Academy Journal of Multidisciplinary Doctoral Research [AJMDR]
Volume 2, Issue 2, 2024 ISSN: 2992-4669 || eISSN: 1116-3321

Mitigating Post-Harvest Losses to Ensure Food Security in North-West Nigeria

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Received: 15-07-24
Accepted: 18-08-24
Published: 25-12-24

Abstract

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, sub-standard storage facilities, and inefficient processing methods contribute to significant losses, compromising food availability and stability. Using the Resource-Based View (RBV), the paper employ 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.

Keywords: Post-Harvest, Losses, Mitigating, Food Security

1.0 Introduction

The cornerstone of social and economic justice lies in ensuring adequate food production. As articulated by Otaha (2013), a nation's ability to feed its populace is paramount for its standing among nations. Yet, despite global food abundance, between 691 and 783 million people worldwide grappled with hunger in 2022 (Food and Agricultural Organisation, 2023). The challenge persists: how to achieve sustainable development while guaranteeing food security for a growing populace. Post-harvest losses stand out as a critical impediment to global economic growth (Wudil, Ali, Aderinoye-Abdulwahab, Raza, Mehmood & 2023). With the World Food Programme (2020) estimating that one-third of global food meant for human consumption, valued at USD $1 trillion annually, goes to waste as a result of post-harvest losses, which is a global issue of concern (World Food Programme, 2020).

In Sub-Saharan Africa, where over 1.2 billion people are undernourished, food losses surpass 30% of total crop production, translating to more than USD $4 billion yearly (FAO, 2020). This not only inflicts economic losses but also ravages natural resources vital for sustenance (Rockefeller Foundation, 2015). Nigeria, with its vast population, underscores the urgency of ensuring food security. Once self-sufficient in food production, Nigeria's agricultural prowess significantly contributed to its GDP before the oil boom of the 1970s (Adebisi et al., 2016). Agriculture remains the largest employer, yet escalating insecurity has stymied agricultural activities, plunging the nation into food insecurity (Akinola, 2016).

The North-West Nigeria which is the focal point of discussion is one of the six geopolitical zones of the country, consisting of seven states: Sokoto, Kebbi, Zamfara, Katsina, Kaduna, Kano, and Jigawa. It is the largest zone in Nigeria both geographically and politically, characterized by a diverse culture and economy. The region plays a crucial role in Nigeria's agricultural output and is known for its vibrant markets and historical significance.

Violent conflicts, particularly in the North-West, North-East, and North-Central zones, have exacerbated Nigeria's woes (Crisis Group, 2020).

Prolonged disputes between herders and farmers have fueled banditry, further dampening agricultural productivity. Banditry not only threatens lives but also disrupts farming communities, perpetuating cycles of poverty and vulnerability. Post-harvest losses compound these challenges, limiting farmers' incomes and aggravating poverty among rural households (Akukwe, 2020).

To mitigate food insecurity, a dual approach is imperative: augmenting production and curbing losses. Post-harvest losses, identified by Adewoyin (2023), stem from various factors, including delayed harvesting, inadequate drying, traditional threshing methods, poor storage, transportation, and market conditions, as well as socio-economic factors (Kumar & Kalita, 2017). Nigeria's agriculture sector hemorrhages an estimated NGN 110 trillion (USD $268 billion) annually due to inadequate storage, processing, and transportation infrastructure (USAID, 2022). Addressing these challenges is paramount for Nigeria to reclaim its agricultural prominence and ensure food security for its burgeoning population.

