RURAL INFRASTRUCTURE AND POSTHARVEST LOSSES OF ORANGES IN KONSHISHA LOCAL GOVERNMENT AREA OF BENUE STATE, NIGERIA

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ABSTRACT
Post-harvest losses of oranges remain a persistent challenge in many rural farming communities in Nigeria due to infrastructural deficiencies that hinder efficient handling, storage, and transportation of agricultural produce. Despite Konshisha Local Government Area of Benue State being an important hub for orange production, farmers continue to experience substantial losses after harvest, which undermines income generation and food security. This study examined the influence of rural infrastructure on post-harvest losses of oranges in Konshisha LGA. Specifically, it assessed the availability of rural infrastructure and analysed how infrastructural conditions affect the magnitude of post-harvest losses among orange farmers. The study was anchored on Modernization Theory. A descriptive survey design was adopted, involving 378 respondents comprising orange farmers, officials of the Ministry of Agriculture, and members of farmers' and traders' associations. Data were collected using questionnaires and key informant interviews and analysed using descriptive statistics and content analysis. Findings revealed that critical rural infrastructures such as reliable road networks, storage facilities, electricity supply, and transportation services were largely inadequate in the study area. Consequently, farmers relied on motorcycles and bicycles for transport, lacked proper storage systems, and faced high transportation costs and seasonal road inaccessibility, all of which significantly increased post-harvest losses of oranges. The study concludes that infrastructural deficits are a major driver of post-harvest losses among orange farmers in Konshisha LGA. It therefore recommends increased government investment in rural roads, electrification, and storage infrastructure, alongside collaborative efforts by agricultural agencies and development partners to establish community storage hubs and provide farmers in Konshisha LGA with training on improved post-harvest management practices.
Key Words: Rural Infrastructure, Post-harvest losse, Oranges, Konshisha Local Government.

Introduction
Orange (Citrus sinensis) is one of the major fruits cultivated globally for its fruit juice, nutritional value, and medicinal attributes. Delicious and juicy, the orange fruit contains essential nutrients necessary for normal growth, development, and overall well-being (Liu et al, 2020). Although there are certain areas of high concentration in terms of production, the leading areas of production for the international fresh market are in the Mediterranean regions, with Spain being the dominant producer (Sarker et al., 2022). Brazil, however, is the leading exporter of orange juice globally. According to the Food and Agriculture Organization (FAO), the global production of oranges reached approximately 75 million metric tons in recent years, with Brazil, China, and the United States being the top producers. FAO (2022) reports that oranges rank first in terms of value in the international fruit trade.

Oranges have immense nutritive and economic value, making them an important agricultural commodity globally. Nutritionally, oranges are rich in vitamin C, a powerful antioxidant that boosts immunity, promotes healthy skin, and enhances iron absorption in the body (Carr & Maggini, 2017). They are an excellent source of dietary fiber, which aids digestion by promoting gut health and preventing constipation. Oranges also contain essential minerals such as potassium, which plays a vital role in regulating blood pressure and supporting heart health (Reynolds et al., 2019). The fruit's high antioxidant content, including flavonoids and carotenoids, helps combat oxidative stress, thereby reducing the risk of chronic diseases such as cardiovascular disorders and certain types of cancer (Liu et al., 2020).

Oranges contribute significantly to employment and income generation, particularly in rural communities where citrus farming is a major livelihood activity. The orange industry supports multiple value chains, including fresh fruit sales, juice production, essential oil extraction, and livestock feed manufacturing from orange peels, all of which enhance market profitability and create diverse income streams (FAO, 2021). However, despite their economic significance, a substantial percentage of oranges produced annually are lost due to post-harvest inefficiencies, poor storage conditions, and inadequate transportation infrastructure (Aminu et al., 2020; FAO, 2021).

In Asia and the Pacific region, two major categories of food production and supply chain infrastructures, modern and traditional, operate in parallel (FAO, 2021). The modern supply chains, which benefit from good roads, transport networks, mobile communication, and post-harvest technologies, supply supermarkets and hypermarkets and conform to market requirements for volume, safety, and quality. Consequently, post-harvest losses in these modern supply systems are relatively low, with waste mainly occurring at the retail, foodservice, and consumer levels. In contrast, traditional or rural supply chains face severe limitations, including inadequate infrastructure, poor pest and disease control, weak supply chain integration, lack of dedicated transport systems, and poor packaging. These constraints lead to high levels of post-harvest losses in orange production and distribution (FAO, 2021).

