



Assessment of Post-Harvest Loss Reduction Strategies in Agricultural Project Management in Minna, Niger State

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Abstract

Post-harvest food loss remains one of the most pressing challenges facing agriculture in developing countries, particularly Nigeria, where it undermines food security, reduces farmers' income, and weakens the agricultural value chain. This study investigated the key factors contributing to post-harvest losses and also, assessed the effectiveness of post-harvest management strategies among agricultural stakeholders in Minna and its surrounding communities. A quantitative research design was employed, adopting a descriptive survey approach. Questionnaire was administered to 300 Smallholder farmers, extension officers, agronomists, produce marketers, and agribusiness operators, through stratified random sampling. Data collected was analyzed with means scores and ranking. Findings revealed that inadequate storage facilities, financial constraints for infrastructure upgrades, and poor transportation infrastructure with (MIS = 4.08), (MIS = 3.76), (MIS = 3.65) respectively were the most critical factors contributing to post-harvest losses. Other factors such as poor handling practices, pest and disease outbreaks, and insufficient market access were also having moderate effect. Regarding management strategies, improved storage systems, collaboration with agricultural project managers and the use of preservatives and packaging materials with (MIS = 4.17), (MIS = 4.00), (MIS = 3.92) respectively were ranked as the most effective interventions. The study concludes that post-harvest losses in Minna are largely driven by infrastructural and financial deficiencies, while the most effective strategies for addressing these challenges are practical, infrastructure-based solutions and stronger project coordination mechanisms. It recommends expanding training in post-harvest handling, and developing policy frameworks that improve access to finance and markets.

Keywords: Agricultural Project Management, Food Security, Post-Harvest Loss, Reduction Strategies.

1.0 Introduction

Post-harvest loss presents a considerable challenge for rural communities in sub-Saharan Africa (SSA) and other developing regions, attributable to constrained resources and inadequate institutions, including agricultural extension services, which impede rural households from adopting vital technologies such as post-harvest management practices, enhanced storage, and crop processing (Amadu and McNamara, 2024). Postharvest food loss and waste refers to the reduction in the amount or quality of the edible portion of food intended for human consumption at any stage of the food supply chain or postharvest system (Bappah and Adejoh 2024). The principal cause of food loss is the malfunction of the food production and supply system or its institutional and policy framework (Muroyiwa *et al.*, 2020). This may result from administrative and technological constraints, including inadequate storage facilities, cold chain systems, correct food handling protocols, infrastructural deficiencies, packaging issues, or ineffective marketing methods (Urugo *et al.*, 2024). Conversely, food waste refers to the elimination of food from the supply chain that remains suitable for human consumption (Debebe, 2022). This withdrawal occurs either voluntarily or subsequent to the food being spoiled or expired (Tria *et al.*, 2020).

Food is an essential need for life and a fundamental factor in human subsistence. In developing nations such as Nigeria, the majority, if not all, of the sustenance eaten by smallholder farmers in rural regions is sourced from their own farms. The perennial shortage of food may be exacerbated by post-harvest losses, thus resulting in food insecurity. Nigeria has fertile territory suitable for cultivating many food crops; nevertheless, a significant portion of these crops is often compromised by insect infestations, rodents, and microbes (Onwude *et al.*, 2020). Food losses also transpire during the harvesting, handling, processing, marketing, packing, and storage of agricultural goods. A study on post-harvest food losses in certain Nigerian communities indicated that 20–30% of total grain production, 30–50% of root and tuber crops, and a significant proportion of fruits and vegetables are lost, particularly during storage (Osabohien, 2024).

