



## MEASUREMENT OF TECHNICAL EFFICIENCY DISPARITY OF COCOA PRODUCTION BY CERTIFICATION STATUS IN OGUN STATE, NIGERIA

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### ABSTRACT

The study Compared the technical efficiency disparity of cocoa Production by certification status among farmers in Ogun State, Nigeria. A multistage sampling technique was used in selecting 240 respondents from the study area. Data were collected through the administration of well-structured questionnaire and analysed using descriptive statistics, stochastic frontier analysis, and probit regression model. The results revealed that cocoa farming is dominated by middle-aged to older men (51years and 53years), with majority (87% and 77%) respondents married and having more than 40years of farming experience (about 21 years and 25years). Majority (38.3% and 28.3%) of Certified farmers attained primary education and tertiary education respectively while 25.0% and 21.7% of non-certified farmers had primary and tertiary education. Most (89.2%) of the certified farmers had contact with extension agents while majority (51.7%) of the non-certified farmers had no contact with extension agents and achieved greater productivity (643.50kg/ha) compared to non-certified farmers (496.02kg/ha), despite non-certified farmers having larger average farm sizes (3.32ha) and slightly higher incomes (₦821,524.16). Stochastic frontier estimates indicated higher mean technical efficiency among certified farmers (0.678) relative to non-certified farmers (0.623), underscoring the role of certification in enhancing resource use and productivity. Ordinary Least Square regression results showed that age (0.086;  $p < 0.01$ ), gender (0.314;  $p < 0.05$ ), household size (0.092;  $p < 0.10$ ), farming experience (0.021;  $p < 0.01$ ), extension contacts (1.512;  $p < 0.05$ ), and farm size (0.109;  $p < 0.10$ ) significantly influenced the certification status of cocoa farmers. The study concluded that certified cocoa farmers have higher technical efficiency compared to their non-certified counterparts in the study area. The study recommends strengthening extension services, expanding access to credit, and promoting farmer training on certification requirements to improve cocoa productivity and sustainability.

**Keyword:** Technical, Efficiency, Cocoa, Production, Certification, Farmers.

### INTRODUCTION

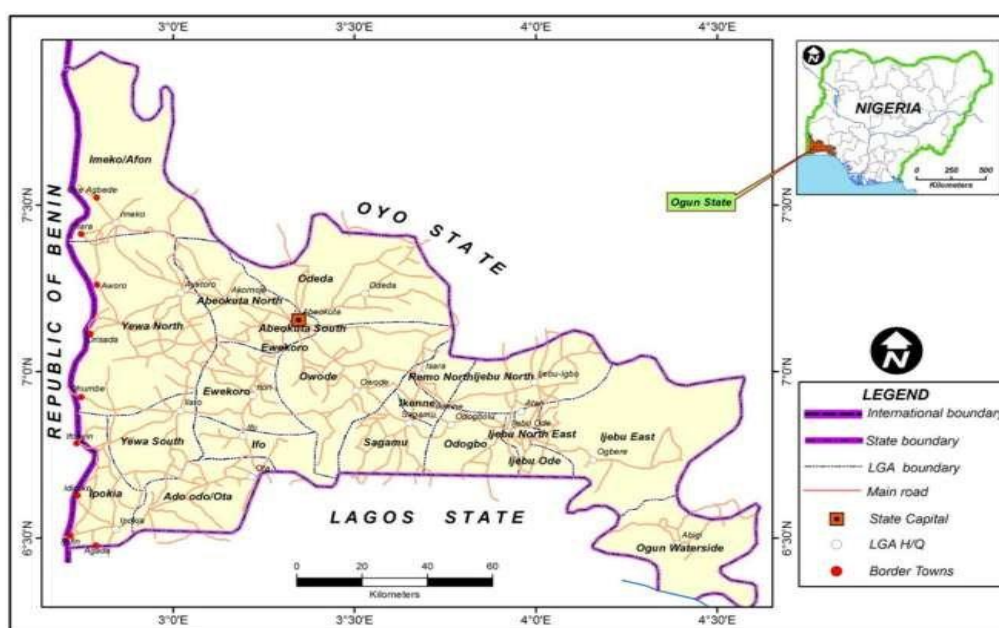
Since the early 1970s oil boom, Nigeria's agriculture economy has been performing poorly. Agriculture accounted for 63% of the Gross Domestic Product (GDP) when the nation gained independence in 1960. Following the oil boom, this percentage fell to 8% in 1988 (Aigbokhan, 2001 as reported in Muhammad et al., 2016). Agriculture's contribution of GDP grew to over 36% in 2001 and 42% in 2007 (United Nation Development Programme - UNDP, 2009) as a result of certain deliberate intervention and government initiatives in the early 2000s, but it decreased to 24.4% in 2017 (Price waterhouse Coopers, 2017). This demonstrates that the prior successes in utilizing agriculture to wean the nation's economy of its excessive reliance on oil have not been long-lasting. An analysis of Nigerian agriculture reveals a total disregard for the export crops, which have been a significant source of foreign cash for the nation. The International Cocoa Organization (2012) reports that nearly 90% of global cocoa production originates from smallholder farmers cultivating less than 5 hectares of land. In Nigeria, approximately 80% of cocoa production is managed by small-scale farmers operating on less than 5 hectares (Samuel, 2017). Cocoa production in Nigeria, particularly in Ogun State, has been declining over the years due to low productivity, aging farms, pest and disease infestations, and weak access to improved technologies (FAO, 2015; World Cocoa Foundation, 2019). Cocoa productivity in Ogun State remains low despite certification schemes aimed at improving farming efficiency. There is limited evidence on the **technical efficiency gap** between certified and

