

Assessment of Tomato Post-Harvest Losses in Selected Nigerian Markets

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Abstract

Post-harvest losses (PHL) of tomatoes represent one of the most critical challenges confronting agricultural market systems in Nigeria. While substantial attention has focused on farm-level production constraints, limited empirical evidence documents where in the marketing chain losses predominantly occur and which physical and logistical determinants drive them. This study assessed the stage distribution, transport conditions, packaging practices, and seasonal patterns of post-harvest tomato losses among 297 traders across seven purposively selected markets in seven Nigerian states: Kaduna, Lagos, Enugu, Adamawa, Gombe, Kwara, and Rivers. A survey research design was employed, and primary data were collected using a structured questionnaire, supplemented by field interviews with tomato market union officials and traders. Descriptive statistics, including frequencies, percentages, and mean scores with standard deviations, were used for analysis. A one-way ANOVA revealed significant differences in weekly basket losses across trader groups with different selling-frequency habits ($F(4,292) = 5.090$, $p = 0.001$). Findings revealed that transport to market (ranked 1st) and market storage/display (ranked 2nd) were the dominant loss stages. The late dry season/irrigation period (February-April) recorded the highest losses (63.6%). Buses were the most commonly cited transport vehicles (Ranked 1st by 106 respondents), while traditional raffia baskets dominated packaging (254 respondents). Among ten rated loss factors, vehicle spoilage/breakdown (Mean = 4.21) and weather conditions (Mean = 4.13) were ranked as the most significant contributors. The study concludes that post-harvest tomato losses in Nigerian markets are primarily driven by transport-stage deterioration and market-level storage deficits, with vehicle spoilage, weather, and poor road conditions as the dominant rated factors, and that the absence of cold-chain infrastructure and modern packaging perpetuates these losses across all markets studied. It recommends improving transport infrastructure, introducing cold-chain logistics, and adopting protective packaging can mitigate PHL.

Keywords: Post-harvest losses, tomato value chain, transport determinants, market storage, cold chain

Introduction

Tomato (*Solanum lycopersicum*) is one of the most widely cultivated vegetable crops globally, valued for its economic importance, nutritional benefits, and versatility in culinary applications. It is rich in antioxidants such as lycopene, β -carotene, polyphenols, and ascorbic acid and is consumed raw or processed into various products. The crop also serves as a primary source of income and employment for millions of smallholder farmers (Anokye-Alexander et al., 2025; Wakene & Sharew, 2024). With an annual global production exceeding 188 million tonnes in 2024, tomato ranks as the second-most-produced vegetable crop after potatoes and is cultivated extensively across Asia, Europe, Africa, and the Americas (Food and Agriculture Organization of the United Nations [FAO], 2025; FAO, 2026).

Post-harvest loss (PHL) refers to the measurable reduction in the quantity and quality of a given product between harvest and consumption (FAO, 2018; Ncube, 2025). In developed countries,

tomato PHL typically ranges from 5–15%, while in developing countries, especially in Africa, losses range from 30–50% due to inadequate infrastructure, poor packaging, and inefficient transport (Goka et al., 2021; Tiwari et al., 2020; Wongnaa et al., 2023).

Nigeria produced approximately 3.73 million tonnes of tomatoes in 2024, ranking it second in Africa after Egypt and 10th in the world (Our World in Data, 2026). However, despite its economic importance, the Nigerian tomato value chain faces a significant challenge due to an alarmingly high PHL, which, therefore, affects food security (Bukar *et al.*, 2022). There exist critical knowledge gaps regarding where in the marketing chain losses are most severe and which logistical and physical factors drive them most significantly. This study addresses these gaps by examining post-harvest tomato losses as reported by traders across selected markets in Northern and Southern Nigeria.

The study was conducted across seven purposively selected markets in seven Nigerian states, capturing variation in market typologies, infrastructure conditions, and regional contexts. Importantly, Nigeria's tomato supply chain is characterised by long inter-state transit routes, with markets in southern and central states sourcing predominantly from production zones in Kano, Katsina, Kaduna, Gombe, and Adamawa, making transport conditions a central determinant of loss outcomes. The specific objectives of this study are to: (i) identify the stages along the tomato marketing value chain where post-harvest losses predominantly occur; (ii) assess the physical, transport, and seasonal factors influencing post-harvest tomato losses in the selected markets; and (iii) examine the loss-reduction practices adopted by traders and their effectiveness. The study's findings align with Sustainable Development Goal (SDG) Target 12.3, which calls for halving food loss along supply chains by 2030 (United Nations, 2015), and with Nigeria's National Tomato Policy (2022-2026), which targets a reduction in post-harvest losses as a national agricultural priority.

