Journal of Tekirdag Agricultural Faculty
Tekirdağ Ziraat Fakültesi Dergisi

Ekim/October 2025, 22(4)
Başvuru/Received: 21/12/24
Kabul/Accepted: 19/08/25
DOI: 10.33462/jotaf.1604969

http://dergipark.gov.tr/jotaf
http://jotaf.nku.edu.tr/

ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Evaluating the Economic Impact of Good Post-Harvest Practices on Cocoa Farming in Southwest Nigeria*

Adewale Isaac OLUTUMISE[1*], Abiodun Festus AKINROTIMI[2], Olanrewaju Peter OLADOYIN[3], Adeyose Emmanuel AKINBOLA[4], Tolulope Seun OLUBUNMI-AJAYI[5], Asiru Monday ABBAS[6]

Abstract

Despite proven benefits in improving product quality and profitability, adoption rates for Good Post-Harvest Practices remain low. Therefore, understanding the factors influencing modern technologies' adoption and the associated income disparities is crucial for promoting sustainable cocoa farming practices and addressing income inequalities among farmers. Thus, this study evaluates the economic impact of Good Post-Harvest Practices (GPHP) adoption among cocoa farmers in Southwest Nigeria. Using a well-designed questionnaire, primary data were collected from 200 cocoa farmers through a multistage sampling technique. The study employs descriptive statistics, budgetary technique and Endogenous Switching Regression Model (ESRM) to estimate the determinants and income effects of GPHP adoption. Results reveal significant demographic differences between adopters and non-adopters. Adopters, characterized by younger age, higher education levels, and greater access to extension services and modern technologies, achieved significantly higher incomes compared to non-adopters. The budgetary analysis shows that the Total Revenue (TR) of adopters (₦7.206.739.63) exceeded that of non-adopters (₦6.706.739.63), with a return on investment (ROI) of 9.15 for adopters and 7.98 for non-adopters. Key determinants influencing the adoption of GPHP include access to credit, market linkages, and membership in associations. Conversely, larger household sizes, limited market access, and lower social support networks hindered adoption. The Average Treatment Effect on the Treated (ATT) estimates indicate that GPHP adoption increased income by 12.77% (₦385.129.30). Therefore, it can be recommended that policies promoting access to credit, education, and market opportunities should be encouraged to bridge the income gap between adopters and non-adopters. This study contributes to the discourse on sustainable agriculture and equitable development in the cocoa value chain.

Keywords: Cocoa farming, Economic impact, Endogenous switching regression model, Performance, Technology adoption, Nigeria

[1]***Sorumlu Yazar/Corresponding Author:** Adewale Isaac Olutumise, Department of Agricultural Economics, Adekunle Ajasin University, P.M.B. 001, Akungba-Akoko, Nigeria. E-mail: adewale.olutumise@aaua.edu.ng OrcID: 0000-0003-4600-9265
[2]Abiodun Festus Akinrotimi, Ondo State Produce Inspection Service, Ministry of Agriculture and Forestry, Alagbaka-Akure, Ondo State, Nigeria. E-mail: akinrotimiabiodun4@gmail.com OrcID: 0009-0009-3444-3233
[3]Olanrewaju Peter Oladoyin, Department of Agricultural Economics, Adekunle Ajasin University, P.M.B. 001, Akungba-Akoko, Nigeria. E-mail: ooladoy24@gmail.com OrcID: 0009-0006-6517-8274
[4]Adeyose Emmanuel Akinbola, Department of Agricultural Economics, Adekunle Ajasin University, P.M.B. 001, Akungba-Akoko, Nigeria. E-mail: ooladoy24@gmail.com OrcID: 0009-0007-2248-3356
[5]Tolulope Seun Olubunmi-Ajayi, Department of Agricultural and Resource Economics, Federal University of Technology, P.M.B. 704, Akure, Nigeria. E-mail: tolulopeolubunmiajayi@gmail.com OrcID: 0009-0000-1645-3715
[6]Asiru Monday Abbas, Department of Agricultural Economics, University of Abuja, P.M.B. 117, Abuja, Nigeria. E-mail: asiruabbas@gmail.com OrcID: 0000-0003-3702-9643
Atıf/Citation: Olutumise, A. I., Akinrotimi, A. F., Oladoyin, O. P., Akinbola, A. E., Olubunmi-Ajayi, T. S., Abbas, A. M. (2025). Evaluating the economic impact of good post-harvest practices on cocoa farming in Southwest Nigeria. *Journal of Tekirdag Agricultural Faculty,* 22(5): 988-1003.

*This study was summarized from the Abiodun Festus Akinrotimi's PhD thesis.

1. Introduction

Cocoa farming represents a critical agricultural sector globally, contributing significantly to rural livelihoods, national economies, and international commodity markets (Neilson et al., 2020; Alho et al., 2021; van Vliet et al., 2021). As one of the primary crops cultivated in tropical regions, cocoa remains an essential source of income for millions of smallholder farmers, particularly in areas such as West Africa, Latin America, and Southeast Asia (Ndungu et al., 2023; Aikins et al., 2021). In Nigeria, cocoa is a predominant cash crop, with the Southwest region being a major hub for its cultivation (Adejuwon et al., 2023; Adesiyan and Kehinde, 2024; Akinrotimi et al., 2024). Despite its economic importance, cocoa farming is fraught with challenges, including fluctuating international prices, low productivity, and inequitable revenue distribution, adversely affecting smallholder farmers' livelihoods.

Again, cocoa farming in Nigeria benefits from favourable climatic conditions, soil types, and topography conducive to high yields (Olaleye et al., 2022), especially in the producing region. The Southwest region is recognized as a significant contributor to Nigeria's cocoa production, reflecting the pivotal role of the region in both domestic and international cocoa markets (Adejuwon et al., 2023; Akinrotimi et al., 2024). However, despite the favourable conditions, the productivity and profitability of cocoa farmers in the region remain suboptimal, influenced by factors such as inefficient agricultural practices, inadequate access to credit, and limited adoption of modern technologies. Good Post-Harvest Practices (GPHP) have been identified as critical interventions to address some of these challenges. Practices such as proper fermentation, drying, and sorting of cocoa beans not only enhance the quality of the produce but also increase its market value (Owusu and Osei, 2020; Akinrotimi et al., 2024). Yet, studies indicate that the adoption of GPHP among Nigerian cocoa farmers remains low, with less than 40% of farmers actively employing these practices (Oluwalade et al., 2023; Akinrotimi et al., 2024; Amuda and Alabdulrahman, 2024). This limited adoption is a significant bottleneck in the value chain, constraining farmers' ability to maximize their returns.