Conceptualization

Post-Harvest Losses

Defining post-harvest losses entails understanding the multifaceted degradation in both quantity and quality of food from harvest to consumption. Scholars offer diverse perspectives on this concept. Mishra and Guru (2017) characterize post-harvest losses as encompassing both quantitative and qualitative aspects, affecting the nutritional and caloric compositions of food. Sawicka (2019) expands this definition, emphasizing losses across the entire food supply chain, from crop harvest to consumption. Buzby and Jeffrey (2011) define post-harvest food loss as any decline in quantity or quality occurring between harvest and consumption, encompassing physical weight losses and diminished edibility, nutritional quality, and consumer acceptability. Kikulwe, Okurut, Ajambo, Nowakunda, Stoian & Naziri (2018) add nuance, framing post-harvest loss as measurable reductions in product quantity and quality throughout the post-harvest chain.

Suleiman and Rosentrater (2015) narrow the focus, delineating post-harvest losses as crop degradation occurring after separation from the production site, affecting both quantity and quality. They classify these losses into three categories: quantitative, qualitative, and economic/commercial. Quantitative losses entail physical weight reduction, while qualitative losses encompass nutritional degradation and diminished consumer acceptability. Economic losses result from reduced product value due to quality or quantity reduction. These losses reverberate beyond mere agricultural output, impacting livelihoods, income, production incentives, and investment (World Bank, 2011; Mbwambo, Kotu, & Mpenda, 2016). Quantifying the economic toll, Nigeria's agriculture sector hemorrhages an estimated NGN 110 trillion annually due to post-harvest losses, highlighting the urgent need for intervention (USAID, 2022).

Food (in)Security:

The evolution of food security paradigms reflects shifting global perspectives on nourishment and access. Initially conceived in response to the 1970s food crisis, food security centered on ensuring consistent food supplies. The 1974 World Food Conference laid the groundwork, defining food security as the perpetual availability of adequate global food supplies to sustain consumption growth and counter production and price fluctuations (Berry, Dernini, Burlingame, Meybeck, & Conforti, 2015). Over time, food security expanded beyond supply concerns to encompass broader socio-economic dimensions. The 1983 emphasis on access marked a shift toward equitable food distribution, addressing poverty and hunger (Berry et al., 2015). The United Nations Development Programme (UNDP) further broadened the scope, recognizing food security as a component of human security, incorporating safety and nutritional balance considerations.

By 1996, the World Food Summit (WFS) crystallized food security as encompassing availability, access, stability, and utilization at individual, household, and global levels (Berry et al., 2015). This multifaceted approach acknowledges the intricate interplay between food production, distribution, and consumption, emphasizing the importance of equitable access to nutritious food for an active, healthy life. FAO's 2003 definition encapsulates the complexity, highlighting the physical, social, and economic dimensions of food security. Household food security extends this concept to the family level, underscoring the importance of individual access

within households. Idachaba (2004) emphasizes the role of food security in ensuring adequate nutrition for decent existence, distinguishing it from food insecurity, characterized by inadequate access to sufficient, safe, and nutritious food.

Food insecurity manifests in various forms, ranging from chronic, enduring inadequacy linked to poverty and structural factors, to temporary or cyclical shortages triggered by shocks or seasonal fluctuations (FAO, 2023). Acute food insecurity represents severe hunger and malnutrition threatening lives, while occasional and chronic food insecurity denote temporary and persistent threats to food access, respectively.

Overall, the dynamic nature of food security underscores its evolving definitions and the imperative of addressing diverse socio-economic factors to ensure adequate access to nutritious food for all individuals and societies.

Theoretical Framework:

The Resource-Based View (RBV) theory offers strategic insights into mitigating post-harvest losses to ensure food security in North-West Nigeria, particularly in states like Katsina, Sokoto, Zamfara, and Kaduna. According to this theory, organizations can gain a sustainable competitive advantage by effectively leveraging their internal resources and capabilities (Barney, 1991). RBV suggests that firms possess unique resources and capabilities that vary in type, quantity, and quality (Wernerfelt, 1984). In the context of North-West Nigeria, organizations involved in agriculture may have diverse resources such as infrastructure, technology, human capital, and financial resources, which can be utilized to address post-harvest losses and improve food security outcomes.