Review of Literature

Empirical evidence on tomato post-harvest losses globally and in Nigeria consistently identifies transport, packaging, and seasonal dynamics as the principal loss drivers. In Bangladesh, Sarma (2018) estimated chain-wide tomato losses at 22.9%, attributing reductions in losses to improved transport and higher sale prices. Rakesh et al. (2022) in Karnataka, India, found 23.23% cumulative losses with transportation as the leading cause across all actor levels. Mukantwali et al. (2018) in Rwanda recorded 56% losses driven by overripe harvesting, mechanical damage, and absence of cooling, with plastic crates demonstrating a strong cost-benefit advantage. Njume et al. (2020) in Cameroon estimated 20-40% rainy-season losses linked to raffia basket injuries, poor logistics, and delayed farm evacuation. Hotegni et al. (2023) in southern Benin found that storage under ambient conditions caused losses exceeding 15% within three days at the semi-wholesale level, with traders coping through price discounting rather than physical discard. In Nigeria, Ojimi et al. (2021) surveyed 120 tomato marketers across five Ibadan markets and reported average daily losses of 18.9%, driven by poor packaging, storage deficits, over-ripeness, and bad roads, with sorting and grading as the universal coping practice. Williams (2022) documented losses of approximately 50% in Akinyele LGA, Oyo State, attributing them to poor road infrastructure and mechanical transit damage. Salisu et al. (2021) in Katsina State found mean losses of 29.6%, highest at the market level (13.9%) due to heat and low patronage, and at transport (9.4%) from poor roads. Korie et al. (2023) in Kaduna State reported that 100% of farmers used raffia baskets, while adoption of modern packaging was below 4%, with car/truck ownership identified as a significant mitigant of transit losses. Collectively, these studies confirm that post-harvest tomato losses in Nigeria are primarily a logistical and infrastructure problem

rather than a farm-level one, and that transport, packaging, and seasonal supply-demand imbalances are the most tractable intervention areas

Research Methods

This study employed a survey research design to assess the stage distribution, transport determinants, and seasonal patterns of post-harvest tomato losses among traders in selected Nigerian markets. The study was conducted across seven purposively selected tomato markets in seven Nigerian states as shown in Figure 1 and Table 1.

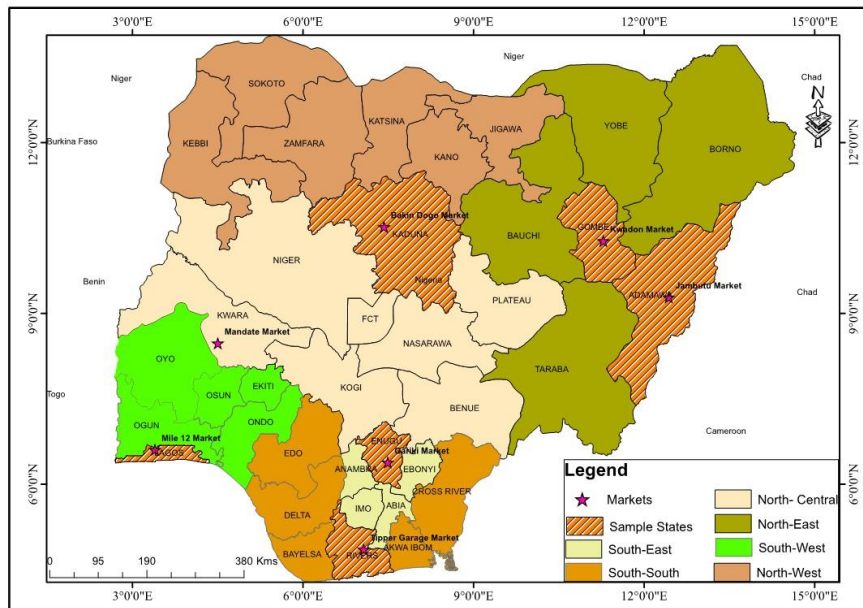


Figure 1: Sampled Markets in Nigeria (2026)

Table 1: Location of Sampled Markets

S/No	Market	LGA	State	Region	Coordinate)
1.	Bakin Dogo Market	Kaduna North	Kaduna State	Northwest	Lat 10.523°N, Long 7.426°E
2.	Kwadon Market (Kasuwan Gwari)	Yamaltu-Deba	Gombe State	Northeast	Lat 10.276°N, Long 11.283°E
3.	Jambutu Vegetables Market	Jimeta/Yola	Adamawa State	Northeast	Lat 9.287°N, Long 12.434°E
4.	Mandate Market	Ilorin West	Kwara State	North-Central	Lat 8.477592°N, Long 4.50244°E
5.	Tipper Garage	Eleme	Rivers State	South-South	Lat 4.858°N, Long 7.066°E
6.	Gariki Market	Enugu South	Enugu State	Southeast	Lat 6.386°N, Long 7.491°E
7.	Mile 12 International Market	Kosofe	Lagos State	Southwest	Lat 6.608°N, Long 3.395°E

Source: Researchers Analysis (2025/2026)

These markets were purposively selected to capture variation in market typologies, infrastructure conditions, and regional contexts across northern and southern Nigeria. They are all major markets serving as arrival and distribution points of tomatoes in their states and regions. Kwadon Market in Gombe was specifically included as a major distribution hub supplying markets across the country.