In many African, Caribbean, and Pacific (ACP) countries, tropical weather and underdeveloped road transport infrastructure further exacerbate post-harvest losses, which can reach 40-50% (FAO, 2021). In Zimbabwe, post-harvest losses in oranges occur at various stages of the supply chain. Losses range from 10% to 50% at the farm level, 0–10% during harvesting, 10–50% in temporary storage, 0–10% during middlemen handling, and 0–10% at market levels (Sarker et al., 2022). In Nigeria, where orange production plays a vital role in income generation and nutrition security, post-harvest losses occur at multiple stages of the supply chain. These losses impact not only farmers' incomes but also the broader national economy. Studies indicate that billions of naira is lost annually due to post-harvest orange losses, making it necessary to strengthen food security through improved rural infrastructure and supply chain management (Obayelu et al, 2022).

Statement of the Problem

In a functional agricultural framework, robust rural infrastructure including well-maintained roads, efficient storage facilities, accessible processing units, and reliable transportation networks support farmers in minimizing post-harvest losses. For orange producers in Konshisha Local Government Area of Benue State, such infrastructure would ensure that harvested fruits are promptly and safely transported to markets or processing centers, thereby preserving quality, maximizing income, and contributing to food security (Ikwuba & Tyav, 2019). However, farmers in the local government grapple with substantial post-harvest losses despite Konshisha's prominence in orange production. A study focusing on the North-Eastern Zone of Benue State, which includes Konshisha, revealed that post-harvest losses among orange farmers are alarmingly high, primarily due to inadequate storage facilities and poor transportation infrastructure. These infrastructural deficits hinder timely market

access, leading to spoilage and reduced earnings (Ikwuba et al, 2019). Efforts to address these challenges have been undertaken. For instance, there is the establishment of Agricultural Service Centres aimed to bolster agricultural productivity by providing essential resources and support to farmers. However, the effectiveness of these centers has been limited, as many farmers in Konshisha LGA still lack access to adequate infrastructural facilities (Gbenyi et al, 2021).

In the face of these initiatives, the problem endures. Research on infrastructural development and agricultural productivity in Konshisha LGA of Benue State revealed that most rural roads are in a deplorable state, making transportation of farm produce to markets difficult. Similarly, health and other social facilities were found to be inadequate and poorly maintained, limiting their effectiveness in supporting rural livelihoods. Such infrastructural shortcomings continue to impede agricultural efficiency and exacerbate post-harvest losses (Gbenyi et al, 2021). It results in diminished farmer incomes, heightened poverty levels, and compromised food security. Consumers also face inflated prices and inconsistent orange supplies. Also, the absence of functional processing facilities means missed opportunities for value addition, which could otherwise enhance product shelf life and open new market avenues.

While several studies have addressed post-harvest losses in Benue State, very few have provided a specific focus on Konshisha LGA. For instance, Suleiman et al (2024) examined the constraints and coping strategies of citrus farmers in Gwer East LGA and found that lack of storage facilities and poor market access heightened post-harvest losses. Similarly, Arah et al (2023) investigated post-harvest handling of citrus fruits in Otukpo and reported that infrastructural deficiencies, especially transportation, were key drivers of spoilage. In a related study, Dooga et al (2021) analyzed factors influencing orange production in the North-East Zone of Benue State and highlighted inadequate rural infrastructure as a persistent challenge. Beyond Benue, Obayelu et al (2022) emphasized that infrastructural bottlenecks remain a major determinant of post-harvest orange losses across tropical regions. More recently, Aminu and Akinbile (2024) showed that infrastructural development significantly reduces fruit wastage in rural Nigerian communities.

The preceding studies however failed to directly examine Konshisha LGA, where orange production is highly significant. Thus, there remains a need for focused research that directly addresses the unique infrastructural challenges and post-harvest loss dynamics within Konshisha LGA. Moreover, given the ongoing challenges faced by orange farmers in the local government, it is imperative to conduct a comprehensive assessment of how existing rural infrastructure influences post-harvest losses of oranges in Konshisha Local Government Area of Benue State, Nigeria. Thus, the study put forward the following specific research questions:

1. What are the available rural infrastructures in Konshisha LGA of Benue State?
2. What are the effects of rural infrastructures on post-harvest losses of oranges in Konshisha LGA of Benue State?

