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Economic analysis of postharvest losses in retail marketing of tomatoes in Oyo state, Nigeria

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Abstract: Postharvest losses of agricultural produce at the retail market level represent a critical challenge in developing countries, significantly impacting retailer income and investment returns. In Nigeria, despite policy efforts aimed at reducing these losses, effective implementation remains a challenge due to insufficient empirical data on current market-level losses. This study addresses this gap by investigating the effects of postharvest losses on the returns to investment with a particular focus on tomatoes. Using structured questionnaires, primary data was collected from tomato retailers in three key tomato retail markets in Ibadan, Oyo state. Postharvest loss was quantified through physical loss—tomatoes deemed unfit for consumption—and economic loss, which accounted for partially spoiled tomatoes that suffered price discounts. An investment loss analysis was conducted to assess the impact of these losses on retailer returns. Findings revealed an average market-level postharvest loss of NGN 4,697.64 per transaction, translating to an estimated investment loss of NGN 298,008.37, representing 10% of potential revenue. The study concludes that substantial investment losses threaten retailers' sustainability, potentially leading to business failures that adversely affect household welfare and food security. Recommendations include enhancing market infrastructure and expanding the provision of complementary services such as credit facilities for retailers.
Keywords: Postharvest Loss, Returns on Investment, Investment Loss, Tomatoes, Retail

INTRODUCTION

Reducing postharvest losses is a focal point for policymakers as part of broader efforts to develop sustainable food systems. These systems aim to enhance food production while minimizing waste throughout the supply chain, a crucial objective, given the significant link between postharvest losses and high levels of poverty, food insecurity, and diminished quality of life in many developing nations (Brander et al., 2020; Tesfaye and Tirivayi, 2018). Postharvest losses, which reduce both the quality and quantity of food, occur at various stages of the food value chain. Globally, these losses are estimated at 1.3 billion tonnes, and are linked to improper handling, storage, transportation, processing, packaging, and distribution (Food and Agriculture Organization, FAO, 2019). These losses are classified into two main groups: qualitative losses, which refer to losses in quality due to bruising or discolouration, and quantitative losses, which refer to damage that makes food unfit for consumption due to physiological, mechanical, or pathological factors. Reducing these losses is, therefore, essential for improving both food security and sustainability.

The Food and Agriculture Organization (FAO, 2019) estimates that approximately 14 percent of the world's food, valued at $400 billion, is lost annually between harvest and the retail market. Although this figure represents an improvement from a previous estimate of one-third lost globally, the problem remains significant, particularly in developing regions like Sub-Saharan Africa, where postharvest losses of key staples like maize can still reach 25%. The focus on where these losses occur has shifted, with developed nations experiencing more food waste at the consumer level, while low-income countries suffer greater losses during harvest, handling, and storage (United Nations Children Fund, UNICEF, 2023). The urgency of addressing postharvest losses is further highlighted by UNICEF's recent report on the potential for nearly 25 million Nigerians to face hunger between June and August 2023 if urgent measures are not implemented. Based on the October 2022 Cadre Harmonisé, this alarming projection underscores the unacceptable nature of food losses and waste in Nigeria, particularly in the context of widespread poverty, food insecurity, and undernourishment. Focusing on postharvest losses at the retail level is especially crucial, as this is where policies and programs aimed at reducing losses could yield the most significant results.

Market-level losses of fruits and vegetables not only reduce food availability but also significantly impact the returns on investment for retailers in Nigeria. Research indicates that postharvest losses—including damages incurred during storage, packaging, and transportation—result in substantial economic setbacks for these retailers. A study conducted in Ibadan; Oyo State revealed that postharvest losses could reduce the marketing margin for tomatoes by as much as percent (Omobowale, 2021). These losses stem from various factors, including physiological, pathological, and mechanical damages. Inadequate storage conditions, such as placing produce on wooden platforms or bare floors in poorly ventilated rooms, further exacerbate these issues. Additionally, the quality of fruits and vegetables deteriorates significantly during and after transportation, with approximately 89.2 percent of the produce experiencing some degree of quality loss (Omobowale, 2021).

