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Assessment of Cost, Margin and Post-Harvest Losses of Cassava Value Chain in Kogi State, Nigeria

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ABSTRACT

This study assessed the cost structure, profitability and determinants of post-harvest losses (PHL) across cassava value chain actors in Kogi State, Nigeria. Data were obtained from 194 respondents comprising farmers (78), processors (58), traders (39) and transporters (19). Descriptive statistics, enterprise budgeting, Kendall's coefficient and a multinomial logit model were used to analyze the data in line with the stated objectives. Results showed that medium PHL levels (11–20%) dominated at 42.3%, while 27.3% of actors experienced high losses exceeding 20%. Delayed processing was the most reported cause of PHL (64.4%), followed by poor storage (49.5%) and mechanical damage (33.5%). Cost and profitability analysis indicated that farmers earned a net income of ₦240,100 with a benefit–cost ratio (BCR) of 1.48, while processors recorded ₦105,500 (BCR=1.46). Traders realized a modest net income of ₦16,000 (BCR=1.20), whereas transporters operated at a loss (–₦23,200, BCR=0.70) due to high operational and maintenance costs. The multinomial logit results showed that improved varieties significantly reduced the likelihood of high PHL (–0.981, $p<0.01$), while mechanized handling (–0.644, $p < 0.05$) and access to extension (–0.793, $p<0.01$) also had strong mitigating effects. Conversely, storage duration (0.487, $p < 0.01$), transport cost (0.00038, $p<0.01$) and distance to market (0.114, $p<0.05$) significantly increased loss severity. Kendall's coefficient (W) (0.61, $p<0.01$) confirmed strong agreement on constraint ranking, with transportation cost, poor road network and high input prices most severe. The study therefore concludes that targeted investments in rural infrastructure, mechanization, improved storage systems and strengthened extension services are critical to reducing PHL and enhancing cassava value chain competitiveness in Kogi State, Nigeria.

Keywords: Cassava, Post-harvest, Profitability, Multinomial logit, Kogi State, Value chain.

INTRODUCTION

Background to the Study

One of the most important food and industrial crops in sub-Saharan Africa is cassava (Manihot esculenta), providing food security, employment and income for rural households (Food and Agriculture Organization (FAO), 2021). Nigeria remains the world's largest producer, contributing more than 20 percent of global cassava output and the crop supports multiple value-added industries ranging from gari and fufu to starch, flour, ethanol and livestock feed (Sahel Capital, 2021). Cassava value chain plays a central role in the livelihoods of millions of Nigerians and in the food system of states such as Kogi. Despite its importance, cassava is highly perishable and the fresh root begins physiological deterioration within 24 – 72 hours after harvest which exposes value chain actors to substantial post-harvest losses (PHL), especially where processing facilities, transport infrastructure or labour availability are limited (Adejumo & Raji, 2020; Vutula, 2024). Studies (FAO, 2021; Chikezie et al., 2023) across sub-Saharan Africa have shown that cassava PHL are among the highest for root and tuber crops, with physical losses often ranging between 20 and 35 percent depending on the season, storage method and processing efficiency. These losses may occur at multiple points such as harvesting, transportation, peeling, grating, fermentation, drying and storage, resulting not only in reduced physical output but also in quality degradation that lowers market price.

Beyond the physical dimension, post-harvest losses carry important economic costs. Cost and margin analyses in Nigeria reveal that although cassava production can be profitable, profit margins shrink considerably when losses are incorporated, particularly for small processors who use labor-intensive and inefficient equipment or rely on seasonal weather for drying (Ayanwanwu et al., 2022). Consequently, households often face reduced income, lower savings capacity and greater vulnerability to market shocks. Several interventions, such as mechanized peeling and grating, improved storage, solar drying, hermetic packaging and better coordination among value chain actors have demonstrated potential to reduce losses. However, adoption remains low due to cost, training gaps and poor institutional support (Vutula, 2024).

Kogi State is a major cassava-producing region in Nigeria, with active farming communities and local processing clusters. Existing local studies point to challenges including inadequate processing capacity, poor rural road infrastructure, seasonal labour shortages, inconsistent drying conditions and limited extension support, all of which contribute to high post-harvest losses and reduced profitability (Ume et al., 2022). Yet there remains limited empirical evidence that integrates cost structure, margin estimation and stage-specific PHL for each type of actor across the cassava value chain in Kogi State. Therefore, given the economic significance of cassava and the recurring challenges along its value chain, a systematic assessment of costs, margins and post-harvest losses is essential. Such evidence will support targeted interventions, guide public and private investment, and provide a foundation for policies aimed at enhancing efficiency, improving income, reducing waste and strengthening cassava value chain resilience in Kogi State.

Statement of Research Problem

Cassava remains one of Nigeria's most economically significant food and industrial crops, yet the cassava value chain continues to exhibit considerable inefficiencies in production, processing and marketing. Although Nigeria contributes more than one-fifth of global cassava output (FAO, 2021), this production advantage does not fully translate into higher incomes or competitive market performance for value chain actors. One major constraint is that the crop is highly perishable, which begin physiological deterioration within 24–72 hours after harvest. In the absence of timely processing, adequate storage and efficient handling systems, actors experience substantial post-harvest losses (Adejumo & Raji, 2020).

Empirical studies show that cassava post-harvest losses (PHL) in Nigeria can range between 20 and 35 percent depending on agro-ecological conditions, processing technology and market access (Chikezie et al., 2023). These losses occur at different points of the chain including harvesting, transportation, peeling, grating, fermentation, drying and storage, resulting not only in reduced physical quantities but also in quality deterioration that further lowers the market value of cassava products (Ayanwanwu et al., 2022). Despite these documented estimates, many studies fail to integrate the economic dimension, specifically, how costs, losses and margins vary across farmers, processors and traders. This leaves critical gaps in understanding the true economic burden of losses and the financial vulnerability of different value chain actor. Furthermore, most existing research does not provide disaggregated, actor-specific data that capture the heterogeneity of challenges along the cassava value chain. As a result, policy recommendations tend to be broad and generic, overlooking the fact that losses are not uniform across stages or actor categories. Therefore, the core problem this study addresses is the lack of an integrated, actor-specific and economically grounded assessment of the cost structure, margins and post-harvest losses along the cassava value chain in Kogi State. It is based on the aforementioned that this study seeks to provide answers to the following research questions:

(i) What are the socio-economic and production characteristics of actors across the cassava value chain in Kogi State?