Previous studies have shown that certification can enhance farmers' access to training, inputs, and markets, thereby improving productivity (Olukayode et al, 2020). However, **most of these studies focused on production and income effects**, not on measuring or comparing technical efficiency levels. In addition, **the factors influencing efficiency between certified and non-certified cocoa farmers remain underexplored**, especially in Ogun State (Food and Agriculture Organization, 2020). This creates a **clear research gap**, the need to provide **empirical evidence on technical efficiency disparity** and its determinants, to guide more effective policy interventions in the cocoa sector.

- i. describe the socioeconomic characteristics of certified and non-certified cocoa producers in the study area;
- ii. assess the productivity status of certified and non-certified cocoa farmers; and
- iii. identify the determinants of choice of status among the farmers with respect to certification of the respondents in the study area.

## Study Area

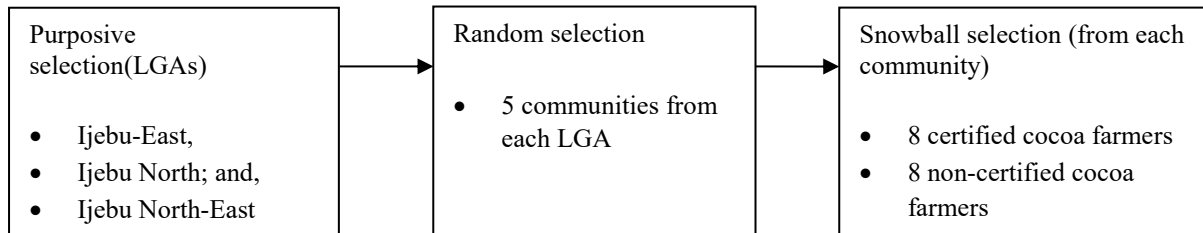
The research was conducted in Ogun State, Nigeria, situated in the south-western region between latitudes 6°N and 8°N and longitudes 3°E and 5°E. It shares its western border with the Republic of Benin and its eastern border with Ondo State. As per recent estimates by the National Population Commission, the population of Ogun State is approximately 4,050,000. Ogun State experiences a tropical humid climate characterized by distinct wet and dry seasons with a yearly average temperature of 84.81 °F (29.34 °C) and 5.57 inches (141.58 millimeters) of precipitation. The wet season typically extends from March or April to October or November, while the dry season lasts from October or November to March or April. Ogun State, Nigeria has a variety of soil types, including sandy clay, sandy loam, and loamy sand. These are conducive to the cultivation of various cash and food crops, including cocoa, oil palm, rubber, coffee, kolanut, cassava, yam, and rice.