The theory further proposes that resources are not perfectly mobile across firms and industries, leading to differences in competitive outcomes (Barney, 1991). This implies that organizations in North-West Nigeria may have access to specific resources and capabilities, such as traditional farming practices, local networks, or geographical advantages, which can contribute to mitigating post-harvest losses and ensuring food security. RBV also emphasizes the importance of identifying resources that are valuable, rare, inimitable, and non-substitutable (Barney, 1991). In the context of North-West Nigeria, organisations need to prioritize resources and capabilities that meet these criteria to effectively address post-harvest losses. For example, investments in durable infrastructure like storage facilities and transportation networks, as well as the adoption of advanced technologies, can create competitive advantages in mitigating losses and enhancing food security. However, RBV has some limitations, including its limited focus on external factors and the challenge of identifying key resources (Peteraf, 1993). In North-West Nigeria, organisations may need to consider broader systemic issues such as market dynamics, regulatory frameworks, and socio-economic conditions when addressing post-harvest losses.

Overall, the Resource-Based View theory provides a valuable framework for organizations in North-West Nigeria to assess and leverage their internal resources and capabilities in mitigating post-harvest losses and ensuring food security. By focusing on building and strengthening their unique assets, organisations can develop sustainable competitive advantages that contribute to long-term food security in the region.

2.0 Result and Discussion

Nexus between Post-Harvest Losses and Food Insecurity

The interconnection between post-harvest losses and food insecurity underscores the intricate challenges facing global food systems. Post-harvest losses, characterized by the degradation in both quantity and quality of food between harvest and consumption, are influenced by multifaceted factors spanning agriculture, economics, and the environment (FAO, 2019).

Central to this nexus are the root causes of post-harvest losses, including inadequate storage, transportation, and processing infrastructure. Insufficient access to modern technologies exacerbates these losses, emphasizing the critical need for technological advancements in the agricultural sector (FAO, 2017). Poor post-harvest handling practices, such as inadequate sorting and packaging, further contribute to diminishing the quality and quantity of harvested produce (Hodges, Buzby, & Bennett, 2011). Environmental factors, including climate change-induced phenomena, heighten crop vulnerability to spoilage and decay, exacerbating post-harvest losses (Lobell, Burke, Tebaldi, Mastrandrea, Falcon & Naylor, 2011).

The implications of post-harvest losses on food security dynamics are far-reaching. Beyond the

immediate reduction in available food, the nexus extends to qualitative erosion of nutritional value, impacting population well-being. Economically, post-harvest losses cause financial setbacks for farmers and contribute to broader economic challenges in the agricultural sector (Cranfield, Henson, & Holliday, 2019). The nexus further exacerbates food insecurity by leading to an escalation of food prices, disproportionately affecting vulnerable populations (Bellemare, 2017).

Regional disparities in post-harvest loss rates stem from geographical and sectoral dynamics, including variations in climatic conditions, infrastructural capacities, and agricultural practices. Moreover, the nexus assumes a crop-specific dimension, necessitating tailored interventions for different crops (FAO, 2013).

Technological interventions play a pivotal role in addressing the nexus. Investments in advanced storage and transportation infrastructure mitigate perishability and reduce post-harvest losses (Buzby, Hyman, & Stewart, 2011). Information and Communication Technology (ICT) solutions, such as supply chain management systems, enhance transparency and efficiency, minimizing losses at various stages of the post-harvest continuum (Beriya, 2021). Advocacy for and implementation of modern harvesting techniques designed to minimize damage contribute to breaking the nexus (FAO, 2018).

Governance and policy interventions are integral to dismantling the nexus. A robust regulatory framework, supported by stringent policies, fosters infrastructural development and incentivizes the adoption of modern agricultural practices (World Bank, 2019). Financial incentives for farmers, facilitated through policy interventions, enable the integration of technology and enhancement of post-harvest infrastructure (Headey, Hirvonen, & Hoddinott, 2018). Research initiatives focused on sustainable agricultural practices and comprehensive educational programs empower stakeholders, actively contributing to breaking the nexus (FAO, 2016).