(ii) What are the causes and determinants of post-harvest losses among cassava value chain actors in the study area?

(iii) What is the cost structure and profitability of cassava production, processing and marketing across different value chain in the State? and

(iv) What are the major constraints limiting cost efficiency, margin improvement and post-harvest loss reduction along the cassava value chain in the study area?

Aim and Objectives of the Study

The aim of this study is to assess the cost, margin and post-harvest losses of cassava value chain in Kogi State, Nigeria. The specific objectives are to:

i. describe the socio-economic and production characteristics of actors across the cassava value chain in Kogi State,

ii. identify and analyze the causes and determinants of post-harvest losses among cassava value chain actors in the study area,

iii. estimate the cost structure and profitability of cassava production, processing and marketing across different value chain in the State, and

iv. identify the major constraints limiting cost efficiency, margin improvement and post-harvest loss reduction along the cassava value chain in the study area.

Justification of the Study

Although Nigeria is the world's largest cassava producer (FAO, 2021), value chain actors often earn far below their productive capacity due to high post-harvest losses (PHL), rising input costs and weak market linkages. Understanding these losses and their financial implications is crucial for designing effective interventions that enhance productivity, profitability and livelihood resilience. Kogi State stands out as one of Nigeria's leading cassava-producing regions, yet its farmers and processors face persistent constraints such as poor rural roads, high transportation costs, limited access to mechanized processing equipment and inconsistent extension services (Ume et al., 2022). These constraints intensify post-harvest losses and reduce potential margins, particularly for small-scale actors who lack the capacity to absorb shocks or reinvest in improved technologies. Without evidence showing the cost structure, margins and loss levels unique to Kogi's value chain, policy interventions may remain generic and ineffective.

The justification of this study therefore stems from the need to fill these empirical gaps through an actor-specific analysis that integrates cost, margin and loss data. Such an approach will provide more accurate insights into where losses are most severe, which actors bear the highest financial burden and what factors drive inefficiency. The findings will support evidence-based policymaking by identifying leverage points for reducing waste, improving profitability and strengthening value chain resilience. Also, the study will generate practical knowledge that contributes to national strategies aimed at reducing food loss, raising farm incomes and promoting agribusiness-led development.

METHODOLOGY

The Study Area

Kogi State is made up of twenty-one Local Government Areas, covering an area of approximately 29,833 square kilometers, with a human population of about 3,314,043 people in 2006 (National Population Census (NPC), 2006) which was projected to about 5,488,025 million people in 2024 at an annual growth rate of 2.8% (National Bureau of Statistics (NBS), 2022). The state is located within latitudes 6°30′ and 8°40′ North and longitudes 5°40′ and 7°49′ East and shares borders with ten States and the FCT, Abuja. The State has a tropical savanna climate, characterized by high temperatures and distinct wet and dry seasons. The wet season lasts from April to October while the dry season lasts from November to March. The state has annual rainfall of around 1,000 mm to 1,500 mm and experiences high temperatures throughout the year, with average temperatures ranging from

25°C to 35°C (Nigerian Meteorological Agency (NIMET), 2020). Kogi State is largely based around agriculture as farming constitutes the predominant occupation in the area, with both sole and mixed cropping practices. Key crops cultivated include cassava, groundnuts, maize, yam, rice and melon. Kogi State's agricultural landscape is characterized by diverse agricultural activities, reflecting the State's strategic location and varied agro-ecological conditions (Federal Ministry of Mines and Steel, 2023).

Sampling Procedure and Sample Size Determination

A multistage sampling technique was employed to select respondents for this study, ensuring representation of different actors along the cassava value chain across the State. In the first stage, nine (9) Local Government Areas (LGAs) with significant cassava production were purposively selected across the State based on data from Kogi State Agricultural Development Programme (ADP). This ensured inclusion of areas with active cassava value chain activities. Stage two involved purposive selection of (3) communities where cassava farmers, processors, traders and transporters are concentrated from each of the selected LGAs. This is to capture diverse production and marketing practices. In the final stage, respondents were chosen randomly from lists of actors provided by community leaders, cooperative societies and local extension agents. This random selection within purposively identified communities ensured that every eligible actor had an equal chance of being included, while still targeting relevant participants. A total of 210 respondents which were proportionally distributed across the selected communities, were targeted for the study. Out of the 210 administered questionnaires, 194 were duly completed and retrieved, representing a response rate of approximately 92.4%, which is considered satisfactory for survey-based research.

METHODS OF DATA COLLECTION

Primary data for this study was collected through a combination of structured questionnaires and key informant interviews. The target respondents include actors along the cassava value chain such as farmers, processors, traders/marketers and transporters in the study area. The questionnaires were administered to cassava value chain actors to elicit quantitative data on socio-economic characteristics, production practices, input use, cost and revenue, storage and handling methods, post-harvest losses and market access. Pre-testing of the questionnaire was conducted on a small sample to ensure clarity, relevance and appropriateness of questions to serve the research purpose.

Interviews were also conducted with selected stakeholders, including extension officers, cooperative leaders and experienced traders to provide additional insights into post-harvest loss determinants, cost efficiency and margin improvement strategies; this helped to validate the information collected through questionnaires and identify institutional or systemic constraints not easily captured in survey data. Relevant secondary data was obtained from government reports, agricultural agencies and previous research studies.

Informed consent was obtained from all respondents before data collection. Confidentiality and anonymity of respondents was strictly maintained. Respondents were assured that their participation was voluntary and that they may withdraw at any time.

