen (18) major states in Nigeria, including Ondo State (NBS, 2013). Most farms in the area were established in the early 1960s, which has now resulted in tree aging. For instance, some cocoa farms in the peri-urban areas of Ondo State had been sold off for residential purposes due to the poor productiveness of their trees. To discourage deforestation and abandonment of cocoa farms by farmers, the Cocoa Rehabilitation Techniques (CRTs) initiative was offered as a means of boosting cocoa output with a view to increasing cocoa farmers' income and subsequently their welfare.

Several studies have been carried out on the adoption of cocoa rehabilitation techniques (Adebiyi et al., 2021; Adeogun et al., 2010; Akinagbe, 2020; Akinpelu et al., 2021; Lawal et al., 2019; Okeniyi et al., 2021; Taiwo et al., 2015). Despite these efforts, cocoa production and productivity is marked by low output amidst rising demand for confectionary products. Cocoa beans are the raw material for producing chocolate and beverages, and also for pharmaceutical firms. The gap in supply and demand for this essential crop are driving the need for further studies on adopting cocoa rehabilitation.

Due to its economic significance, Nigerian governments have implemented a number of policies and initiatives to boost cocoa output. The Cocoa Research Institute of Nigeria (CRIN) was created with a mandate to generate technologies and disseminate information about research breakthrough on cocoa seedlings. Farmers' use of traditional methods of maintaining cocoa farms in Ondo State in particular and Nigeria as a whole continues to undermine the state's potential, despite the introduction of numerous initiatives to support the rehabilitation of cocoa farms.

Based on this knowledge, it is pertinent to identify the elements that promote or hinder the intensity of adoption of CRTs in order to create appropriate interventions. Cocoa production will continue to fall if efficient rehabilitation methods are not widely adopted.

To identify the major barriers militating against adopting CRTs in the study area, it is indispensable to understand the factors that influence CRT adoption and its implementation. This study was therefore carried out to evaluate factors determining the intensity of adopting CRTs, with a view to providing guidance on how to modify support initiatives and policies that will increase their production.

The outcome of this study will provide policymakers, government and non-governmental organization with evidence-based suggestions to promote, plan and implement cocoa rehabilitation initiatives. The expected results will also help extension agents to better understand the factors affecting the level of adoption of CRT, thus guaranteeing sustainable cocoa output and incomes in the sector.

THEORETICAL AND CONCEPTUAL FRAMEWORK

Factors influencing the diffusion of innovations

In his diffusion theory framework, Rogers (1983) identified five characteristics of farmers that could affect adoption. Firstly, relative advantage, which defines the degree to which an innovation is regarded as better than the idea or object it is intended to replace. The acceptance of an innovation thus stands in relation to economic gains, social prestige factors, satisfaction and the convenience associated with it. Secondly, compatibility of the technology intended for adoption. This compatibility is related to the degree of consistency of the package with the farmer's value, management objectives, the level of technology and the stage of farm development. According to CIMMYT (1993), farm size, availability of equipment and machinery are among the factors that determine an innovation's compatibility. Other variables that could affect this compatibility may be related to ethnic, religious and community factors.

Thirdly, Rogers suggests that complexity of a technology could affect its adoption. In the context of CRTs, the farmers' knowledge is highly significant in the adoption process. Rogers explains that some innovations are readily understood by most members of a social system, while others are more complicated and will be adopted more slowly. Education may make a farmer more able to deal with technical recommendations that require some level of literacy.

The fourth characteristic, according to Rogers, is the trialability of a technology. A pilot project of an innovation on a farmers' plot is sufficient for farmers to avoid unforeseen risks while assessing the viability of an innovation. This is done before adopting it on a large scale. Farmers invariably wish to be sure of the applicability of the technology they are being persuaded to adopt.

The fifth and final characteristic is observability, which is the degree to which the results of an innovation are evident to farmers. Farmers are more inclined to adopt an innovation after seeing its results than when results are not easily visible.

