Assessing Good Post-Harvest Practices and Barriers among Cocoa Farmers and Licensed Buying Agents in Southwest, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study assesses the post-harvest practices and barriers among cocoa farmers and Licensed Buying Agents (LBAs) in Southwest Nigeria. The research utilizes primary data collected through structured questionnaires distributed to 200 cocoa farmers and 120 LBAs in the region, analyzed using descriptive statistics and Tobit regression analysis. Findings reveal that although there is a

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high level of awareness of good post-harvest practices among farmers, adoption is hindered by cultural beliefs, labour constraints, and inadequate financial incentives. LBAs face similar challenges, including limited access to information, inadequate infrastructure, and financial constraints. The analysis highlights that education, experience, and access to credit significantly influence the adoption of GPHP among farmers and LBAs, while older age and larger family sizes negatively impact farmers' adoption rates. The study concludes that targeted educational programs and training, improved infrastructure, financial support, strengthened extension services, market stability mechanisms, enhanced regulatory frameworks, and ongoing research and development are essential to improve post-harvest practices in the cocoa sector. These measures will not only enhance the quality and marketability of Nigerian cocoa beans but also contribute to the economic well-being of farmers and the broader community. By addressing the identified barriers and leveraging the influencing factors, the cocoa sector in Southwest Nigeria can achieve significant advancements in post-harvest handling, thereby supporting sustainable development and increasing economic returns.

1. INTRODUCTION

Cocoa (*Theobroma cacao* L.), one of the main cash crops in Nigeria, plays a pivotal role in the economies of many tropical countries, contributing significantly to the livelihoods of small-scale farmers. Nigeria is the world's fourth-largest producer of cocoa, with the majority of its production concentrated in the Southwest region. The importance of cocoa extends beyond agricultural value; it is a vital component of the global chocolate industry, a sector that generate billions of dollars annually. Despite its significance, the cocoa sector in Nigeria faces numerous challenges that undermine its productivity and profitability, especially in the domain of post-harvest practices [1].

The quality of cocoa beans largely depends on the efficacy of post-harvest practices such as fermentation and drying. These practices are critical for developing the flavor profiles and physical properties of the beans, which in turn influence their market value and the economic returns for farmers and Licensed Buying Agents (LBAs). Research has shown that optimal post-harvest handling can significantly enhance the quality of cocoa beans, thereby fetching higher prices on the international market and supporting sustainable economic development in producing regions [2,3].

In Nigeria, especially in the states of Ondo, Cross Rivers, and Osun, where the bulk of cocoa production is concentrated, farmers generally manage small and medium-sized farms that are highly susceptible to fluctuations in international commodity prices. Despite the country's vast potential, the cocoa sector is hampered by aged plantations, poor farm management practices, and inadequate access to markets. Moreover, the lack of adherence to good agricultural and post-harvest practices among farmers and LBAs is a significant issue, often resulting in poor-quality cocoa beans that fail to meet international standards [1].

Again, good post-harvest practices encompass a series of coordinated actions taken after the harvesting of cocoa pods to ensure the quality preservation and enhancement of cocoa beans. These practices include proper pod storage, timely and efficient fermentation, adequate drying, and appropriate storage conditions to prevent contamination and deterioration of beans. Each step in the post-harvest process is crucial; improper practices at any stage can lead to a significant reduction in the quality and economic value of the cocoa beans. For instance, inadequate fermentation or drying can lead to the development of molds and off-flavors, making the beans unsuitable for premium markets [4,3]. Several factors have been identified in the literature that impede the adoption of effective post-harvest techniques in cocoa value chains. Kotey et al. [5] reported that many farmers are not well-informed about the modern post-harvest techniques essential for producing high-quality cocoa beans. There is a dire need for more extensive training and extension services to educate farmers on the importance of good post-harvest practices. According to Fawole and Ozkan [2], the high cost of implementing and maintaining good post-harvest systems, such as fermentation facilities and solar dryers, is a significant barrier. Many

smallholders struggle with financial constraints that limit their capacity to invest in improved technologies and infrastructure. The absence of supportive infrastructure, such as roads and electricity, complicates the transportation and processing of cocoa beans, thereby affecting the overall efficiency of post-harvest handling [3]. The fluctuating demand and prices in the international market also influence farmers' motivation to adopt better practices. When market prices are low, farmers are less likely to invest in costly post-harvest processes, leading to poorer quality outputs [1].

Therefore, this study aims to comprehensively assess the current status of post-harvest practices among cocoa farmers and LBAs in Southwest Nigeria, identify the barriers to adopting these practices, and determine the factors influencing the rate of adoption of good post-harvest practices (GPHP) in the area. By improving post-harvest practices, the cocoa sector in Nigeria can enhance bean quality, increase farmers' income, and contribute more significantly to the regional and national economy. This research will provide valuable insights that can inform policy-making, aid in the design of development programs by international bodies, and foster a more sustainable cocoa supply chain.