Primary data were collected using a structured questionnaire administered digitally via KoboCollect between September 2025 and April 2026. The questionnaire was developed and

adapted to the specific context of Nigerian tomato marketing. Qualitative data were also gathered through semi-structured interviews with market union chairmen or their representatives and individual traders in each market. Interview data were used to contextualise and elaborate on the quantitative findings. A total of thirteen semi-structured interviews were conducted with market union chairmen, their representatives, and individual traders across all seven sampled markets. Interviews were conducted in Hausa, except in Enugu and Rivers State where English was used. Audio recordings were made with participants' consent and were subsequently translated into English by the researcher. Data gathered through interview were not subjected to formal qualitative analysis software; instead, translated responses were listened to systematically and relevant excerpts were used inductively to contextualise and elaborate specific quantitative findings at the point where they arose in the Results and Discussion section.

A total of 297 valid questionnaire responses were obtained from tomato traders across the selected markets. Respondents were selected on the basis of their willingness to participate after confirming their status as active tomato traders. The use of a convenience sampling approach was necessitated by the mobile nature of the respondents, as well as the unavailability of data on the specific number of tomatoes traders operating within the markets. Reason given in the markets was that the traders operate mostly by season of produce that they perceived to be lucrative for them to engage in, hence a sampling frame could not be statistically derived. Data collection was carried out by trained field assistants. Informed consent was obtained from all participants prior to data collection, and permission was sought from market management authorities before surveys were administered. No personal identifiers were collected from the respondents.

Quantitative data were analysed using the Statistical Package for Social Sciences (SPSS Version 23). Descriptive statistics, including frequencies and percentages, were computed for all categorical variables. Multiple response analysis was applied where respondents could select more than one option. For the ten-item PHL factor rating scale, mean scores, standard deviations, and medians were computed and ranked. A five-point Likert interpretive scale was applied as follows: 1.00-1.49 = Not at all; 1.50-2.49 = Slightly; 2.50-3.49 = Moderately; 3.50-4.49 = Significantly; 4.50-5.00 = Very significantly. The reliability of the rating scale was assessed using Cronbach's alpha, which yielded a coefficient of 0.833, indicating good internal consistency. A one-way analysis of variance (ANOVA) was conducted to examine whether statistically significant differences existed in the mean number of tomato baskets lost per week across groups of traders who differed in how frequently they sold quickly to avoid spoilage. The independent variable was the five-category selling-frequency scale (Never, Rarely, Sometimes, Often, Always) and the dependent variable was the self-reported weekly basket loss count. Homogeneity of variances was assessed using Levene's test prior to interpreting the ANOVA result.

The purposive convenience sampling approach, necessitated by the absence of trader enumeration data, limits the generalizability of findings beyond the sampled markets; additionally, loss estimates are trader-reported and therefore subject to recall bias, as no objective physical measurement of loss quantities was conducted.

Results and Discussion

Stage Distribution of Post-Harvest Tomato Losses along the Value Chain

Table 2 presents the multiple response analysis of stages at which the majority of post-harvest losses occur. Respondents were permitted to select up to two stages.

Table 2: Stages along the Tomato Value Chain where Post-Harvest Losses Occur (n = 297, Multiple Response)

Stage	N	Rank
During transport to market	191	1st
During market storage/display	176	2nd
During the purchase from farmers	85	3rd
During sales to customers	48	4th
Total Responses*	500	-

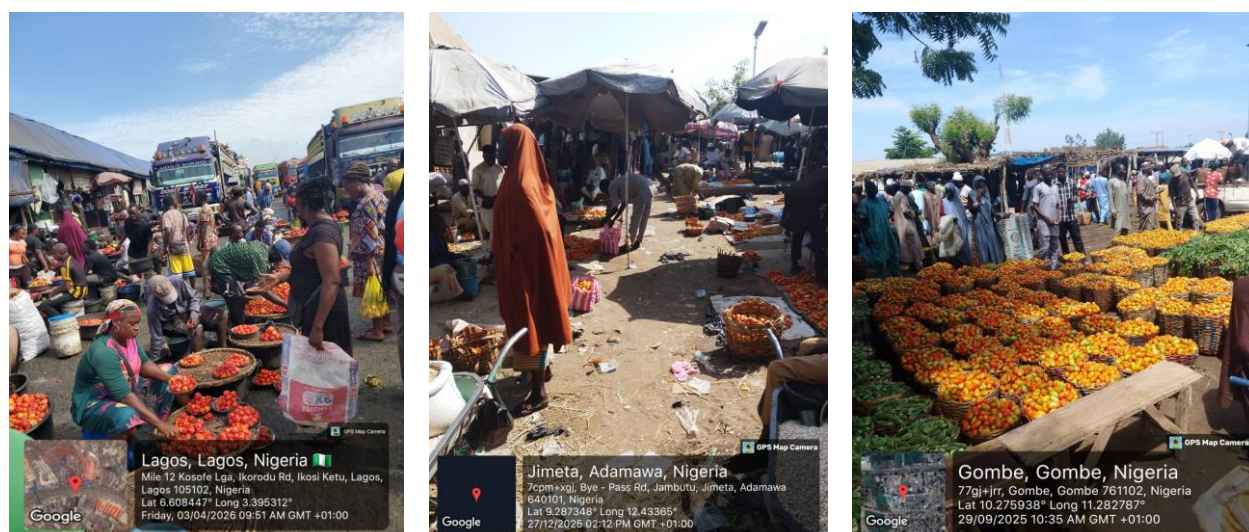
*Note: *Multiple responses were allowed; total responses exceed 297.*

Source: Researchers Fieldwork (2025/2026)

The results from Table 2 revealed that transport to market was the dominant tomato loss stage, cited by 191 respondents (ranked 1st), followed by market storage and display, reported by 176 respondents (2nd). Losses during purchase from farmers were noted by 85 respondents, while sales-related losses affected 48 respondents. That the two highest-ranked loss stages occur after the produce is out of the farm underscores that PHL in markets is primarily a logistical and infrastructure problem rather than solely a production one.