Empirical review

Rehabilitation in cocoa production refers to the process of restoring deteriorating farms and replanting aged cocoa trees with improved seedlings in order to enhance its productivity without necessarily expanding cultivated land (Gockowski and Sonwa, 2011; Nnadi et al., 2018; ICCO, 2012). Among these, farmers often prefer the former, due to its lower cost and faster returns. Techniques promoted by the Cocoa Research Institute of Nigeria (CRIN) include coppicing, side and top grafting, phased replanting, complete replanting, fertilizer application, and the use of shade trees (Okeniyi et al., 2021). These techniques aim to improve productivity and profitability, especially as cocoa trees tend to yield optimally between the ages of 15 and 25 but decline significantly after the 26th year (Opeke, 2015).

Recent empirical studies continue to highlight the low level of adoption of cocoa rehabilitation techniques (CRTs) among Nigerian farmers, largely due to various socioeconomic, institutional, and farm-specific constraints. Ilesanmi and Afolabi (2020) found that adoption of improved cocoa technologies in Ekiti State was significantly influenced by education, extension contact, and access to information. Similarly, Adebayo et al. (2022) reported that extension services, cooperative membership, and access to credit were critical regarding farmers' decisions to adopt improved cocoa technologies in Ondo State.

Other factors, such as institutional support, also play a significant role. Kehinde (2021) observed that farmers who were members of agricultural cooperatives had significantly higher adoption rates of improved practices due to increased access to resources and information. This study corroborated the findings of Kehinde and Ogundeji (2022), which emphasized that cocoa productivity increased substantially when farmers had simultaneous access to both credit and cooperative services.

Okeniyi et al. (2021) evaluated cocoa rehabilitation approaches training and the extent to which CRT facilitated by CRIN was accepted among farmers in Southwest Nigeria. The study found that farmers in the area adopted the method of planting under the old tree compared to

coppicing and side-grafting. Similarly, Lawal et al. (2019) investigated the determinants of adoption of cocoa rehabilitation techniques among cocoa farmers in Boki LGA of Cross River State. They found that age, education level and experience were significant drivers of CRT adoption in that state. However, they also acknowledged that the use of older methods and lack of awareness continued to pose barriers to newer CRT uptake.

Amerino et al. (2024) assessed the factors influencing adoption of cocoa agroforestry in Ghana using an ordered probit regression. The study found that adoption of cocoa agroforestry was significantly impacted by farmers' characteristics, farm-specific attributes and institutional factors. In contrast, the study conducted by Kouassi et al. (2023) in Cote d'Ivoire investigated the drivers of cocoa agroforestry adoption by smallholders. Their results showed that the adoption of cocoa agroforestry was impacted by gender, length of residency, the number of cash crops cultivated, and the incidence of pests.

In Nigeria, Ayodele and Afuye (2025) showed that the methods of planting under trees and complete replacement were most embraced by cocoa farmers. Many studies also found that farm income encourages farmers to embrace CRTs. For example, research by Adebayo et al. (2022) and Boateng et al. (2023) associate higher income with increased adoption.

Regarding cocoa rehabilitation techniques, Onemolese et al. (2025) examined the intensity and inequalities associated with the adoption of cocoa technologies among farmers in Ondo and Ekiti States, Nigeria. This study gathered data from 391 cocoa farmers, using multiple regression and Gini coefficient for its analysis. The key drivers of adoption intensity identified were extension agents, awareness of technologies, age, and farming experience.

Despite the potential of CRTs to improve productivity and sustainability, the intensity of adoption across regions remains unclear, thereby necessitating further research to determine factors affecting the intensity of cocoa rehabilitation techniques adopted by cocoa farmers in Ondo State.

METHODS

Study area

The study was conducted in the Ondo West Local Government Area of Ondo State, an area with

a predominance of cocoa producers. It is located in the Ondo central senatorial district of the State, with a headquarters in Ondo town. The LGA is highly populated with a projected population estimated at 443,000 from 2006 (NPC, 2022). It covers an area of approximately 970 km², at Latitude 7°45' N and Longitude 4°50' E.

The study area is located in the tropical rainforest zone of Ondo State, with two distinct seasons-wet and dry seasons, which usually occur between April–October, and November–March, respectively. There is usually a low rainfall in August, known as ‘August Break’. The LGA also experiences a moderate temperature that ranges between 21–29°C with an annual rainfall, varying between 1,150 mm in the north and 2,000 mm in the south of the State. The LGA enjoys an average annual humidity of 51%.