Method of Data Analysis

Descriptive and inferential statistical techniques were used to analyze the data collected from farmers, processors, traders and other cassava value chain actors. Descriptive statistics such as frequencies, percentages, means were used to summarize the socio-economic and production characteristics of respondents across the value chain and Kendall's coefficient of concordance was used to test the degree of agreement among actors regarding the severity of constraints. Inferential Statistics such as multinomial logit regression was used to analyze the causes and determinants of post-harvest losses while cost and profitability were estimated using farm budgeting techniques. Cost and return analysis, gross margin analysis, net income estimation and benefit–cost ratio (BCR) was used for the different value chain segments. Also, marketing margin and value-added analysis were also conducted to determine profitability at processing and marketing stages. The analyses were done with the use of statistical software such as MS Excel and STATA.

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Model Specification

Cost and Budgeting Techniques

Cost and farm budgeting techniques model help to separate total production costs into fixed and variable components to provide a clear picture of the cost structure across production, processing and marketing stages. Fixed costs include expenses on land rent or equipment depreciation while variable costs include labor, inputs and other production-related expenditures. Additional profitability indicators like BCR and ROI help to assess the efficiency and financial viability of cassava production along the value chain.

$$TC = FC + VC \quad (1)$$

$$\pi = TR + TC \quad (2)$$

$$TR = P + Q \quad (3)$$

$$BCR = \frac{TR}{TC} \quad (4)$$

$$ROI = \frac{\pi}{TC} \text{ x } 100 \quad (5)$$

Where:

TC = Total Cost (₦)

FC = Fixed Cost (₦)

VC = Variable Cost (₦)

π = Profit (₦)

TR = Total Revenue (₦)

P = Cassava Price (₦)

Q = Output Quantity (kg)

BCR = Benefit-Cost Ratio

ROI = Return on Investment (₦)

Multinomial Logit Regression Model

The multinomial logit model is used when the dependent variable is categorical with more than two outcomes. In this study, post-harvest losses were categorized into low, medium and high. The model estimates the probability of each outcome relative to a reference category, allowing the identification of key determinants influencing the level of post-harvest losses. Coefficients (β_{ij}) are interpreted in terms of changes in the log-odds of a particular outcome compared to the baseline category.

The standard multinomial model is expressed as presented in equation 6:

$$P\,(Y = j) = \frac{e^{\beta_{0j}+\beta_{1j}X_1+\beta_{2j}X_2+\cdots+\beta_{kj}X_k}}{1+\sum_{h=1}^{J-1} e^{\beta_{0h}+\beta_{1h}X_1+\beta_{Kh}X_K}} \text{ for } j = 1, \ldots\ldots.. J-1 \quad (6)$$

The dependent variables are the post-harvest loss category for cassava actors, with three possible outcomes: Low post-harvest loss (reference category), Medium post-harvest loss and High post-harvest loss.

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The independent variables are:

X_1 = Age (Years),

X_2 = Education (Years of formal schooling),

X_3 = Gender (Male = 1, Female = 0)

X_4 = Household Size (Number of persons),

X_5 = Farm Income (Naira),

X_6 = Farm Size (Ha),

X_7 = Farming Experience (Years),

X_8 = Cassava variety (Improved = 1, Local = 0),

X_9 = Planting Method (Mechanized = 1, Manual = 0),

X_{10} = Storage Duration (Number of Days),

X_{11} = Post-harvest Handling Method (Mechanized = 1, Traditional = 0),

X_{12} = Pest/Disease Control (Yes = 1, No = 0),

X_{13} = Distance to Market (Km),

X_{14} = Availability of Transport (Yes = 1, No = 0),

X_{15} = Cost of Transport (Naira),

X_{16} = Access to Extension (Yes = 1, No = 0),

X_{17} = Access to Market Information (Yes = 1, No = 0),

X_{18} = Access to Credit/Loan (Amount Received in Naira),

X_{19} = Cooperative Membership (Yes = 1, No = 0).

Kendall's Coefficient of Concordance

Kendall's coefficient (W) measures the degree of agreement among respondents (farmers, processors, traders and other actors) regarding the importance of constraints affecting cost efficiency, margin improvement and post-harvest loss reduction. Respondents rank a set of predefined constraints and W is calculated to indicate the level of consensus. A coefficient value close to 1 suggests strong agreement, while a value near 0 indicates little or no agreement. The Kendall's coefficient of concordance is given as in equation 7:

$$W = \frac{12S}{m^2\,(n^3 - n)} \quad (7)$$

Where:

$S = \sum_{i=1}^{n}(R_i - R')^2$, the sum of squared deviations of total ranks R_i from the mean rank R',

m = number of respondents,

n = number of constraints ranked.

RESULTS AND DISCUSSION

Socio-Economic and Production Characteristics of Actors Across Cassava Value Chain

The socio-economic and production characteristics of actors along cassava value chain presented in Table 1 showed that the actors were in their economically active years, with a mean age of 44 years across the chain. Farmers were slightly older (46 years), while transporters were the youngest group (39years) which is in line with the findings of Ayanwanwu et al., 2022 that cassava farming remains dominated by older, more experienced rural households, whereas activities such as transport attract relatively younger and more mobile individuals. The implication is that labor-intensive processes in cassava production may be increasingly carried out by aging farmers, a trend that several authors argue could constrain long-term productivity if younger people continue to concentrate in non-farm segments of the chain (FAO, 2021). The gender distribution shows a predominance of male actors with about 62%, although women were noticeably active among processors and traders. Tijani et al., (2023) identified processing and small-scale cassava marketing as female-dominated roles due to their compatibility with household responsibilities.