**Figure 1:** Map of Nigeria showing the boundary of Ogun State.  
(Source: Ogun State, Ministry of Land and Housing, 2017)

### Sampling Techniques

The study employed a multi-stage sampling procedure. Based on the investigation and close observation of cocoa farmers in Ogun State, the first stage involved purposive selection of three high cocoa producing Local Government Areas (LGAs) of Ogun State, Nigeria namely, Ijebu-East, Ijebu North and Ijebu North-East Local Government Area. The second stage involved random selection of five (5) communities from each of the selected local governments. The final stage therefore, involved the snowball selection of sixteen (16) cocoa farmers consisting of eight (8) certified cocoa producers and eight (8) non-certified producers making a total of 240 respondents to be used for the study.



**Figure 2: Sampling Procedure**

**Source:** Author's Idea, 2025

### Analytical Tools

#### Descriptive Statistics

Descriptive Statistics was used in analyzing and describing the socio-economic characteristics of the respondents as stated specifically in objective one (i). Descriptive statistics consist of frequency counts, percentages, and mean among others.

#### The Cobb-Douglas Functional Form

The stochastic frontier production model of Cobb-Douglas functional form was employed to estimate the farm level technical efficiency of both the certified and non-certified cocoa producers and its determinants. Cobb-Douglas functional form have been used in many studies, particularly in those relating to developing agriculture. It meets the requirement of being self-dual, allowing an examination of economic efficiency (Battese & Coelli 1988). It is specified as:

$$Y_i = f(X_i; \beta) \exp(v_i - \mu_i) \quad (1)$$

The technical efficiency of individual farmers is defined in terms of the ratio of observed output to the corresponding frontier output conditioned on the level of input used by the cocoa farmers. It is expressed as:

$$TE_i = \frac{Q_i}{Q_i^*} = \frac{f(X_i; \beta) \exp(v_i - \mu_i)}{f(X_i; \beta) \exp V} = \exp(-\mu_i) \quad (2)$$

Where

$Y_i$  = Cocoa Output (in kg)

$X_1$  = Farm Size (in ha)

$X_2$  = Labour (in man-days)

$X_3$  = Quantity of seeds used (in kg)

$X_4$  = Quantity of herbicide used (in litres)

$X_5$  = Quantity of fertilizer used (in kg)

$\beta$  = Regression coefficients

$v_i$  = disturbance not in control of the farmer. It assumes an independent and identically distributed random errors having normal  $N(0, \delta v^2)$  distribution and independent of  $\mu$  and

$\mu_i$  = Deviation from output maximization that can be attributed to technical inefficiency. The  $\mu_i$  assumes a non-negative truncation of the half-normal distribution  $N(\mu, \delta \mu^2)$ .

According to Coelli *et al.*, (2005), the factors responsible for technical inefficiency are a function of the socioeconomic factors. These factors are expressed in the inefficiency model given below:

$$\mu_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i} + \delta_6 Z_{6i} + \delta_7 Z_{7i} \dots \delta_{12} Z_{12i} \quad (3)$$

Where;

$\mu_i$  = Inefficiency effect



$\delta_1$  = undisclosed scalar factors to be predicted.

$Z_1$  = age (in years)

$Z_2$  = contact with extension agents

$Z_3$  = Farming experience (in years)

$Z_4$  = Household size

$Z_5$  = Cooperative membership (Yes=1; No=0)

$Z_5$  = Access to loan (Yes=1; No=0)

$Z_6$  = Marital status

$Z_7$  = Gender (Male=1; if otherwise=0)

$e_i$  = error term

The values of unknown coefficients in the equations, (i.e  $\beta$  and the  $\delta$ ) can be obtained jointly using the maximum likelihood method (ML). An estimated value of technical efficiency for each farmer was calculated in  $TE_{1i} = \exp(-\mu_i)$ . The maximum likelihood estimates (MLE) of the parameters in the Cobb-Douglas stochastic frontier production function model and the technical inefficiency effects was obtained using STATA 15