Transport losses arise from journey delays caused by bad roads, vehicle breakdowns, and accidents, as well as bruising from jolting and potholes. Vehicular heat accumulation was also reported to accelerate ripening and spoilage during transit. A driver interviewed at Mandate Market stated that rough driving over bad roads directly bruises and deteriorates tomatoes. Several respondents cited security checkpoints collecting what was named as 'produce money' on routes from North to South, also contributes to delays that compound deterioration. A respondent in Jambutu Market explained that if a consignment is loaded at 6:00 p.m. it is ideally expected to arrive by 5:00 a.m, or any reasonable time in the morning so it can be sold for that day, otherwise if it comes by evening, it must wait until the next market day, compounding deterioration and losses.

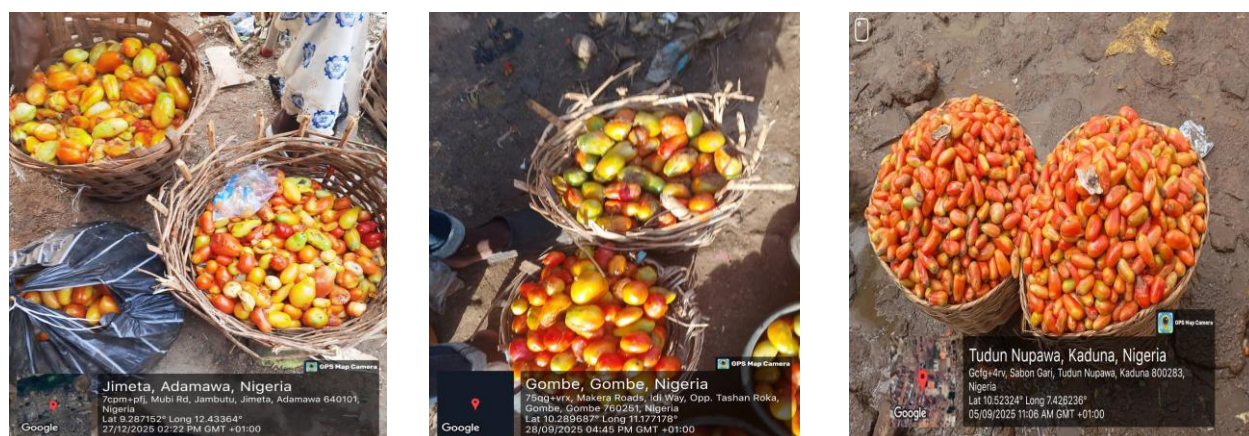
For market storage and display, none of the markets visited had a modern infrastructure for tomato storage, such as temperature controls. Once tomatoes arrive at market, they are openly displayed, exposing them to ambient temperature, either sunlight or rain, all of which hasten over-ripening and spoilage. A respondent in Gombe noted that trees were planted in the tomato section of Kwadon Market to provide improvised shade. Some of the traders operate under roofed sheds while others sell under umbrellas or in the open to sell (Plates 1-3). This finding implies that whenever the tomato is not sold the day it is brought, it starts depreciating and resulting in financial losses. The prices of the tomato can be discounted by as much as 50 per cent to attract sales if it stayed beyond 24 hours in the markets.



Plates 1-3: Open-air display of tomatoes without storage infrastructure at (left) Mile 12 Market, Lagos State; (Middle) Jambut Market, Adamawa; and (right) Kwadon Market, Gombe State, illustrating the inadequacy of shaded or ventilated market display facilities at both northern and southern Nigerian markets.

Source: Researchers Fieldwork (2025/2026)

Regarding losses during purchase from farmers (3rd), market union officials at Bakin Dogo Market, Kaduna, noted that they have a dedicated section for the sales of only damaged or depreciated tomatoes, which is known locally as '*Bagge*' (Plates 4-6). They explained that some of the *bagge* are deliberately bought from farms and resold. This practice of buying *bagge* or soft tomatoes from the farms by traders was found in northern markets in the Northwest and Northeast due to the closeness of the markets to the production centre. It was observed that only sorted tomatoes are shipped to distant southern markets. A Kwadon respondent confirmed that after sorting approximately 300 baskets, 50 to 60 (between 16-20%) may be classified as *Bagge*, especially during rainy season when rot may have started from the farms. or arising from mishandling.



Plates 4-6: Evidence of tomato PHL across northern Nigerian markets classified as "*Bagge*" (unsaleable or low grade) at Jambutu Market, Jimeta, Adamawa State (Left). Kwadon Market, Gombe State (Middle) and in Tudun Nupawa, Kaduna State (Right). Collectively, these images illustrate the physical manifestation of mechanical damage, heat exposure, sorting and moisture contact that drive PHL at the markets.