2. MATERIALS AND METHODS

The research was conducted in the Southwest region of Nigeria, which is recognized for its significant contribution to the national cocoa output. This region, comprising states like Ondo, Osun, Ekiti, Ogun, and others, provides a pertinent setting for studying cocoa post-harvest practices due to its prominent role in cocoa production. This study utilized primary data sources. Primary data were collected through structured questionnaires distributed to cocoa farmers and Licensed Buying Agents (LBAs) in the selected study areas. The questionnaire covers aspects such as current post-harvest practices, barriers to adopting good practices, and the socio-economic impacts of these practices. A multistage sampling technique was employed to randomly select 200 cocoa farmers and 120 LBAs in the area. The first stage involved two purposive selections of two states based on their high cocoa production volumes. They are Ondo and Osun states. In the second stage, within each selected state, four major cocoa-producing Local Government Areas (LGAs) were randomly chosen. Two communities

in each LGA were randomly selected in the third stage. The fourth stage involved simple random selection. From each community, cocoa farmers and LBAs were randomly selected to participate in the survey. The number of participants from each group was determined based on the total number of active cocoa producers and agents in each area to ensure representativeness. The sample size includes approximately 200 cocoa farmers and 100 LBAs, distributed proportionally across the selected communities based on the size and cocoa production capacity of each area. The data collected from the field were analyzed using statistical software. The analysis includes descriptive statistics to describe the socio-economic characteristics of the participants, summarize the current post-harvest practices, and identify the constraints faced by both groups. To assess the factors influencing the rate of adoption of GPHP in the area, Tobit regression analysis was employed.

The model is specified as:

$$Y^* = Pi\ (Y = 1) = (Fxi) \tag{1}$$

Where: $Y = \beta_0 + \beta_i X_i$
Explicitly,

$$Y^* = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \ldots + \beta_8 X_8 + \mu_i \tag{2}$$

Here, Y^* = Rate of adoption which is the proportion of GPHP adopted by the respondents. That is, the number adopted by a respondent divided by the total number of GPHP recommended.

The independent variables are stated as:

X_1 = Age (in years)
X_2 = Sex (Male= 1, Otherwise= 0)
X_3 = Education level (years)
X_4 = Years of experience (years)
X_5 = Marital status (Married =1, Otherwise =0)
X_6 = Access to credit (Yes= 1 and 0, otherwise)
X_7 = Access to extension agent (Yes= 1 and 0, otherwise)
X_8 = Family size (numbers)

β is a vector of parameters to be estimated; μ is the error term.

3. RESULTS AND DISCUSSION

3.1 Socioeconomic Characteristics

Table 1 outlines various demographic and socioeconomic characteristics of cocoa farmers

and Licensed Buying Agents (LBAs) in the study area. Cocoa farmers have an average age of 52.5 years, while LBAs are slightly older on average, at 53.8 years. Similar findings were reported by Oseni et al. [6] and Adegoroye et al. [7]. This suggests that both groups are relatively mature, which might reflect the experience needed in the cocoa industry. There is a high percentage of males in both groups—78% among cocoa farmers and 85% among LBAs. This indicates that cocoa farming and buying are predominantly male-dominated activities in this region. There is a notable difference in the average years of education between the two groups. Cocoa farmers average 8.8 years of education, which typically represents some secondary education. In contrast, LBAs average 13.0 years, suggesting they often have some level of tertiary education. This higher educational attainment among LBAs could be linked to their roles which might require more formal education for business, regulation comprehension, and negotiation. Both groups have considerable experience, with cocoa farmers averaging 16.7 years and LBAs 15.6 years. This slight difference is minimal, indicating that both roles benefit from years of hands-on experience. Cocoa farmers have slightly larger families (average 5.9 members) compared to LBAs (average 5.5 members). This difference might be related to rural versus more urban settings, where LBAs are likely to be located. A higher percentage of LBAs (86.7%) are married compared to cocoa farmers (60.5%). This could suggest socio-economic stability among LBAs, possibly reflecting better economic conditions or different social norms within their community. Access to agricultural extension services is higher among cocoa farmers (50.8%) than LBAs (35.8%). This likely reflects the more direct involvement of farmers with agricultural practices needing guidance on best practices, pest management, and other agricultural inputs. Access to credit is significantly higher among

LBAs (58.3%) compared to cocoa farmers (37.0%). This may be due to the LBAs' better economic positioning and possibly better documentation and credit histories which are often prerequisites for financial services.

3.2 Expected Good Post-Harvest Practices in Cocoa Production

3.2.1 Received information on good post-harvest practice

Table 2 outlines the distribution of cocoa farmers and licensed buying agents (LBAs) in the study area based on whether they have received information on good post-harvest practices. This result is crucial as it highlights the extent of knowledge dissemination and its potential impact on the quality of cocoa beans produced and handled. A stark contrast exists between farmers and LBAs regarding the receipt of information on good post-harvest practices. While a large majority of farmers (84.0%) have received this information, only a minority of LBAs (35.8%) have been similarly informed. This disparity suggests that training and outreach efforts have been more focused on farmers, potentially neglecting the crucial role of LBAs in the supply chain. The higher level of information received by farmers likely correlates with their better adherence to recommended practices. In contrast, the lower level of information among LBAs could explain the gaps observed in their compliance with best practices, as discussed in previous tables. Thus, ensuring that, both farmers and LBAs are well-informed about good post-harvest practices is essential for improving the overall quality of cocoa beans. This, in turn, can enhance marketability and economic returns for all stakeholders in the cocoa value chain. Similar findings are corroborated with the results such as Oduntan and Adegbuyi [8] and Adesiyan et al. [9].