Literature review

Rural infrastructure refers to all the social amenities or facilities that support growth and development of agrarian communities. Nigeria has some considerable rural infrastructural amenities. These include electricity supply, water supply system (from bore-holes, wells streams among others), road networks, market infrastructures, schools, health facilities, local processing infrastructures for agricultural produce (Gbenyi et al, 2021). Scholars have pointed out the multiple effects of rural infrastructure on post-harvest loss of oranges. Adewoyin (2025) stressed that road transport infrastructure appears to be an important concern for rural dwellers. Similarly, Donnges et al (2007) states that roads are a crucial component of physical access, without which orange farmers in rural communities could face greater obstacles in accessing markets and other social services. The World Bank (2022), FAO (2021) assert that if infrastructure including facilities like electrical energy, transportation, processing technologies,

Information Communications Technology (ICT), roads, mobile communication network, irrigation, storage facilities, market facilities, research and extension institutions, schools and universities among others are available and effectively utilized, it can boost orange productivity, curtail post-harvest losses, generate employment and as well increase rural income. On the contrary, the absence of rural infrastructure can lead to high transport costs, lower market access for oranges and damages due to spoilage and consequently reduce farmers' incomes (Ugoh et al., 2015; Sarker et al., 2022; Olatilewa et al., 2017).

Theoretical Framework: Modernization Theory

Modernization theory was developed by David Mcclleland and Walt Rowstow. The theory asserts that modern societies are more productive, experience higher educational standards, and provide better welfare systems. The theory is rooted in the following assumptions: Modernization is a phased process; Modernization is a homogenizing process; Modernization follows a Western model; Modernization is irreversible and progressive; and Modernization is a lengthy process. Another set of classical assumptions based more strictly on the Talcott Parsons' functionalism-structuralism theory which emphasizes the interdependence of social institutions, the importance of structural variables and the built-in process of change through homeostasis equilibrium are as follows: Modernization is a systematic process; Modernization is a transformation process; and Modernization is an imminent process due to its systematic and transformation nature, which builds change into the social system (Perera, 2024).

While modernization theory provides valuable insights, it has been criticized for its Western-centric perspective, which assumes that all societies must follow a uniform development path. Notwithstanding, the theory is relevant to the issue of rural infrastructure and post-harvest losses of oranges. Modernization theory suggests that economic progress relies on efficient infrastructure. In Konshisha LGA, poor road networks, inadequate storage facilities, and limited access to markets contribute significantly to post-harvest losses. As communities modernize, investments in transportation, cold storage, and processing facilities can help to minimize wastage and improve market access. Also, the theory emphasizes the adoption of modern technology as an important step toward development. Traditional farming methods and poor post-harvest handling techniques result in significant losses for orange farmers. Going by the theory, the integration of modern preservation techniques such as improved packaging, cold storage, and processing technologies, farmers can extend the shelf life of oranges and enhance profitability in Konshisha Local Government Area of Benue State.

Methodology

The study was carried out in Konshisha Local Government Area of Benue State, Nigeria. The research adopted a descriptive survey design. 378 respondents comprising orange farmers, officials of the ministry of agriculture, executive members of farmers' associations, and executive members of traders' associations participated in the study. The study utilized Cochran's (1977) formula to determine the sample size for the study. Multistage was adopted to select respondents for the study. The study adopted quantitative and qualitative methods of data analysis including descriptive, inferential statistics and content analysis.

Results

Socio-demographic Characteristics of Respondents

This section presents and analyzes data on the socio-demographic attributes of the respondents.