Furthermore, reports indicate that Nigeria's post-harvest losses have escalated to over \$9 billion per year, approximating 50% of food production (Ogundele, 2022). Fruits and vegetables suffer over 50% loss, often occurring on the field post-harvest, as well as during transit, storage, and at markets. The Federal Ministry of Agriculture and Rural Development of Nigeria reported that in 2015, the demand for tomatoes was estimated at 2.2 million tonnes, while the actual harvest amounted to 1.5 million tonnes, resulting in a supply of only 800,000 tonnes and a total shortfall of 700,000 tonnes (Oketola, 2016). It has been stated that in underdeveloped nations, 90% of waste arises from food losses throughout the value chain. It adversely affects impoverished farmers by resulting in lost revenue, while simultaneously impacting disadvantaged consumers by diminishing food supply, elevating costs, and lowering nutritional quality. Post-harvest losses (PHL) profoundly impact food security, economic stability, and sustainable agricultural advancement. These losses transpire at several phases, including harvesting, storage, processing, and distribution.

Mitigating post-harvest losses (PHL) via efficient agricultural project management may substantially increase food supply, elevate farmers' earnings, and diminish waste (Galford *et al.*, 2020; Balana *et al.*, 2022; Obi-Egbedi and Ifoga, 2023; Khan *et al.*, 2024). Effective project management techniques, including value chain integration, infrastructure development, and capacity building, are essential for mitigating post-harvest inefficiencies and facilitating market access (Affognon *et al.*, 2015; Sheahan and Barrett, 2017). Kikulwe *et al.* (2018) assert that enhancing farmer cooperatives and implementing organised training programs in post-harvest management markedly boosts farmers' productivity and income levels. The use of digital technology and intelligent agricultural practices has been shown to enhance operational efficiency, reduce food waste, and increase farmers' profitability (World Bank, 2021; Food and Agriculture Organization, 2022)). Effective monitoring, assessment, and adaptive management strategies guarantee that treatments retain their relevance and efficacy over time (Abebe and Bekele, 2022). Therefore, comprehensive agricultural project management frameworks are crucial for minimising waste and promoting resilient food systems and rural economic growth. This study intends to investigate strategic interventions in agricultural project management to minimise post-harvest losses and promote food security, given the interaction between agricultural project management and post-harvest loss reduction measures.

The specific objectives include:

- i. To examine the key factors contributing to post-harvest losses; and
- ii. To assess the effectiveness of various post-harvest management strategies.

2.0 Literature Review

2.1 Conceptual Review

The major concepts of the study are reviewed as follows:

2.1.1 Concept of Post-Harvest Losses

The Food and Agricultural Organisation defines the post-harvest system as the process of transporting a product from the point of harvest to the point of consumption, aiming for minimal loss, optimal efficiency, and optimum returns for all parties involved (Spurgeon, 2008). The word "system" refers to a dynamic aggregation of logically interrelated functions or activities within a certain domain of activity. Thus, when examining the agro-food chain in its entirety, harvesting may be seen as the apex between the pre-harvest and post-harvest phases, spanning from harvesting to consumption.

The post-harvest system comprises a series of activities and operations categorised into two groups: technical activities (harvesting, field drying, threshing, cleaning, additional drying, storage, processing) and economic activities (transporting, marketing, quality control, information and communication, administration and management) (Food and Agriculture Organization, 2024). Post-harvest Food Loss (PHL) is defined as quantifiable qualitative and quantitative food loss along the supply chain, commencing at the point of harvest and continuing until consumption or other end uses (Hodges *et al.*, 2011).

2.1.2 Key factors contributing to post-harvest losses;

Postharvest losses exhibit significant variability between commodities, production regions, and seasonal periods. During the postharvest chain, product losses may arise from several factors, including inadequate handling or biodeterioration caused by microbes, insects, rodents, or birds. A significant issue in industrialised nations is that a substantial portion of produced food is not consumed but rather disposed away, due to factors such as being left uneaten on plates or beyond its expiration date. Conversely, the inability to use accessible food in Less Developed Countries (LDCs) is not a documented issue; rather, the inferior food left in marketplaces at day's end serves as nourishment for the impoverished. The challenge in LDCs is the ineffectiveness of postharvest agricultural systems, resulting non the wastage of food that might otherwise be consumed, sold, or exchanged to enhance lifestyles (Hodges *et al.*, 2011). Postharvest loss is influenced by both internal and external causes.