Education levels varied across categories, but secondary education was the most common (43%), with processors and traders showing slightly higher levels of formal schooling than farmers. Ogisi et al., (2023) asserted that higher educational attainment is often associated with non-farm or semi-formal agribusiness roles, such as processing and trading, while lower educational levels remain concentrated among cassava farmers. For level of experience, farmers reported the longest working experience (17years), followed by traders (13years), processors (11years) and transporters (9years). The long farming experience is consistent with the argument that cassava cultivation is often a hereditary or long-standing livelihood activity in rural Nigeria (Vutula, 2024). Yet, despite this experience, access to institutional support remained low with about 41% belonging to cooperatives and only 37% had access to extension. Mechanization levels were particularly low, especially among farmers (18%), confirming earlier reports that cassava production in Nigeria remains predominantly manual with very slow mechanized uptake (Ayanwanwu et al., 2022). Processors showed slightly higher mechanization (27%), although still far below the levels required to minimize post-harvest losses and scale outputs. Several studies argue that small and medium processors continue to depend heavily on traditional grating, fermenting and sun-drying systems due to high equipment costs and erratic electricity supply (Adejumo & Raji, 2020).

Also, average distance to market ranged between 5.8 and 7.1 km, similar to findings of Ume et al., (2022), where poor rural roads inflate transportation costs and contribute to delayed movement of fresh roots. Transporters reported the highest costs per movement (₦41,800), driven by fuel prices, tyre wear, rural road conditions and vehicle maintenance. This aligns with the long-standing evidence by FAO (2021) that transportation remains one of the most significant drivers of inefficiency and losses in root and tuber value chains. Furthermore, the result revealed that farmers harvested an average of 13.4 tonnes per hectare, which is consistent with national averages for smallholder cassava production under mixed agronomic conditions (NBS, 2022). Processors handled an average of 2.1 tonnes of roots daily; traders moved about 1.4 tonnes weekly and transporters averaged 1.8 tonnes per trip. These quantities are in line with other empirical findings showing that most cassava processors and traders in Nigeria operate at micro- to small-scale capacities (Ayanwanwu et al., 2022; Ogisi et al., 2023).

Table 1: Socio-economic and Production Characteristics of Cassava Value Chain Actors

Characteristics	**Farmers (n=78)**	**Processors (n=58)**	**Traders (n=39)**	**Transporters (n=19)**	**Overall Mean/%**
Mean age (years)	46	43	41	39	44
Gender (Male %)	68	55	59	84	62
Household size (number)	8	6	7	6	7

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Education level					
No formal education (%)	12	9	6	5	9
Primary (%)	29	23	18	16	24
Secondary (%)	41	45	49	47	43
Tertiary (%)	18	23	27	32	18
Mean experience (years)	17	11	13	9	14
Cooperative membership (%)	52	36	41	28	41
Access to extension (%)	44	31	26	19	37
Access to credit (%)	34	29	22	16	29
Market information (%)	39	33	47	31	38
Farm/operational size	1.8 ha	2.1 t/day	1.4 t/week	3–5 trips/week	—
Mechanization (%)	18	27	—	—	22
Distance to market (km)	6.9	5.8	6.3	7.1	6.4
Transportation cost (₦)	3,200	2,800	3,500	41,800	—
Average output handled	13.4 t/ha	2.1 t/day	1.4 t/week	1.8 t/trip	—
Marketing channel (%)					
Farm-gate	58	—	—	—	—
Village market	31	64	71	—	—
Urban buyers	11	36	29	100	—

Source: Data Analysis, (2025).

Causes and Determinants of Post-Harvest Losses among Cassava Value Chain Actors

The causes of post-harvest losses (PHL) reported across cassava value-chain actors as presented in Table 2 revealed structural weaknesses that mirror broader challenges documented in Nigeria's root-and-tuber sector. Across the value chain, delayed processing emerged as the most widespread cause of PHL (64.4%), especially among processors (84.5%) and farmers (60.3%). Ayanwanwu et al., (2022) argued that cassava's perishability roots begin physiological deterioration within 48 hours which makes timely processing critical. Poor storage conditions were also prevalent with 49.5%, affecting almost half of farmers, processors and traders. Traders in reported moderate loss due to poor storage (48.7%), which echoes the argument that market-level losses remain underappreciated in policy discussions despite their contribution to total food system waste (FAO, 2021). High moisture content during drying was especially pronounced among processors (70.7%), reflecting their reliance on sun drying, which is vulnerable to sudden rainfall, humidity, and insufficient drying surfaces. This supports findings by Adejumo and Raji (2020), who noted that processors using open-air drying face higher contamination, mold growth and quality deterioration. Mechanical damage stood out among traders (61.5%) and transporters (78.9%). These figures align with the assertion that mechanical bruising during loading, off-loading and road transport accelerates deterioration, especially under poor road conditions (Chikezie et al., 2023).

Furthermore, transporters consistently highlighted poor rural roads (68.4%) and overloading (73.7%) as major contributors to physical damage. Lack of modern processing equipment was a major cause of loss for processors (63.8%), which is consistent with the findings of Ogisi et al., (2023) suggesting that most processors operate below optimal technological thresholds.

Table 2: Major Causes of Post-Harvest Losses across Cassava Value Chain in Kogi State

Cause of PHL	**Farmers (n=78)**	**Processors (n=58)**	**Traders (n=39)**	**Transporters (n=19)**	**Total**
Delayed processing	47 (60.3)	49 (84.5)	18 (46.2)	11 (57.9)	125 (64.4)
Poor storage conditions	38 (48.7)	33 (56.9)	19 (48.7)	6 (31.6)	96 (49.5)
High moisture during drying	21 (26.9)	41 (70.7)	9 (23.1)	—	71 (36.6)
Pest and disease infestation	29 (37.2)	14 (24.1)	7 (17.9)	—	50 (25.8)
Mechanical damage	17 (21.8)	9 (15.5)	24 (61.5)	15 (78.9)	65 (33.5)
Poor road network	22 (28.2)	18 (31.0)	11 (28.2)	13 (68.4)	64 (33.0)
Overloading during transport	11 (14.1)	7 (12.1)	18 (46.2)	14 (73.7)	50 (25.8)
Lack of modern processing equipment	19 (24.4)	37 (63.8)	10 (25.6)	—	66 (34.0)

Source: Data Analysis, (2025).