Table 1: Socio-demographic Characteristics of the Respondents

Characteristics	Frequency (n = 378)	Percentage (%)
Sex		
Male	220	58.2
Female	158	41.8
Age		
18–30 years	202	53.4
31–42 years	90	23.8
43 years and above	86	22.8
Marital Status		
Single	98	25.9
Married	186	49.2
Divorced	47	12.4
Widowed	47	12.4
Educational Attainment		
Primary Education	106	28.0
Secondary Education	127	33.6
Tertiary Education	48	12.7
Non-formal Education	96	25.4
Years of Farming Experience		
1–5 years	93	24.6
6–10 years	174	46.0
11–15 years	104	27.5
16 years and above	7	1.9
Farm Size (in hectares)		
Below 1 hectare	37	9.8
1–3 hectares	156	41.3
4–6 hectares	128	33.9
6 hectares and above	57	15.1

Source: Field Survey, 2025

Table 1 above shows the socio-demographic profile of the respondents involved in the study on Rural Infrastructure and Postharvest Losses of Oranges in Konshisha LGA. The sex distribution shows that a greater proportion (58.2%) of the respondents were male, while females constituted 41.8%. This suggests that orange production in the area is male-dominated. In terms of age, the majority (53.4%) were within the productive youth bracket of 18–30 years, with another significant proportion (23.8%) aged 31–42 years. This indicates that the respondents are mostly within an active working age, which implies good physical capacity to engage in orange farming activities.

The marital status data shows that almost half (49.2%) of the respondents were married. Regarding educational attainment, about 33.6% of the respondents had secondary education, 28% had primary education, 12.7% had tertiary education, and 25.4% had no formal education. This implies that while a substantial number had some level of formal education, there is still a significant portion with limited literacy, which could affect their knowledge and practices in postharvest management.

Most respondents (46%) had between 6-10 years of farming experience, indicating moderate expertise in farming practices, including orange production. A notable proportion

(27.5%) also had 11-15 years of experience, suggesting that accumulated farming knowledge may help reduce postharvest losses if complemented with adequate infrastructure. Lastly, the farm size data shows that the majority operated on small to medium-scale farms, with 41.3% cultivating 1-3 hectares and 33.9% cultivating 4-6 hectares.

Rural infrastructures available in Konshisha LGA of Benue State

This section presents data on the rural infrastructure that is available in the study area.

Table 2: Respondents' Assessment of Rural Infrastructures in Konshisha LGA

S/N	Responses	Frequency	Percentage (%)
1	Road network is available and usable for transporting oranges during harvest season	108	28.6
2	Reliable transportation means (e.g., suitable trucks/vans) are available for moving oranges	46	12.2
3	Functional market facilities (e.g., shaded stalls, unloading areas) are available	134	35.4
4	Electricity supply is available and usable for storage/cooling/preservation of oranges	36	9.5
5	Banking/financial services (e.g., credit/loans) are available for investing in PHL reduction	27	7.1
6.	Others (e.g., perceived none of the above as available/usable)	27	7.1
	Total	**378**	**100.0**

Source: Field Survey, 2025

Table 2 presents respondents' assessment of the availability and functionality of key rural infrastructures in Konshisha LGA that influence the extent of post-harvest losses of oranges. Perception that road network is available and usable for transporting oranges during harvest season Only 28.6% of the 108 respondents perceived the road network as available and usable during the orange harvest season. The majority reported that roads are either not available or unusable due to seasonal degradation, potholes, erosion, and mud during the rainy season, which coincides with peak harvest. A farmer from Tse-Agberagba Council Ward explained:

> The Tse-Agberagba to Ikyurav road is the main one we use to carry oranges to bigger markets, but during rainy season it becomes like a river. Last harvest, many bags got spoilt on the way because the motorcycle kept shaking and pressing the oranges. We lose a lot just from bad roads (KII/Farmer/Tse-Agberagba/2025).

A small minority (12.2%) of the respondents perceived reliable transportation means (e.g., suitable trucks or vans) as available for moving oranges. Most farmers rely on motorcycles or bicycles, which cause crushing, squeezing, and physical damage, leading to significant transportation-related losses. A key interview from Ikyurav-Mbatwer who farms and trades in oranges noted that, "Most of us do not perceive any reliable vehicle here. We use motorcycles and the oranges get pressed and spoil before we reach buyers. Better trucks would mean less damage on the way."

On the idea that functional market facilities are available, 35.4% of the respondents perceived functional market facilities such as shaded stalls or unloading areas as available. However, the majority did not, describing markets as open-ground sites with no shade or proper storage, which accelerates overheating and spoilage of unsold oranges. A member of exco of farmer's association from Mbatsen Council Ward recounted:

> At the local market, we just put oranges on the ground or in bags with no cover. If it doesn't sell that day, by next market some are already bad from sun and people stepping on them. Better market sheds would help a lot (KII/Exco/Mbatsen/2025).