Community-centric engagement strategies play a crucial role in addressing the nexus. Empowering farmers with knowledge and skills, coupled with strengthening linkages between farmers and markets, actively contribute to minimizing post-harvest losses and disrupting the nexus (Gautam, Gaur, & Varma, 2020; Goyal & Singh, 2019).

Root Causes of Post-Harvest Losses

Post-harvest losses result from a multitude of factors occurring throughout the food value chain, with each stage presenting unique challenges. The significance of these factors varies across countries and commodities, influenced by the level of mechanization and infrastructure in the supply chain (Aulakh & Regmi, 2013). In less developed countries like Nigeria, where mechanization is limited, substantial losses occur during drying, storage, processing, and transportation. Mechanization of practices such as harvesting and processing can help mitigate these losses. However, various factors contribute to post-harvest losses, including:

1. ***Weather Conditions:*** Unfavorable weather, such as excessive heat, humidity, or rainfall, can accelerate spoilage and deterioration of harvested crops.
2. ***Production Practices:*** Inadequate agricultural practices, such as improper harvesting techniques or insufficient pest control measures, can result in crop damage and losses.
3. ***Transportation Facilities:*** Poor transportation infrastructure, including bad roads and inadequate cold chain facilities, can lead to physical damage and spoilage during transit.
4. ***Grading Issues:*** Inaccurate grading and sorting processes may result in the discarding of edible produce, contributing to post-harvest losses.
5. ***Infrastructure:*** Lack of proper storage facilities, such as cold rooms and ventilated warehouses, can lead to premature spoilage and deterioration of perishable goods.
6. ***Consumer Preferences/Attitudes:*** Consumer demand for visually appealing produce may lead to rejection of perfectly edible but aesthetically imperfect fruits and vegetables, resulting in market losses.
7. ***Market Availability:*** Limited access to markets and lack of market information may hinder farmers' ability to sell their produce efficiently, leading to surplus and eventual losses.

8. ***Biological and Environmental Causes:*** Factors such as temperature fluctuations, relative humidity, and sanitation procedures play a significant role in determining the shelf life and quality of harvested crops.
9. ***Insecurity:*** Threats posed by banditry and insecurity in certain regions disrupt transportation and market access, exacerbating post-harvest losses.
10. ***Weak Government Regulations and Policies:*** Inadequate regulatory frameworks and policies aimed at reducing post-harvest losses contribute to inefficiencies in the food value chain.

Addressing these factors requires a holistic approach involving technological innovations, infrastructure development, policy reforms, and capacity building initiatives aimed at improving post-harvest handling practices and minimizing losses throughout the food value chain.

Mitigating Post-Harvest Losses to Ensure Food Security in North-West Nigeria

Post-harvest losses present a significant challenge to food security throughout North-West Nigeria, affecting states like Katsina, Sokoto, Zamfara, and Kaduna. Reports from international organisations stress the urgent need for comprehensive strategies to address these losses and ensure a sustainable food supply in the region.

In Sokoto, Kaduna, and Zamfara states, tackling post-harvest losses requires a multifaceted approach, with a primary focus on infrastructure investment. These losses are particularly pronounced in key food crops such as sorghum, millet, maize, and cowpea, occurring mainly during handling and storage phases (Ibrahim, Ibrahim, Adeola, & Ojoko, 2022). Contributing factors include inadequate post-harvest practices, deficient storage facilities, and the utilization of inferior packaging materials, all of which significantly jeopardize household food security and exacerbate poverty levels in these areas. Moreover, various determinants influence the extent of post-harvest losses, encompassing factors like farmers' age, proximity to farms, agricultural experience, and access to credit (Ibrahim et al., 2022). These diverse factors manifest in unique ways, further underscoring the complexity of the issue. Thus, targeted interventions aimed at bolstering infrastructure, improving post-harvest practices, and ensuring sufficient storage facilities are imperative to mitigate losses and fortify food security across Sokoto, Kaduna, and Zamfara states.