2.1.3 Effectiveness of various post-harvest management strategies

Post-harvest management has existed for decades; however, since 2008, there has been a resurgence of interest in agricultural investment, positioning post-harvest management methods in the centre of discussions on agricultural sector growth (Kiaya, 2014). In September 2015, the United Nations (UN) announced an ambitious objective to halve global food waste and significantly diminish food loss by 2030, coinciding with the Sustainable Development Goals (SDGs) agenda, alongside a resurgence of interest in agricultural investment (Sheahan and Barrert, 2017). This aligns significantly with the worldwide objective of guaranteeing food security for the expanding population while simultaneously assuring sustainable food production for consumption. Notwithstanding substantial expenditures in enhanced climate-smart agricultural and animal production methods, a critical and overlooked contributor to food insecurity remains post-harvest losses resulting from inadequate post-harvest management.

Clearly, a primary method of enhancing food security is via the mitigation of these losses (Affognon *et al.*, 2015). A food self-sufficient and food insecure nation such as Lesotho must adopt a realistic strategy to tackle the issues arising from post-harvest losses. Enhancing

farmers' welfare by increasing yields of major crops in Lesotho will be ineffective if a significant percentage of the harvested crops is lost due to inadequate handling, processing, marketing practices, and storage technologies (Abass *et al.*, 2014). Postharvest Loss (PHL) refers to any degradation in quality or quantity that transpires from the moment of harvesting until it reaches the customer (Grolleaud, 2002). The postharvest sector encompasses all stages in the value chain, from field production to the food served on a plate for consumption. Postharvest operations include harvesting, handling, storage, processing, packing, transportation, and marketing of agricultural goods. Postharvest management influences food quality and safety, market competitiveness, and producer profitability. In several poor nations, postharvest management of food is significantly inadequate (Tadesse *et al.*, 2018).

2.2 Theoretical Review

Stakeholders Theory (ST)

Companies are positioned at the core of an association of stakeholders by the supply chain formation rationale, which is based on stakeholder management. A company's stakeholders, according to Freeman (1994), are any group of people who can positively or negatively impact the company, such as its regulators, workers, suppliers, customers, investors, competitors, local communities where the company operates, and so forth (Touboulic and Walker, 2015). Jensen and Meckling (1976) refer to a firm as a "nexus of contracts" between itself and its stakeholders in this regard. Jones (1995) asserts that those agreements are composed of both formal written contracts and unwritten agreements that are mostly based on expectations. The company's top managers are its primary contract marketers since they quickly or obliquely concur with stakeholders. The notion that businesses should organize stakeholder interests is one recurrent subject in the literature on stakeholders (Busse *et al.*, 2017). According to Camilleri (2017), this viewpoint is based solely on the notion that organisations are by nature cooperative systems. Because they are cooperative by nature, organisations are likely to create coalitions with stakeholders to achieve common goals (Wu and Axelrod, 1995). These coalitions are referred to as strategic networks, networks, and constellations, among other terms (Jones *et al.*, 1997). These cooperative relationships may be an effective means of harmonizing stakeholder goals and can assist a corporation in lowering environmental uncertainty (Kraatz, 1998).

The Stakeholder Theory (ST), introduced by Freeman (2010), emphasizes the importance of engaging all relevant stakeholders in decision-making to achieve organizational success. In agricultural project management, the application of ST in post-harvest loss (PHL) reduction highlights the necessity of collaborative efforts between farmers, policymakers, agribusinesses, financial institutions, and consumers. Each stakeholder plays a critical role in minimizing food losses and improving food security. Farmers, as primary producers, benefit from capacity-building programs that enhance their knowledge of post-harvest handling, storage, and value addition techniques, ultimately reducing waste. Government agencies and policymakers contribute by developing regulations, policies, and incentives that encourage investment in post-harvest infrastructure, such as warehouses, cold storage facilities, and improved transportation networks (Muroyiwa, *et al.*, 2020).