However, the operationalization of postharvest loss reduction strategies in Nigeria remains a challenge. Ogundele (2022) points out significant gaps in the nation's understanding of food

crop losses, particularly regarding their nature, extent, and structural dimensions. Also, there is limited knowledge about the roles of various stakeholders along the value chain and the effectiveness of postharvest technologies. Addressing these information deficits is a primary goal of the National Agricultural Technology and Innovation Policy (NATIP:2022-2027) which aims to improve agricultural development by comprehensively addressing these gaps.

The research on market level postharvest losses of tomatoes generally follows two strains of thought. One focuses on the identification of causes and trends as in the case of a recent evaluation of the impact of the PYXERA Global Yieldwise project's improved post-harvest loss management practices on tomato farmers' output, income, and poverty status in Nigeria's North-West Zone by Tobe et al. (2023) which utilized a multi-stage random selection method, and applied descriptive statistics, double difference estimates, and the Foster-Greer-Thorbecke (FGT) poverty index. The findings revealed a significant output value difference of ₦82,888.94 between adopters and non-adopters of the improved practices. The poverty incidence among poor farm households was notably high, with 95% of non-adopters and 61% of adopters classified as poor. Furthermore, the depth of poverty was recorded at 85% for non-adopters compared to 36% for adopters, and the severity of poverty was 79% for non-adopters versus 26% for adopters. These results indicate a higher poverty incidence among non-adopting households, underscoring the positive effects of adopting improved post-harvest management practices on reducing losses, increasing income, and enhancing overall poverty status. The study concluded with recommendations to sustain the tomato post-harvest loss reduction campaign, particularly as the deadline for achieving the Sustainable Development Goals (SDGs) on food loss and waste approaches. It also emphasized the need for stakeholders in the tomato value chain to address challenges such as inadequate extension services, poor market linkages, and long distances to markets, which impede the adoption of improved practices. The second focuses on the empirical analysis of how postharvest losses significantly affect business margins, as in the case of empirical analysis by Adeoye et al. (2009) revealed that retail level postharvest losses significantly impacted retail marketing margins, reducing them by 34% to 94% depending on the variety.

This study fills a gap in knowledge through addition of another dimension of thought by focusing on the effect of retail level postharvest losses on returns on investments and how these could potentially affect retail trade of tomatoes. The broad objective of the study was to conduct an economic analysis of post-harvest losses in the retail trade of tomatoes in Oyo state. Specifically, the study aimed to estimate postharvest losses of tomatoes, determine the effect of market-level losses on the returns on investment of tomato retailers and identify constraints to the retail trade of tomatoes in Oyo state, Nigeria.

METHODOLOGY

The study was designed as a cross-sectional, descriptive and quantitative study and was conducted in three major retail tomato markets within Ibadan Metropolis, namely, Shasha market (Akinyele LGA), Bodija market (Ibadan North LGA), and Oje market (Ibadan South West LGA) in Oyo State, Nigeria. Oyo State, located in Southwestern Nigeria, and covers approximately 28,454 square kilometres (Sq. Km) and has a population of about 6,617,720. The selected markets are major hubs for fruits and vegetables, particularly tomatoes, attracting farmers, middlemen, retailers, and consumers due to their large quantities of merchandise and competitive prices. This makes them suitable for economic analysis at the market level.

The study used a two-stage sampling method. First, three markets (Shasha, Bodija, and Oje) were purposively selected from different Local Government Areas in Ibadan, chosen for their significance in fruit and vegetable trade. The sample size was determined using Yamane's formula, resulting in 150 retailers. forth by Yamane (1967):

$$n = \frac{N}{1 + Ne^2}$$

Where N=250 (based on headcount of retailers undertaken by the researcher)
n= sample size
e= precision level=5%.
N was found to be 153 and is approximated to 150 retailers.
The second stage involved the random selection of 50 retailers in each of the market to give a total sample size of 150 retailers for the study.

The study employed descriptive analysis and investment analysis. Frequencies and percentages were employed in describing the socioeconomic and enterprise characteristics of retailers, while investment analysis was used to estimate the investment loss incurred in retail trade because of postharvest losses.

Estimating Postharvest Losses: Following the work of Hodges *et al*., (2011), postharvest loss (PHL) was calculated as the sum of physical and economic losses:

- Physical losses: Proportion of tomatoes unfit for human consumption
- Economic losses: Proportion of partially spoiled tomatoes sold at discounted prices.