### **Probit Regression Analysis**

The probit regression analysis was used to examine the determinants of choice of status among the cocoa farmers with respect to certification. Probit to be appraised is specified as:

$$P\left(Y_i = \frac{1}{x_i}\right) = \frac{\exp(x_i\beta)}{1 + \exp(x_i\beta)} \quad (4)$$

Which can be in form of,  $Y_{it} = bx_{it} + e_{it}$

Where  $Y_{it}$  = an unobtrusive dormant variable for level of compliance

$X_{it}$  = vector of explanatory variables

$b$  = vector of factors to be projected

$e_{it}$  = error term

The observed binary (0, 1) for if determinants of choice is non-compliance or compliance is presumed in the customary probit model. Chance that binary takes up the worth of 1 or 0 infers,

$$prob.(Y_{it} = 1,0) = \frac{e^{x_{it}} + \beta^{x_{it}}}{1 + e^{x_{it}} + \beta^{x_{it}}} \quad (5)$$

Where  $Y$  = Choice of status (1= certified, 0 = non-certified)

$X_1$  = Age

$X_2$  = Gender

$X_3$  = Level of education (Year)

$X_4$  = Cocoa Farm size (Ha)

$X_5$  = contact with extension agents

$X_6$  = farming experience

$X_7$  = Cocoa output (kg)

$X_8$  = Access to credit

$X_9$  = Marital status

$X_{10}$  = Household size

$e$  = error term

## **RESULTS AND DISCUSSION**

### **Socioeconomic Characteristics of Cocoa Farmers by their Certification Status**

The socioeconomic characteristics of cocoa farmers in the study area show both commonalities and differences between certified and non-certified farmers. The results indicated that cocoa farming was largely practiced by middle-aged to older farmers, with mean ages of 51.03 years for certified and 52.60 years for non-certified farmers. This finding aligns with the study of Omoare et



al., (2016) who reported ageing population could be attributed to the rural-urban drift by the youth which resulted to leaving behind women and old people in the rural areas of Nigeria. The majority of farmers are male which is consistent with the findings of Oduntan and Adegbuyi (2018) who reported that men dominate both the certified and conventional cocoa production in their study area and most of the respondents were married, this findings align with Adetarami et al., (2022) who also reported that majority of the cocoa farmers in the study area were married, with average household sizes of about six members, suggesting reliance on family labor. Majority (38.3%) of certified farmers have primary education while most (36.7%) of non-certified farmers had secondary education. Although non-certified farmers have slightly larger farm sizes (3.32ha) and longer farming experience (25.4years). The result supported the findings of Poelmans and Swinnen (2016) that more than 90% of the world's cocoa is grown by individual farmers that own between one and ten hectares of land and small holder farmers are regarded as people with landholdings of less than 10 hectares., certified farmers record higher productivity (643.50kg/ha) in terms of number of cocoa stands planted and yield harvested. Interestingly, average income (821,524.16) is higher among non-certified farmers, possibly reflecting larger farm holdings or alternative income sources. Institutional support appears more favorable for certified farmers, with majority (55.0%) having no access to credit facilities and most (89.2%) had contact with extension agents compared to (70.8%) and (48.3%) respectively for non-certified farmers. These findings suggest that certification plays an important role in improving farmers' access to services, adoption of improved practices, and productivity, though its impact on income remains mixed.





