



DETERMINANTS OF VEGETABLE LOSS AND WASTE ALONG MARKETING CHANNELS IN PLATEAU STATE, NIGERIA: EVIDENCE FROM A MULTIPLE REGRESSION MODEL

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ABSTRACT

This study employed multiple regression analysis to determine the causes of vegetable loss and waste among 360 marketers across 16 vegetable markets in nine Local Government Areas of Plateau State, Nigeria, during the 2022 cropping season. Five predictor variables were modelled: mode of transportation, distance to market, storage system quality, marketing experience, and vegetable shelf life. The model explained 69.6% of the total variation in vegetable loss ($R^2 = 0.696$; $F = 12,055.51$; $p < 0.001$). All five variables were statistically significant ($p < 0.001$), with marketing experience as the largest contributor ($\beta = -0.265$; 26.5% contribution), followed by transportation ($\beta = -0.260$; 26.0%), shelf life ($\beta = -0.148$; 20.2%), storage system ($\beta = -0.158$; 15.8%), and distance to market ($\beta = 0.081$; 8.1%). Collectively, these factors account for 69.6% of all vegetable losses in the Plateau State marketing system. The findings provide a nuanced, evidence-based framework for targeting post-harvest loss reduction investments, prioritising interventions that address marketers' experience and training, transportation infrastructure, vegetable shelf-life extension, storage improvement, and market accessibility.

Keywords: Post-harvest, Loss, Determinants, Vegetable, Marketing, Transportation.

INTRODUCTION

Reducing post-harvest losses is one of the most cost-effective pathways to improving food security without expanding the agricultural production frontier (Nishad *et al.*, 2024). Globally, approximately one-third of food produced for human consumption about 1.3 billion tonnes annually is lost or wasted across the supply chain (Marimuthu, 2024). For vegetables, which are among the most perishable commodity categories, post-harvest losses in developing countries commonly exceed 50% (FAO, 2025; Kader and Marimuthu, 2024). In Nigeria, these losses contribute to reduced food availability, depressed farm incomes, and compromised nutritional security. Plateau State, a leading vegetable-producing region, is particularly vulnerable to post-harvest losses due to its inland geographic position, underdeveloped rural road network, limited cold chain infrastructure, and reliance on traditional storage and marketing systems. Despite these challenges, the specific causal architecture of vegetable losses, that is, the relative contribution of different supply chain factors to total loss has not been rigorously quantified for Plateau State. This knowledge gap limits the precision with which interventions can be designed and prioritised. This study addresses the gap by estimating a multiple regression model of vegetable loss determinants, providing both effect direction and magnitude for each causal factor, enabling evidence-based prioritisation of post-harvest loss reduction investments.

The conceptual framework draws on the FAO post-harvest loss model, which identifies loss drivers as broadly classifiable into: (1) biological and environmental factors (including commodity perishability and atmospheric conditions); (2) mechanical factors (including transport and storage systems); (3) economic factors (including market information, pricing, and distance to market); and (4) human capital factors (including marketing knowledge, experience, and skills). The following a priori hypotheses were tested: Transportation mode positively and significantly influences vegetable loss; Distance to market positively influences vegetable loss; Quality of storage system negatively influences vegetable loss; Marketing experience negatively influences vegetable loss; and Vegetable shelf life negatively influences vegetable loss.



METHODOLOGY

The Study Area

Plateau State was created out of the then Benue-Plateau State on February 3, 1976 by the Murtala Mohammed Regime. Its capital is Jos. Jos the original name of 'Gwosh' was wrongly pronounced as 'Jos' by the Hausa who settled on the site and turned it into a trading centre. Plateau State gets its name from the Jos Plateau, a mountainous area in the north of the State with captivating rock formations. The population of the State was 4,807,509 (Nigerian Informer, 2026) Bare rocks are scattered across the grasslands, which cover the plateau. The altitude ranges from around 1,200 meters (about 4000 feet) to a peak of 1,829 meters above sea level in the Shere Hills range near Jos. Plateau State has led to a reduced incidence of some tropical diseases such as malaria. The Jos Plateau, makes it the source of many rivers in northern Nigeria including the Kaduna, Gongola, Hadejia and Yobe rivers Located in North Central Nigeria, Plateau State occupies 30,913 square kilometers. Plateau State shares boundaries with Kaduna State to the North, Kaduna and Nasarawa States to the East, Benue to the South, and Taraba State to the East. Plateau State is located between latitude ($9^{\circ}21'82'' - 9^{\circ}45'50''$) North and longitude ($8^{\circ}37'31'' - 9^{\circ}51'74''$) East (Harris *et al.*, 2014; Solomon, 2024). Although situated in the tropical zone, the higher altitude gives Plateau State a near-temperate climate, with an average temperature between 13°C and 22°C . Harmattan winds cause the coldest weather between December and February, with the warmest temperatures usually occurring in the dry season months of March and April. The mean annual rainfall varies between 1,317 mm in the southern part to 1,460 mm on the plateau, with the highest rainfall during the wet season in July and August (Ojumu *et al.*, 2024).