Source: Researchers Fieldwork (2025/2026)

This finding implies that post-harvest losses of tomatoes occur across multiple stages in the marketing chain, with transport and market-level storage being the most severe nodes. The finding aligns with Rakesh et al. (2022) in India, who found transportation to be the leading cause of losses at the trader, wholesaler, and retailer levels.

Seasonal Patterns of Post-Harvest Tomato Losses

Table 3 presents the distribution of respondents by the season in which they experience the highest tomato losses.

Table 3: Time of Year with Highest Post-Harvest Tomato Losses (n = 297)

Category	Frequency	Percentage (%)
Late dry season/irrigation season (February - April)	189	63.6
Rainy season (May - October)	94	31.6
No significant seasonal variation	9	3.0
Early dry season (November - January)	5	1.7
Total	297	100.0

Source: Researchers Fieldwork (2025/2026)

From the results in Table 3, the late dry/irrigation season (February-April) was identified as the peak loss period by 63.6% of respondents, followed by the rainy season at 31.6%. The predominance of losses during the late dry season is because this is when tomatoes are mostly harvested in bulk in Northern Nigeria, the unavailability of proper preservation methods especially in the farms implies that there is market glut during these months, where supply is very high and prices crash. In addition, this period coincides with the hot dry season, which means higher temperatures that quicken the ripening process and reduce the period within which a trader can sell the tomato before it deteriorates. These compounding pressures make the period challenging for the traders.

For the 31.6% of respondents who cited the rainy season as the period of higher PHL, this is due to the period having its own challenges. During this rainy season, the prices tend to be very high because supply from most production zones drops, reducing demand for the fresh tomatoes as customers switch to using sachet tomato paste, which is a cheaper alternative during the period and contributing to losses for the traders. At the same time, roads in production zones in the north become worse and some become impassable, delaying the evacuation of harvested tomatoes from farms, so that by the time it arrives the market, it has already begun to depreciate. A respondent at Kwadon, Gombe, noted that wet tomatoes cannot be sent to distant markets as they begin rotting during transit. Only 1.7% of respondents attributed peak losses to the early dry season (November–January), consistent with the cooler harmattan temperatures that extend shelf life during this period, combined with high demand driven by festive activities including Christmas, New Year, and wedding celebrations.

This finding aligns with Salisu *et al.*'s. (2021) which equally found that losses from heat during the dry season and low market patronage contributed significantly to PHL in Katsina State. Njume et al. (2020) also documented PHL of between 20–40% during rainy seasons when poor roads delayed evacuation in Cameroon.

Types of Transport Vehicles Used

Table 4 presents the types of vehicles used to transport tomatoes to markets.

Table 4: Types of Vehicles Used to Transport Tomatoes to Market (n = 297, Multiple Response)

Vehicle Type	N	Rank
Bus	106	1st
Pickup van	85	2nd
Truck	79	3rd
Trailer	77	4th
Tricycle	64	5th
Motorcycle	59	6th
Tanker	43	7th
Total Responses*	513	-

*Note: *Multiple responses allowed.*

Source: Researchers Fieldwork (2025/2026)

The results from Table 4 showed that buses are the most commonly cited transport vehicle (106 respondents), followed by pickup vans (85) and trucks (79). Respondents at Jambutu Market explained that buses and cars (Hummer bus, J5 and Toyota Starlets) were preferred because of their speed, which is crucial for a time-sensitive commodity like tomato. Bakin Dogo Market respondents noted that trucks were less common for shorter distances within Kaduna State, whereas J5 (bus) and pickup vans were preferred because of the proximity of production zones, while trailers were reserved for longer-haul routes such as those for tomatoes sourced from Jigawa or Maiduguri.

In southern markets, which include Gariki (Enugu), Tipper Garage Market (Eleme), and Mile 12 (Lagos) Boxer buses, trailers and Canters were the dominant transport mode, owing to their higher carrying capacity. A single trailer can carry up to 1,200 crates at a time, offering economies of scale on long-haul routes. Motorcycles (59 respondents) and tricycles (64) are used mainly for short-distance transport within and between nearby markets in the northern markets. A Kwadon respondent noted that a motorcycle can carry ten to fifteen baskets at once, however, when it falls, it mostly causes damages leading to immediate losses. Tankers (7th) were observed to be conveying tomatoes to Mandate Market Ilorin from the north, in addition to busses and canters. (Figure 7-9).



Figure 7-9: Non-refrigerated transport of tomatoes demonstrating structural vulnerability in Nigeria's tomato logistics chain.

Left: raffia baskets of tomatoes stacked on top of a fuel tanker, fully exposed to direct sunlight and vibration, at Mandate Market, Ilorin, Kwara State. Middle: Manual offloading of tomato baskets from a bus at Mandate Market, illustrating the labour-intensive, impact-prone unloading practices that contribute to bruising and mechanical damage. Right: Trailer with tomatoes in Crates in Tipper Garage Market, Eleme, Rivers State

Source: Researchers Fieldwork (2025/2026)

The finding of this study reveals the near-universal use of non-refrigerated, general-purpose vehicles across all markets. Any available vehicle is used to convey the tomatoes as shown with fuel tankers, which convey the tomatoes to markets over long distances, and the vehicles were not designed for transporting perishable produce. This constitutes a structural vulnerability that exposes the tomatoes to high temperatures, vibrations, and compression throughout the journey reducing their quality and contributing to PHL. This finding is consistent with Korie et al. (2023), who documented the exclusive use of non-refrigerated transport in Kaduna State.