Beyond governmental efforts, agribusiness firms and food processors have a vested interest in reducing losses along the supply chain. Companies that invest in efficient logistics, processing technologies, and market linkages help ensure that agricultural produce is not wasted before reaching consumers. Additionally, financial institutions and investors play a crucial role in providing funding for post-harvest loss mitigation strategies, including access to credit for smallholder farmers to invest in better storage facilities and handling equipment (Nnaemeka, 2024). Consumers also contribute to reducing food losses by advocating for sustainable

consumption practices, demanding better food preservation techniques, and supporting initiatives that promote food security.

The collaborative approach advocated by Stakeholder Theory ensures that post-harvest loss reduction efforts are holistic, inclusive, and sustainable. By aligning the interests of different stakeholders, agricultural project managers can create mutually beneficial solutions that address inefficiencies in the supply chain. For example, public-private partnerships (PPPs) have proven effective in many regions by bringing together government bodies, private investors, and farmers' cooperatives to develop post-harvest processing hubs and improved market access (Mohammadiatedresi, 2018). Ultimately, the successful application of Stakeholder Theory in agricultural project management fosters greater accountability, resource sharing, and long-term sustainability, leading to significant reductions in post-harvest food losses.

2.3 Empirical Review

Muroyiwa *et al.* (2020) in their study investigated the extent of integration of post-harvest management in agricultural policy in Lesotho and strategies to minimise post-harvest losses. Purposive sampling was utilised in order to select a sample of twenty-five respondents on which interviews were conducted. Thematic analysis was used to identify a set of overarching themes that can be used to describe the policy environment and strategies to reduce post-harvest losses. The findings suggests that there is absence of a direct policy to guide post-harvest management activities in Lesotho, it is only referred to indirectly in other policies with the exception of dairy products sector which has a direct post-harvest management policy. Strategies to curb post-harvest losses were also identified. The study concludes that there is need for a direct policy to address post-harvest management in Lesotho.

Also, Olakiumide (2021) comprehensively explores the causes, impacts, and potential solutions related to post-harvest losses in the African context. The causes encompass a range of factors, including inadequate infrastructure, poor handling practices, limited technology access, and socioeconomic challenges. Consequently, post-harvest losses have dire implications for both food security and economic prosperity, impacting stakeholders along the agricultural value chain. Modern post-harvest technologies, coupled with effective pest management practices, can extend the shelf life and quality of harvested crops. Policymakers, researchers, farmers, and the private sector must collaborate to implement these solutions. By addressing post-harvest losses, Africa can move towards achieving sustainable development goals related to hunger eradication, economic growth, and improved livelihoods. Ultimately, this paper emphasises that addressing post-harvest losses is not only a technical challenge but a moral imperative. By reducing losses, African nations can enhance food security, empower local economies, and contribute to a more sustainable and equitable global food system. This paper calls for collective action to combat post-harvest losses and create a brighter future for the continent and beyond.

In the study of Balana *et al.* (2022) for which they were of the view that Postharvest loss is a major challenge in food production and supply chains in developing countries like Nigeria. This leads to significant falls in livelihood outcomes such as reduced household income and food insecurity. Using primary data from perishable agricultural commodity dealers in Nigeria and endogenous switching econometric modelling, they investigate factors determining postharvest technology (PHT) adoption, the impacts of PHT adoption on net returns and its implication on livelihood outcomes. We found that adoption of PHT significantly increases net returns and thus improves livelihoods. The counterfactual impact analysis indicates that value chain actors who adopted PHT would have earned 7% lower net returns had they not used the

technology. Conversely, non-adopters would have increased their net returns by 5% had they adopted the technology. However, heterogeneous treatment effects were observed due to heterogeneities among the adopters. Results further indicate that the position of value chain actors along the perishable supply chain, income level, product seasonality, sales frequency, and technology affordability positively influence adoption decisions. The high cost of technology is found to be the major barrier to technology adoption. We suggest targeted interventions to enhance access to PHT for reducing food losses, reducing food insecurity, and improving livelihoods for agricultural actors along perishable value chains.