**Table 1: Socioeconomic Characteristics of Cocoa Farmers in the Study Area (Frequency=240)**

Variables	Certified		Non-Certified	
	Frequency	Percentage (%)	Frequency	Percentage (%)
<b>Age (in years)</b>				
≤30	11	9.1	9	7.5
31-40	18	15.0	13	10.7
41-50	23	19.2	23	19.2
51-60	40	33.3	40	33.3
61-70	24	19.0	30	24.9
>70	4	3.3	5	4.0
<b>Mean</b>		<b>51.03</b>		<b>52.60</b>
<b>Gender</b>				
Male	73	60.8	75	62.5
Female	47	39.2	45	37.5
<b>Marital Status</b>				
Single	6	5.0	6	5.0
Married	104	86.7	92	76.7
Divorced	1	0.8	1	0.8
Widowed	9	7.5	17	14.2
Separated	-	-	4	3.3
<b>Household size</b>				
1-4	39	32.5	44	36.7
5-8	70	58.3	66	55.1
>8	11	5.1	10	8.3
<b>Mean</b>		<b>5.6</b>		<b>5.5</b>
<b>Educational status</b>				
No formal education	8	6.7	20	16.7
Primary education	46	38.3	30	25.0
Secondary education	32	26.7	44	36.7
Tertiary education	34	28.3	26	21.7
<b>Cocoa Farm Size (Ha)</b>				
<2.00	56	46.7	39	32.6
2.00-5.00	49	40.6	62	51.5
>5.00	15	12.3	19	15.8
<b>Mean</b>		<b>2.77</b>		<b>3.32</b>
<b>Farming experience (in years)</b>				
≤10	26	21.6	19	15.8
11-20	37	30.7	37	22.5
21-30	28	23.4	30	25.0
31-40	26	21.6	32	26.7
>40	3	2.4	12	10.0
<b>Mean</b>		<b>21.4</b>		<b>25.4</b>
<b>Number of stands planted</b>				
<100	23	19.2	98	81.7
100-200	21	17.5	11	9.2
201-300	38	31.7	2	1.7
301-400	20	16.7	2	1.7
>400	18	15.0	7	5.8
<b>Mean</b>		<b>219.58</b>		<b>117.05</b>
<b>Quantity harvested (kg)</b>				
<250	24	20.0	35	29.2
250-500	48	40.0	47	39.2
501-750	20	16.7	15	12.5
751-1000	12	10.0	11	9.2
>1000	16	13.3	12	10.0
<b>Mean</b>		<b>643.50</b>		<b>496.02</b>



<b>Annual income (₦)</b>				
<500,000	66	53.6	61	50.1
500,000-1,000,000	31	25.0	33	26.7
1,000,001-1,500,000	13	10.4	11	8.9
1,500,001-2,000,000	5	4.0	6	4.8
>2,000,000	5	4.0	9	4.2
<b>Mean</b>		<b>742,253.15</b>		<b>821,524.16</b>
<b>Access to credit</b>				
Yes	54	45.0	35	29.2
No	66	55.0	85	70.8
<b>Contact with extension agents</b>				
Yes	107	89.2	58	48.3
No	13	10.8	62	51.7

**Source:** Computed from Field Survey, 2025

### Factors Influencing Productivity of Cocoa Farmers Across Certification Status

The results in Table 2 highlight the factors influencing the productivity of cocoa farmers across certification status. For certified farmers, farm size (5%), improved seeds (10%), and insecticide use (1%) were positive and significant determinants of productivity, indicating that access to improved inputs enhances output. This finding aligns with **Asfaw et al. (2010)** and **Chiputwa et al. (2015)**, who reported that certification improves access to quality inputs. In contrast, for non-certified farmers, productivity was positively influenced by farm size, labor, and access to credit, suggesting reliance on traditional resources and institutional support rather than modern inputs. This supports **Ajibefun & Daramola (2003)**, who found farm size as a key driver of technical efficiency in Nigeria. Fungicide use was negatively significant at 5% for non-certified farmers, possibly reflecting misuse or over-application. This is consistent with **Abiodun et al. (2019)**, who noted that poor handling and over-application of chemicals reduce output. The inefficiency model shows important socio-economic influences. For certified farmers, age negatively influenced efficiency, implying that younger farmers are more productive, consistent **Abdulai & Huffman (2014)**, who stressed that younger farmers are more adaptable to innovation, while contact with extension agents and farming experience reduced inefficiency, underscoring the role of knowledge transfer, aligning with **Anderson and Feder (2007)**, who highlighted the importance of knowledge transfer. Experience reduced inefficiency, consistent with **Oladeebo and Oluwaranti (2012)**, who observed that accumulated skills enhance efficiency. Household size also contributed positively by reducing inefficiency, reflecting labor availability. This corroborates **Enete and Amusa (2010)**, who emphasized the importance of household labor in traditional farming systems. For non-certified farmers, age, gender, household size, extension contact, and access to credit significantly reduced inefficiency, suggesting that both demographic and institutional factors shape productivity. This agrees with **Awotide et al. (2015)** and **Nyangena (2010)**, who showed that credit eases liquidity constraints and enables better input utilization.