The agricultural economy of Plateau State is predominantly agrarian, covering an estimated land area of 53,585.89 square kilometres, with about two-thirds being arable. Major food crops cultivated include Irish potatoes, sweet potatoes, chili pepper, tomatoes, various vegetables, cereals, legumes, roots and tubers, and tree crops such as coffee, cashew, citrus, mangoes, and guava (Elijah, 2020).

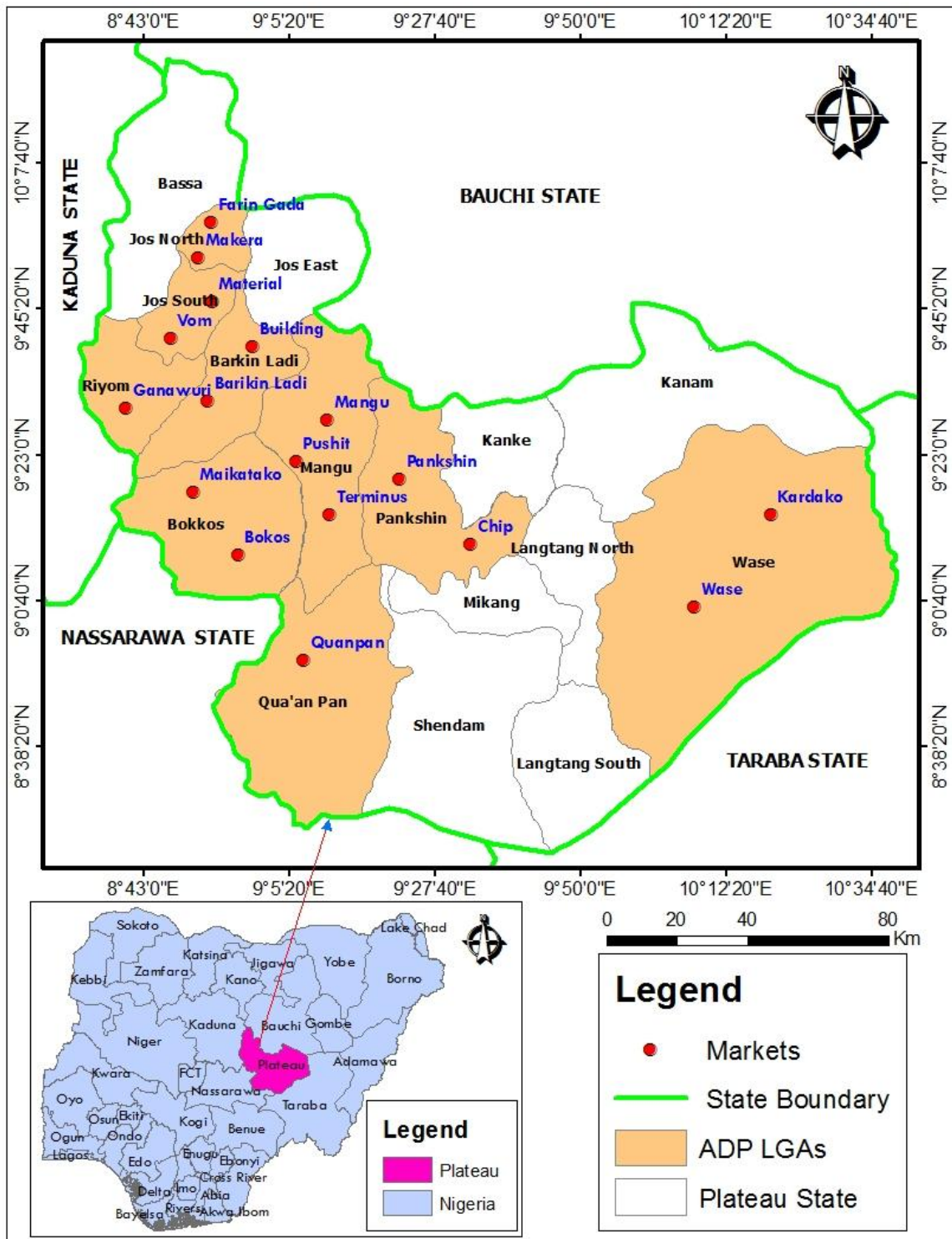


Figure 1: Map of the Study Area showing the Selected L.G.As

Sampling Procedure and Sample size

The study employed a multi-stage sampling technique involving purposive, proportionate, and random sampling methods to select participants across Plateau State.