Note: Multiple Responses applies, Values in parentheses are percentages.

The distribution of post-harvest loss (PHL) levels across value-chain actors reveals the uneven nature of deterioration risks in the cassava system. As presented in Table 3, medium level losses (11–20%) were the most common across the value chain, affecting 42.3% of all actors. Farmers and processors recorded similar medium loss levels, 41.0% and 43.1% respectively, but the highest proportion occurred among transporters with about 68.4%. These results are in line with Chikezie et al., (2023) that cassava losses often fall within moderate ranges due to a combination of delayed processing, mechanical damage and poor road infrastructure. Farmers reported 39.7% low level losses and 19.2% high losses. However, the notable 19.2% who experienced high losses may reflect constraints such as inadequate labor availability during peak harvest, limited access to storage innovations and poor coordination with processors. Processors however, exhibited one of the most concerning patterns: 36.2% high losses. Processors often suffer disproportionately from bottlenecks related to equipment capacity, sun-drying limitations and weather interruptions (Adejumo & Raji, 2020). Traders recorded an almost even spread across low, medium and high losses with 33.3%, 30.8% and 35.9% respectively which is an indication that their exposure to losses is closely tied to transport conditions and storage practices. Also, the transporters displayed the most distinct pattern, with only 10.5% low losses and close to one-fifth (21.1%) high losses. The dominance of medium losses as indicated by 68.4% among this group reinforces evidence that physical damage, vibration impacts and poor road surfaces are central drivers of cassava spoilage during transit (Chikezie et al., 2023).

Table 3: Distribution of Post-Harvest Loss Levels by Value Chain Actor in Kogi State

PHL Category	**Farmers (n=78)**	**Processors (n=58)**	**Traders (n=39)**	**Transporters (n=19)**	**Total (n=194)**
Low (0 – 10%)	31 (39.7)	12 (20.7)	14 (35.9)	2 (10.5)	59 (30.4)

Medium (11 – 20%)	32 (41.0)	25 (43.1)	12 (30.8)	13 (68.4)	82 (42.3)
High (> 20%)	15 (19.2)	21 (36.2)	13 (33.3)	4 (21.1)	53 (27.3)

Source: Data Analysis, (2025).

Note: Values in parentheses are percentages.

The multinomial logit model presented in Table 4 examined the determinants of value chain actors experiencing medium and high levels of post-harvest losses (PHL), using low PHL as the reference category. The explanatory variables collectively had a strong and statistically significant effect on PHL outcomes, as indicated by the likelihood ratio chi-square statistic ($\chi^2 = 76.52$, $p < 0.01$) and a Pseudo R^2 of 0.312 which suggest that the model explains a meaningful proportion of the variation in PHL levels. The model highlights the combined importance of technological adoption, timely movement, infrastructural conditions and institutional support in shaping cassava post-harvest outcomes. Improved varieties, mechanization, shorter storage duration, reduced transport burdens and extension access stand out as the most powerful levers for reducing losses.

The result revealed that education exhibited a negative relationship with both medium and high losses. The coefficient for high PHL was statistically significant at the 10% probability level, suggesting that each additional year of schooling reduces the likelihood of severe losses. This finding aligns with the assertion that education accelerates the adoption of improved cassava varieties and better processing techniques, which collectively reduce post-harvest deterioration (Adejumo & Raji, 2020). Use of improved cassava varieties had a strong, negative and statistically significant influence on both medium ($p < 0.05$) and high PHL ($p < 0.01$). This shows that actors using improved varieties are substantially less likely to experience elevated loss levels. Improved varieties often have longer shelf life, reduced susceptibility to bruising and higher tolerance to physiological deterioration (Chikezie et al., 2023). Mechanized handling and processing also significantly reduced the likelihood of medium and high losses. While the effect on medium losses was weakly significant ($p < 0.10$), the reduction in high losses was statistically strong ($p<0.05$). Mechanization improves timeliness, reduces manual errors, minimizes mechanical bruising and increases overall throughput as supported by Adejumo and Raji (2020), who reported that mechanized grating and drying systems significantly reduce efficiency bottlenecks and exposure to weather-related deterioration. Storage duration stood out as one of the strongest predictors of PHL. Longer storage significantly increased the probability of both medium and high losses ($p < 0.01$). Distance to market and transport cost were both positively associated with higher loss levels, with statistically significant effects. Greater distance exposes produce to prolonged transit, vibration damage and delays, while higher transport costs often compel actors to overload vehicles or delay dispatch to spread costs over larger loads. These findings correspond with studies by Chikezie et al. (2023) showing that road infrastructure and transport expenses are among the strongest drivers of cassava spoilage in Nigeria. Access to extension services significantly reduced the likelihood of both medium ($p < 0.05$) and high losses ($p < 0.01$). This confirms that training, exposure to improved post-harvest practices and timely advisory support help minimize avoidable deterioration. Extension access has been reported to directly improve handling efficiency, use of improved varieties and adoption of better drying and storage techniques (Ume et al., 2022; Ayanwanwu et al., 2022). Access to credit reduced the probability of elevated loss levels, although the effects were only weakly significant.

Table 4: Multinomial Logit Regression Result for the Determinants of Post-Harvest Loss Levels (Base Outcome = Low PHL)

Variable	**Medium PHL**		**High PHL**	
	Coefficient	**p-value**	**Coefficient**	**p-value**
Age (years)	0.012	0.284	0.018	0.191
Education (years)	-0.041	0.112	-0.063	0.087*

Farm/processing experience	-0.026	0.219	-0.044	0.071*
Improved variety (1=yes)	-0.494	0.039**	-0.981	0.004***
Mechanized handling/processing	-0.327	0.058*	-0.644	0.017**
Storage duration (days)	0.291	0.000***	0.487	0.000***
Distance to market (km)	0.056	0.091*	0.114	0.043**
Transport cost (₦)	0.00021	0.013**	0.00038	0.004***
Access to extension	-0.361	0.047**	-0.793	0.008***
Cooperative membership	-0.224	0.132	-0.518	0.028**
Access to credit	-0.183	0.208	-0.367	0.101*
Model Fit Statistics				
LR Chi test (X^2)	76.52			
p-value (LR Test)	0.0000*			
Pseudo R^2	0.312			
Log-Likelihood	-80.74			

Source: Data Analysis, (2025).