Table 1. Distribution by the Socioeconomic Characteristics of the Respondents

Variable	Cocoa farmers	LBAs
Age (years)	52.5	53.8
Sex (%Male)	78	85
Education (years)	8.8	13.0
Experience	16.7	15.6
Family size (numbers)	5.9	5.5
Marital status (married)	60.5	86.7
Extension services (%access)	50.8	35.8
Credit access (%yes)	37.0	58.3

Source: field survey, 2024

Table 2. Distribution by receiving information on good post-harvest practices

Response	Farmers		LBAs	
	Frequency	Percentage	Frequency	Percentage
Yes	168	84.0	43	35.8
No	32	16.0	77	64.2
Total	200	100.0	120	100.0

Source: field survey, 2024

3.2.2 Mode of acquiring information on good post-harvest practices

Table 3 provides insights into how cocoa farmers and licensed buying agents (LBAs) acquire information about good post-harvest practices. Only a small fraction (2%) of farmers do not receive any information about good post-harvest practices, indicating that the vast majority have some access to this critical information. However, a significant proportion of LBAs do not receive any information on good post-harvest practices, indicating a gap in information dissemination that needs to be addressed. Agricultural extension services (30.0%) are a significant source of information for farmers, playing a crucial role in educating them about best practices while extension services play a relatively minor (9.2%) role in informing LBAs, suggesting that these services are not as effectively targeted towards LBAs as they are towards farmers. Farmer cooperatives or associations (17.0%) also contribute to information dissemination, though to a lesser extent than extension services, while it was 8.3% in the case of LBAs. The majority of farmers (51.0%) and LBAs (66.7%) receive information through training programs or workshops, highlighting the effectiveness of these organized efforts in providing education on post-harvest practices. The distribution of information on good post-harvest practices reveals that while a majority of farmers and LBAs receive information through organized training programs or workshops, there are significant gaps, particularly among LBAs.

3.2.3 Good post-harvest practices expected of cocoa farmers in the study area

Table 4 outlines the good post-harvest practices expected of cocoa farmers in the study area, detailing how farmers adhere to each practice. About 14.0% of farmers use platforms with cover for fermentation. This method provides better aeration and control over the fermentation process. A majority of 86.0% of farmers use baskets with cover, indicating a preference for this method, which might be more accessible or

traditional. Only 2.0% of farmers ferment cocoa beans for less than 4 days. This short duration might result in under-fermented beans, affecting flavour and quality. Likewise, the majority, 68.5%, ferment beans for 4 to 5 days, aligning with standard practices for optimal fermentation. Nearly 29.5% of farmers ferment beans for 6 to 7 days, which can enhance flavour development but requires careful monitoring to prevent over-fermentation. About 45.5% of farmers use paddles and shovels for turning, which helps ensure even fermentation and aeration of the beans. Nearly 76.5% of farmers spread cocoa on elevated surfaces, preventing contamination and ensuring better drying conditions. All farmers (100.0%) use direct sunlight for drying, a traditional and effective method to reduce moisture content; and avoid shady areas, ensuring consistent exposure to sunlight for uniform drying. Again, just over half (53.5%) of the farmers adhere to practices that prevent contamination during the drying process, indicating that there is room for improvement to ensure that all farmers adopt these crucial practices for maintaining bean quality. Majority (82%) of farmers use the recommended drying area of 40kg per square meter, which is a positive trend towards optimal drying practices that ensure quality and consistency.

Again, 89.0% of farmers adhere to this practice turning of beans 5 – 10 times a day, ensuring uniform drying, preventing mold growth and maintaining the quality of the beans. This practice is essential for achieving the desired moisture content and quality, making the cocoa beans more marketable and reducing post-harvest losses. About 90% of farmers also ensure that cocoa beans are protected from rain and dew. About 90.5% of farmers mix beans at different drying stages. Mixing beans ensures that all beans dry uniformly, preventing some beans from becoming over-dried while others remain too moist. This practice contributes to consistent bean quality, which is important for meeting market standards. Nearly 60.5% of farmers achieve the recommended moisture content of between 6.5 – 8%. Drying beans to the specified moisture content ensures they are

safe for storage and transport, reducing the risk of spoilage and maintaining quality. Proper drying is essential to prevent mold growth and maintain the flavour and aroma of the cocoa beans.

Also, 48.5% of farmers remove moldy beans. Removing moldy beans prevents contamination of healthy beans, maintaining overall quality and safety. This practice ensures that only high-quality beans are marketed, enhancing the reputation and profitability of the farmers' produce. Also, 61.5% of farmers take measures to prevent contamination by domestic animals. Preventing contamination by animals ensures that beans remain clean and free from pathogens, maintaining food safety standards. This practice helps in producing high-quality beans that meet health and safety regulations. About 80.0% of farmers attested to clean their drying equipment and tools. Regular cleaning of equipment prevents cross-contamination and ensures that beans are not exposed to residues or pathogens. This practice is vital for maintaining the hygiene and quality of the cocoa beans. Lastly, 41.5% of the farmers claimed to sort their beans to remove foreign materials. Sorting beans to remove debris, stones, and other foreign materials ensures that the final product is pure and of high quality. This practice is essential for meeting market standards and ensuring consumer safety.