The existing literature (e.g., Wongnaa et al., 2022; Agbenyo et al., 2022; Adegoroye et al., 2024; Krumbiegel and Tillie, 2024) highlights the persistent income disparity between adopters and non-adopters of improved agricultural practices among cocoa farmers. While studies have established the benefits of GPHP on productivity and profitability (Akinrotimi et al., 2024), the factors influencing their adoption and the broader implications for income distribution remain inadequately explored (Adegoke et al., 2023). In particular, there is a need for robust analytical frameworks to assess the impact of these practices on farmers' economic outcomes, accounting for both observed and unobserved factors. Additionally, the current body of research often overlooks the heterogeneity among cocoa farmers, including variations in farm sizes, access to resources, and socio-economic characteristics. For instance, larger farm sizes, while offering economies of scale, may pose challenges in implementing labour-intensive practices like GPHP (Aikins et al., 2021; Adegoroye et al., 2024). Similarly, access to credit and education, though critical for technology adoption, varies significantly across different farmer demographics. These variations underline the necessity for a more comprehensive and context-specific understanding of the determinants and impacts of GPHP adoption. Another significant gap lies in the evaluation of policy and institutional support mechanisms for cocoa farmers. While government and non-governmental organizations have initiated programs to promote improved practices, the efficacy and reach of these interventions remain under-researched. Understanding the interplay between institutional support, farmer characteristics, and adoption outcomes is vital for designing effective policies (Ndungu et al., 2023).

This study is anchored on the premise that addressing the challenges faced by cocoa farmers requires a holistic approach that integrates economic, social, and institutional dimensions. By leveraging the Endogenous Switching Regression Model (ESRM), the study aims to provide a detailed analysis of the adoption of GPHP and its impact on farmers' incomes in the Southwest region of Nigeria. The ESRM framework enables the simultaneous estimation of the determinants of GPHP adoption and its income effects, accounting for selection bias and unobserved heterogeneity (Owusu and Osei, 2020; Adegoroye et al., 2024). This approach not only underscores the economic benefits of GPHP but also informs targeted interventions to enhance adoption rates among cocoa farmers. Furthermore, the inclusion of variables such as access to credit, education, and market linkages in the analysis offers valuable insights into the enabling factors for successful adoption. Therefore, the broad objective of this study is to evaluate the impact of GPHP adoption on the incomes of cocoa farmers in the Southwest region of Nigeria. Specific objectives are to:

1. examine the demographic profile of the respondents;
2. estimate the costs and returns of cocoa farming based on the adoption in the area;
3. identify the determinants of GPHP adoption among cocoa farmers; and
4. analyse the impact of GPHP adoption on income distribution.

2. Materials and Methods

2.1. Study area's description

The research was conducted in the Southwest region of Nigeria, an area notable for its agricultural productivity and cultural diversity. This region, home to an estimated population of 27.5 million people as of the 2006 census, predominantly comprises the Yoruba ethnic group, representing approximately 21% of Nigeria's population (National Population Commission, 2006). The Southwest includes the states of Ondo, Ekiti, Osun, Oyo, Lagos, and Ogun, all located within the tropical forest belt. Geographically, it spans latitudes 4° to 9° North and longitudes 7° to 3° East, covering a total area of about 191,843 square kilometers (Oni and Odekunle, 2016). The region's climate is characterized by an annual rainfall of approximately 1,486 mm and an average temperature of 26°C, conditions ideal for cultivating cocoa (Amusa and Simonyan, 2017). The soil in this region, predominantly loamy and sandy, supports cocoa farming well, provided it is well-drained to avoid waterlogging and potential disease outbreaks. The undulating terrain enhances drainage and reduces soil erosion, making it suitable for sustainable agricultural practices. Alongside cocoa, other agricultural activities include the cultivation of oil palm, cassava, rice, and vegetables, as well as poultry and fish farming. These contribute significantly to the regional and national economy. The area experiences two distinct seasons (a rainy season from April to October and a dry season from November to March) with temperatures ranging between 25°C and 35°C (Amusa and Simonyan, 2017).

2.2 Sources of data

The study relied on primary data collected through a well-structured questionnaire designed to capture key information from respondents.

2.3 Sampling technique and sample size

A multistage sampling approach was used to select participants for the study. Stage one, two states (Ondo and Osun) were purposively selected due to their prominence in cocoa production within the Southwest region. Stage two, four Local Government Areas (LGAs) were also purposively selected from each state, based on high cocoa production volumes, as identified by the Agricultural Development Programme. In stage three, two communities were randomly selected using a simple random sampling technique from each of the eight LGAs. Finally, 13 cocoa farmers were randomly selected from each community using lists provided by extension agents from the Ministry of Agriculture in both states. This process resulted in a total sample of 208 farmers. However, only 200 completed copies of the questionnaire were returned and deemed valid for analysis due to logistical challenges such as participants' busy schedules, survey fatigue, and accessibility issues.

2.4 Method of data analysis

In analyzing the data obtained for this study, the analytical tools employed include Descriptive statistics, Sigma Scoring method, Budgetary technique, and Endogenous Switching Regression Model (ESRM).

Model Specifications: Descriptive statistics such as mean, frequency distribution and percentages were used to analyze the explanatory variables for the ESRM, while the Sigma scoring method was used to identify adopters and non-adopters based on the recommended good post-harvest practices for cocoa farmers. It is worth noting to mention that the list of recommended good post-harvest practices was provided in the *appendix* for the farmers. The adoption of Good Post-Harvest Practices (GPHP) among cocoa farmers was assessed using the Sigma Scoring Method, which classified respondents into adopters and non-adopters based on a set of predefined indicators. These indicators were selected from recommended best practices, including fermentation methods, drying techniques, contamination prevention, and moisture control. Each indicator was assigned an equal weight on a 10-point scale, ensuring uniformity in the evaluation process. The adoption score for each farmer was computed using the standard formula in Equation (1).

$Z = (X - \mu)/\sigma$ (Eq. 1)

Where:

Z = the mean score

X = is the value being standardized

μ = the mean of the data set

σ = the standard deviation of the dataset

Thus, farmers scoring 5 and above were categorized as adopters, while those scoring below 5 were classified as non-adopters. This approach provided a structured and objective assessment of GPHP adoption, facilitating a clearer understanding of its impact on cocoa farming practices.

Budgetary Technique: To estimate the costs and returns of cocoa farming, the budgetary technique involves calculating the Total Cost of Production (TCP), Total Revenue (TR), Gross Margin (GM), Net Income (NI), and Return on Investment (ROI). These parameters are derived as follows:

$TCP = TVC + TFC$ (Eq. 2)

Where:

TVC = Total Variable Costs (e.g., labour, inputs like pesticides, herbicides)

TFC = Total Fixed Costs (e.g., tools, depreciation on equipment)

$TR = P \times Q$ (Eq. 3)

Where:

P = Price per unit of cocoa/kilograms

Q = Quantity of cocoa produced (in kilograms ha^{-1})

$GM = TR - TVC$ (Eq. 4)

GM evaluates the efficiency of variable cost utilization.