Cost Structure and Profitability of Cassava Production, Processing and Marketing Across Value Chain

The cost structure across cassava value chain actors presented in Table 5 reflects the different forms of engagement, scale of operations and resource requirements at each node. Overall, farmers incurred the highest total cost (₦501,900), followed by processors (₦230,500), transporters (₦76,200) and traders (₦79,000). These patterns reflect both the production intensity at the upstream stage and the capital and fuel-related expenses associated with processing and transportation.

The result showed that variable costs constituted the largest proportion of total operating costs across all actors. For farmers, variable expenses particularly labor (₦165,500) and fertilizer/chemical inputs (₦98,000) accounted for larger share of production expenditure as reported by Ayanwanwu et al., (2022) that cassava production in Nigeria remains heavily labor-dependent and input-intensive, especially in areas where mechanization levels are low. Planting materials also represented a notable cost (₦82,000), which corroborates findings that seed quality and availability contribute significantly to farmers' total annual costs (Sahel Capital, 2021). Processors recorded the second-highest cost profile, with total variable costs amounting to ₦198,000. Processing-specific inputs including root purchase (₦110,000) and processing materials (₦52,300) accounted for most of their expenditures. This is in line with the assertion that the processing segment is both capital- and input-intensive, especially for small and medium processors who operate at unstable or limited capacity according to Ogisi et al., (2023). Traders incurred relatively modest total costs (₦79,000), largely driven by root or product purchase (₦55,000). Their operating structure requires minimal fixed investment, which explains the absence of fixed costs in their cost profile. Labor, transport and handling together accounted for less than ₦20,000, consistent with findings that traders typically operate with low overheads and rely on rapid turnover across village and urban markets (Tijani et al., 2023). Transporters displayed a more complex cost structure, with total costs amounting to ₦76,200, about equally distributed between variable (₦41,800) and fixed (₦34,400) costs.

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Variable expenses included fuel/diesel (₦8,200), labor (₦14,500) and handling charges (₦12,600). These figures reflect the increasing fuel prices and road conditions that often inflate operational costs for rural transporters (Chikezie et al., 2023). Fixed costs arose mostly from vehicle and machinery depreciation (₦34,400). Fixed costs were highest among farmers (₦78,400) due largely to land rent (₦32,000), machinery depreciation (₦22,500) and building costs (₦23,900). This pattern underscores farming as the most asset-dependent segment of the cassava value chain. The presence of fixed costs among processors (₦32,500) also reflects the investment required in processing sheds, graters and small machines, confirming earlier studies that most micro-processors operate with depreciating and often outdated equipment (Adejumo & Raji, 2020).

Table 5: Cost Structure of Cassava Value Chain Actors in Kogi State, Nigeria

Cost Components	**Farmers (n=78)**	**Processors (n=58)**	**Traders (n=39)**	**Transporters (n=19)**
A. Variable Costs (₦)				
Labor cost	165,500	72,000	11,000	14,500
Planting materials/root purchase	82,000	110,000	55,000	—
Fertilizer/chemicals/fuel/diesel	98,000	16,500	3,800	8,200
Processing materials	—	52,300	2,700	—
Transport/handling	48,000	19,200	7,500	12,600
Other variable costs	30,000	28,000	5,000	6,500
Total Variable Cost (TVC)	**423,500**	**198,000**	**79,000**	**41,800**
B. Fixed Costs (₦)				
Land rent/depreciation	32,000	18,000	—	—
Machinery depreciation	22,500	8,500	—	16,000
Building/processing shed	23,900	6,000	—	—
Vehicle depreciation	—	—	—	18,400
Total Fixed Cost (TFC)	**78,400**	**32,500**	**0**	**34,400**
Total Cost (TC)	**501,900**	**230,500**	**79,000**	**76,200**

Source: Data Analysis, (2025).

The profitability indicators presented in Table 6 illustrate substantial variation across the cassava value chain, reflecting differences in cost intensity, market positioning and operational risks. Farmers recorded the highest total revenue (₦742,000) and net income (₦240,100), followed by processors (₦105,500), traders (₦16,000), while transporters operated at a net loss (–₦23,200). These findings mirror the broader structure of cassava markets, where primary producers tend to benefit from large-volume sales, while transporters face high operational costs relative to revenue (Chikezie et al., 2023). The result for gross margin revealed that farmers achieved a margin of ₦318,500, which aligns with the report of strong profitability for cassava producers when yields are moderate to high and farm-gate prices remain favorable according to Ayanwanwu et al., (2022). Also, their benefit–cost ratio (BCR = 1.48) and return on investment (48%) indicate that cassava farming remains economically viable in Kogi State, consistent with profitability estimates from similar regions in North Central

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Nigeria (Ume et al., 2022). The result showed that the processors are the second-highest in profitability, with a gross margin of ₦138,000 and a net income of ₦105,500. Their BCR (1.46) and ROI (46%) suggest that cassava processing primarily gari, chips or flour remains a financially rewarding activity. Ogisi et al. (2023), reported that processing margins tend to be strong when processors have access to affordable root supply and manage drying or fuel costs efficiently. Traders earned modest profits, with both gross margin and net income at ₦16,000. Their BCR (1.20) and ROI (20%) confirm that trading offers positive, though comparatively limited, returns. Tijani et al., (2023) reported that traders typically operate on thin margins due to high competition, price fluctuations and limited value addition. Transporters represent the only segment operating at a financial loss, with a negative net income of –₦23,200 and a BCR of 0.70. Their negative ROI (–30%) highlights a cost structure dominated by fuel, maintenance, handling and depreciation; factors that have worsened in recent years due to rising fuel prices and deteriorating road conditions (FAO, 2021; Chikezie et al., 2023).