Table 3. Distribution according to the mode of acquiring information on good post-harvest practices

Information about good post-harvest service acquisition	Farmers		LBAs	
	Frequency	Percent	Frequency	Percent
None	4	2.0	19	15.8
Through agricultural extension services	60	30.0	11	9.2
Farmers' cooperation or association	34	17.0	10	8.3
Training programs or workshops organized by cocoa exporters, processors or regulators	102	51.0	80	66.7
Total	200	100.0	120	100.0

Source: field survey, 2024

Table 4. Distribution by expected good post-harvest practices by the farmers

s/n	Good Post-Harvest Practices Expected 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	172	**86.0**
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.	Spreading of cocoa on an elevated surface (not directly on bare ground or concrete floor) to dry	153	**76.5**
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	164	**82.0**
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	83	**41.5**

Source: field survey, 2024

In summary, the adherence to good post-harvest practices among cocoa farmers in the study area is generally fair, with some farmers following key recommendations that ensure the production of high-quality cocoa beans. Practices such as turning beans frequently, protecting them from moisture, and maintaining cleanliness and hygiene are moderately followed, indicating a strong commitment to quality among the farmers. However, there are areas for improvement, particularly in the methods of fermentation, sorting, removing moldy, avoiding contamination, and adherence to recommended drying areas. Increasing training and support from agricultural extension services can help farmers adopt these practices more widely.

3.2.4 Good post-harvest practices expected of LBAs in the study area

Table 5 outlines the good post-harvest practices expected of licensed buying agents (LBAs) in the study area, detailing how the LBAs adhere to each practice. These practices are crucial for ensuring the quality, safety, and marketability of cocoa beans during storage and transportation. Less than half (42.5%) of the LBAs comply to always ensure that cocoa beans are stored in good jute bags. Storing cocoa beans in clean jute bags prevents contamination and allows for proper aeration, maintaining the quality of the beans. This universal compliance indicates a strong adherence to basic hygiene standards among LBAs. About 53.3% of the LBAs claimed that bagged cocoa beans are stored in buildings that are neat, weatherproof, whitewashed, well-ventilated, free from dampness, free from insect pests, free from smoke, and free from contaminants. Ensuring that storage buildings meet these stringent conditions protects the beans from environmental damage and pests, maintaining their quality and safety. About 70.8% affirmed that the cocoa store has dunnages or pallets to avoid direct contact with the bare floor. Using dunnages or pallets prevents moisture absorption from the ground, reducing the risk of mold and other quality issues. However, there is room for improvement to ensure all LBAs adopt this practice. Nearly 64.2% of them normally store cocoa 90cm away from the building wall. Storing cocoa away from walls allows for better air circulation and reduces the risk of moisture accumulation and pest infestation. Increasing adherence to this practice could further improve storage conditions. About 91.7% of the respondents avoid exposing stored cocoa beans to direct sunlight or near heating sources.

Protecting stored beans from heat sources prevents quality degradation and maintains the moisture content within acceptable limits, crucial for preserving bean quality.

Some (60.0%) of the LBAs affirmed that they always re-dry wet cocoa beans to between 6.5 - 8% as recommended. Maintaining the recommended moisture content ensures the beans are safe for long-term storage and reduces the risk of mold growth. About 80.8% of the respondents reported avoiding storing cocoa beans with other produce as they are hygroscopic. Storing cocoa beans separately prevents them from absorbing moisture from other produce, which can spoil the beans. This practice ensures that the beans maintain their quality and do not become damp, which can lead to mold growth and deterioration. The majority (80.0%) of the LBAs disinfect stores once a year followed by 2 times (8.3%) and then 3 times (2.5%). It was reported that about 9.2% of them do not disinfect at all. Regular disinfection is critical to prevent pest infestations and maintain bean quality. The majority of LBAs disinfect their stores at least once a year, which is a good practice. However, increasing the frequency of disinfection could further reduce the risk of contamination and pest issues, ensuring the beans remain in optimal condition. About 57.5% of the LBAs comply with always re-sorting cocoa beans to remove extraneous matters, sieves, defective beans, and so on. Re-sorting ensures that only high-quality beans are stored and transported, maintaining overall quality and market value. This universal compliance indicates a strong commitment to quality control among LBAs.

Also, 96.7% of the respondents always presented cocoa beans for grading by the authorized agents. Thus, regular grading by authorized agents helps maintain quality standards and ensures that the beans meet market requirements. This high level of compliance indicates that LBAs are diligent about maintaining the standards required for market readiness. Also, 96.7% of them always carry out standardization (as standardized cocoa bags should weigh 63.5kg) using a good weighing scale. The implication is that standardizing the weight of cocoa bags ensures uniformity and helps maintain consistency during trade. Proper weighing ensures that transactions are fair and that all parties can trust the accuracy of the weights reported. Similarly, 96.7% affirmed that bags are well stacked and crossed over for

mutual support. Proper stacking of bags prevents them from collapsing and ensures better storage space management and protection of the beans. This practice helps maintain the integrity of the stored beans and prevents losses due to bag damage or spillage. Lastly, 40.8% of the LBAs stated that sewing of cocoa bean bags (19 stitches per bag) to avoid spilling during transportation. The implication is that properly sewn bags prevent spillage and loss during transportation, which is critical for maintaining the quantity and quality of cocoa beans during transit. The relatively low compliance rate suggests that there is significant room for improvement in this area. Ensuring all bags are securely sewn can reduce losses and improve the efficiency of transportation.

