

# Challenges and innovations in harvesting and handling of vegetables in Nigeria

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## ABSTRACT

Vegetable production plays a crucial role in Nigerian agriculture, serving as a primary income source for numerous small-scale farmers across the country. Despite this, the sector grapples with substantial post-harvest losses attributed to inadequate harvesting and handling practices. These losses not only diminish the quantity and quality of vegetables available for consumption but also undermine the economic viability of farming operations. In Nigeria, harvesting techniques vary widely and often lack standardization. Many farmers harvest vegetables manually, using rudimentary tools, which can lead to physical damage and bruising. Moreover, the timing of harvests may not be optimal, resulting in produce that is either under ripe or overripe by the time it reaches markets or processing facilities. Post-harvest handling practices, such as sorting, cleaning, and packaging, also suffer from inefficiencies. Poor hygiene during handling contributes to contamination and spoilage, further escalating losses. The consequences of these challenges are profound. Farmers experience reduced income due to lower market prices for damaged or spoiled produce. Consumers face limited access to high-quality vegetables, impacting their nutritional intake and the environment suffers as valuable resources invested in cultivation are wasted. Addressing these issues requires a multifaceted approach. Introducing improved harvesting tools and techniques can minimize physical damage to vegetables during harvest. Training programs aimed at educating farmers on optimal harvest timing and post-harvest handling practices could enhance overall crop quality. Infrastructure development, such as storage facilities and transportation networks, is essential to prolong shelf life and maintain freshness from farm to market. Moreover, policy interventions and investment in research and development are critical to supporting sustainable improvements in vegetable production. By addressing these challenges and seizing opportunities for innovation, Nigeria can bolster its agricultural sector, improve food security, and enhance livelihoods for millions of smallholder farmers. This review aims to underscore these issues and advocate for transformative changes in harvesting and handling practices to mitigate post-harvest losses and optimize vegetable production in Nigeria.

**Keywords:** post-harvest, vegetable, horticulture

## INTRODUCTION

Nigeria is the largest producer of vegetables in West Africa, with a production capacity of over 1.5 million metric tons annually (Food and Agriculture Organization [FAO], 2020). Vegetables are an essential component of the Nigerian diet, providing vital nutrients and contributing to food security, vegetables make up a large portion of a people diet in Nigeria, because they include significant levels of fiber, minerals, vitamins, and antioxidant (Smart et al., 2023). However, the harvesting and handling practices employed in the Nigeria often result in significant post-harvest loss, reducing the

quality and quantity of vegetables available for consumption (Daramola et al., 1998; Msogoya et al., 2011). One of Nigeria's hidden revenue generators is the country's vegetable farming industry. Vegetable farming is, in fact, very profitable in Nigeria, a country of over 100 million people from various tribes and ethnic backgrounds, whose primary commonality is the use of vegetables in food preparation. Nigeria is a major supplier of tomato derivatives and the continent's second-largest producer of vegetable, according to FAO (2023). However, only 20% of Nigeria's vegetable production is processed, mostly as a result of an inadequate processing infrastructure (Ngowi & Selejio, 2019). Furthermore, there are inconsistent quality standards for export, low access to

financing for small-scale farmers, and post-harvest losses in Nigeria's tomato and vegetable value chain that can reach up to 50% (Amurtiya & Adewuyi, 2020). Some common vegetables produced in Nigeria are tomatoes, onions, peppers, cucumbers, spinach, okra, amaranthus, pumpkin, eggplant, while leafy vegetables are lettuce, cabbage, cauliflower, celosia (soko), bitter leaf (vernonia), water leaf (talinum), fluted pumpkin (telfairia), ewedu (corchorus), and ugu (fluted pumpkin) (FAO, 2011, 2022).