$NI = TR - TCP$ (Eq. 5)

NI represents the profitability after accounting for all costs.

$ROI = TR/TCP$ (Eq. 6)

ROI indicates the income generated for every unit of cost incurred.

Endogenous Switching Regression Model: Endogenous Switching Regression model (ESRM) was used to examine the effect of good post-harvest practices on cocoa farmers' incomes in the study area. The Endogenous Switching Regression Model (ESRM) was selected to address self-selection bias and unobserved heterogeneity in adoption studies. ESRM allows us to simultaneously estimate both the determinants of Good Post-Harvest Practices (GPHP) adoption and its income effects while correcting for selection bias. Unlike other econometric techniques such as Ordinary Least Squares (OLS) or Propensity Score Matching (PSM), ESRM accounts for both observed and unobserved factors influencing farmers' decisions, ensuring robust impact estimation. In the ESRM framework, a two-stage estimation procedure is computed simultaneously. The first stage involves estimating the selection to determine the factors influencing the choice of good post-harvest practices using probit regression model as shown in Equations (7) and (8):

$P_i(P_h = 1) = (\int X_i)$ (Eq. 7)

Where: $P_h = \beta_0 + \beta_i X_i$

Explicitly,

$P_h = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \cdots + \beta_{14} X_{14} + \mu_i$ (Eq. 8) where, P_h = Adoption of good post-harvest practices (Dichotomous variable: 1 = adopters; 0 = non-adopters)

β_0 = slope or intercept

β_{1-14} = vector of unknown coefficients

X_{1-14} = Independent variables.

In the second stage, the effect of good post-harvest practices on the outcome variable was specified for two regimes of adopters and non-adopters as shown in the Equations (9) and (10);

Regime 1 (adopters): $Y_{hA} = Z'_{hA}\beta + \mu_{hA} \; if \; P_h = 1,$ (Eq. 9)

Regime 0 (non-adopters): $Y_{hN} = Z'_{hN}\beta + \mu_{hN} \; if \; P_h = 0,$ (Eq. 10)

Where:

Y_{hA} and Y_{hN} are the outcome variables for adopters and non-adopters, respectively;

Z is a vector of households' endowments and farm-level characteristics

β is a vector of parameters to be estimated

μ is the error term

The expected values of the outcome Y on adopters and non-adopters of good post-harvest practices can be expressed as in Equations (11) and (12):

Regime 1 (adopters): $E(Y_{hA}|P = 1) = Z'X_{hA} - \sigma_{A\varepsilon}\gamma_A$ (Eq. 11)

Regime 0 (non-adopters): $E(Y_{hN}|P = 0) = Z'X_{hN} - \sigma_{N\varepsilon}\gamma_N$ (Eq. 12)

A change in the outcome due to good post-harvest practices termed the average treatment effect on the treated (ATT), is expressed in Equation (13) below as the difference in the expected outcomes:

$ATT = E(Y_{hA} - Y_{hN}|X_i = 1) = E\{(E(Y_{hA} - Y_{hN}|X_i,\; Y_i = 1)|Y_i = 1)\}$ (Eq. 13)

Where:

E(Y_{hA} and Y_{hN}) are expected outcome variables for adopters and non-adopters of GPHP, respectively. X_i is a vector of households' endowments and farm-level characteristics. Thus, the independent (explanatory) variables that were used for probit and ESRM are specified below:

X_1 = Age (in years)

X_2 = Sex (Male= 1, Otherwise= 0)

X_3 = Household size (Numbers)

X_4 = Farming experience (years)

X_5 = Marital status (Married = 1, Otherwise= 0)

X_6 = Membership of association (Yes =1, No =0)

X_7 = Extension contacts (Numbers)

X_8 = Education level (in years)

X_9 = Farm size (in hectares)

X_{10}= Access to credit (1= yes and 0, otherwise)

X_{11}= Access to market (1= yes and 0, otherwise)

X_{12}= Labour source (1= hired labour and 0, otherwise)

X_{13}= Location (Ondo = 1 and 0, otherwise)

X_{14}= Access to modern technological information (1 = yes and 0, otherwise)

3. Results and Discussion

3.1. Demographic profiles of respondents in the ESR Model

The demographic profiles of the respondents, as summarized in *Table 1*, reveal significant variations between adopters and non-adopters of Good Post-Harvest Practices (GPHP) in the area. Adopters had an average age of 48.11 years, which was notably younger compared to non-adopters, whose average age was 53.59 years. This age disparity suggests that younger farmers may be more inclined to adopt innovative practices, as younger individuals often demonstrate higher adaptability to change (Adegoke et al., 2023; Firdauzi et al., 2024). The gender distribution indicates a slightly higher proportion of males among non-adopters (72%) compared to adopters (65%).

Table 1. Demographic profiles of the respondents used in the ESR model

Variable	**Description**	**Adopters**		**Non-adopters**	
		Mean	**SD**	**Mean**	SD
Age	Continuous: measured in years	48.11	32.93	53.59	**36.02**
Sex	Dummy: Male= 1, Female = 0	0.65	0.24	0.72	**0.46**
Household size	Discrete: measured in numbers	5.00	4.50	8.00	**3.09**
Experience	Continuous: measured in years	16.70	10.99	15.60	**11.43**
Marital status	Dummy: Married = 1, otherwise = 0	0.61	0.33	0.87	**0.54**
Membership association	Dummy: member = 1, otherwise = 0	0.92	0.78	0.30	**0.48**
Extension	Discrete: measured in the number of contacts	4.00	4.58	2.00	**4.01**
Education	Continuous: measured in years	11.52	9.45	10.44	**9.01**
Farm size	Continuous: measured in hectares	1.90	2.01	2.07	**2.00**
Market access	Dummy: access = 1, otherwise = 0	0.67	0.43	0.42	**0.55**
Labour source	Dummy: hired = 1, otherwise = 0	0.89	0.40	0.91	**0.38**
Location	Dummy: Ondo = 1, otherwise = 0	0.60	0.21	0.60	**0.21**
Access to modern technology	Dummy: access = 1, otherwise = 0	0.88	0.45	0.31	**0.52**