In stage 1: Nine vegetable-producing Local Government Areas (LGAs) were purposively selected across three Agricultural Development Programme (ADP) zones. From these, sixteen specific vegetable markets were identified based on their prominence in vegetable marketing;

Stage 2: Sample size for each market was determined proportionately based on the total population of marketers in each location to ensure representative coverage; and

Stage 3: A total of 360 marketers were randomly selected from the identified markets.

The sampling frame and size distribution across ADP, L.G.As and markets in Plateau State is presented in Table 1.

Table 1: Sampling and Size Distribution across ADP, LGAs and Markets in Plateau State

| ADP | LGA | Market | Number of sampled Marketers | Number of Marketers Fully Participated |
|-------|-------------|--------------------|-----------------------------|--|
| 1 | Barkin Ladi | Barkin Ladi | 30 | 28 |
| | | Building Materials | 24 | 22 |
| | Jos –South | Vom Market | 13 | 10 |
| | | Farin gada | 44 | 41 |
| | Riyom | Makera | 20 | 20 |
| | | Ganawuri | 11 | 10 |
| 2 | Bokkos | Bokkos | 30 | 30 |
| | | Maikatako | 20 | 20 |
| | Mangu | Mangu | 33 | 33 |
| | | Pushit | 16 | 14 |
| | Pankshin | Terminus | 22 | 19 |
| | | Chip | 13 | 12 |
| 3 | Quanpan | Pankshin | 25 | 25 |
| | | Quanpan | 32 | 32 |
| | Wase | Kardako | 12 | 12 |
| Wase | | 15 | 15 | |
| Total | | | 360 | 343 |

Source: Field Survey (2022)

Method of Data Collection

Primary data were collected from 360 vegetable marketers across 16 markets in nine LGAs of Plateau State during the 2022 cropping season. Market visits were conducted bi-monthly over 12 months. Structured questionnaires captured data on estimated vegetable loss, transportation mode, distance from source to market, storage system type, years of marketing experience, and vegetable type (as a proxy for shelf life in days).

Model Specification

The empirical model was specified as:

$$EVL = \beta_0 + \beta_1MT + \beta_2DM + \beta_3SS + \beta_4ME + \beta_5VT + \mu$$

Where EVL = Estimated Vegetable Loss (dependent variable); MT = Method of Transportation (nominal: head load=1, bicycle=2, motorcycle=3, van/pickup=4); DM = Distance to Market (km); SS = Storage System (nominal: sack=1, basket=2, plastic container=3); ME = Marketing Experience (years); VT = Vegetable Type (shelf life in days). Collinearity diagnostics included Variance Inflation Factors (VIF) and tolerance values.

RESULTS AND DISCUSSION

Model Fitness

The regression model demonstrated strong overall explanatory power. The F-statistic of 12,055.51 ($p = 0.000$) confirms statistical significance. The R-square of 0.696 and adjusted R-square of 0.733 indicate that the five variables jointly explain approximately 69.6–73.3% of the variation in vegetable loss along the marketing channel. The Durbin-Watson statistic of 2.016 confirms the absence



of serial autocorrelation in residuals. VIF values were all below 10 and tolerance values exceeded 0.1 for all variables, confirming the absence of problematic multicollinearity.

Transportation (Contribution: 26.0%)

Transportation was a statistically significant negative determinant of vegetable loss ($\beta = -0.260$, $t = -13.684$, $p = 0.001$). The negative coefficient indicates that improvements in transportation mode reduce loss; conversely, deterioration in transport quality increases loss by 26.0%. This is the second-largest contributor to vegetable loss in the study area and reflects the pervasive impact of poor road infrastructure and inadequate vehicle conditioning on produce quality during transit. The finding is consistent with Atman *et al.* (2025) who established mechanical injuries during transport as a primary driver of post-harvest losses in Nigerian vegetable markets.