Packaging Materials Used During Transport

Table 5 presents the types of packaging materials used during the transport of tomatoes from farms to markets.

Table 5: Packaging Used for Tomatoes during Transportation from Farms to Market (n = 297, Multiple Response)

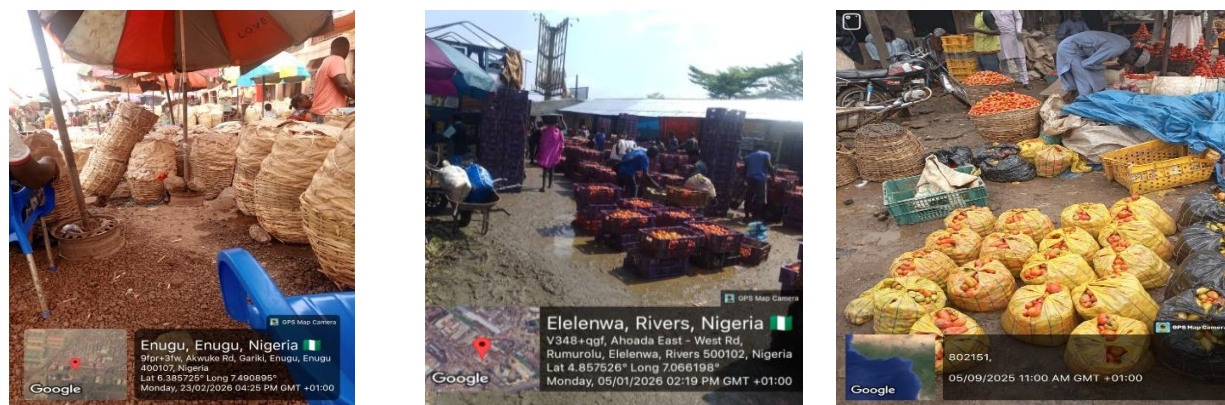
Packaging Type	N	Rank
Baskets (raffia)	254	1 st
Crates (plastic)	94	2 nd
Nylon/polythene bags	55	3 rd
Cartons	4	4 th
Sacks	1	5 th
Total Responses*	408	-

Note: *Multiple responses allowed.

Source: Researchers Fieldwork (2025/2026)

The results in Table 5 reveal that traditional raffia baskets dominate tomato packaging as cited by 254 respondents, followed by crates (94) and nylon/polythene bags (55). The respondents attributed tomato dominance to their varying sizes, which range from small to large and can hold more tomatoes than the crates. In addition, they are cheaper than reusable plastic crates (between ₦500 and ₦600 as at the time of the study), and the cost can be transferred to customers buying in bulk. Baskets are used in five out of the seven markets surveyed to transport the tomatoes (Bakin Dogo, Gariki, Mile 12, Kwadon and Mandate). Crates were used exclusively for transport to Port Harcourt. A Port Harcourt respondent explained that baskets cause tomatoes to press against each other and that the acidity of the produce means that dripping moisture tend to spoil adjacent tomatoes especially in buses. However, with reusable plastic crates, they do not have an issue with overloading because the crates have a balance and there is a limit to how much you can load the crate, hence they do not encounter any loss from there. In Lagos (Mile 12 Market), crates are used for transport, but the tomatoes are transferred to baskets within the market for display and sale.

In northeastern and northwestern markets (Kaduna, Gombe and Jambutu), polythene bags (locally called 'black-and-white bags' and “*Ja da yellow*”) are commonly used to bring tomatoes from farms, after which they are transferred into baskets at the market because of heat. This geographic variation in packaging practice, with modern crates concentrated in southern urban markets and traditional baskets predominant elsewhere, suggests that adoption of better packaging is feasible and driven by market-level incentive structures, but requires deliberate logistical and policy intervention to scale across other markets.



Plates 10-12: Packaging practices in southern and northern Nigerian markets. Left: tomatoes packaged in raffia baskets in Gariki Market, Enugu State. Middle: reusable plastic crates of tomatoes in waterlogged market conditions at Tipper Market, Rivers State. Left: tomatoes in nylons and baskets on display at Bakin Dogo market, Kaduna State, illustrating packaging prone to heat and faster PHL

Source: Researchers Fieldwork (2025/2026)

The dominance of baskets is well-documented across sub-Saharan Africa. Hotegni et al. (2023) in southern Benin found that tomatoes are transported in large woven baskets tightly stacked in vehicles. Korie et al. (2023) attributed low packaging modernisation in Kaduna to high acquisition costs and limited rural availability. Mukantwali et al. (2018) in Rwanda demonstrated that plastic crates were highly cost-effective alternatives, which is a finding with clear policy relevance for Nigerian market conditions.

Traders' Perceptions on the Factors Contributing to Post-Harvest Tomato Losses

Table 6 presents traders' mean ratings of ten factors contributing to post-harvest losses, ranked from highest to lowest on a five-point Likert scale (1 = Not at all, 5 = Very significantly). The scale demonstrated good internal consistency (Cronbach's alpha = 0.833).