The formula used in estimating Postharvest loss was
PHL = Physical Losses + Economic Losses,
where $0 \leq PHL \leq 1$

Investment Loss Analysis: This analysis examined the effect of postharvest losses on returns to investment. It was as adapted from Murthy *et al.*, (2007) and calculated as:

Investment Loss (IL) = Potential Returns (PR) - Actual Returns (AR)

where: PR = (Total quantity sold × selling price) - ((total quantity purchased × buying price) + other market costs)
AR = (Total quantity sold × selling price) - ((total quantity purchased × buying price) + total value of physical and economic losses + other market costs)
Total investment loss in the study area will be given as:
$\sum_{i-n}$ (PRi- ARi)

RESULTS AND DISCUSSION

Socioeconomic and enterprise characteristics

The findings from the descriptive analysis are presented in Table 1. Findings showed that females dominated the retail trade of tomatoes (and other fruits and vegetables generally) with 66.4% of retailers being women. This is consistent with the body of research which posits that women generally dominate the retail trade of food and fruits and vegetables in particular while men dominate wholesale trade (Wongaa *et al*., 2014). Being majorly involved in retail trade directly links women with market, economic, sociological and environmental factors, which have implications on retail losses which in turn have effects on welfare for not just the retailers but on their households by extension. Therefore, the a need to pay attention to how retail market losses affect their business outcomes.

Of the 149 retailers sampled, majority (96%) were married. The average age of the retailers sampled was found to be 43.30 years. This indicated that most of the tomato retailers were still within the active age group. Participation of youth (ages 15-35) and older persons (> 60 years) were found to be low, accounting for 9.4% and 11% of the retailers in the study area.

The average household size of respondents was found to be 6. The average years of experience in retail trade of fruits and vegetables among the respondents was found to be 20.63 years. This finding agrees with Adejobi *et al*., (2011). This result implies that retailers have requisite experience to understand the effect of retail level postharvest losses on their businesses and should over these years of experience developed means to reduce losses.

Majority of the respondents (94.6%) reported membership in a cooperative or some form of trade association. Personal equity was the most reported (90.6%) source of financing for the retail trade of fruit and vegetables in the study area. Where personal equity became insufficient, 75.8% and 20.1% resorted to loans from cooperatives and money lenders respectively. No retailer of fruits and vegetables got any financing from government sources. Other sources of financing reported were friends and relatives and other forms of contributions. From these findings, it is evident that government support for retail trade of fruits and vegetables is very low leaving retailers on their own to sort their finances often from predatory sources. When this situation combines with postharvest losses, they could have negative effects on retail trade and returns on investment.

About half (50%) of the respondents did not have access to any form of credit facilities. Against the backdrop of retail postharvest losses, this constitutes a challenge to retail trade of fruits and vegetables. In addition to paucity of funds to invest in retail trade, the lack of credit facilities implies that in the case that retailers incur losses, there is no means to refinance the business. Lack of credit facilities also makes it difficult for retailers to invest in loss reduction techniques and strategies. Almost half of the respondents (47%) attained and completed secondary school education. Another 22.1% completed primary education. 10.1% completed some form of education from higher institutions while only 2 retailers did not receive any formal education. On the average, respondents attained at least ten years of education.

Table 1: Socioeconomic and retail characteristics of tomato retailers in the study area

Characteristics	Frequency	Percentages
Sex		
Male	50	33.6
Female	99	66.4
Age (Years)		
25-34	14	9.4
35-44	77	51.7
45-54	47	31.5
55-64	11	7.4
	Mean = 43.30	
Educational Status		
No Formal education	2	2
Primary school	37	24.8

Characteristics	Frequency	Percentages
Secondary School	95	63.8
Tertiary education	15	10.1
Household Size	Mean=6	
Experience in retail trade (Years)	Mean= 20.63	
Membership of cooperative or Trade association		
Yes	141	94.6
Source of Finance for retail trade		
Personal equity		
Cooperatives	135	90.6
Money lenders	113	75.8
Friends and relatives	30	20.1
Government sources	32	21.5
Access to credit		
Yes	68	45.63
Quantity of tomatoes purchased in the last transaction (Kg)		
<500	43	28.9
500-1000	53	35.6
1001-1500	15	10.1
1501-2000	14	9.4
2001-2500	11	7.4
>2501	13	8.7

Source: Field Survey, 2021.