This may reflect traditional gender roles or disparities in access to resources that influence adoption patterns (Ndungu et al., 2023). Non-adopters reported a larger household size, with an average of 8 members compared to 5 for adopters. Larger households may face greater financial and resource constraints, potentially limiting their ability to invest in improved practices (Aikins et al., 2021). Farming experience, however, showed marginal differences, with adopters averaging 16.7 years and non-adopters 15.6 years. Married farmers were significantly higher among non-adopters (87%) compared to adopters (61%). Married farmers may prioritize immediate household needs over investments in new practices, affecting their adoption decisions. Membership of associations was significantly higher for adopters (92%) compared to non-adopters (30%), highlighting the critical role of social networks in facilitating access to information and resources necessary for adopting improved practices (Owusu and Osei, 2020). Adopters had greater exposure to extension services, with an average of 4 contacts compared to 2 for non-adopters. Extension services provide essential technical knowledge and support, which are instrumental in promoting GPHP adoption (Olaleye et al., 2022). Education levels were also slightly higher among adopters, with an average of 11.52 years compared to 10.44 years for non-adopters. Higher educational attainment equips farmers with the ability to understand and implement complex practices effectively (Olutumise, 2023; Nogay and Azabağaoğlu, 2024). Farm size showed minimal variation between adopters (1.9 hectares) and non-adopters (2.07 hectares), while market access was substantially higher for adopters (67%) compared to non-adopters (42%). Improved market access enables farmers to realize better returns on investments, incentivizing the adoption of enhanced practices (Ndungu et al., 2023). Access to modern technology was significantly higher among adopters (88%) compared to non-adopters (31%), underscoring the importance of technological advancements in driving adoption. The source of labour, predominantly hired, showed minimal variation, with adopters and non-adopters reporting 89% and 91%, respectively. The result is similar to the findings of Oseni et al. (2018) and Olutumise et al. (2020) in Osun State, Nigeria. Both groups were equally distributed geographically, with 60% of respondents from Ondo State, reflecting a balanced representation in the sample.

3.2 Adoption of Good Post-Harvest Practices (GPHP)

As stated in the methodology, the distribution of adopters and non-adopters among farmers was obtained through a sigma-scoring approach. A benchmark value of 5 was set to classify the participants into adopters and non-adopters. The adopters were the participants with a score ≥ 5, while the non-adopters were the participants with a score < 5 for the cocoa farmers. The results in *Table 2* revealed that a higher percentage of farmers (60.5%) had not adopted GPHP in the area. The adoption rate among farmers was below 50%, indicating that most of the cocoa farmers were non-adopters. Similar results were reported by studies by Akinrotimi et al. (2024) and Amuda and Alabdulrahman (2024) on cocoa farming.

Table 2. Distribution by the Adoption of Good Post-Harvest Practices (GPHP)

Adoption GPHP	Frequency	Percentage
Adopters	79	**39.5**
Non-Adopters	121	**60.5**
Total	200	**100.0**

3.3 Income Estimation of the Cocoa Farmers

The results in *Table 3* provided an in-depth analysis of the costs and returns associated with cocoa farming, showcasing the financial performance of the adopters and non-adopters of GPHP in the area. From the Table, labour remains the most significant component of variable costs for both groups, affirming the labour-intensive nature of cocoa farming. For adopters, labour accounted for 79.51% of the Total Cost of Production (TCP), whereas it represented a higher proportion (83.51%) for non-adopters. Cocoa farming requires significant manual labour, especially for planting, weeding, pest control, harvesting, and post-harvest processing, making labour the dominant cost. The result indicates that non-adopters rely more heavily on manual labour, potentially reflecting inefficiencies in labour utilization compared to adopters. Also, adopters incurred a total variable cost of ₦686.855.10, constituting 87.17% of their TCP, while non-adopters recorded a higher variable cost of ₦754.755.10, comprising 89.96% of their TCP. Among the variable cost components, expenditures on fungicide and herbicide were slightly lower for non-adopters (2.30% and 2.45%, respectively) compared to adopters (2.83% and 2.86%). Similarly, costs associated with insecticides and pesticides were marginally reduced for non-adopters, suggesting either lower usage or suboptimal application practices, which could adversely impact crop health and yield. Fixed costs formed a smaller portion of TCP for both groups. Adopters incurred ₦101.062.90 in fixed costs (12.83% of TCP), while non-adopters reported a lower amount of ₦86.162.90 (10.04% of TCP). Among the fixed cost items, tarpaulin/nylon contributed the highest proportion for both groups, accounting for 3.46% of TCP for adopters and 2.72% for non-adopters. Notably, non-adopters spent less on essential farming tools such as knapsack sprayers and cutlasses, which may limit their ability to efficiently manage post-harvest activities.

Table 3. Distribution by costs and returns of the cocoa farming in the area

Indicator	Cost Items	Adopters - Mean Value (₦)	Percent (%) of TCP	Non-Adopters - Mean Value (₦)	Percent (%) of TCP
	Variable Inputs				
	Labour	626.510.15	79.51	700.510.15	**83.51**
	Water	3.859.45	0.49	3.559.45	**0.42**
	Fungicide	22.311.50	2.83	19.311.50	**2.30**
	Herbicide	22.573.50	2.86	20.573.50	**2.45**
	Insecticide	5.463.00	0.69	4.963.00	**0.59**
	Pesticide	6.137.50	0.78	5.837.50	**0.69**
A	**Total Variable Cost**	**686.855.10**	**87.17**	**754.755.10**	89.96
	Depreciation Cost on Fixed Inputs				
	Cutlass	19.180.00	2.43	17.180.00	**2.05**
	Wheelbarrow	6.832.04	0.87	5.832.04	**0.69**
	Shovel	2.974.56	0.38	2.574.56	**0.31**
	Knapsack sprayer	16.725.55	2.12	14.725.55	**1.75**
	Go-to-hell	3.527.12	0.45	2.927.12	**0.35**
	Basket and bucket	6.615.33	0.84	5.615.33	**0.67**
	Jute bags	15.855.17	2.01	12.855.17	**1.53**
	Rake	2.055.79	0.26	1.655.79	**0.20**
	Tarpaulin/nylon	27.297.35	3.46	22.797.35	**2.72**
B	**Total Fixed Cost**	**101.062.90**	**12.83**	**86.162.90**	**10.04**
C	**Total Cost of Production (TCP)**	**787.918.00**	**100.00**	**840.918.00**	100.00
	TCP/ha	414.693.68		450.693.68	
D	**Total Revenue (TR)**	**7.206.739.63**		**6.706.739.63**	
	TR/ha	3.793.020.86		3.193.020.86	
	Gross Margin (D – A)	6.519.884.53		5.951.984.53	
	Gross Margin/ha	3.431.518.17		2.742.518.17	
	Net Income (D – C)	6.418.821.63		5.865.821.63	
	Net Income/ha	3.378.327.17		2.742.327.17	
	Return on Investment (D/C)	9.15		7.98	