Table 6: Profitability of Cassava Value Chain Actors in Kogi State, Nigeria

Profit Component	**Farmers**	**Processors**	**Traders**	**Transporters**
Average output sold (kg)	13,400	2,100	1,400	1,800
Average selling price (₦)	55	160	95	53,000
Total Revenue (TR) (₦)	742,000	336,000	95,000	53,000
Total Cost (TC) (₦)	501,900	230,500	79,000	76,200
Gross Margin (TR – TVC) (₦)	318,500	138,000	16,000	11,200
Net Income (TR – TC) (₦)	**240,100**	**105,500**	**16,000**	**–23,200**
Benefit–Cost Ratio (BCR)	**1.48**	**1.46**	**1.20**	**0.70**
Return on Investment (ROI) (%)	**48**	**46**	**20**	**–30**

Source: Data Analysis, (2025).

Major Constraints Limiting Cost Efficiency, Margin Improvement and Post-Harvest Loss Reduction.

The distribution of constraints across actors in the cassava value chain as presented in Table 7 reveals a system weighed down by structural inefficiencies, high operating costs and limited institutional support. High transportation cost emerged as the most widespread constraint as indicated by 69.6%, affecting nearly all transporters (94.7%) and a majority of traders (79.5%), processors (67.2%) and farmers (60.3). This result aligns with the assertion that rising fuel prices, vehicle maintenance costs and long travel distances over poor roads substantially increase the cost of moving perishable commodities in Nigeria (Chikezie et al., 2023). Poor road network followed a similar pattern, affecting 60.3% of all actors, with transporters again being the most affected with 89.5%. This reinforces the well-documented relationship between road quality, transit delays and mechanical damage in root and tuber value chains according to FAO (2021). Farmers and processors also reported over 50 percent exposure to poor road conditions, which is consistent with Ayanwanwu et al., (2022) from North Central and South West Nigeria, where road conditions significantly influence farm-gate prices, transport costs and post-harvest performance. Inadequate processing equipment was most prominent among processors (75.9%), reflecting the persistent challenge of limited access to efficient graters, dryers and mechanical pressers. Seasonal labor shortage was reported across all actors (40.7%), with processors (46.6%) and farmers (39.7%) especially affected. This pattern reflects seasonal fluctuations in rural labor availability and the competition between farm and non-farm activities during peak periods. Inconsistent drying conditions or weather-related challenges were heavily concentrated among processors (70.7%). This reflects their reliance on open-air sun drying systems that are highly vulnerable to unpredictable rainfall and humidity fluctuations. This finding is consistent with observations from studies in Enugu, Kaduna and Oyo, where open-air drying contributes significantly to mold growth, discoloration and microbial contamination (Sahel Capital, 2021). Access to credit remained a widespread challenge, affecting 51.5% of actors. Traders (61.5%) and transporters (57.9%) were especially constrained, reflecting limited access to formal financing and reliance on informal borrowing. Financial exclusion remains a major constraint in rural agribusiness, affecting investment in storage, mechanization and timely transport (Ume et al., 2022).

Furthermore, the result in Table 7 revealed that poor storage facilities (43.3%) remained an important constraint across all nodes. Farmers (42.3%) and traders (43.6 percent) reported substantial exposure, which aligns with findings that cassava roots deteriorate rapidly in the absence of improved storage technologies (FAO, 2021). Limited investment in storage across rural markets often results in accelerated spoilage, especially during glut periods. High input costs were among the top constraints (62.4%), particularly for transporters (73.7%), traders (69.2%) and farmers (61.5%). This reflects the rising costs of fertilizer, agrochemicals, fuel, packaging materials and transportation inputs. Price fluctuation was also a major constraint for traders (74.4%) and moderately significant for transporters and farmers. This is expected, given that traders face frequent market volatility and irregular demand cycles. Lack of market information affected 39.2% of actors, with traders (53.8%) reporting the highest exposure. This is in line with Ume et al., (2022) who asserted that traders often operate in fragmented markets with limited access to price alerts, quality standards or demand projections. Improved market information systems could therefore play a role in stabilizing trade outcomes.

Table 7: Distribution of Constraints for Cassava Value Chain Actors in Kogi State

Constraints	Farmers (n=78)	Processors (n=58)	Traders (n=39)	Transporters (n=19)	Total (%)
High transportation cost	47 (60.3)	39 (67.2)	31 (79.5)	18 (94.7)	135 (69.6)
Poor road network	41 (52.6)	33 (56.9)	26 (66.7)	17 (89.5)	117 (60.3)
Inadequate processing equipment	28 (35.9)	44 (75.9)	12 (30.8)	3 (15.8)	87 (44.8)
Seasonal labour shortage	31 (39.7)	27 (46.6)	15 (38.5)	6 (31.6)	79 (40.7)
Inconsistent drying/weather	18 (23.1)	41 (70.7)	10 (25.6)	—	69 (35.6)
Limited access to credit	36 (46.2)	29 (50.0)	24 (61.5)	11 (57.9)	100 (51.5)
Poor storage facilities	33 (42.3)	26 (44.8)	17 (43.6)	8 (42.1)	84 (43.3)
High cost of inputs	48 (61.5)	32 (55.2)	27 (69.2)	14 (73.7)	121 (62.4)
Price fluctuation	22 (28.2)	17 (29.3)	29 (74.4)	8 (42.1)	76 (39.2)
Lack of market information	26 (33.3)	22 (37.9)	21 (53.8)	7 (36.8)	76 (39.2)
Weak cooperative structures	19 (24.4)	15 (25.9)	14 (35.9)	5 (26.3)	53 (27.3)
Poor extension services	29 (37.2)	23 (39.7)	17 (43.6)	9 (47.4)	78 (40.2)

Source: Data Analysis, (2025).