In summary, the result shows some level of adherence to many key good post-harvest practices among LBAs, particularly those related to storage cleanliness, proper drying, and cocoa beans standardization. However, there are areas where compliance could be improved, such as the use of dunnages or pallets, proper spacing from the walls, re-sorting, and ensuring all bags are well-sewn to avoid spillage.

3.3 Factors Militating Against Good Postharvest Practices among the Cocoa Farmers and LBAs in the Study Area

3.3.1 Factors militating against good cocoa postharvest practices among the cocoa farmers

Cocoa postharvest practices are critical for ensuring the quality and marketability of cocoa beans. However, various factors can hinder the implementation of good postharvest practices among farmers. Table 6 outlines the constraints perceived by farmers, ranked by their impact based on mean scores from a survey. Cultural and traditional beliefs (ranked 1st) significantly impact postharvest practices. A high percentage of farmers (34.5% each for 'Agree' and 'Strongly Agree') acknowledge that these beliefs influence their practices, suggesting a need for educational interventions to align traditional methods with modern practices. Time constraints (ranked 2nd) are a major barrier, with 57% of farmers agreeing. This indicates that farmers may struggle to allocate sufficient time for optimal postharvest activities, possibly due to competing

demands on their time. Limited labour availability (ranked 3rd) is another significant constraint. The agreement from 57% of farmers underscores the need for mechanization or other labour-saving technologies to improve postharvest handling. A lack of adequate rewards for high-quality cocoa (ranked 4th) discourages farmers from adopting better practices. With 61% agreeing, improving incentives and premium pricing for quality beans could motivate better postharvest handling. Ranking 5th, concerns about weight, which influence payment, are highlighted by 62.5% agreement. This suggests that farmers might prioritize weight over quality, pointing to a need for balanced metrics that reward quality. Buyers' position on good quality cocoa (ranked 6th) where farmers feel that buyers' demands do not always align with quality improvement efforts. With 60.5% agreement, it indicates that market dynamics and buyer expectations should be better aligned with quality standards. Pest and disease pressure (ranked 7th) significantly affects postharvest quality. The 46.5% agreement suggests that better pest and disease management strategies are needed to mitigate this issue. The unavailability of low-cost storage facilities was ranked eighth and it can be deduced that the lack of affordable storage facilities is a barrier, with 28.5% strongly disagreeing with the sufficiency of current storage options. Investment in cost-effective storage solutions is essential. Limited access to information and extension services (ranked 9th) is a notable constraint, with 70% disagreeing that they have sufficient access. Enhancing extension services and information dissemination (ranked 10th) could bridge this gap. Awareness of proper postharvest practices is low and ranked eleventh, with 69.5% disagreeing with their sufficiency. Educational campaigns and training programs are necessary to raise awareness and knowledge. Weak regulatory enforcement (12th rank) affects postharvest quality, with 61.5% strongly disagreeing with the effectiveness of current enforcement. Strengthening regulatory frameworks and enforcement mechanisms is crucial. Market incentives are limited and ranked 13th, as indicated by 48.5% strongly disagreeing. Developing better market incentives could encourage farmers to adopt and maintain good postharvest practices. Inadequate infrastructure and equipment (13th rank) are significant challenges, with 51.5% strongly disagreeing with their adequacy. Investment in infrastructure and equipment is essential for improving postharvest processes. Financial constraints are a pervasive issue (14th rank), with 78% strongly disagreeing

with their financial capability to implement good practices. Access to credit and financial support systems could alleviate this constraint. Fluctuations in market demand and prices (15th rank) are a major concern, with 92% strongly disagreeing with stability. Mechanisms to stabilize prices and demand could reduce uncertainty for farmers. Rank 16th, climate change, and environmental factors are the least concerning for farmers, with 96.5% strongly disagreeing with their impact. This may reflect a lack of immediate perceived impact or awareness among farmers.

In short, the analysis reveals that cultural beliefs, time constraints, labour availability, and inadequate rewards for quality are the top factors hindering good cocoa postharvest practices. Addressing these issues through education, better incentives, improved labour solutions, and enhanced infrastructure could significantly improve postharvest outcomes for cocoa farmers.