Furthermore, Bappah and Adejoh (2024), in their study, opined that post-harvest losses present a formidable obstacle to food security in North-West Nigeria, a region heavily reliant on agriculture. Inadequate infrastructure, limited market access, substandard storage facilities, and inefficient processing methods contribute to significant losses, compromising food availability and stability. Using the Resource-Based View (RBV), the paper employs qualitative methods. It examines the root causes and extent of post-harvest losses, revealing that they constitute 30-40% of annual food production, primarily occurring during harvesting, storage, and transportation. Challenges such as unreliable electricity, insufficient infrastructure, and security issues worsen the situation. To tackle this issue, the paper proposes investment in robust post-harvest infrastructure, including upgraded storage facilities with proper cooling and pest control, enhanced transportation networks, and improved market access. Additionally, farmer education initiatives on advanced post-harvest practices and value addition are recommended to strengthen food security in the region.

Urugo *et al.* (2024) examine Ethiopia's potential in agro-processing, aligning with existing agricultural policies. Techniques such as drying, canning, freezing, and packaging can optimise agricultural potential and minimise losses. Despite challenges such as inadequate infrastructure and limited financial resources, Ethiopia can leverage its market-orientated approach to establish integrated agro-processing systems. A holistic approach is necessary, requiring the Ethiopian government to develop an integrated policy framework with incentives for investment and technology adoption. Improving infrastructure, enforcing quality standards, and strengthening market linkages are essential. Climate-smart practices and information technologies can enhance long-term viability. Collaborative efforts can drive sustainable development and prosperity through agro-processing in Ethiopia.

3.0 Methodology

This study adopted using a descriptive survey approach to investigate post-harvest challenges and management practices among agricultural stakeholders in Minna and its surrounding communities. The choice of survey research was informed by its suitability for capturing opinions, behaviours, and practices across a broad population, thereby aligning with the study objectives of examining factors contributing to post-harvest losses and assessing the effectiveness of post-harvest management strategies. The target population comprised agricultural stakeholders actively involved in post-harvest activities, including smallholder farmers, extension officers, produce marketers, and agribusiness operators. Based on data obtained from the Niger State Ministry of Agriculture and Rural Development and farmers' cooperatives, the estimated population size was 1,200 stakeholders. A sample size of 300 was determined using Yamane's (1967) formula at a 5% margin of error. To ensure proportional representation, stratified sampling was adopted, with each stakeholder group treated as a stratum. Within each group, simple random sampling was employed to select participants, thereby improving representativeness and reducing bias.

A structured questionnaire served as the primary instrument for data collection. The questionnaire was divided into sections to capture demographic information, factors contributing to post-harvest losses, and the effectiveness of management strategies. Responses were measured using a 5-point Likert scale, which enabled respondents to indicate the extent of their agreement with various statements. Three trained research assistants supported the distribution of the questionnaires to improve response rates and data quality. The reliability of the instrument was confirmed through Cronbach's Alpha, with coefficients above the acceptable 0.7 threshold, ensuring internal consistency. The validity of the instrument was ensured through expert review, where specialists in agricultural economics and post-harvest management assessed the questionnaire items for clarity, relevance, and alignment with the study objectives. Their feedback helped refine the instrument, thereby establishing its content validity.

The data analysis was conducted using both descriptive and inferential statistics. For Objective One, frequencies, percentages, means, and standard deviations were used to summarise stakeholders' opinions on factors contributing to post-harvest losses. For Objective Two, the Relative Importance Index (RII) method was employed to rank the effectiveness of different post-harvest management strategies. This approach provided a systematic means of identifying the most critical factors influencing losses as well as the most effective strategies for improving agricultural outcomes in the study area.

4.0 Result and Discussion

Table 1 presents the demographic characteristics of the respondents, with a focus on their professional backgrounds.