Distance to Market (Contribution: 8.1%)

Distance to market was a statistically significant positive determinant of vegetable loss ($\beta = 0.081$, $t = 4.500$, $p = 0.002$). The positive coefficient confirms that as the distance from vegetable sources to markets increases, loss and waste increase by 8.1%. This reflects the cumulative exposure of produce to unfavourable atmospheric conditions, handling damage, and time-dependent deterioration during longer supply journeys. Markets sourcing vegetables from distant, remote production areas are therefore structurally disadvantaged in terms of loss management. This corroborates Atman *et al.* (2025) and Gandaa (2022) found distance to market to be driver of vegetable loss.

Storage System (Contribution: 15.8%)

Storage system quality was a statistically significant negative determinant of vegetable loss ($\beta = -0.158$, $t = -9.875$, $p = 0.001$). Better storage systems reduce vegetable loss by 15.8%, while poor storage increases loss by a corresponding magnitude. Traditional storage in sacks and baskets — commonly used by marketers in Plateau State — provides inadequate protection against temperature fluctuations, mechanical damage, and microbial contamination. Although lower than the 46.76% contribution reported by Bakari and Usman (2015) for a two-variable model, storage quality remains a significant and actionable loss driver.

Marketing Experience (Contribution: 26.5% — Largest Contributor)

Marketing experience was the single largest contributor to vegetable loss variation ($\beta = -0.265$, $t = -11.522$, $p = 0.000$). This negative coefficient confirms that more experienced marketers record significantly lower losses. Each additional year of marketing experience is associated with a reduction in loss, capturing the cumulative effect of tacit learning about optimal procurement volumes, handling techniques, market timing, and loss-coping strategies. This finding underscores the critical role of human capital accumulation in post-harvest loss management (Atman *et al.*, 2025; Nakwe *et al.*, 2018).

Vegetable Shelf Life (Contribution: 20.2%)

Vegetable shelf life was a statistically significant negative determinant of loss ($\beta = -0.148$, $t = -37.000$, $p = 0.000$). Commodities with shorter shelf lives — including tomato, spinach, spring onion, and leafy vegetables experienced disproportionately higher losses than those with longer shelf lives such as onion, shombo, and cucumber. This confirms that the biological characteristics of the vegetable commodity interact with handling and market conditions to amplify or moderate loss risk (Marimuthu *et al.*, 2024).



Table 2: Regression Analysis on Causes of Loses and Waste of Vegetable in the Vegetable Markets in Plateau State

| Model | Unstandardised Coefficients | | T-value | Sig. | Collinearity Statistics | |
|----------------------------|-----------------------------|------------|----------|------|-------------------------|-------|
| | B | Std. Error | | | Tol | VIF |
| (Constant) | .609 | .120 | 5.075 | .001 | | |
| Transportation | -.260*** | .019 | -13.684 | .001 | .982 | 1.019 |
| Distance to Market | .081*** | .018 | 4.500 | .002 | .994 | 1.006 |
| Storage System | -.158*** | .016 | -9.875 | .001 | .991 | 1.01 |
| Market Experience | -.265*** | .023 | -11.522 | .000 | .983 | 1.017 |
| Shelf Life | -.148*** | .004 | -37.000 | .000 | .345 | 1.005 |
| R square | 0.696 | | | | | |
| Adjusted R | 0.733 | | df | | 5, 337 | |
| Std. Error of the Estimate | 0.48288 | | F-Anova | | 12055.51 | |
| Durbin-Waston | 2.016 | | P(Anova) | | 0.000 | |

a. Dependent Variable: Estimated Vegetable Loss,

Source: Field Survey (2022)

CONCLUSIONS AND RECOMMENDATIONS

This study establishes that marketing experience, transportation quality, vegetable shelf life, storage system, and distance to market collectively determine vegetable loss along marketing channels in Plateau State, Nigeria. In addition, the primacy of marketing experience (a human capital variable) underscores that post-harvest loss reduction requires not only physical infrastructure investment but equally important investment in the knowledge and skills of market actors.

Evidence-based policy recommendations include:

- (1) implementation of structured apprenticeship and mentorship programmes connecting novice marketers with experienced counterparts;
- (2) targeted road rehabilitation on key vegetable supply routes;
- (3) public provision of communal modern storage infrastructure at major market points;
- (4) promotion of longer-shelf-life vegetable varieties during peak rainy season supply periods; and;
- (5) market access improvement through the development of feeder roads connecting distant production areas to consumption centres.

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