Note: 1USD = ₦1,655

The Total Revenue (TR) accrued by adopters was significantly higher at ₦7.206.739.63 compared to ₦6.706.739.63 for non-adopters. This revenue disparity highlights the potential benefits of adopting GPHP in terms of improved crop quality and market value. Consequently, the Gross Margin (TR minus TVC) for adopters was ₦6.519.884.53, substantially exceeding the ₦5.951.984.53 recorded for non-adopters. Similarly, adopters achieved a higher Net Income (TR minus TCP) of ₦6.418.821.63 compared to ₦5.865.821.63 for non-adopters. The ROI analysis further emphasizes the profitability benefits of GPHP adoption. Adopters recorded an ROI of 9.15, indicating that for every Naira invested, they earned back 9.15 Naira. In contrast, non-adopters achieved an ROI of 7.98, reflecting a lower efficiency in converting investments into revenue. This disparity underscores the economic benefits of adopting GPHP, as it enables farmers to achieve higher returns through improved productivity and reduced post-harvest losses. The higher revenue, gross margin, and net income achieved by adopters demonstrate the tangible benefits of GPHP in enhancing the financial outcomes of cocoa farming. These results align with previous studies by Oladoyin and Aturamu (2022), Akinbola (2023), and Oluwalade et al. (2023), which have consistently reported the positive impact of improved agricultural practices on profitability. The superior ROI for adopters further reinforces the argument for promoting GPHP adoption as a strategy to boost the economic viability of cocoa farming.

3.4 Effect of Good Post-Harvest Practices on Cocoa Farmers' Income in the Study Area

3.4.1 Estimates of Endogenous Switching Regression (ESR) for Cocoa Farmers

The diagnostic results of the ESR model in *Table 4* indicated that the model was robust and the variables included were jointly significant in explaining the income variation among farmers. The significant sigma values (0.22 and 0.18) suggested variability in income within both adopters and non-adopters, respectively. The rho values highlighted the correlation between unobserved factors influencing adoption and income, with a slight negative correlation for adopters (-0.08) and a positive correlation for non-adopters (0.18). The highly significant Wald chi-square value (190.99) and significant Wald test of independent equations confirmed the appropriateness of the ESR model in capturing the endogenous relationship between the adoption of GPHP and farmers' income. These diagnostics reinforced the validity of the model's findings and the importance of considering both observed and unobserved factors in analysing the impact of GPHP adoption on income.

3.4.2. Selection Equation for Adoption of Good Postharvest Practices (GPHP)

According to the second column of *Table 4*, the selection equation for the adoption of Good Postharvest Practices (GPHP) was analysed using endogenous switching regression. The results indicated the coefficients and significance levels of various factors influencing the likelihood of a cocoa farmer adopting GPHP. The positive coefficient for sex indicated that male farmers were more likely to adopt GPHP by 33.3% compared to their female counterparts. This suggests a moderately strong relationship between gender and GPHP adoption. Kehinde et al. (2024) also reported a positive and significant relationship between sex and the adoption of technology among cocoa farmers. Also, experience had a significant positive effect on the adoption of GPHP, indicating that more experienced farmers were more likely to adopt these practices by 21.1%, *ceteris paribus*. This relationship was significant at the 1% level, highlighting the importance of experience in influencing adoption decisions. Belonging to membership associations positively influences GPHP adoption, with significance at the 5% level. This finding underscores the role of social networks and collective action in facilitating the adoption of improved practices, as this increased the probability of adopting GPHP by 1.3%. Education had a strong positive effect on the likelihood of adopting GPHP, with significance at the 1% level. This finding highlights the critical role of education in enabling farmers to understand and implement better postharvest practices, which contribute about 34.5% to the probability of adopting GPHP in the area. Farm size negatively affected GPHP adoption (-0.229), with significance at the 10% level. The finding was contrary to the theory (*a priori* expectation), but it could be that larger farms might face more challenges in implementing these practices compared to smaller farms. Access to credit positively influenced GPHP adoption, with significance at the 5% level. This indicates that financial resources are crucial for farmers to invest in and adopt improved postharvest practices (Adesiyan et al., 2023). This contributed to about a 7.7% probability of adopting the GPHP in the area. Labour availability had a small positive coefficient, significant at the 10% level. This suggests that having adequate labour resources can slightly increase the likelihood of adopting GPHP by 1.5%. The location's coefficient was positive and significant at a 5% level, indicating that Ondo cocoa farmers had a likelihood of adopting GPHP by 9.8% compared with the Osun cocoa farmers. This could be due to varying levels of access to resources and information across different locations, as also observed by Oluwalade et al. (2023) and Akinbola (2023). The instrumental variable was access to modern technology information, and it had the largest positive coefficient (0.876), significant at a 1% level. This finding emphasizes the importance of information and knowledge about modern technologies in driving the adoption of improved practices (Bolatan et al., 2022). This contributed about 87.6% probability of increasing the likelihood of adopting GPHP in the area.

These findings implied that policies aimed at improving farmer education, enhancing access to credit, and facilitating the dissemination of modern technology information could be effective in promoting the adoption of GPHP. Moreover, the significance of location and labour availability highlighted the need for tailored interventions that consider regional specificities and labour dynamics. The negative relationship between farm size and GPHP adoption pointed to potential scalability issues that larger farms might face, which could be addressed through targeted support and resources.

3.4.3. Outcome Equation of Endogenous Switching Regression (ESR)

The third (Adopter) and fifth (Non-adopter) columns of *Table 4* revealed the outcome equation analysis of the Endogenous Switching Regression (ESR) model, indicating several significant factors influencing the income of farmers based on their adoption status of Good Postharvest Practices (GPHP).

Age of the cocoa farmers: For both adopters and non-adopters, age had a negative impact on income. This effect was marginally significant for adopters (coefficient of -0.049, p-value = 0.067) and highly significant for non-adopters (coefficient of -0.061, p-value = 0.007). This suggests that as farmers get older, their income tends to decrease, possibly due to reduced physical capability or less inclination to adopt new practices and technologies. The stronger negative impact on non-adopters could indicate that younger farmers are more open to adopting innovative practices that enhance productivity and income (Adesiyan et al., 2023; Kehinde et al., 2024).

Sex: Gender plays a significant role in determining income, with male farmers having higher incomes compared to female farmers. This effect was highly significant for both adopters (coefficient of 0.236, p-value = 0.000) and non-adopters (coefficient of 0.413, p-value = 0.001). The stronger effect among non-adopters suggested that male non-adopters benefit more from factors other than GPHP, possibly due to better access to resources or market opportunities. The study of Olutumise et al. (2020) and Akinbola (2023) advocated the need for targeted interventions to support female farmers in improving their income in cocoa production.