Table 6: Respondents' Perception of Factors Contributing to Post-Harvest Tomato Losses (n = 297)

S/N	Factor	Mean	SD	Median	Rank
1	Vehicle spoilage/breakdown	4.21	1.102	5.00	1st
2	Weather conditions	4.13	0.824	4.00	2nd
3	Poor road conditions	3.98	1.209	4.00	3rd
4	Seasonal glut/delayed sales	3.54	1.199	4.00	4th
5	Poor handling/over-ripening in transport/storage	3.43	1.204	4.00	5th

6	Lack of cold storage or cooling facilities	3.21	1.479	4.00	6th
7	Overloading of tomatoes in vehicles	3.04	1.496	3.00	7th
8	High price leading to low sales	2.89	1.401	3.00	8th
9	Security issues	2.32	1.647	1.00	9th
10	Tomato variety	2.10	1.427	1.00	10th
Overall Mean		3.28			

Note: Scale: 1.00–1.49 = Not at all; 1.50–2.49 = Slightly; 2.50–3.49 = Moderately; 3.50–4.49 = Significantly; 4.50–5.00 = Very significantly. SD = Standard Deviation. Cronbach's alpha = 0.833.

Source: Researchers Fieldwork (2025/2026)

The findings in Table 6 showed that vehicle spoilage/breakdown was rated the most significant loss factor (Mean = 4.21), followed by weather conditions (Mean = 4.13) and poor road conditions (Mean = 3.98). Respondents across virtually all markets cited these three factors as their primary sources of loss. The union chairman at Kwadon, Gombe, stated that vehicle spoilage is the foremost cause of transport losses, as a two-hour journey can stretch to six hours when a vehicle develops a fault, by which time deterioration will start setting in especially if the tomatoes purchased from the farm, are not good ones. A driver at Mandate Market noted that the Kontagora-Jebba route in Niger State, leading to the market, is particularly severe, with several vehicles typically broken down along that stretch at any given time. A respondent at Jambutu further noted that accidents during transport also contribute to losses, occasionally involving the loss of both goods and lives.

Seasonal glut ranked fourth (Mean = 3.54). When irrigation-season harvests produce oversupply, prices collapse and tomatoes remain unsold beyond their viable shelf life. In addition, when receiving regions, especially the southern parts of the country, reduce tomato collection, sales are negatively affected, as tomatoes tend to remain in the north with no buyers, leading to losses. Poor handling and over-ripening in transport and storage ranked fifth (Mean = 3.43). Traders explained that when vehicles are packed beyond capacity, with baskets stacked on top of one another, the weight crushes tomatoes at the bottom, causing bruising. Because of the acidic nature of tomatoes, even a few damaged fruits quickly spread spoilage to the surrounding sound ones if not sorted immediately. In addition, tomatoes do not ripen uniformly. Traders, therefore, place unripe fruits at the bottom and riper ones on top during loading, hoping that the fruit will continue ripening en route to the market. However, if ripening progresses too far, the tomatoes become soft and overripe, reducing their quality.

The absence of cold storage ranked sixth (Mean = 3.21) and was mentioned by respondents across all markets as a critical gap, though the responses also revealed differing views. A respondent in Enugu stated that cold rooms are useless as they spoil the consistency of the tomato and traders would still have to reduce the price when this happens. In Port Harcourt, a respondent stated that due to the high quantity of tomatoes they handle, a cold storage facility would not be able to handle it. In Jambutu market and Bakin Dogo Markets, those interviewed stated that private organisations have met them at different times with the proposal of setting up cold storage facilities, but they never returned and they are of the view that this will help them in the preservation of the tomatoes if available. These views suggest that trader attitudes toward cold storage are context-specific and shaped by limited exposure to well-managed cooling technologies.

Security issues were rated slightly significant (Mean = 2.32). A respondent mentioned that insecurity in some sourcing areas occasionally forces traders to abandon goods temporarily. Tomato variety ranked lowest (Mean = 2.10), indicating that traders do not primarily attribute losses to varietal characteristics. The overall mean score of 3.28 (Moderately significant) confirms that traders perceive multiple contributing factors, with physical and logistical dimensions dominating.

This finding aligns with Bwade et al. (2024), whose systematic review confirmed vehicle conditions and road infrastructure as the most frequently identified drivers of transport-related tomato losses globally. The finding on weather also agrees with Abera et al. (2020) in Ethiopia, who found absence of temperature management to be one of the key causes of losses at multiple stages of the chain. Ojimi et al. (2021) in Ibadan similarly found bad roads (91%), poor storage (100%), and over-ripeness (98%) as universal causes among tomato marketers.

Adoption of Post-Harvest Loss Reduction Practices

Table 7 presents the frequency of adoption of three post-harvest loss reduction practices among the 297 respondents.