Table 1: Profession

Profession	Frequency	Percent
Farmer	81	30.0
Agricultural Project Manager	24	8.9
Extension Officer	54	20.0
Agronomist	45	16.7
Researcher	24	8.9
Others (Please specify)	42	15.6
Total	270	100.0

Source: Author's field work (2025)

4.1 Results on key factors contributing to post-harvest losses

Table 2 reveals ten (10) key factors contributing to post-harvest losses, as identified by the respondents.

Table 2: key factors contributing to post-harvest losses

Code	Key factors contributing to post-harvest losses	MIS	Rank	Decision
B1	Inadequate storage facilities	4.08	1 st	High
B10	Financial constraints for infrastructure upgrades	3.76	2 nd	High
B2	Poor transportation infrastructure	3.65	3 rd	High
B3	Poor handling practices (during harvest)	3.44	4 th	Moderate
B9	Inadequate knowledge on proper post-harvest handling	3.33	5 th	Moderate
B6	Pest and disease outbreaks	3.32	6 th	Moderate
B4	Lack of modern post-harvest technology	3.26	7 th	Moderate
B8	Poor supply chain logistics	3.13	8 th	Moderate
B5	Climate change (e.g., unpredictable weather)	3.13	8 th	Moderate
B7	Insufficient access to market	3.04	10 th	Moderate
	<i>Average MIS</i>	<i>3.41</i>		<i>Moderate</i>

Source: Author's field work (2025)

Among these, three were rated as highly important, while the remaining seven were considered moderately important, with Mean Importance Scores (MIS) ranging from 4.08 to 3.04. The most significant factor was inadequate storage facilities (MIS = 4.08; ranked 1st), reflecting a widespread lack of proper storage infrastructure across the agricultural value chain. This was followed by financial constraints for infrastructure upgrades (MIS = 3.76; ranked 2nd), and poor transportation infrastructure (MIS = 3.65; ranked 3rd), both of which point to systemic issues limiting the movement and preservation of agricultural produce. Conversely, the least important factors contributing to post-harvest losses were poor supply chain logistics and climate change (e.g., unpredictable weather), both with an MIS of 3.13 and ranked 8th, as well as insufficient access to market, which was ranked 10th with an MIS of 3.04. The overall average MIS of 3.41 suggests that, while not all factors were seen as critical, the majority were acknowledged as having a moderate level of influence on post-harvest losses. This implies that strategic interventions should prioritize infrastructural improvements particularly in storage and transportation and financial support mechanisms, as these are perceived to have the greatest impact. Addressing these top-ranked issues may significantly reduce post-harvest losses and enhance food security across the agricultural sector.

4.2 Results on Effectiveness of Various Post-Harvest Management Strategies

Table 3 presents ten (10) post-harvest management strategies evaluated by the respondents in terms of their effectiveness.

Table 3: Effectiveness of Various Post-Harvest Management Strategies

Code	Effectiveness of various post-harvest management strategies	MIS	Rank	Decision
C1	Improved storage systems (e.g., silos, cold storage)	4.17	1 st	Effective
C9	Collaboration with agricultural project managers for better coordination	4.00	2 nd	Effective
C4	Use of preservatives and packaging materials	3.92	3 rd	Effective
C2	Use of better transportation methods (e.g., refrigeration)	3.91	4 th	Effective
C7	Integration of modern technology in storage and processing	3.88	5 th	Effective
C3	Training on proper post-harvest handling techniques	3.88	5 th	Effective
C10	Policy interventions to support farmers	3.85	7 th	Effective
C6	Adoption of mechanized harvesting tools	3.82	8 th	Effective
C1	Improved access to market information	3.72	9 th	Effective
C8	Post-harvest loss monitoring systems	3.62	10 th	Effective
	<i>Average MIS</i>	3.88		<i>Moderate</i>

Source: Author's field work (2025)