Ondo West LGA is the hub of cocoa production with many cocoa processing factories located in Ondo town. It has contributed significantly to the livelihood of the rural people, with many engaged in cocoa farming. Some other crops cultivated in the state include cassava, rubber, Kola nut, tomatoes, etc., coupled with livestock husbandry. Ondo West LGA shares borders with Ondo East Local Government Area to the east, Ile-oluji/Okeigbo Local Government Area to the north-west, and Odigbo Local Government Area to the south.

Sampling procedure and sample size

The study was carried out among cocoa farmers in Ondo West LGA. The respondents were selected from the study area using a multistage random sampling procedure. The first stage involved a purposive selection of five (5) cocoa-producing communities, out of 17 communities. In the second stage, three (3) villages in the area with a high predominance of cocoa production were randomly chosen from each community to obtain fifteen (15) villages. The final stage involved a simple random selection of ten (10) farmers from each village, yielding a total sample size of one hundred and fifty (150) farmers selected from the study area.

Description, hypothesis and measurement of variables

Dependent variable

The dependent variable in this study is measured as the level of adoption of CRTs by farmers. The farmers were asked to choose rehabilitation techniques they utilized out of nine possible ones. The adoption level was

derived from the number of rehabilitation techniques adopted relative to the total number available in the study area.

A weighted adoption index (A_i) was first computed for each respondent as:

$$A_i = \frac{\text{Number of CRTs adopted by farmer } i}{\text{Total number of CRTs recommended}} \times 100 \quad (1)$$

The computed adoption index ranges from 0 to 100 percent and was subsequently categorized into three ordered levels, where a value less than 50% was classified as low adoption, 50–74% as moderate adoption, while values between 75% and above were classified as high adoption. Thus, the dependent variable used in this study is an ordinal variable taking the ordered values 1, 2, and 3, representing low, moderate and high, respectively.

The independent variables used in the study were measured as follows:

Age. The age of the farmer was measured as a continuous variable. The expected age of the farmer is indeterminate, the reason being that younger farmers are always more receptive to adopting innovation than older ones. Older farmers are known to be risk-averse and reluctant to accept long-term investments or innovation. Hence, the sign could be either positive or negative.

Gender. In the study, we measured gender at the nominal level and scored as male = 1, female = 0. A positive sign for this variable would indicate male household heads are more likely to accept innovation than female household heads. Male farmers have more resources than female.

Marital status. This was measured at nominal level as single = 1, married = 2, divorced = 3, widow = 4. The *a priori* expectation is indeterminate. If resources are diverted for household needs, adoption of CRTs will be affected negatively, otherwise it may be positive.

Years of schooling. This variable was treated as a categorical variable, with a positive *a priori* expectation. Many studies have shown that education promotes the probability of adoption.

Household size. This study measured household size as the number of family members living under the same roof. It is a continuous variable. In this study, it is expected to be positively related to the probability of adopting CRTs.

Farm size (hectare). Farm size is a continuous variable measured in hectares. It is expected to be positive. As farm size increases, the probability of adopting of CRTs by farmers is also expected to grows.

Years of experience in cocoa farming. It is a continuous variable measured as years of farming experience. Experience in farm management and agronomic practices for years are expected to have a positive effect on adoption.

Age of cocoa farm. This is a continuous variable measured as the number of years the farm has been in existence. We hypothesized a positive significant relationship between cocoa age and the adoption of CRTs. This is because we observe that as the trees age, farmers' attention is also drawn to the need to maintain their farms for optimal productivity.

Depth of adoption. The depth of adoption was measured on a 5-point Likert scale. The respondents were asked to indicate the depth of adoption of rehabilitation techniques The variable was assessed as follows: Not integrated = 1, Slightly integrated = 2, Moderately integrated = 3, Mostly integrated = 4, and Fully integrated = 5.

What proportion of your total farm area is covered by the rehabilitation techniques you have adopted? Less than 25% = 1; 25–50% = 2; 51–75% = 3; more than 75% = 4.

The percentage increase in cocoa yield due to the adoption of rehabilitation techniques was measured:

Less than 10% = 1; 10–20% = 2; 21–30% = 3; 31–40% = 4; more than 40% = 5.

The percentage increase in farm income due to the adoption of rehabilitation techniques was measured as: Less than 10% = 1; 10–20% = 2; 21–30% = 3; 31–40% = 4; more than 40% = 5.