Estimates of retail market level postharvest losses

Retailers provided information on the most recent wholesale purchases of tomatoes, prices and quantitative and qualitative losses of tomatoes. These were used to estimate the total market level postharvest loss. Postharvest loss was computed as the sum of physical loss and economic loss. Physical losses were estimated as the proportion of tomatoes that was deteriorated to the point that it was unfit for human consumption. Economic losses referred to the proportion of tomatoes that were partially spoiled or damaged and whose market price was discounted as a result. The study measured both the indicative average prices of good quality tomatoes and the discounted prices for tomatoes that had incurred quality deterioration at the different market chain nodes.

Physical Loss: Physical loss refers to the quantity of tomatoes that were completely damaged and unsellable. Total physical losses in the study area amounted to 7,830 kilograms. Among the respondents, 43% reported physical losses of less than 50 kilograms, while 39% lost between 50 and 100 kilograms, and 13% experienced losses ranging from 101 to 150 kilograms. Notably, larger volume retailers, although fewer in number, faced the highest losses; 4% reported losses between 15 and 200 kilograms, and 1% lost over 201 kilograms. This trend may be linked to the larger quantities of stock these retailers purchased. On average, each retailer lost 55.22 kilograms of tomatoes from their last transaction, resulting in a total loss with no potential for sale. Based on daily average prices for high-quality tomatoes, which were estimated at NGN 749.16 per kilogram, the average loss per retailer amounted to NGN 41,368.61.

Table 2: Distribution of respondents by physical loss incurred

Quantity (Kg)	Frequency	Percentage
Below 50	64	43.0
50-100	58	38.9
101-150	19	12.8
151-200	6	4.0
201 and above	2	1.3
	149	100
	Mean: 55.22Kg	

Source: Field Survey, 2021.

Economic loss

This is the value of tomatoes sold at discounted prices due to quality loss. The analysis revealed that the average economic loss incurred was NGN 3,864.60 per transaction. This was the economic value that was lost in the process of selling off tomatoes that had lost quality but was sold at discounted price.

Total market level postharvest loss is therefore calculated as the sum of physical loss and

economic loss. The average postharvest loss per retailer in the study area was found to be NGN 45,233.21 per transaction.

Investment Loss: is defined as the difference between potential and actual revenue for tomato retailers. On average, each retailer had a potential revenue of NGN 3,267,040.37 without postharvest losses, but this was reduced to an actual revenue of NGN 2,969,032.97 due to such losses. Consequently, the total investment loss in the retail trade of tomatoes in the study area was estimated at NGN 44,403,102, with an average loss of NGN 298,008.37 per retailer, representing 10% of their actual revenue.

Table 3: Potential Revenue, Actual Revenue and Investment Loss in retail tomato trade

	Potential Revenue	Actual Revenue
Mean value (NGN)	3,267,040.37	2,969,032.97
Average Investment loss (NGN)	298,008.37	

Source: Field Survey, 2021

Investment losses were further categorized by market and results are presented in Table 4. The findings revealed significant variations in investment losses:

- In Bodija market, 50% of retailers incurred losses between NGN 200,001 and NGN 300,000.
- In Oja Oba market, 62% faced losses between NGN 100,001 and NGN 200,000.
- In Shasha market, 38% of retailers experienced losses exceeding NGN 500,000, the highest among the three markets.

Overall, 29.5% of retailers incurred losses between NGN 100,001 and NGN 200,000, while 30.9% lost between NGN 200,001 and NGN 300,000.

Total and average investment losses were found to be highest in Shasha market (NGN 21,843, 120 and NGN 445,778 respectively). Similarly, investment losses were found to be high in Bodija and Oja oba markets. These substantial investment losses are detrimental to the retail trade of tomatoes and, if unaddressed, could lead to business failures and negatively impact on retail trade of tomatoes. Urgent action is particularly needed in Shasha market, where the losses are most pronounced.

Table 4: Total and average investment losses by retail markets

Market	Total Market loss (NGN)	Average Investment loss (NGN)
Bodija	13,561,250	271, 225
Oja-oba	8,998,732	179,974
Shasha	21,843,120	445,778

Source: Field Survey, 2021

Constraints to the retail trade of tomatoes in the study area

Respondents indicated how several factors constrained the retail trade of fruits and vegetables in their respective markets. Across all the categories of constraints, weighted scores of responses were estimated and indicated that these constraints exerted serious or fairly serious challenges to the retail trade of tomatoes in the study area. Low demand for tomatoes was found to be the most serious constraint. The majority (98.3%) indicated that low demand for fresh produce constituted a severe constraint. As it relates to market level postharvest losses, 91.3% of the respondents revealed that bad roads seriously constrained the retail trade of tomatoes. 77% of the respondents felt that the long distances covered between the source and destination markets only fairly constrained retail trade.