All the strategies were rated as effective, with Mean Importance Scores (MIS) ranging from 4.17 to 3.62. The most effective strategy identified was improved storage systems (e.g., silos, cold storage), with an MIS of 4.17 (ranked 1st), reflecting the critical role of proper storage in preserving produce quality. This was followed by collaboration with agricultural project managers for better coordination (MIS = 4.00; ranked 2nd), and the use of preservatives and packaging materials (MIS = 3.92; ranked 3rd), both of which contribute to extending the shelf life and marketability of agricultural products. On the other hand, the least effective strategies were improved access to market information (MIS = 3.72; ranked 9th) and post-harvest loss monitoring systems (MIS = 3.62; ranked 10th), suggesting these areas may require further refinement or better implementation to increase their impact. The overall average MIS of 3.88 indicates a strong perception of the general effectiveness of the evaluated strategies. This implies that practical, infrastructure-based and coordination-focused interventions are viewed as more impactful by stakeholders, and should therefore be prioritized in future agricultural project planning and post-harvest loss reduction efforts.

4.3 Discussion of findings

For the first objective, which examined the key factors contributing to post-harvest losses, the results showed that inadequate storage facilities, financial constraints for infrastructure upgrades, and poor transportation infrastructure were the most critical challenges. These findings align with existing literature, particularly the works of Kader (2005) and Oketola (2016), who emphasized that lack of storage systems and bad roads significantly increase the rate of food spoilage. Similarly, Balana *et al.* (2022) emphasized that without access to credit

and financing, farmers are unable to invest in improved facilities, leading to continued inefficiencies in post-harvest handling. While other factors such as poor handling practices, pest and disease outbreaks, and lack of modern technologies were also noted, they were considered moderately important. This suggests that while technical knowledge and equipment are relevant, systemic infrastructural and financial issues are more pressing from the stakeholders' perspectives.

Regarding the second objective, which assessed the effectiveness of various post-harvest management strategies, the most highly rated strategies were improved storage systems, collaboration with agricultural project managers, and the use of preservatives and packaging materials. These strategies directly address the challenges highlighted in the first objective and support the arguments made by Affognon *et al.* (2015) and Abass *et al.* (2014), who noted that proper storage, coordination, and packaging are vital for reducing spoilage and maintaining produce quality. Training on post-harvest techniques, the integration of technology, and mechanized harvesting were also found to be effective, consistent with the findings of Kiaya (2014) and Sheahan and Barrett (2017). Interestingly, strategies like improved access to market information and post-harvest loss monitoring systems were rated lower, which may indicate limited awareness or underdevelopment of these practices in the study area.

5.0 Conclusion and Recommendation

This study assessed the factors contributing to post-harvest losses and the effectiveness of post-harvest management strategies in Minna, Nigeria. The findings highlighted that the most significant contributors to post-harvest losses are inadequate storage facilities, lack of financial resources for infrastructure development, and poor transportation networks. These challenges are consistent with the systemic infrastructural and economic limitations observed in many developing countries. Other factors such as poor handling practices, pest outbreaks, and limited technological adoption, though relevant, were perceived as secondary compared to infrastructural and financial barriers. On the other hand, strategies such as improved storage systems, effective collaboration with agricultural project managers, and the use of preservatives and packaging were identified as the most effective in reducing post-harvest losses. These results demonstrate that practical, infrastructure-oriented, and coordination-based interventions have greater potential to yield immediate and sustainable improvements. However, strategies such as post-harvest monitoring and market information access, though less impactful according to stakeholders, should not be overlooked, as they may become more critical with greater awareness and integration into agricultural systems.

Overall, the study establishes that post-harvest losses in Minna can be significantly reduced through targeted infrastructural investments, financial support, and improved management strategies, thereby enhancing food security and contributing to rural economic development.

5.1 Recommendations

Based on the findings of this study, the following recommendations are proposed:

- i. Policymakers and development partners should prioritize investment in modern storage facilities such as silos and cold storage systems to reduce losses during storage and marketing.
- ii. Credit schemes, subsidies, and cooperative financing models should be established to enable farmers and agribusiness operators to invest in improved post-harvest infrastructure and technologies.

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