The widespread adoption index of CRTs was measured as: Not widespread = 1, Somewhat widespread = 2, Moderately widespread = 3, and Very widespread = 4.

Model specification

The study uses the Random Utility Model (RUM), which assumes that a farmer's decision to adopt a given level of cocoa rehabilitation techniques (CRTs) is based on the utility or satisfaction derived from such adoption. Each individual farmer is assumed to face a set of adoption choices (low, moderate and high) and selects the level that provides the highest utility.

Mathematically, the utility U^* associated with adoption level can be expressed as:

$$U_i^* = \beta_i'X_i + \varepsilon_i \quad (2)$$

where,

U^* – is the unobserved or latent utility derived from adopting CRTs

X_i – is a vector of farmer and farm characteristics (e.g. age, gender, years of schooling, farm size, household size, years of farming experience, age of cocoa trees, yield percentage, income, yield, etc.)

β_i – is a vector of parameters to be estimated

ε_i – is an error term assumed to follow a standard logistic distribution with a mean of zero.

A farmer chooses a particular adoption level if the utility from that level is greater than that from any other level, i.e. $U_j^* > U_k^*$ for all $k \neq j$. Since the true utility cannot be observed, the observed outcome is the adoption level Y_i , which takes ordered values depending on the range of the latent utility.

$$Y_i = \begin{cases} 1 & \text{if } U_i^* \leq \mu_1 \text{ (Low adoption)} \\ 2 & \text{if } \mu_1 < U_i^* \leq \mu_2 \text{ (Moderate adoption)} \\ 3 & \text{if } U_i^* > \mu_2 \text{ (High adoption)} \end{cases} \quad (3)$$

where: μ_1 and μ_2 are the threshold (cut-off) parameters that separate the adoption levels.

Since ε_i is logistic, the cumulative distribution function (CDF) used is te logistic CDF:

$$\Lambda(Z) = \frac{1}{1 + e^{-Z}} \quad (4)$$

Hence, the categorical probabilities are written as:

$$P(R_i = 1 | X_i) = Pr(U_i^* \leq \mu_1 | X_i) = \Lambda(\mu_1 - X_i\beta) \quad (5)$$

$$P(R_i = 2 | X_i) = Pr(\mu_1 < U_i^* \leq \mu_2 | X_i) = \Lambda(\mu_2 - X_i\beta) - \Lambda(\mu_1 - X_i\beta) \quad (6)$$

$$P(R_i = 3 | X_i) = 1 - \Lambda(\mu_2 - X_i\beta) \quad (7)$$

The estimation is based on maximum likelihood method. The log-likelihood is constructed from the above category probabilities and maximized to obtain estimates of β and the thresholds μ_1 and μ_2 .

RESULTS AND DISCUSSION

Socioeconomic characteristics of cocoa farmers

As shown in Table 1, the study revealed that the average age of cocoa farmers was 51 years, with the majority (52%) falling between 41–55 years. This suggests an aging farming population may exert a negative impact on the adoption of cocoa rehabilitation techniques. About 73.3% of the farmers were male, indicating that male farmers dominated cocoa farming in the study area, 84% of the farmers were married, while the mean education is 4.91 with a standard deviation of 2.77. This shows the CRTs practices are predominantly in the hands of those who hold primary school leaving certificate. Education plays a vital role in the adoption of improved agricultural practices, as educated farmers are more likely to understand and implement technical recommendations. The average household size was 10, with larger households potentially providing farm labour but also imposing financial constraints. Farming experience averaged 21 years with an average farm size of 2.04 hectares, indicating cocoa farms in the study area are small-scale, which may limit investments in mechanization and rehabilitation. The mean age of cocoa trees was 19 years; however, the age of cocoa trees shows that cocoa plantations are still young in the study area. Probably, there are many young farmers who recently ventured into cocoa farming.

LEVEL OF ADOPTION OF COCOA REHABILITATION TECHNIQUES (CRTS)

Table 2 presents the level of integration of various CRTs by farmers, as based on a Likert scale. The majority (25.7%) of the farmers slightly integrated pruning, with a moderate integration (23.2%) on their farms. Lack of full implementation of this technique may be attributed to a deficit of information on the benefits of adopting pruning on cocoa farms. Fertilizer usage shows low levels of complete integration (2.8%), with most farmers moderately integrating it (21%).