Farming experience: Farming experience significantly increased the income of both adopters and non-adopters. The effect was highly significant for adopters (coefficient of 0.032, p-value = 0.000) and even more pronounced for non-adopters (coefficient of 0.244, p-value = 0.001). Experienced farmers are likely to have better farming skills, knowledge, and networks that contribute to higher productivity and income. The larger significant effect for adopters suggested that by adopting GPHP, experienced farmers had made a relatively higher income. This is similar to the findings of Adebiyi et al. (2021), Kehinde (2021), and Kehinde et al. (2024), who reported a positive and significant relationship between experience and adoption of technologies.

Membership association: Membership in agricultural or other relevant associations significantly boosted the income of adopters (coefficient of 0.228, p-value = 0.000). This finding underscored the importance of social networks and collective action in facilitating the adoption of improved practices and enhancing income. Associations provide access to information, resources, and support, which are crucial for adopting and benefiting from GPHP. For non-adopters, the effect was not significant, indicating that association membership alone may not be sufficient to increase income without adopting improved practices.

Education: Education had a significant positive effect on the income of both adopters (coefficient of 0.078, p-value = 0.000) and non-adopters (coefficient of 0.009, p-value = 0.059). Educated farmers are better equipped to understand and implement advanced agricultural practices, manage their farms more efficiently, and access information and resources. The stronger effect for adopters highlighted the critical role of education in enabling farmers to successfully adopt and benefit from GPHP. The result corroborates the findings of Oseni et al. (2018), Adebiyi et al. (2021), and Kehinde et al. (2024), who reported a positive and significant relationship between education and the adoption of technologies.

Farm Size: Farm size significantly increased the income of non-adopters (coefficient of 0.399, p-value = 0.010) but did not have a significant impact on the income of adopters. Larger farm sizes provide economies of scale, allowing non-adopters to generate higher income even without adopting GPHP. For adopters, farm size may not be as critical because the benefits of GPHP, such as reduced postharvest losses and improved quality, can enhance income regardless of farm size.

Table 4. Full information maximum likelihood estimates of endogenous switching regression model for adoption and impact of adoption of GPHP on cocoa farmers' Income

Variable	Selection Equation		Adopters		Non-Adopters	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Constant	1.595	0.049	1.081	0.042	0.943	**0.002**
Age	0.231	0.201	-0.049*	0.067	-0.061***	**0.007**
Sex	0.333*	0.071	0.236***	0.000	0.413***	**0.001**
Household size	-0.204	0.312	-0.171	0.288	-0.044	**0.357**
Experience	0.211***	0.000	0.032***	0.000	0.244***	**0.001**
Marital status	-0.036	0.402	0.006	0.556	0.912	**0.323**
Membership association	0.013**	0.043	0.228***	0.000	0.091	**0.669**
Extension	-0.021	0.131	0.008	0.537	0.117	**0.621**
Education	0.345***	0.000	0.078***	0.000	0.009*	**0.059**
Farm size	-0.229*	0.068	0.139	0.599	0.399**	**0.010**
Credit	0.077**	0.031	0.579**	0.013	0.217*	**0.084**
Access to market	0.523	0.101	0.200**	0.015	0.192	**0.551**
Labour source	0.015*	0.089	0.258	0.711	0.812**	**0.021**
Location	0.098**	0.020	0.641**	0.018	0.005	**0.445**
Access to modern technology information	0.876***	0.000	-	-	-	**-**
Diagnostic statistic						
sigma_1			0.216***			
rho_1			-0.0788**			
sigma_2					0.181***	
rho_2					0.184***	
Wald chi2(13)	190.99***					
Log likelihood	-69.89					
Wald test of indep. eqns.: $\chi^2(1)$	274.26***					

Note: *,**,*** denote significance at 10%, 5%, and 1% levels, respectively.

Access to credit: Access to credit significantly boosted the income of both adopters (coefficient of 0.579, p-value = 0.013) and non-adopters (coefficient of 0.217, p-value = 0.084). Credit provides the necessary financial resources for farmers to invest in inputs, technology, and practices that enhance productivity and income. The stronger effect for adopters indicated that access to credit is particularly important for financing the adoption of GPHP, which translates to higher income, as also noticed by Kehinde et al. (2024).

Access to Market: Access to market significantly increased the income of adopters (coefficient of 0.200, p-value = 0.015) but not for non-adopters. Access to markets enables adopters to sell their produce at better prices, reducing postharvest losses and increasing profitability. This finding suggests that the benefits of GPHP are maximized when farmers have access to markets where they can sell their improved produce.

Labour Source: The coefficient of labour source significantly increased the income of non-adopters at a 5% level, but did not significantly impact the income of adopters. This implies that hired labour increased the income of non-adopter cocoa farmers by 81.2% compared with those who use other sources, such as family labour. It can be deduced that non-adopters relied more on hired labour to maintain their income levels, possibly because they compensated for the lack of improved practices with more intensive labour use. For adopters, the benefits of GPHP may reduce the reliance on labour, making this factor less critical.

Location (Ondo): Geographical location significantly affected the income of adopters (coefficient of 0.641, p-value = 0.018) but not non-adopters. It can be deduced that adopters from Ondo cocoa farmers make more income by 64.1% compared with their counterparts in Osun state. This suggests that certain locations provide better opportunities for adopters to benefit from GPHP, possibly due to factors such as climate, soil quality, infrastructure, and access to information and markets.

3.5 Income Impact of Cocoa Farmers

The Average Treatment Effect on the Treated (ATT) provided an estimate of the effect of adopting Good Postharvest Practices (GPHP) on the income of farmers who had adopted these practices. *Table 5* presents the income levels for adopters and non-adopters, along with the ATT value of 385,129.30 (12.77%). The ATT represents the difference in income between adopters and non-adopters, specifically estimating the effect of adopting GPHP on the income of those who have adopted these practices. This was statistically significant at the 1% level, indicating a strong and significant positive effect of GPHP adoption on the income of farmers. This implies that farmers who adopt GPHP have significantly higher incomes compared to those who do not adopt these practices. This substantial income difference underscores the economic benefits of adopting GPHP. The results suggested that adopting GPHP could lead to an increase in income by approximately ₦385,129.30 for the farmers who had adopted these practices. This increase can be attributed to various benefits associated with GPHP, such as reduced postharvest losses, improved quality of produce, and better market prices.