Vegetables are perishable, therefore as soon as harvest maturity has occurred, speedy harvesting and handling become crucial (Vishal et al., 2014). It is the goal of any manufacturer to get their goods to the final customer as soon as feasible. Regretfully, once the produce leaves their farm or packing sheds, they are powerless. On the farm or at the shed, though, handling produce as quickly and effectively as possible will help preserve quality. As such, a grower needs to be ready to go well in advance of the actual harvesting process. In order to prepare for harvest, it is important to arrange for enough workers, supplies (containers and packaging materials), clean the grading/packing shed, and make sure all of the equipment is working. Delays of any kind after the produce reaches harvest maturity can cause significant quality and yield losses. Furthermore, the nutritional value of vegetables also varies. Even when being handled and stored, biosynthetic and degrading reactions will continue to take place. For vegetables to be harvested, handled, graded, and packaged in a way that ensures maximum produce quality at the market, specific skills are needed. Whatever the quality is at harvest, it doesn't really matter if it gets compromised by careless handling, packaging, or storage. The quality of the produce in the market determines the price received. A significant portion of our harvest in Nigeria is wasted because most items are seasonal, and our post-harvest industry is still in its infancy. Therefore, lowering the losses of vegetables could boost output, boost farmer income, enhance the supply of leafy vegetables available, and ultimately improve the socioeconomic standing of Nigeria's end users. Additionally, it might significantly improve food security in Nigeria and beyond (Mohammed & Usman, 2023). By addressing post-harvest losses, this also contribute to sustainable development goals 2 (zero hunger), 8 (decent work), and 12 (responsible consumption) in Nigeria.

This review's goal is to provide a sufficient understanding of all aspects of vegetable harvesting and handling in Nigeria, from harvesting to distribution, in order to enable appropriate technology at each stage and to minimize losses and maintain the highest possible level of quality throughout the sales channel. And also provides an overview of the procedures for gathering, handling, and processing vegetables in Nigeria while considering the entire post-harvest chain, which includes transportation, storage, processing, and both traditional and new enhanced ways for storing collected vegetables. Additionally, to discuss about the significant post-harvest losses and identify solutions to post-harvest losses and how to increase the quality of vegetables shelf life.

## HARVESTING AND HANDLING PRACTICES

The harvesting of vegetables in Nigeria is often done manually, using traditional methods that can lead to damage and spoilage. For example, tomatoes and peppers are typically harvested by pulling the entire plant, leading to bruising and damage to the fruit. Similarly, leafy vegetables like lettuce and spinach are often harvested by cutting the entire head, resulting in damage to the leaves.

After harvesting, vegetables are typically handled and stored in a manner that can lead to further damage and spoilage, and every change in food that causes the food to lose its desired quality and eventually become inedible is called food spoilage or rotting (Moris & Jobing, 2000). For example, vegetables are often stored in open markets, exposed to direct sunlight, heat, and moisture, leading to a reduction in quality and shelf life. Food losses will occur without effective harvesting and handling practices, and food losses are unacceptable everywhere in the world given the resources needed to produce and process food (Ojo, 2015). Vegetable post-harvest losses should be considered a service to mankind in a world where millions, if not billions, of people suffer from either acute or chronic illness. A significant portion of agricultural products are lost during production, transportation, or commodities markets.

## CHALLENGES FACED WITH HARVESTING AND HANDLING

The harvesting and handling practices employed in Nigeria face several challenges, including the limited access to modern harvesting and handling technologies, which hinders the efficiency and effectiveness of the harvesting and handling process, leading to increased labor costs and reduced productivity (Kughur et al., 2015).

Furthermore, inadequate training and education on proper harvesting and handling techniques among farmers and handlers result in a lack of knowledge on how to handle vegetables properly, leading to damage and spoilage during harvesting, handling, and storage.

Adewoyin et al. (2022) reported that when the temperature is low before 12 pm, farmers typically mobilize themselves or hire labor to begin harvesting as early as 6 am. After harvesting, the produce is brought to the market to be sold directly to customers or merchants. Vegetables gathered in the evening may occasionally be spread out on flat surfaces over night to prevent them from overlapping before being sold in the market the following morning. This procedure may shorten the vegetables shelf life due to stress before they are delivered to the market.