3.3.2 Challenges good postharvest practices among the licensed buying agents (LBAs)

Licensed Buying Agents (LBAs) play a crucial role in the cocoa supply chain, influencing the postharvest quality of cocoa beans. Understanding the constraints faced by LBAs can help in developing strategies to improve cocoa postharvest practices. Table 7 provides ranks of the factors based on mean scores from a survey conducted among LBAs. Cultural and traditional beliefs (1st rank) are the most significant constraint, with 42.5% of LBAs agreeing and 22.5% strongly agreeing. This indicates a deep-rooted influence of traditions on cocoa postharvest practices, necessitating targeted awareness campaigns to encourage the adoption of modern techniques. A significant portion of LBAs (43.3%) agree that there is limited awareness of proper postharvest practices (2nd rank). This gap can be bridged by providing more comprehensive training and educational resources to LBAs. Limited access to information and extension services (3rd rank) is a major constraint, with 29.2% of LBAs agreeing. Strengthening extension services and ensuring that LBAs have access to the latest information could improve postharvest practices. Weight concerns (4th rank) are a significant issue, with 35% of LBAs agreeing. This indicates that weight-based payment systems may incentivize practices that prioritize quantity over quality,

suggesting a need for revised payment systems that also reward quality. The position of exporters on good quality cocoa is a constraint for LBAs (5th rank), with 26.7% agreeing. Aligning the expectations of exporters with the realities faced by LBAs can help improve postharvest practices. Time constraints (6th rank) are a notable issue, with 20% of LBAs agreeing and another 20% strongly agreeing. This suggests that LBAs may need more efficient processes or additional support to manage their time better. The position of regulators on quality cocoa poses challenges (7th rank), with 24.2% of LBAs agreeing. Better communication and cooperation between regulators and LBAs could facilitate improved postharvest practices. Labour availability (8th rank) is a constraint, with 40% disagreeing that there is sufficient labour. Implementing labour-saving technologies or providing incentives to attract labour could address this issue. Limited market incentives (9th rank) hinder good postharvest practices, as 42.5% disagree with the adequacy of current incentives. Developing new market incentives that reward quality improvements is essential. Rewards for premium quality are seen as inadequate (10th rank), with 32.5% disagreeing. Enhancing the reward systems for high-quality cocoa could motivate better postharvest practices. The unavailability of affordable storage facilities (11th rank) is a constraint, with 41.7% disagreeing. Investment in low-cost storage options is needed to support LBAs in maintaining cocoa quality. Pest and disease pressure (12th rank) is a concern for 67.5% who strongly disagree with adequate control measures. Improved pest and disease management strategies are necessary. Market demand and price fluctuations (13th rank) are significant issues, with 59.2% strongly disagreeing with market stability. Mechanisms to stabilize market conditions and prices could benefit LBAs. Inadequate infrastructure and equipment are major constraints (14th rank), with 61.7% strongly disagreeing with the sufficiency of current infrastructure. Investment in better infrastructure and equipment is essential. Financial constraints (15th rank) are a pervasive issue, with 69.2% strongly disagreeing with their financial capability to support good practices. Access to financial resources and credit facilities could alleviate this constraint. Climate change and environmental factors (16th rank) are the least concerning for LBAs, with 90% strongly disagreeing with their impact. This may reflect a perception of limited immediate impact, but awareness and mitigation strategies should still be considered.

Table 5. Distribution by expected good post-harvest practices by the LBAs

s/n	Good Post-Harvest Practices Expected of Licensed Buying Agents (LBAs)	Frequency	Percentage
1.	Always ensure that cocoa beans are stored in good jute bags	51	42.5
2.	Bagged cocoa beans are stored in buildings that are neat, weatherproof, whitewashed, well-ventilated, free from dampness, free from insect pests, free from smoke, and free from contaminants	64	53.3
3.	Cocoa store has dunnages or pallets to avoid direct contact with the bare floor	85	70.8
4.	Normally store cocoa 90cm away from the building wall	77	64.2
5.	Avoid exposing stored cocoa beans to direct sunlight or near heating sources	110	91.7
6.	Always re-dry wet cocoa beans to between 6.5-8% as recommended	72	60.0
7.	Avoid storing cocoa beans with other produce as they are hygroscopic	97	80.8
8.	**Number of times do you disinfect stores for storing cocoa beans per year**		
	None	11	9.2
	1	96	80.0
	2	10	8.3
	3	3	2.5
9.	Always re-sort cocoa beans to remove extraneous matters, sieves, defective beans, and so on	69	57.5
10.	Always presenting cocoa beans for grading by authorized agents	116	96.7
11.	Always carry out standardization (as standardized cocoa bags should weigh 63.5kg) using a good weighing scale	116	96.7
12.	Bags are well stacked and crossed over for mutual support	116	96.7
13.	Sewing of cocoa bean bags (19 stitches per bag) to avoid spilling during transportation	49	40.8

Source: field survey, 2024

Table 6. Factors militating against good cocoa postharvest practices (Farmers)