Only 9.5% of the respondents perceived electricity as available and usable for any form of orange storage, cooling, or preservation. The vast majority reported no suitable power supply, making refrigeration, ventilation, or basic cooling impossible and causing rapid heat-induced spoilage.

A member of EXCO of orange trader's association from Mbake Council Ward stated:

> We have no steady light here. If we had electricity, maybe we could keep oranges longer in a cool place or even use a small fan to dry them a bit. But everything rots fast under the sun because there's no power (KII/Exco/Mbake/2025).

Also, 7.1% of the respondents perceived banking or credit services as available for investing in PHL reduction measures including better crates, storage structures, or transport). The lack of financial access prevents farmers from improving infrastructure and perpetuates ongoing losses. A farmer from Mbanor added that "No bank or loan service here to buy good crates or build a small store. Without money to invest, we keep losing oranges the same way every season." The views in Table 2 reveal very low levels of availability and functionality across all critical rural infrastructures in Konshisha LGA.

4.1.4 Effects of rural infrastructure on post-harvest losses of oranges in Konshisha LGA

This section presents data on orange farmers' in Konshisha LGA reported experiences of how specific rural infrastructural deficiencies contribute to Post-Harvest Losses (PHL) of oranges.

Table 3: Effects of Rural Infrastructure on Post-Harvest Losses of Oranges in Konshisha LGA

S/N	Responses	Frequency	Percentage (%)
1	High transportation costs increase post-harvest losses of oranges	54	14.3
2	Seasonal flooding and poor road network make it difficult to transport oranges and cause losses	60	15.9
3	Lack of proper storage facilities causes more spoilage of harvested oranges	64	16.9
4	Lack of electricity in farm settlements increases orange wastage	61	16.1
5	Reliance on motorcycles and bicycles due to poor transport services causes bruising and spoilage of oranges	70	18.5
6	Traditional storage methods are ineffective for preserving oranges long-term and lead to increased losses	69	18.3
	Total	**378**	**100.0**

Source: Field Survey, 2025

Table 3 presents respondents' views on specific ways rural infrastructure affects post-harvest losses of oranges in Konshisha LGA. The most frequently identified effects relate to inadequate transport services (18.5%) and ineffective traditional storage methods (18.3%), followed closely by lack of proper storage facilities (16.9%), electricity shortages (16.1%), poor road networks and flooding (15.9%), and high transportation costs (14.3%). High transportation costs were reported by 14.3% of the respondents as a primary cause of increased PHL. In Konshisha LGA, fuel prices, vehicle hire fees, and distances to markets inflate costs, compelling farmers to delay shipments, abandon portions of their harvest, or opt for distress sales, which often lead to spoilage and economic losses. A farmer from Mbayegh Council Ward explained:

> When we harvest oranges, we spend so much just to hire motorcycles and trucks because fuel is expensive and drivers charge high. Sometimes, we leave part of the harvest in the farm because we can't pay to move it all. By the time we get more money, the leftover oranges have gone bad (KII/Farmer/Mbayegh/2025).

A staff member from the Ministry of Agriculture in Konshisha LGA added:

> Transportation costs are a big issue here; farmers tell us they lose up to 20% of their oranges because they can't afford timely transport. With better subsidies or improved local markets, these costs could drop and save more produce (KII/Ministry of Agriculture Staff/Mbaiwarnyam/2025).

These accounts confirm that elevated transportation expenses not only reduce farmers' profits but also directly amplify spoilage by prolonging the time oranges are not transported or unsold.

Seasonal flooding and poor road networks were identified by 15.9% of the respondents as a primary contributor to PHL of oranges in the study area. The roads in Konshisha LGA, predominantly laterite and earth-based, degrade rapidly during the rainy season, which coincides with peak orange harvesting. This results in impassable routes, extended travel times, physical damage from vibrations, and heightened spoilage risks. An executive member of traders' associations from Mbaiwarnyam Council Ward stated:

> During the rainy season, some roads are completely cut off by floods. Even when we try to pass, the mud damages our motorcycles. Sometimes, oranges stay days longer in the village until the road dries, but by then, many are spoiled. Good roads and proper drainage would really help us (KII/EXCO/Mbaiwarnyam/2025).