Table 5. Impact of Cocoa Farmers' Income using ATT

Variable	Adopters	Non-Adopters	ATT
Income (₦)	3,401,975.45	3,016,846.16	385,129.30***
	(1,934,893.10)	(2,005,853.99)	(199,001.07)

Note: Standard errors in parentheses. ***Significant at the 1% level. ***1USD = ₦1,655***

4. Conclusions

This study empirically examines the factors influencing the adoption of Good Post-Harvest Practices (GPHP) among cocoa farmers in Southwest Nigeria and their impact on income generation. It is concluded that adopters of GPHP consistently achieved higher incomes compared to non-adopters, driven by enhanced access to education, extension services, market linkages, and modern technology. Younger farmers, association membership, and access to credit also emerged as significant enablers for adoption. Conversely, larger household sizes, limited market access, and insufficient social support networks hindered adoption rates, exacerbating income disparities. Therefore, the findings affirm the economic benefits of GPHP adoption, particularly increased profitability. However, persistent barriers, such as financial constraints and limited institutional support, prevent widespread adoption, highlighting the need for targeted interventions. Based on the findings, it can be suggested that policymakers should design tailored interventions that enhance access to education, credit facilities, and extension services. These efforts can bridge the knowledge and resource gaps between adopters and non-adopters, fostering equitable agricultural development. The government should strengthen market access through improved infrastructure and cooperative frameworks that will enable farmers to realize better returns, incentivizing the adoption of GPHP. Also, initiatives focused on training and capacity building for farmers, particularly targeting non-adopters, can improve awareness and implementation of GPHP, ultimately boosting productivity and income. Encouraging membership in agricultural associations can provide farmers with critical information, resources, and peer support to facilitate the transition toward adopting improved practices. The government should also promote access to modern agricultural technologies and information systems that can further drive adoption rates, ensuring that cocoa farmers remain competitive in global markets.

Study Limitations and Future Research Directions

The main limitation is the geographical scope, as the study focuses on only two states (Ondo and Osun), which may limit the generalizability of the findings to other cocoa-producing regions in Nigeria or beyond. Another limitation is the potential influence of unobserved external factors, such as government policy interventions, climate variability, and global market conditions, which could significantly affect both the adoption of GPHP and the resulting economic benefits.

To build on these findings, future research should consider expanding the study to other cocoa-producing regions in Nigeria or West Africa to assess how geographical and socio-economic differences influence GPHP adoption. Additionally, evaluating the effectiveness of policy interventions, such as government subsidies, access to credit, and training initiatives, would offer insights into how institutional support can drive wider adoption of GPHP. Future studies could also explore the impact of climate change and global cocoa price fluctuations on post-harvest practices and farm income.

Ethical Statement

This study was prepared under the permission numbered AD/FATAAUA/IRB/24/138, dated 12/03/2024, from the Ethics Committee of Faculty of Agriculture, Institutional Review Board (IRB), Adekunle Ajasin University, Akungba-Akoko.

Conflicts of Interest

We declare that there is no conflict of interest between us as the article authors.

Authorship Contribution Statement

Concept: Olutumise, A. I., Akinrotimi, A. F.; Design: Olutumise, A. I., Akinrotimi, A. F., Oladoyin, O. P..; Data Collection or Processing: Akinrotimi, A. F., Oladoyin, O. P., Akinbola, A. E., Olubunmi-Ajayi, T. S.; Statistical Analyses: Olutumise, A. I., Abbas, A. M..; Literature Search: Akinrotimi, A. F., Oladoyin, O. P., Akinbola, A. E..; Writing, Review and Editing: Olutumise, A. I., Abbas, A. M., Akinrotimi, A. F., Olubunmi-Ajayi, T. S.

References

Adebiyi, S., Okunlola, J. O. and Akinnagbe, O. M. (2021). Effect of rehabilitation techniques on cocoa beans yield in Southern Nigeria. *Scientific Papers: Management, Economic Engineering in Agriculture and Rural Development,* 21(3): 45 – 52.

Adegoke, A., Ajayi, S. and Okon, F. (2023). The role of good agricultural practices in enhancing farmers' productivity: A case study of cocoa farming in Nigeria. *Journal of Agriculture and Food Research,* 13: 100596. https://doi.org/10.1016/j.jafr.2023.100596

Adegoroye, A., Oluwalade, T. A., Adeyelu, A. A., Olorunfemi, O. A. and Mope, C. (2024). Impacts of Farm Business of School (FBS) intervention on the Income of the cocoa farmers in Nigeria. *Asian Journal of Agricultural and Horticultural Research*, 11(1): 44-57.

Adejuwon, J. O., Tewogbade, K. E., Oguntoke, O. and Ufoegbune, G. C. (2023). Comparing farmers' perception of climate effect on cocoa yield with climate data in the humid zone of Nigeria. *Heliyon,* 9(12): e23155. https://doi.org/10.1016/j.heliyon.2023.e23155

Adesiyan, A. T. and Kehinde, A. D. (2024). Is there a linkage between credit access, land use, and crop diversification in achieving food security? Evidence from cocoa-producing households in Nigeria. *Heliyon*, 10(16): e35844. https://doi.org/10.1016/j.heliyon.2024.e35844

Adesiyan, T. F., Yesufu, O. A. and Kehinde, A. D. (2023). Impact of certification on market performance of cocoa industry in Osun State, Nigeria. *Social Sciences and Humanities Open,* 8(1): 100692.

Agbenyo, W., Jiang, Y., Jia, X., Wang, J., Ntim-Amo, G., Dunya, R. and Twumasi, M. A. (2022). Does the adoption of climate-smart agricultural practices impact farmers' income? Evidence from Ghana. *International Journal of Environmental Research and Public Health,* 19(7): 3804.

Aikins, S. H. M., Oppong, A. and Boakye, F. (2021). Adopting sustainable agricultural practices: A focus on post-harvest losses in cocoa production. *World Development Perspectives,* 24: 100043. https://doi.org/10.1016/j.wdp.2021.100043

Akinbola, A. E. (2023). Effect of credit services and socioeconomic factors on the income of cocoa marketers in Ondo State, Nigeria. *International Journal of Multidisciplinary Research and Growth Evaluation,* 4(4): 710 – 718. https://doi.org/10.54660/IJMRGE.2023.4.4.710-718

Akinrotimi, A. F., Thompson, O. A. and Arifalo, S. F. (2024). Assessing good post-harvest practices and barriers among cocoa farmers and licensed buying agents in Southwest, Nigeria. *Asian Journal of Research in Agriculture and Forestry*, 10(3): 60–74. https://doi.org/10.9734/ajraf/2024/v10i3300

Alho, C. F., da Silva, A. F., Hendriks, C. M., Stoorvogel, J. J., Oosterveer, P. J. and Smaling, E. M. (2021). Analysis of banana and cocoa export commodities in food system transformation, with special reference to certification schemes as drivers of change. *Food Security,* 13: 1555-1575.