**Table 2:** Factors Influencing Productivity of Cocoa Farmers by Certification Status

Variables	Certified			Non-certified		
	Coefficient	Std. Error	t-ratio	Coefficient	Std. Error	t-ratio
Constant	0.582***	0.254	2.291	0.493***	0.239	2.063
Farm size	0.364**	0.152	2.395	0.659***	0.324	2.034
Seeds	0.682*	0.121	5.636	0.428	0.319	1.342
Fungicide	-0.016	0.022	0.758	-0.039**	0.0139	-2.806
Labour	0.084	0.262	0.321	0.079**	0.021	3.762
Insecticide	0.543***	0.215	2.526	0.149	0.108	1.380
<b>Inefficiency model</b>						
Constant	0.638	0.425	1.501	0.613	0.421	1.456
Age	-0.394**	0.112	3.518	0.216*	0.052	4.122
Gender	0.022***	0.010	2.150	0.029***	0.014	2.071
Educational status	0.036	0.082	0.440	0.022	0.029	0.759
Household size	-0.0651***	0.030	-2.163	0.782***	0.321	2.436
Contact with extension agents	0.0459**	0.014	3.279	0.381**	0.121	3.149
Farm experience	0.124**	0.054	2.296	0.365	0.219	1.667
Access to credit	0.051	0.046	1.109	0.402**	0.114	3.526
Gamma	2.109*	0.312	6.760	2.181**	0.901	2.421
Sigma-square	3.251*	0.712	4.566	5.617*	1.026	5.475
Log likelihood			-89.1104			-73.8633

**Source:** Computed from Field Survey, 2025

### Technical Efficiency Estimates of Cocoa Farmers across Certification Status

The technical efficiency estimates revealed in Table 3 shows that both certified and non-certified cocoa farmers operate below the frontier, though with varying levels of efficiency. Certified farmers achieved a higher mean efficiency score (0.678) compared to non-certified farmers (0.623), suggesting that certification contributes to better resource use and productivity. The efficiency distribution further indicates that most certified farmers (34.2%) clustered within the 0.51–0.60 decile, while the largest proportion of non-certified farmers (31.7%) also fell within this range, but with a higher share (23.3%) in the 0.41–0.50 range, reflecting lower efficiency overall. At the upper end of efficiency, a higher proportion of certified farmers (17.5%) were found within the 0.71–1.00 range compared to non-certified farmers (10.9%), indicating that certification is associated with more farmers approaching optimal production levels. The minimum and maximum efficiency scores show that both groups have farmers operating very inefficiently, but also a few close to full efficiency.

**Table 3:** Distribution of Respondents by Technical Efficiency Estimates

Decile range	Certified		Non certified	
	Frequency	Percentage (%)	Frequency	Percentage (%)
≤0.20	9	7.5	15	12.5
0.21-0.30	18	15.0	12	10.0
0.31-0.40	15	12.5	9	7.5
0.41-0.50	16	13.3	28	23.3
0.51-0.60	41	34.2	38	31.7
0.61-0.70	6	5.0	5	4.2
0.71-0.80	5	4.2	2	1.7
0.81-0.90	6	5.0	8	6.7
>0.90	4	3.3	3	2.5
Mean efficiency	0.678		0.623	
Minimum	0.11		0.13	
Maximum	0.98		0.99	