Additionally, limited access to storage facilities and transportation infrastructure hampers the ability to store and transport vegetables properly, leading to high levels of spoilage and damage during transportation and storage, which further exacerbates the problem of post-harvest losses

High levels of spoilage and damage during transportation and storage remain a significant challenge, as vegetables are



**Figure 1.** Produce display with no shade decreasing quality and appearance (Source: Field study)



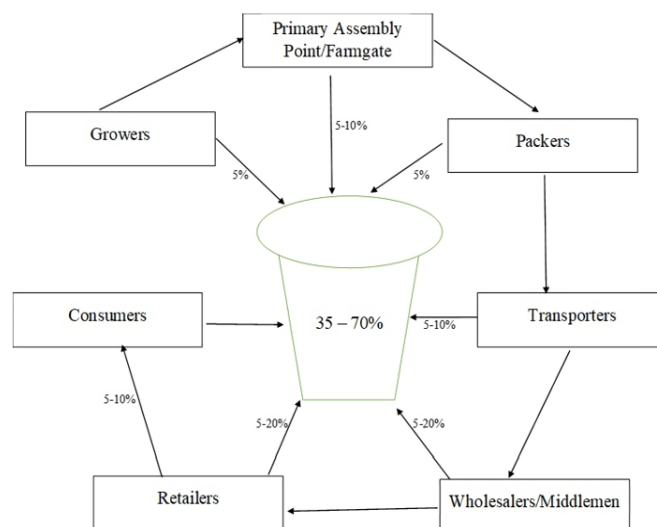
**Figure 2.** Primary assembly point at a local market (Source: Field study)



**Figure 3.** Vegetables bask in the sunlight at a local market (Source: Field study)

often exposed to unfavorable conditions such as high temperatures, humidity, and physical damage, which can lead to a significant reduction in quality and quantity (Babatola et al., 2003).

**Figure 1, Figure 2, and Figure 3** shows direct sunlight exposure at a local market which are one of the reasons of post-harvest losses in vegetables due to temperature



**Figure 4.** Schematic diagram showing different stage of post-harvest losses of vegetables with estimate losses in Nigeria (Adewoyin et al., 2022; Olorunda & Aworh, 1981)

fluctuations, moisture loss, and quality degradation, necessitating improved storage solutions.

**Figure 4** shows schematic diagram showing different stage of post-harvest losses of vegetables with estimate losses in Nigeria

## SOLUTION TO HARVESTING AND HANDLING LOSSES IN NIGERIA

To address the challenges in harvesting and handling practices in Nigeria, investments can be made in providing modern harvesting and handling technologies to farmers and handlers, alongside establishing technology transfer programs, training, and demonstrations, as well as offering credit facilities to support farmers' acquisition of new technologies. Additionally, training programs can be established for farmers and handlers on proper harvesting and handling techniques, in partnership with research institutions, extension services, and farmer organizations, to develop and disseminate best practices through workshops, demonstrations, and on-farm training. Moreover, investments can be made in building modern storage facilities and transportation infrastructure, through public-private partnerships and infrastructure development projects, with financing initiatives to support private sector investment. To reduce spoilage and damage, proper handling and storage practices can be implemented, such as cooling systems, humidity control, and gentle handling, alongside investments in transportation infrastructure like refrigerated trucks and containers (Bisht et al., 2024). Furthermore, market access programs can be established to connect farmers with processors, wholesalers, and retailers, and quality control and standards can be implemented for vegetables, while encouraging farmer organizations and cooperatives to pool resources, share knowledge, and access modern technologies and markets.



## Use of Ripening Inhibitors

In certain cases, ripening inhibitors, high carbon dioxide, low oxygen, and waxing are combined to extend the shelf life of the product (Olmedo et al., 2023). It is still challenging to identify the most effective treatments for endogenous ethylene and ripening inhibition (Dias et al., 2021). To keep ethylene levels below the limit, a variety of chemical combinations have been tested. Ethylene absorbents such as potassium permanganate and calcium chloride have significant economic potential when used in conjunction with controlled storage atmospheres. According to Imahori and Bai (2024), the application of 1-methylcyclopropene (1-MCP) before and after harvest has achieved significant success in various vegetables and fruits. This finding aligns with the research conducted by Bai et al. (2009), which demonstrated the crucial role of strategic 1-MCP application in achieving optimal results for post-harvest management in vegetables. The ripening inhibitor can be made accessible to small-scale farmers at an affordable cost through collaborative efforts between extension workers, government agencies, and non-governmental organizations. By providing training and education on the proper use of this technology, farmers can effectively extend the shelf life of their produce, reducing post-harvest losses and improving their livelihoods.