Without a subsidy, the cost of fertilizers is expensive in Nigeria, thus farmers may lack the financial resources to bear the full cost. The result shows that pesticides are overwhelmingly adopted compared to other techniques, with the largest group (33.9%) moderately integrating it. Pest attacks on cocoa are rampant and if not averted in time, both significant yields and income will be

Table 1. Socioeconomic characteristics of cocoa farmers (150)

Variable	Frequency	Percentage	Mean ±Sd
Age			
≤40	9	12	51.05 ±7.69
41–55	39	52	
56+	27	36	
Gender			
Male	110	73.3	
Female	40	26.7	
Marital status			
Single	8	5.3	4.91 ±2.77
Married	126	84	
Widow	6	4	
Divorced	10	6.7	
Educational status			
No formal education	8	5.3	4.91 ±2.77
Primary education	126	84	
Secondary education	3	4.0	
Tertiary education	5	6.7	
Household size			
≤5	36	24	10.39 ±5.88
6–12	62	41.3	
13–19	42	28	
≥20	10	6.7	
Experience			
≤20	80	53.3	21.43±11.64
21–35	52	34.7	
36+	18	12	
Farm size			
≤0.5	18	12	2.04 ±1.42
0.6–2.9	102	68	
3.0–5.3	26	17.3	
5.4+	8	2.7	
Age of cocoa trees			
≤30	122	81.3	19.02 ±13.42
31–39	10	6.7	
40–48	14	9.3	
≥49	4	2.7	

Source: field survey, 2024.

Table 2. Level of adoption of Cocoa Rehabilitation Techniques (CRTs) (%)

Technique	Not integrated freq	Slightly integrated freq	Moderately integrated freq	Mostly integrated freq	Fully integrated freq
Pruning	14(9.4)	42(28.2)	37(24.4)	10(6.8)	12(8.3)
Fertilizer application	15(9.8)	21(13.9)	33(22.2)	11(7.5)	5(3.0)
Pesticide application	7(4.9)	16(10.9)	54(35.7)	28(18.4)	14(9.4)
Grafting	42(27.8)	5(3.0)	3(2.3)	0(0.0)	0(0.0)
Coppicing	32(21.4)	8(5.3)	13(8.7)	2(1.1)	1(0.4)
Phase replanting	8(5.6)	26(17.3)	39(26.3)	7(4.5)	2(1.1)
Complete planting	21(14.3)	8(5.6)	21(14.9)	6(3.8)	1(0.8)
Use of improved seedlings	2(1.1)	6(3.8)	39(25.9)	13(8.7)	24(16.2)
Shade tree management	11(7.5)	24(15.8)	20(13.2)	13(8.7)	2(1.1)

Source: field survey, 2024.

sacrificed. This reflects its perceived effectiveness in addressing pest challenges. Grafting has the lowest adoption: approximately 26.4% of the farmers are not integrating it at all. This response suggests that farmers either lack the necessary technical knowledge or are probably resource-challenged.

Similarly, we find coppicing poorly adopted, with 20.3% not integrating it; phase replanting has moderate adoption (25%), but fully integrated levels remain very low (1%). Similar results were observed by Adeogun et al. (2010), Akinagbe (2020) and Oluyole et al. (2015), who found relatively low rates of coppicing practices in their study areas. Complete planting adoption is low, with only 0.7% fully integrating this technique. The higher level of not integrating this technique (13.5%) is an indication that the farmers are facing some challenges relating to the availability of labour and finance. This agrees with the findings of Oluyole et al. (2015) and Akinagbe (2020), but contrary to Adebisi et al. (2021).

In terms of the use of appropriate tools, the highest percentage of adoption here is 24.6% of farmers, indicating moderate integration on their farms. It should also be noted that of all the techniques, this one is relatively better adopted, with 15.3% of farmers fully integrating it. Its higher adoption levels may stem from the availability or perceived simplicity of using appropriate tools.

Shading of cocoa trees (12.5%) is also reported to be moderately adopted. However, only 1% of the sample farmers fully integrated this technique. This might indicate a lack of understanding of the benefits or an

absence of extension services in the study area. The result is contrary to the findings of Oluyole et al. (2015) and Akinagbe (2020).