S/N	Constraints	Strongly disagree	Disagree	Indifferent	Agree	Strongly agree	Mean	Rank
1	Cultural and traditional beliefs	7(3.5)	0(0.0)	7(3.5)	69(34.5)	69(34.5)	4.45	1st
2	Time constraints	11(5.5)	32(16.0)	20(10.0)	114(57.0)	23(11.5)	3.53	2nd
3	Labour availability	14(7.0)	45(22.5)	12(6.0)	114(57.0)	15(7.5)	3.36	3rd
4	Inadequate reward for premium quality	32(16.0)	24(12.0)	12(6.0)	122(61.0)	10(5.0)	3.27	4th
5	Weight concerns	48(24.0)	15(7.5)	12(6.0)	125(62.5)	0(0.0)	3.07	5th
6	Buyers position on good quality cocoa	51(25.5)	24(12.0)	4(2.0)	121(60.5)	0(0.0)	2.98	6th
7	Pest and disease pressure	54(27.0)	27(13.5)	17(8.5)	93(46.5)	9(4.5)	2.88	7th
8	Unavailability of low cost storage facilities	57(28.5)	86(43.0)	23(11.5)	34(17.0)	0(0.0)	2.17	8th
9	Limited access to information/extension services	26(13.0)	140(70.0)	30(15.0)	0(0.0)	4(2.0)	2.08	9th
10	Limited awareness to proper information on post harvest practices	34(17.0)	139(69.5)	23(11.5)	0(0.0)	4(2.0)	2.01	10th
11	Low enforcement by regulators	123(61.5)	15(7.5)	27(13.5)	31(15.5)	4(2.0)	1.89	11th
12	Limited market incentives	97(48.5)	61(30.5)	23(11.5)	19(9.5)	0(0.0)	1.82	12th
13	Inadequate infrastructure and equipment challenges	103(51.5)	78(39.0)	6(3.0)	13(6.5)	0(0.0)	1.65	13th
14	Financial constraints	156(78.0)	44(22.0)	0(0.0)	0(0.0)	0(0.0)	1.22	14th
15	Market demand and price fluctuations	184(92.0)	16(8.0)	0(0.0)	0(0.0)	0(0.0)	1.08	15th
16	Climate change and environmental factors	193(96.5)	7(3.5)	0(0.0)	0(0.0)	0(0.0)	1.04	16th

Source: Field Survey, 2024

Table 7. Distribution by factors militating against good cocoa postharvest practices (LBAs)

S/N	Constraints	Strongly disagree	Disagree	Indifferent	Agree	Strongly agree	Mean	rank
1	Cultural and traditional beliefs	24(20.6)	3(2.5)	15(12.5)	51(42.5)	27(22.5)	3.45	1st
2	Limited awareness of proper information on post harvest practices	29(24.2)	35(29.2)	0(0.0)	52(43.3)	4(3.3)	2.73	2nd
3	Limited access to information/extension services	39(32.5)	32(26.7)	0(0.0)	35(29.2)	14(11.7)	2.61	3rd
4	Weight concerns	32(26.7)	28(23.3)	18(15.0)	42(35.0)	0(0.0)	2.58	4th
5	Exporters position on good quality cocoa	40(33.3)	28(23.3)	11(9.2)	32(26.7)	9(7.5)	2.52	5th
6	Time constraints	24(20.0)	54(45.0)	14(11.7)	24(20.0)	4(3.3)	2.42	6th
7	Regulators position on good quality cocoa	40(33.3)	42(35.0)	4(3.3)	29(24.2)	5(4.2)	2.31	7th
8	Labour availability	40(33.3)	48(40.0)	8(6.7)	13(10.8)	11(9.2)	2.22	8th
9	Limited market incentives	40(33.3)	51(42.5)	12(10.0)	6(5.0)	11(9.2)	2.14	9th
10	Inadequate reward for premium quality	47(39.2)	39(32.5)	6(5.0)	28(23.3)	0(0.0)	2.13	10th
11	Unavailability of low cost storage facilities	46(38.3)	50(41.7)	0(0.0)	16(13.3)	8(6.7)	2.08	11th
12	Pest and disease pressure	81(67.5)	26(21.7)	0(0.0)	13(10.8)	0(0.0)	1.54	12th
13	Market demand and price fluctuations	71(59.2)	43(35.8)	0(0.0)	6(5.0)	0(0.0)	1.51	13th
14	Inadequate infrastructure and equipment challenges	74(61.7)	43(35.0)	0(0.0)	3(2.5)	0(0.0)	1.43	14th
15	Financial constraints	83(69.2)	37(30.8)	0(0.0)	0(0.0)	0(0.0)	1.31	15th
16	Climate change and environmental factors	108(90.0)	12(10.0)	0(0.0)	0(0.0)	0(0.0)	1.10	16th

Source: field survey, 2024

The analysis also reveals that cultural and traditional beliefs, limited awareness, and access to information are the top factors hindering good cocoa postharvest practices among LBAs. Addressing these issues through education, better incentives, improved labour solutions, and enhanced infrastructure could significantly improve postharvest outcomes for LBAs and the overall quality of cocoa.

Both farmers and LBAs identify cultural and traditional beliefs as the top constraint, reflecting their pervasive influence on postharvest practices. However, farmers are more affected by time constraints, labour availability, and inadequate rewards for premium quality compared to LBAs. On the other hand, LBAs highlight limited awareness and access to information as major issues. This suggests that while both groups face some common challenges, the severity and nature of constraints differ, necessitating tailored interventions for each group to improve postharvest practices.