**Source:** Computed from Field Survey, 2025





### Factors Influencing Certification Measures of Respondents in the Study Area

The probit regression results identify the socio-economic and institutional factors influencing farmers' compliance with certification measures. Age was positively significant at 1%, suggesting that older farmers are more likely to comply with certification requirements, possibly due to accumulated experience and stability. This result aligns with **Abdulai & Huffman (2014)**, who emphasized the role of age and experience in technology adoption, and **Oduntan & Adegbuyi (2018)**, who found older farmers more willing to participate in cocoa certification. Gender was also significant at 5%, with male farmers more likely to adopt certification. This reflects gender-based differences in access to land, resources, and decision-making power, consistent with **Oduntan & Adegbuyi (2018)**, who reported higher male participation in certification programs. Similar gender disparities in resource access and participation in agricultural schemes were also highlighted by **Enete & Amusa (2010)**. Household size showed a strong positive effect (10% level), implying that larger households, with greater labor supply, are better positioned to meet certification demands. This supports **Ajibefun & Daramola (2003)**, who stressed the role of family labor in improving farm-level participation in development initiatives, and is in line with findings from **Afolami *et al.* (2015)**, who noted household resources as key drivers of technology adoption. Farming experience was positively significant at 1%, reinforcing the role of accumulated knowledge in motivating adoption of certification. Similar conclusions were reached by **Oladeebo & Oluwaranti (2012)**, who found that longer farming experience enhances responsiveness to institutional programs. Contact with extension agents had the strongest positive effect (1% level), highlighting the importance of advisory services in promoting awareness and compliance with certification standards. This finding is consistent with **Adepoju & Oyewole (2014)**, who found that extension contact enhances compliance with improved farming practices. Cocoa farm size was also positively significant at 5%, indicating that larger-scale farmers are more motivated or able to participate in certification schemes. Conversely, variables such as educational status, access to credit, income, and marital status were not significant, suggesting that they do not play a central role in determining compliance. Interestingly, education showed a negative though insignificant effect, which may reflect that more educated farmers diversify into non-farm activities, reducing reliance on certification. Overall, the results demonstrate that **experience, household resources, farm size, and extension contact** are the key drivers of certification compliance, with institutional support emerging as a critical factor.

**Table 4:** Probit Regression showing Factors influencing Certification Measures

Variables	Coefficient	Std.error	T-value	P> t
Age	0.086***	0.039	2.21	0.011
Gender	0.314**	0.121	2.60	0.009
Marital status	0.086	0.282	0.30	0.761
Household size	0.092*	0.0201	4.58	0.000
Educational status	-0.763	0.658	-1.16	0.246
Farming experience	0.021***	0.011	1.91	0.047
Access to credit	-0.338	1.007	-0.34	0.737
Extension contacts	1.512*	0.230	6.58	0.000
Farm size	0.109**	0.040	2.72	0.007
Income	-0.111	0.109	-1.03	0.302
Constant	0.972	1.506	0.65	0.579
Number of observations	240			
Log likelihood	-131.1390			
LR chi <sup>2</sup> (10)	64.43			
Prob>chi <sup>2</sup>	0.0000			

NB: \*, \*\*, \*\*\* specifies level of significance level at 10%, 5%, and 1% respectively

*Dependent variable = Certification status*

**Source:** Computed from Field Survey, 2025



## CONCLUSION AND RECOMMENDATIONS

The study concludes that certified cocoa farmers have higher technical efficiency compared to their non-certified counterparts in the study area. Also certification is influenced by age, gender, household size, farming experience, extension contact and farm size. In addition certification improves efficiency and compliance through structured markets, extension services, and farm management practices. It is recommended that extension services should be strengthened to provide continuous technical support and advisory services, access to credit should be expanded through farmer-friendly loan schemes to enable smallholders adopt improved inputs, youth participation in cocoa farming should be encouraged through incentives, training, and modern technologies, input availability should be improved by ensuring timely access to improved seeds and agrochemicals at subsidized prices, and farmers' education should be promoted through adult literacy and awareness programs to enhance knowledge and adoption of improved practices.

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