Determinants of the level of adoption of cocoa rehabilitation techniques

As shown in Table 3, the study estimated an ordered logit regression model to determine the factors influencing the level of adoption of cocoa rehabilitation techniques among farmers. The overall model is statistically significant, with LR χ^2 (13) = 34.68 (p = 0.0009), indicating that the explanatory variables jointly influence adoption intensity. The Pseudo R^2 value (0.1164) suggests a moderate explanatory power consistent with cross-sectional behavioral data, while the mean variance inflation factor (2.88) confirms the absence of multicollinearity.

Gender was found to have a negative but statistically insignificant coefficient (β = -0.1436, p = 0.726). The corresponding odds ratio (0.8662) implies that male farmers are 13% less likely to adopt cocoa rehabilitation techniques at higher intensities compared to female farmers. Although the effect is not significant, the marginal effects reveal that males are slightly more likely to remain in the low adoption category. This suggests that gender alone does not critically determine rehabilitation decisions, possibly because both men and women have relatively equal access to extension services and information in the study area.

In contrast, household size exhibits a positive and weakly significant effect (β = 0.1060, p = 0.098). The

Table 3. Results of the determinants of CRTs

Variable	Coeff	Odds ratio	P value	dy/dx (low)	dy/dx (moderate)	dy/dx (high)
Gender	−0.1436	0.8662	0.726	0.0205	0.0016	−0.0221
Household size	0.1060	1.1118	0.098	−0.0151	−0.0012	0.0163
Age (yr)	0.0469	1.0480	0.074	−0.0067	−0.0005	0.0072
cocoa tree age	−0.0143	0.9858	0.504	0.0020	0.0002	−0.0022
Edu_dummy2	−0.2321	0.7929	0.573	0.0332	0.0026	−0.0357
edu_dummy3	2.5646	0.0770	0.023	0.3664	0.0286	0.3950
education * experience	0.0950	1.0996	0.017	−0.0136	−0.0011	0.0146
farm size (ha)	−0.0657	0.9364	0.595	0.0094	0.0007	−0.0101
Farming experience	−0.0387	0.9620	0.195	0.0055	0.0004	−0.0060
Area covered	−0.6424	0.5260	0.001	0.0918	0.0072	−0.0989
Widespread adoption index	0.4861	0.6150	0.038	0.0694	0.0054	−0.0749
income	0.0000	1.0000	0.51	0.0000	0.0000	0.0000
yield percentage	0.0257	1.0260	0.028	0.0037	0.0003	0.0040
/cut1	−3.3525	0.9809				
/cut2	−0.3563	0.9671				
Model diagnostics						
No of obs.		150				
LR chi ² (13)		34.68				
Prob > chi ²		0.0009				
Pseudo R ²		0.1164				
Log likelihood		−131.557				
Variance inflation factor		2.88				

Source: field survey, 2024

odds ratio (1.1118) indicates that each additional household member increases the likelihood of higher adoption by about 11%. Larger households may have more available labor to undertake labor-intensive rehabilitation tasks such as pruning, replanting, and field sanitation. The marginal effect on the high adoption category (0.0163) further supports the notion that household labor availability enhances the adoption of cocoa rehabilitation techniques.

Similarly, the age of the farmer shows a positive association ($\beta = 0.0469$, $p = 0.074$), implying that older farmers are more likely to adopt rehabilitation techniques intensively. The odds ratio (1.048) suggests that a one-year increase in age increases the odds of higher

adoption by 4.8%. This finding may reflect the influence of experience and accumulated knowledge over time, as older farmers better appreciate the long-term productivity benefits of rehabilitating aging cocoa stands. However, the low effects indicate that this impact, though positive, remains modest. This finding corroborates the findings of Oluyole et al. (2015), and Akinnagbe (2020), who also estimated a positive relationship between age and adoption of cocoa technology practices.

Scrutinizing the results, we found that the role of education is mixed. Farmers with a low education level (Edu_dummy2) have a negative and insignificant coefficient ($\beta = -0.2321$, $p = 0.573$), indicating no significant

difference from farmers with little or no formal education. However, those with tertiary education (Edu_dummy3) show a strong positive and significant relationship ($\beta = 2.5646$, $p = 0.023$). The marginal effect (0.3950) for high adoption reveals that tertiary-educated farmers are substantially more likely to adopt cocoa rehabilitation techniques intensively. This highlights the crucial role of formal education in improving understanding and responsiveness to new agronomic practices.