The Food and Agriculture Organisation (FAO) highlights the inadequacy of storage facilities as a significant contributor to crop losses. Therefore, there is a pressing demand to enhance storage infrastructure, including warehouses and silos equipped with modern cooling and ventilation systems. The World Bank echoes this sentiment, emphasizing the importance of investing in robust infrastructure to curb post-harvest losses (Food and Agriculture Organisation, 2024).

Adomi, Abdoulaye, Mohammed, Abdu, Musa & Baributsa (2023) shed light on the profound impact of post-harvest losses on food security in North-West Nigeria, with a particular emphasis on cowpea grains. Their study reveals the widespread occurrence of these losses attributed to insect pests like cowpea bruchids, posing a substantial threat to household food security across the region. These losses not only reduce food availability but also exacerbate existing levels of food insecurity among local communities. In addressing these challenges, the study underscores the common practice among farmers of resorting to the indiscriminate use of insecticides for pest management. However, this conventional approach has negative repercussions, including adverse effects on human health and the environment. Moreover, the overuse and misuse of chemicals perpetuate the cycle of dependence on unsustainable agricultural practices, further worsening food insecurity in the area (Adomi et al., 2023). To mitigate these challenges, the study advocates for non-chemical solutions such as the Purdue Improved Crop Storage (PICS) bags. These hermetic storage methods offer a safer and more sustainable alternative to conventional pest management practices, aiming to reduce post-harvest losses and improve food security outcomes among smallholder farmers in North-West Nigeria. The study evaluates the effectiveness of adopting PICS bags in enhancing food security among smallholder cowpea farmers in the region, employing household food expenditure analysis and poverty analysis as primary methodologies. The findings reveal promising outcomes for households that adopt PICS bags, indicating a

positive correlation between adoption and improved food security outcomes. By mitigating post-harvest losses, PICS bags contribute to enhanced food availability and access for smallholder farmers in North-West Nigeria, playing a crucial role in bolstering food security at the household level.

According to Ogundele (2022), minimizing post-harvest food losses in Nigeria requires pragmatic policies and dedicated leadership. Achieving the goal of food security hinges on reducing these losses to the barest minimum. It is crucial for all stakeholders, including those in the public and private sectors, as well as civil society, to recognize their role in fostering a supportive environment for decision-making and the adoption of technologies aimed at reducing post-harvest losses in Nigeria.

Technological innovations are pivotal in minimizing post-harvest losses, particularly in North-West Nigeria, as highlighted by reports from the International Food Policy Research Institute (IFPRI). However, there remains a low adoption rate of modern harvesting and processing technologies in these areas. To address this challenge, the implementation of mechanized harvesting methods and advanced storage techniques, such as hermetic storage bags, can significantly reduce losses. Additionally, recommendations from the International Renewable Energy Agency (IRENA) advocate for the deployment of solar-powered cold storage units, especially in areas with unreliable electricity supply, to effectively preserve perishable crops (Amjad, Munir, Akram, Parmar, Precoppe, Asghar & Mahmood, 2023).

Capacity building is essential for empowering farmers with the necessary knowledge and skills to mitigate post-harvest losses, as emphasized by FAO (FAO, 2024). Tailored training programs and extension services focused on post-harvest handling practices are crucial in this regard. Similarly, the World Food Programme (WFP) underscores the significance of capacity building initiatives to enhance farmers' abilities to minimize losses effectively.

Community engagement emerges as a vital component in devising sustainable solutions to post-harvest losses, as advocated by the FAO. Collaborative efforts involving local communities, government agencies, and non-profit organisations can effectively harness local knowledge and resources. Community-driven initiatives can disseminate best practices and foster knowledge sharing among farmers, thereby reducing losses and promoting food security in the region (FAO, 2024). Post-harvest losses necessitates a holistic approach encompassing infrastructure investment, technological innovation, capacity building, value addition, market access improvement, policy support, and community engagement. By implementing strategies recommended by international organisations, significant strides can be made towards reducing losses and ensuring food security in North-West Nigeria.