Table 7: Frequency of Use of Post-Harvest Loss Reduction Practices Among Tomato Traders (n = 297)

S/N	Practice	Never n(%)	Rarely n(%)	Sometimes n(%)	Often n(%)	Always n(%)	Mean (SD)
1	Selling quickly to avoid spoilage	1 (0.3)	2 (0.7)	14 (4.7)	112 (37.7)	168 (56.6)	4.49 (0.653)
2	Rapid transport arrangements	10 (3.4)	3 (1.0)	34 (11.4)	112 (37.7)	138 (46.5)	4.23 (0.934)
3	Shaded/ventilated market storage	15 (5.1)	41 (13.8)	105 (35.4)	60 (20.2)	76 (25.6)	3.47 (1.160)

Scale: 1.00–1.49 = Never; 1.50–2.49 = Rarely; 2.50–3.49 = Sometimes; 3.50–4.49 = Often; 4.50–5.00 = Always.

Source: Researchers Fieldwork (2025/2026)

From Table 7, selling quickly to avoid spoilage was the most consistently adopted practice (Mean = 4.49), with 94.3% of traders always or often employing it. Rapid transport arrangements were similarly prevalent (Mean = 4.23, 84.2% always or often). In contrast, shaded or ventilated market storage was consistently used by only 45.8% of respondents, with 35.4% using it only sometimes and 18.9% rarely or never.

Differences in Basket Losses by Selling Frequency

Table 8: One-Way ANOVA: Differences in Weekly Basket Losses by Selling Frequency (n = 297)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	35.278	4	8.820	5.090	.001
Within Groups	505.940	292	1.733		
Total	541.219	296			

Note: Dependent variable = number of baskets typically lost or damaged per week. $F(4, 292) = 5.090$, $p = 0.001$. Levene's test: $p = 0.063$ (homogeneity of variances not violated).

Source: SPSS Analysis (2026)

A one-way ANOVA was conducted to examine whether significant differences existed in weekly basket losses across trader groups defined by their selling-frequency habits. The results revealed a statistically significant difference, $F(4, 292) = 5.090$, $p = 0.001$ (Table 8). Levene's test confirmed that the assumption of homogeneity of variances was not violated ($p = 0.063$). Group mean inspection showed that traders who always sold quickly experienced the fewest average losses ($M = 2.15$ baskets per week), compared to those who sometimes ($M = 2.71$) or often ($M = 2.84$) employed this approach. Post-hoc tests were not performed because the 'Never' and 'Rarely' groups had very small sample sizes ($N = 1$ and $N = 2$, respectively). These results confirm that consistent rapid turnover is associated with lower weekly losses. However, the finding is correlational in nature, and faster sales may also reflect stronger customer networks, smaller stock volumes, or better market access rather than selling behaviour alone. A Jambutu respondent noted that when tomato prices are high, they distribute produce to surrounding retailers to accelerate turnover, illustrating how market context shapes the viability of this practice. The finding is consistent with Ojimi et al. (2021) in Ibadan, where sorting and proper handling were the most widely adopted mitigation strategies.

Conclusion

This study documents PHL of tomatoes in selected Nigerian markets, with the majority occurring during transport to market and at the market storage/display stage. The findings indicate that these losses reflect systemic failures in market infrastructure and transport logistics rather than farm-level problems alone. As a result, traders are left with limited options other than selling produce as quickly as possible to minimise losses.

The adoption of plastic crates on southern routes (Lagos and Port Harcourt) shows that traders understand what works and readily respond to practical solutions that protect their livelihoods. In contrast, the continued reliance on raffia baskets and polythene bags in northern markets highlights cost considerations and the strong influence of weather on deterioration.

The evidence clearly identifies priority areas for investment that include road rehabilitation, improved vehicle standards, and better market infrastructure. Such interventions can significantly reduce PHL, enhance traders' incomes, strengthen food security, and support Nigeria's National Tomato Policy (2022–2026) and SDG Target 12.3.

Recommendations

Based on the findings of the study, the following recommendations are made:

- i. **Road Infrastructure Rehabilitation:** Federal and state governments should prioritise maintenance of key tomato transport corridors, particularly the Kontagora–Jebba axis (Niger State) and routes in Taraba, Gombe, and Mubi, which respondents specifically identified as critical bottlenecks. Investment in these routes would directly address the top three rated tomato PHL factors.
- ii. **Introduction of Insulated or Refrigerated Transport on Long-Haul Routes:** The exclusive reliance on non-refrigerated vehicles is a structural vulnerability. Pilot programmes introducing insulated containers or refrigerated vehicles on high-volume routes should be developed in partnership with transport unions and agro-logistics operators.
- iii. **Market Infrastructure Development:** Market management authorities and local government councils should invest in more extensive shaded display areas, ventilated

- enclosures and cold rooms as interventions that reduce direct sunlight and heat exposure.
- iv. Plastic Crate Adoption Programmes: The Port Harcourt and Lagos evidence demonstrates that plastic crates can be adopted successfully in Nigerian markets. Subsidised crate-lending programmes, modelled on successful schemes in Rwanda (Mukantwali *et al.*, 2018), should be introduced, prioritising high-volume, long-haul routes where basket-induced bruising and moisture damage are most severe.
 - v. Regulation of Security Checkpoints on Produce Routes: Levies at security checkpoints on inter-state produce routes cause journey delays that directly compound tomato spoilage. Federal road transport authorities should establish enforceable guidelines on vehicle inspections and levy collection for perishable produce.

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