In addition, the interaction between education and farming experience is positive and statistically significant ($\beta = 0.0950$, $p = 0.017$). The odds ratio (1.0996) indicates that education's positive influence on adoption is amplified when combined with practical farming experience. This synergy suggests that educated farmers who have accumulated experience over time can better interpret and apply rehabilitation recommendations, thus enhancing adoption intensity.

On the other hand, farm size shows a negative but insignificant effect ($\beta = -0.0657$, $p = 0.595$). The odds ratio (0.9364) indicates that larger farms are slightly less likely to adopt rehabilitation practices intensively. This may result from higher costs, labor shortages, or difficulties in managing rehabilitation over large areas. The negative marginal effect on the high adoption category (-0.0101) reinforces this interpretation, suggesting that smaller farms may be more flexible and responsive to rehabilitation innovations.

Similarly, farming experience shows a negative but statistically insignificant relationship ($\beta = -0.0387$, $p = 0.195$). Although experienced farmers might have accumulated practical skills, they may also be more conservative, relying on traditional practices instead of adopting new rehabilitation methods. Nonetheless, the earlier interaction with education suggests that experience becomes productive only when coupled with formal learning.

The area covered by CRTs adoption exerts a strong negative and statistically significant influence ($\beta = -0.6424$, $p = 0.001$). The odds ratio (0.5260) indicates that expanding the area covered by rehabilitation reduces the odds of high-intensity adoption by about 47%. The marginal effect (-0.0989) for high adoption confirms that larger coverage areas discourage intensive rehabilitation due to financial and labor constraints. Therefore, the scale of operation significantly affects the intensity of cocoa rehabilitation adoption.

The results also show that the widespread adoption index exerts a positive and statistically significant effect

($\beta = 0.4861$, $p = 0.038$). The marginal effect (0.0749) for high adoption suggests that farmers in communities where rehabilitation is widely practiced are more likely to intensify adoption. This emphasizes the importance of social influence, peer learning, and information sharing, consistent with the diffusion of innovation theory, where adoption by peers encourages wider uptake within social networks.

Finally, yield percentage has a positive and significant influence ($\beta = 0.0257$, $p = 0.028$). The odds ratio (1.0260) indicates that higher yields increase the odds of adopting rehabilitation techniques at higher intensities by about 2.6%. The marginal effects confirm that farmers achieving better yields are more motivated to reinvest in their farms through rehabilitation, reinforcing the productivity–adoption feedback mechanism. This finding is in agreement with the findings of Djuideu et al. (2021) and Adebayo et al. (2022), who found that yield improvements led to greater adoption rates.

CONCLUSION

This study examined the determinants of the adoption of cocoa rehabilitation techniques (CRTs) among cocoa farmers in Ondo State. The findings revealed that the majority (52%) of the respondents were aged between 41 and 55 years, with an average age of 51 years. Most cocoa farmers (73.3%) were male, indicating that cocoa production in the study area is largely dominated by men. Furthermore, 84% of the respondents were married, and their level of formal education was generally low. The average household size was 10 persons, while the mean farming experience stood at 21 years. The average farm size was 2.04 hectares, suggesting that cocoa farming in the area is primarily small-scale. In addition, the mean age of cocoa trees was 19 years, indicating that most trees were relatively young and below 30 years.

The regression results identified age of farmers, farm size, yield percentage, and the widespread adoption index as significant positive determinants of CRT adoption. Conversely, years of schooling, farming experience, household size, and income level were found to exert negative influences on CRT adoption. These findings underscore the importance of strengthening extension services, improving farmers' access to credit facilities, enhancing land reforms, and promoting educational initiatives that are tailored toward practical agricultural skills.

Given the low participation of women in cocoa farming, gender-sensitive interventions are recommended to encourage greater female involvement in cocoa rehabilitation programs. Overall, policies that enhance farmers' capacity, access to productive resources, and technical knowledge are essential to accelerating the adoption of cocoa rehabilitation techniques and improving the sustainability of cocoa production in Ondo State.

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