Amuda, Y. J. and Alabdulrahman, S. (2024). Cocoa, palm tree, and cassava plantations among smallholder farmers: Toward policy and technological efficiencies for sustainable socio-economic development in Southern Nigeria. *Sustainability,* 16(2): 477.

Amusa, T. A. and Simonyan, J. B. (2017). Ordered probit analysis of factors influencing farmer's contributions to climate change adaptation decisions in Southwest Nigeria. *Trends in Agricultural Economics,* 10: 1-11.

Bolatan, G. I. S., Giadedi, A. and Daim, T. U. (2022). Exploring acquiring technologies: adoption, adaptation, and knowledge management. *IEEE Transactions on Engineering Management,* 71: 1950-1958.

Firdauzi, A., Ekowati, T., Prasetyo, A. S. and Mariyono, J. (2024). Factors determining the smallholder farmer's perception on organic farming: A case of Makmur Sejahtera farmers group, Batu City, Indonesia. *Journal of Tekirdag Agricultural Faculty*, 21(3): 722-731.

Kehinde, A.D. (2021). Agricultural cooperatives and improved technologies adoption among smallholder farmers in cocoa-based farming systems of Southwest Nigeria. *International Journal of Agricultural Management and Development* (IJAMAD), 11(4): 467-483.

Kehinde, A.D., Ojo, T., Ogunleye, A. and Ogundeji, A. (2024). Impact of access to cash remittances on cocoa yield in Southwestern Nigeria. *Sustainable Futures,* 7: 100168.

Krumbiegel, K. and Tillie, P. (2024). Sustainable practices in cocoa production: The role of certification schemes and farmer cooperatives. *Ecological Economics*, 222: 108211.

National Population Commissions (NPC) (2006). Nigeria: Report on the survey of the demographic and health survey. *Retrieved from* https://www.nigeria/npc/ (Accessed Date: 15.05.2011).

Ndungu, J., Chomba, C. and Mburu, J. (2023). Agricultural innovations for poverty alleviation: Evaluating sustainable cocoa farming practices. *Food Security,* 15(1): 45-60. https://doi.org/10.1007/s12571-023-01348-x

Neilson, J., Dwiartama, A., Fold, N. and Permadi, D. (2020). Resource-based industrial policy in an era of global production networks: Strategic coupling in the Indonesian cocoa sector. *World Development,* 135: 105045.

Nogay, Y. and Azabağaoğlu, M. Ö. (2024). Analysis of factors affecting corn seed preferences of producers: case of Sakarya province, Turkey. *Journal of Tekirdag Agricultural Faculty*, 21(1): 125-138.

Oladoyin, O. P. and Aturamu, O. A. (2022). Cost-benefit analysis of cocoa production in Idanre Local Government Area of Ondo State, Nigeria. *Asian Journal of Advanced Research and Reports,* 16(2): 1-10.

Olaleye, A. and Afolayan, J. (2022). Soil and climatic conditions for cocoa productivity: A case study of Southwest Nigeria. *Agroforestry Systems,* 104: 723-737. https://doi.org/10.1007/s10457-022-00736-1

Olutumise, A. I. (2023). Impact of credit on the climate adaptation utilization among food crop farmers in Southwest, Nigeria: application of endogenous treatment Poisson regression model. *Agricultural and Food Economics*, 11(1): 7.

Olutumise, A. I., Oparinde, L. O. and Simon-Oke, O. O. (2020). Assessment of income inequality, structure and conduct of cocoa marketers in Osun State, Nigeria. *Journal of Scientific Research and Reports,* 25(6): 1-12.

Oluwalade, T. A., Adegoroye, A., Mope, C. and Olorunfemi, O. A. (2023). Performance of Farm Business School (FBS): A case study of cocoa farmers in Nigeria. *International Journal of Advanced Economics,* 5(9): 285-297.

Oni, F. G. O. and Odekunle, T. O. (2016). An assessment of climate change impact on maize (*Zea Mays*) yield in South-western Nigeria. *International Journal of Applied and Natural Sciences,* 5(3): 109-114.

Oseni, J. O., Olutumise, A. I. and Olutumise, B. O. (2018). Performance evaluation of cocoa marketing in Osun State, Nigeria. *Jurnal Perspektif dan Pembanguan Daerah,* 6(1): 97-111.

Owusu, A. B. and Osei, K. B. (2020). Enhancing value through good post-harvest practices in cocoa farming. *Cogent Food & Agriculture,* 6(1): 1717745. https://doi.org/10.1080/20421338.2020.1717745

van Vliet, J. A., Slingerland, M. A., Waarts, Y. R. and Giller, K. E. (2021). A living income for cocoa producers in Côte d'Ivoire and Ghana? *Frontiers in Sustainable Food Systems,* 5: 732831.

Wongnaa, C. A., Jelilu, F., Apike, I. A., Djokoto, J. G. and Awunyo-Vitor, D. (2022). Effect of hybrid cocoa seedlings adoption on profit efficiency in Ghana. *Sustainable Futures*, 4: 100074.

Appendix

Table 1A: Distribution by the Adoption of Good Post-Harvest Practices (GPHP) of the cocoa farmers

s/n	Good Post-Harvest Practices Adopted of Cocoa Farmers	Frequency	Percentage
1.	Method of fermentation when extracting cocoa beans with pulps inside		
	Platforms with cover	28	14.0
	Baskets with cover	92	46.0
	Use of sacks	80	40.0
2.	Numbers of days cocoa beans is fermented		
	< 4	4	2.0
	4 – 5	137	68.5
	6 – 7	59	29.5
3.	Use of paddle and shovel for turning during fermentation	91	45.5
4.	**Drying methods**		
	Spreading of cocoa beans on surfaces of tarpaulin to dry	153	76.5
	Use of concrete floor	41	20.5
	Use of roadsides	6	3.0
	Use of elevated surfaces for drying	N/O	
5.	Types of drying use		
	Under direct sunlight	200	100.0
6.	Avoiding shady areas when drying	200	100.0
7.	Avoid contamination	107	53.5
8.	Use of 40kg of wet cocoa beans per square meter of drying area as recommended	N/O	-
9.	Normally turn beans about 5-10 times a day to ensure uniformly dried beans	178	89.0
10.	Always protecting cocoa beans from rain and dew	180	90.0
11.	Mix cocoa beans at different drying stages	181	90.5
12.	Dry to a safe moisture content of between 6.5 - 8%	121	60.5
13.	Normally remove mouldy cocoa beans	97	48.5
14.	Normally avoid contamination by domestic animals during drying	123	61.5
15.	Normally clean drying equipment and tools for dried beans	160	80.0
16.	Normally sort to remove foreign materials or cocoa-related matters	83	41.5