3.4 Socioeconomic Factors Influencing the Rate of Adoption of GPHP in the Area

The Tobit regression analysis offers insights into how various socioeconomic factors influence the adoption of Good Post Harvest Practices (GPHPs) among cocoa farmers and Licensed Buying Agents (LBAs) in the study area (Table 8). For cocoa farmers, the regression indicates that age has a significant negative effect on GPHP adoption, with a coefficient of -0.234, suggesting that older farmers are less likely to adopt these practices. Being male significantly increases the likelihood of adopting GPHPs, as indicated by a coefficient of 0.453. Education plays a crucial role, with each additional year of

schooling increasing the adoption rate, underscored by a significant coefficient of 0.345. Experience also contributes positively, albeit more modestly, to adoption with a coefficient of 0.112. A larger family size appears to deter adoption, with a negative coefficient of -0.329, while marital status shows no significant impact.

For LBAs, the pattern differs slightly. Age positively influences GPHP adoption, with a coefficient of 0.119, although this effect is less statistically significant. Education is a strong positive driver, with a high coefficient of 0.599, highlighting the importance of formal education in the adoption process. Experience is another strong positive factor, with a coefficient of 0.418, suggesting that more experienced LBAs are better positioned to implement these practices. Unlike for farmers, family size and marital status have negligible impacts on GPHP adoption among LBAs. Credit access remains a significant positive factor for both groups, but it is more pronounced among LBAs with a coefficient of 0.184. Extension services, interestingly, have a negative influence on LBAs' adoption rates, a departure from the generally expected positive role, indicated by a coefficient of -0.222.

Overall, these results demonstrate that socioeconomic factors like age and sex, education, experience, financial access, and family dynamics play differentiated roles in the adoption of GPHPs among cocoa stakeholders, emphasizing the need for tailored approaches in policy and practice to enhance adoption rates effectively. The results support the views of researchers e.g. Oseni et al. [6], Olutumise et al. [10], Akinbola [11], Oluwalade et al. [12] and Adegoroye et al. [7] on cocoa value chain in Southwest, Nigeria.

Table 8. Results of tobit regression

Variable	Cocoa farmers		LBAs	
	Coefficient	**P-value**	**Coefficient**	**P-value**
Age (years)	-0.234**	0.032	0.119*	0.089
Sex (%Male)	0.453**	0.021	0.207	0.399
Education (years)	0.345***	0.000	0.599***	0.000
Experience	0.112*	0.058	0.418***	0.001
Family size (numbers)	-0.329*	0.078	-0.021*	0.069
Marital status (married)	-0.910	0.121	-0.301	0.113
Extension services (%access)	0.089	0.234	-0.222	0.358
Credit access (%yes)	0.438**	0.022	0.184***	0.002
Constant	-1.232	0.567	2.191	0.017

*Note: *, **, *** means significant at 10%, 5% and 1% levels*

4. CONCLUSION AND RECOMMENDA-TIONS

This study aimed to assess the post-harvest practices among cocoa farmers and Licensed Buying Agents (LBAs) in Southwest Nigeria, identifying barriers to adoption and factors influencing the implementation of Good Post-Harvest Practices (GPHP). The findings highlight that while there is a general awareness of good post-harvest practices among farmers, significant gaps remain in their adoption, primarily due to cultural beliefs, labour constraints, and inadequate rewards for quality. LBAs also face challenges, including limited access to information, inadequate infrastructure, and financial constraints. The socioeconomic analysis revealed that education, experience, and access to credit are critical factors influencing the adoption of GPHP. Conversely, older age and larger family sizes negatively impact the adoption rates among farmers. For LBAs, the role of education and experience is even more pronounced, underscoring the importance of these factors in improving post-harvest practices. Based on the findings of this study, it can be recommended that implementing extensive training programs for both farmers and LBAs focus on modern post-harvest techniques. These programs should be tailored to address the specific needs and gaps identified, such as proper fermentation, drying processes, and storage practices. Again, invest in developing and improving infrastructure, including roads, storage facilities, and drying equipment. Providing access to affordable and efficient post-harvest processing facilities can significantly enhance the quality of cocoa beans. Establish financial support systems and incentives for farmers and LBAs to adopt good post-harvest practices. This could include subsidies for purchasing necessary equipment, access to low-interest loans, and premium pricing for high-quality cocoa beans. Strengthen extension services to ensure continuous support and dissemination of information. Extension agents should be adequately trained and equipped to provide hands-on guidance and support to farmers and LBAs. Develop mechanisms to stabilize market demand and prices for cocoa beans. This could involve setting up cooperatives that can help buffer against price fluctuations and provide a more stable income for farmers and LBAs. Also, enhance the regulatory framework to ensure compliance with good post-harvest practices. Regular monitoring and evaluation, coupled with enforcement of standards, can help maintain the quality of cocoa beans. Promote research and development in the cocoa sector to continuously improve post-harvest practices. This includes studying the impacts of various practices on bean quality and exploring innovative solutions to existing challenges.

5. LIMITATIONS

The study faces limitations such as response bias and the accuracy of responses, particularly in low literacy areas. Efforts were made to mitigate these through the use of local languages for questionnaires and involving community leaders in the data collection process.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

ETHICAL APPROVAL AND CONSENTS

All participants were informed about the purpose of the study, and consent was obtained before administering surveys. Confidentiality and anonymity of the respondents were maintained throughout the study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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