## Cold Storage System

Nigeria's agricultural sector faces significant losses, with an estimated NGN 110 trillion (approximately US \$268 billion) lost annually due to post-harvest losses. This substantial loss is attributed to the inadequate infrastructure available to farmers, fishermen, and retailers, including insufficient cold storage facilities, agro-processing capabilities, and transportation networks (United States Agency for International Development [USAID], 2022). Furthermore, a recent report by USAID (2024) revealed that a staggering 50% of fresh agricultural produce in Nigeria is lost at the post-harvest stage, highlighting the urgent need for improvements. Cold storage systems can play a crucial role in addressing these challenges by maintaining the freshness and quality of vegetables from harvesting to consumption in the sector's infrastructure and logistics to reduce these losses and enhance food security.

## Improved Harvest and Handling Method

Harvesting and handling fresh produce requires extreme care (Adebayo, 2017), including harvesting at optimal quality and under cool conditions, batch harvesting, planting varied varieties to extend the season, shading before transportation, removing poor-quality produce, preventing temperature and moisture fluctuations, and using appropriate tools and containers, especially for export commodities. **Table 1** shows few improvements made on handling materials for vegetable in Nigeria.

1. **Burlaps and canvas bags:** Allow for ventilation, reducing moisture buildup and ethylene production, which can cause spoilage.
2. **Iron and steel buckets:** Provide a clean, dry, and durable container for storing vegetables, protecting them from contamination and physical damage.

**Table 1.** Existing and improved handling materials (Adewoyin et., al 2022)

S/N	Existing packages	Improvement made
1	Jute bags	Burlap and canvas bags
2	Plastic bucket	Iron and steel buckets
3	Open lorries	Shipping containers
4	Newspaper	Foil paper
5	Wooden boxes	Iron boxes

3. **Shipping containers:** Offer a controlled environment for transportation, shielding vegetables from extreme temperatures, humidity, and physical stress.
4. **Foil papers:** Act as a barrier against moisture, light, and oxygen, preventing spoilage and preserving freshness.
5. **Iron boxes:** Provide airtight storage, maintaining humidity and temperature control, and protecting vegetables from pests and contamination.

These materials improve shelf life by reducing moisture buildup and ethylene production, preventing contamination and physical damage, regulating temperature and humidity, protecting from light and oxygen exposure, maintaining cleanliness and hygiene. Using these materials, vegetable producers and suppliers have been able to reduce post-harvest losses and extend shelf life, increase marketability and enhance food safety.

## RECOMMENDATIONS

To address post-harvest losses and vegetable waste in Nigeria, it is recommended to invest in infrastructure development, adopt modern technologies, provide training and education, develop and promote appropriate packaging, establish market linkages, offer policy support, conduct research and development, and foster public-private partnerships, all aimed at creating a sustainable and efficient vegetable sector that benefits all stakeholders and ensures food security and economic growth.

## CONCLUSIONS

Post-harvest losses in Nigeria's vegetable sector are attributed to a combination of factors, including suboptimal harvesting methods and tools, lack of cold chain systems, inadequate storage facilities, and ineffective marketing strategies. To preserve vegetable quality and ensure food security, efficient and rapid post-harvest handling is crucial. This involves immediate removal of field heat, protection from sun and unhygienic conditions, and adherence to specific produce handling methods, market requirements, and appropriate packaging techniques. The adoption of proper vegetable harvesting and handling practices is vital for sustaining food security, ensuring universal access to nutritious food, and maintaining the freshness and quality of vegetables. However, Nigeria's inadequate infrastructure across the supply chain, from picking to storing to shipping and processing, hinders the implementation of optimal handling practices. Despite these challenges, opportunities for

improvement exist. By embracing modern technologies, providing training and education to farmers and handlers, and investing in transportation infrastructure and storage facilities, Nigeria can significantly reduce post-harvest losses and enhance the overall quality and availability of vegetables. This multifaceted approach will require collaboration among stakeholders, policymakers, and industry players to prioritize improvements in vegetable harvesting and handling practices, ultimately contributing to a more food-secure and sustainable future.

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