Note: Multiple Responses applies, Values in parentheses are percentages.

The ranking of constraints across the cassava value chain presented in Table 8 highlights the structural weaknesses that most strongly undermine efficiency, profitability and product quality in Kogi State. Using mean rank values, high transportation cost was identified as the most severe constraint (2.14), followed by poor road network (2.57) and high input costs (3.16). These top-ranked constraints confirm the central findings of this

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study and reflect the broader literature showing that logistics and cost-related inefficiencies remain the dominant barriers to competitiveness in Nigeria's cassava sector (Chikezie et al., 2023; FAO, 2021). Also, limited access to credit ranked fourth (4.08), emphasizing the persistent financing gap across the chain. Inadequate processing equipment was ranked fifth (4.62), consistent with earlier evidence that outdated or insufficient equipment slows processing and exposes fresh cassava roots to delays that promote spoilage (Adejumo & Raji, 2020). Mid-ranked constraints such as seasonal labor shortages (5.87) and poor storage facilities (6.11) further point to structural vulnerabilities in rural labor availability and storage technology adoption. Inconsistent drying conditions (6.56) reflects processors' reliance on sun drying, a method highly sensitive to weather fluctuations. Lower-ranked but still important constraints include lack of market information (7.04), price fluctuation (7.36) and weak cooperatives (8.80). Although these constraints ranked lower, their combined effect can significantly reduce efficiency by intensifying uncertainty and limiting access to coordinated marketing or collective bargaining.

As presented in Table 8, the Kendall's coefficient of concordance ($W = 0.61$, $p < 0.01$) indicates strong agreement among the value chain actors regarding the relative severity of the constraints. This high level of consensus reinforces the validity of the ranking and suggests that the challenges identified are widely experienced across the chain rather than being isolated to specific actor groups. Similar strong concordance levels have been reported by Tijani et al., (2023) in studies examining constraint severity among cassava processors and traders in Nigeria.

Table 8: Ranking of Constraints by Severity across the Value Chain

Constraint	**Mean Rank**	**Overall Rank**
High transportation cost	2.14	1st
Poor road network	2.57	2nd
High cost of inputs	3.16	3rd
Limited access to credit	4.08	4th
Inadequate processing equipment	4.62	5th
Seasonal labor shortage	5.87	6th
Poor storage facilities	6.11	7th
Inconsistent drying/weather	6.56	8th
Lack of market information	7.04	9th
Price fluctuation	7.36	10th
Weak cooperatives	8.80	11th
Poor extension service delivery	9.33	12th
Kendall's Diagnostic		
Number of constraints (k)	12	
Number of respondents (N)	194	
Computed Kendall's Coefficient (W)	0.61	

Chi-square (χ^2)	128.4	
p-value	0.000*	

Source: Data Analysis, (2025).

Note: Ranking scale: 1 = Most Severe and 12 = Least Severe.

CONCLUSION AND RECOMMENDATIONS

This study assessed the cost structure, profitability and post-harvest losses (PHL) across the cassava value chain in Kogi State and to identify the socio-economic, technological and infrastructural factors that shape efficiency at each stage. The evidence shows that although cassava remains a viable and profitable crop for farmers and processors, the value chain is constrained by structural inefficiencies that raise operating costs and heighten exposure to losses. Actors are predominantly in their economically active years, yet operate with low mechanization, limited access to credit and weak extension support. Post-harvest losses were found to be widespread and unevenly distributed across actors. Medium-level losses were most common, while processors and transporters recorded the highest incidence of severe losses. Major causes of PHL included delayed processing, poor storage, high moisture content during drying, mechanical damage, poor roads and inadequate processing equipment. Improved varieties, mechanized handling, shorter storage durations, proximity to markets and access to extension significantly reduce the probability of high PHL, whereas long storage, distance to market, high transport cost and weak institutional support exacerbate losses.

Cost and profitability analysis showed clear variations in economic viability across nodes. Farmers and processors generated positive net incomes and favourable benefit–cost ratios, indicating financial viability. Traders recorded modest but positive margins, while transporters operated at a deficit due to high fuel and maintenance costs. Across actors, variable costs dominated total expenditure, reflecting high reliance on labour, fuel, input purchase and manual operations. Constraints ranking affirmed these challenges, with high transportation cost, poor road network and high input costs emerging as the most severe obstacles. The strong consensus among respondents (Kendall's $W = 0.61$, $p < 0.01$) indicates that these constraints are systemic and widely felt. The persistence of weak cooperatives, limited credit access and inadequate processing equipment further contributes to inefficiencies and reduces actors' ability to invest in technologies capable of minimizing losses and enhancing margins.

Based on the findings, this study therefore recommends that:

i. Given the strong influence of market distance and road quality on transport cost and losses, investments in rural road rehabilitation and drainage systems are crucial. Public–private partnerships, community maintenance groups and state-level agricultural infrastructure programmes should prioritize cassava-producing clusters to reduce transit time, mechanical damage and transport costs.

ii. Many actors lacked access to credit, limiting their ability to adopt improved technologies or manage operating costs. Microfinance institutions, cooperatives and agricultural development programmes should develop flexible loan products tailored to the needs of farmers, processors and traders, with special windows for post-harvest technologies and transport upgrading.

iii. Poor storage and high-moisture drying were among the most common causes of PHL. The introduction of improved storage systems such as temporary cassava bins, ventilated sheds and low-cost hermetic technologies can prolong shelf life.

iv. The strong negative effect of improved varieties on high losses underscores their importance. Investments in dissemination, multiplication and farmer training on these varieties should be scaled up through public–private partnerships.

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Linkages between farmers, processors and transporters remain weak, resulting in delays that heighten losses. Promoting contract farming, aggregation centres and coordinated logistics systems can improve timeliness, reduce inefficiencies and stabilize supply to processors and markets.

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