3.0 Conclusion

Mitigating post-harvest losses to ensure food security in North-West Nigeria demands a multifaceted approach that integrates various strategies and stakeholders. Through the lens of the Resource-Based View theory, organisations in the region can strategically harness their internal resources and capabilities to address this pressing challenge. By focusing on investments in infrastructure, technology adoption, capacity building, market access, policy support, and community engagement, stakeholders can create a robust framework for reducing post-harvest losses and enhancing food security. Infrastructure development, including the construction and improvement of storage facilities, transportation networks, and processing facilities, is crucial for preserving harvested crops and minimizing losses. Moreover, leveraging technological solutions such as mechanized harvesting methods, advanced storage techniques, and information systems can significantly improve efficiency and reduce losses along the food supply chain. Capacity building initiatives, including training programs and extension services, are essential for empowering farmers with the knowledge and skills needed to implement best practices in post-harvest handling. Additionally, enhancing market access through better transportation infrastructure and market information systems can facilitate the efficient movement of produce from farms to consumers, reducing losses and ensuring food availability. Government policies and regulations play a pivotal role in creating an enabling environment for mitigating post-harvest losses. By implementing

measures to improve food safety standards, enhance market access, and provide financial incentives for investment in post-harvest infrastructure, policymakers can support efforts to enhance food security in the region. Community engagement is also critical for fostering collaboration and knowledge sharing among stakeholders. Collaborative initiatives involving government agencies, non-profit organisations, private sector actors, and local communities can leverage collective expertise and resources to develop sustainable solutions tailored to the needs of North-West Nigeria.

Mitigating post-harvest losses to ensure food security in North-West Nigeria requires a holistic and collaborative approach that addresses the root causes of losses while leveraging internal resources and external support mechanisms. By embracing the principles of the Resource-Based View theory and adopting strategic interventions across the food supply chain, stakeholders can make significant strides towards achieving food security and improving livelihoods in the region.

Recommendations

To effectively address the issue of post-harvest losses and enhance food security in Nigeria, concerted efforts from both the public and private sectors are essential. Governments, research institutes, agricultural engineers, food scientists, farmers, agro-processors, and NGOs all have vital roles to play in reducing post-harvest losses and ensuring food security. The following recommendations aim to mitigate losses and enhance the attainment of food security:

1. *Infrastructure Investment*; the governments should develop and improve rural roads to facilitate easier access to markets for farmers, invest in storage facilities to reduce post-harvest losses due to spoilage, establish irrigation systems to ensure consistent water supply, especially during dry seasons among others.

2. *Technological Innovation*; promote the use of technologies for farmers to access weather forecasts, market prices, and best practices in farming, introduce precision agriculture technologies to optimize resource use and increase yields and Implement solar-powered cold storage solutions to preserve perishable goods.

3. *Capacity Building*; conduct training programs for farmers on modern agricultural practices and post-harvest handling techniques, provide workshops on financial literacy and business management to help farmers make informed decisions and collaborate with agricultural extension services to ensure farmers receive support and education.

4. *Market Access Improvement*; facilitate the creation of cooperatives to enhance bargaining power and access to larger markets, organise farmers' markets to connect producers directly with consumers, reducing reliance on middlemen and Leverage e-commerce platforms to expand market reach for local farmers.

5. *Policy Support*; advocate for government policies that provide subsidies for inputs like seeds and fertilizers to reduce costs for farmers, implement regulations that protect farmers from exploitative practices by buyers and middlemen and encourage policies that support research and development in agriculture to foster innovation.

By integrating these strategies, North-west Nigeria can effectively address the challenges of post-harvest losses and enhance food security for its population.

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