More than half (68%) of the respondents fingered lack of storage facilities as a serious constraint to retail trade. Of the respondents, 51.4% indicated that the lack of credit facilities was a serious nosiness constraint. This seems to be a situation that would endure for a long time. Given the level of losses incurred, it would be difficult for any creditor to make loans or finances available for a trade where losses are so high. It would require a turnaround in the retailers' fortunes to convince creditors to make finances available for retailers.

Table 5: Retailers' perception of constraints to retail trade of tomatoes

Constraint	Weighted Scores	Effect of the constraint	Frequency (percentages)
Low demand for tomatoes	4.00	Seriously affects business	149 (100)
Bad condition of roads	3.92	Fairly affects business	12 (8.1)
		Seriously affects business	137 (91.9)
High cost of transportation	3.74	Little effect on the business	2 (1.3)
		Fairly affects the business	35 (23.5)
		Seriously affects the business	112 (75.2)
After-effects of the COVID-19 Pandemic	3.70	Little effect on the business	4 (2.7)
		Fairly affects the business	37 (24.8)
		Seriously affects the business	108 (72.5)
Lack of storage facilities	3.64	Little effect on the business	7 (4.7)
		Fairly affects the business	40 (26.8)
		Seriously affects the business	102 (68.5)
Poor mode of transportation	3.53	Little effect on the business	5 (3.4)
		Fairly affects the business	60 (40.3)
		Seriously affects the business	84 (56.4)
Inadequate access to credit	3.28	Little effect on the business	15 (10.1)
		Fairly affects the business	77 (51.7)
		Seriously affects the business	57 (38.3)
Distance to the markets	3.05	Little effect on the business	14 (9.4)
		Fairly affects the business	114 (76.5)
		Seriously affects the business	21 (14.1)

Source: Field Survey, 2021.

Almost four-fifths of the respondents were forthwith in declaring the ongoing COVID-19 pandemic as seriously constraining the retail trade of tomatoes. Reduced social activity and declining disposable incomes, they say, affected trade in serious ways and raised concern amongst retailers. Market level postharvest losses add further uncertainty to already uncertain retail trade of fruits and vegetables.

CONCLUSION

This study examined the effect of market-level losses of fruits and vegetables on the returns to investment for retailers in Oyo State, focusing on postharvest losses of tomatoes. each retailer lost an average of 55.22 kilograms of tomatoes per transaction, translating to a loss of NGN 41,368.61 based on potential selling prices. Additionally, retailers incurred an average loss of NGN 3,864.60 from selling lower-quality tomatoes at discounted prices, leading to an overall retail market-level loss of NGN 45,233.21 for the last wholesale purchase transaction. Total and average investment losses were found to be highest in Shasha market (NGN 21,843, 120 and NGN 445,778, respectively). These substantial investment losses are detrimental to the retail trade of tomatoes and, if unaddressed, could lead to business failures and negatively impact on retail trade of tomatoes Potential revenue for each retailer was NGN 3,267,040.37 without losses, but actual revenue dropped to NGN 2,969,032.97 due to postharvest losses, resulting in an average investment loss of NGN 298,008.37—representing 10% of actual revenue. low demand for tomatoes, poor road conditions, limited access to credit, and the COVID-19 pandemic as significant constraints on the retail trade.

Retail-level postharvest losses of fruits and vegetables are a significant challenge in the study area, impacting income generation and poverty reduction. The study indicates high and unacceptable levels of postharvest losses, exacerbated by a lack of awareness among retailers regarding innovative practices to mitigate these losses. Given the substantial investment losses incurred, the absence of adequate credit facilities poses a risk of driving retailers out of business, adversely affecting household welfare and food security. Urgent policy interventions are therefore necessary. Such recommended policy actions include the provision of improved infrastructure and complementary services (e.g., electricity, roads, water, credit facilities). The government should focus on providing infrastructure, while private entities can offer additional services.

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