A staff member from the Ministry of Agriculture in Konshisha LGA noted:

> Our surveys show that poor roads and flooding cause about 15-25 bags of losses per farmer per season. Without all-weather roads, transport becomes a bottleneck, leading to bruising and rot before market (KII/Official of Agriculture/Mbatsen/2025).

The absence of proper storage facilities was reported by 16.9% of the respondents as a primary driver of orange spoilage after harvest. In the study area, farmers lack access to ventilated warehouses, cold rooms, or pack houses, relying instead on rudimentary open-air or household storage, which exposes oranges to heat, humidity, pests, and fungal infections, accelerating deterioration. A farmer from Mbake Council Ward described:

> Once we harvest, we must sell quickly because we don't have cold rooms or good stores. Oranges spoil fast in the sun or rain. Many of us use old thatched sheds that do nothing to keep the fruits fresh. If we had proper storage, we would lose less (KII/Farmer/Mbake/2025).

Lack of electricity in farm settlements increases orange wastage was reported by 16.1% of the respondents as a cause of orange wastage. A village head from Mbaikyase Council Ward noted "Without steady electricity, we can't operate cold rooms or even power small fridges. So, we have no choice but to store oranges the old way or rush to sell. Many fruits get overripe and wasted because of no power."

A staff member from the Ministry of Agriculture in Konshisha LGA added that "Electricity shortages mean no modern preservation; farmers lose bags daily to heat. If we had solar or grid power in settlements, wastage could drop by half through simple cooling." These responses show how energy deficits compound other issues, making preservation impossible and amplifying overall losses. Reliance on motorcycles and bicycles due to poor transport services causes bruising and spoilage of oranges as reported by 18.5% of the respondents.

Due to the lack of affordable trucks or vans, farmers overload these vehicles, causing physical damage, squeezing, and exposure to elements during transport. When interviewed at

Ikyurav-Mbatwer Council Ward, a farmer recounted that "We depend on motorcycles and bicycles because no proper transport services exist. Oranges get bruised and crushed from the shaking on bad roads. Many spoil before reaching the market". A staff member from the Ministry of Agriculture in Konshisha LGA further observed that "Poor transport services force this reliance, causing 10-20% losses per trip from bruising. With better vehicle access, spoilage during movement would decrease significantly". The inadequacy of available transport options, directly translating infrastructural shortfalls into physical and quality losses.

Discussion of findings

The first objective of the study was to examine the rural infrastructures available in Konshisha Local Government Area of Benue State as they relate to post-harvest losses of oranges. Findings from this objective revealed that while over half of the respondents (52.6%) reported the presence of road networks in their communities, only 28.6% perceived these roads as usable for transporting oranges during the harvest season. This finding aligns with Adeoye et al. (2009), who reported that poor rural road infrastructure significantly contributes to agricultural produce losses during transportation in Nigeria. Similarly, Olukosi and Isitor (2012) observed that deteriorated rural roads remain a major constraint to efficient agricultural marketing in rural Nigeria.

Findings also revealed that 12.2% of respondents perceived reliable transportation vehicles, such as suitable trucks or vans, as available for moving oranges. Most farmers therefore rely on motorcycles and bicycles, which are unsuitable for conveying large quantities of perishable fruits. This finding supports Akinola and Adeyemo (2013), who noted that inadequate access to appropriate transport equipment among smallholder farmers leads to high levels of physical damage and spoilage of perishable produce.

The study further revealed that storage facilities are critically lacking in Konshisha LGA. Findings showed that only 11.1% of respondents reported the availability of any form of storage facility, while qualitative evidence showed that most farmers store oranges in open spaces, under trees, or in poorly ventilated rooms. This finding is consistent with Adepoju and Salau (2017), who found that the absence of appropriate storage facilities significantly increases post-harvest losses of fruits in rural Nigeria. Similarly processing facilities were found to be almost non-existent, with only 4.5% of respondents indicating their availability. This finding corroborates Omotayo and Aremu (2021), who reported that lack of rural agro-processing facilities forces farmers to depend solely on fresh produce markets, heightening vulnerability to post-harvest losses.

Market facilities were also found to be poorly developed, with only 8.5% of respondents reporting their availability. Although some respondents perceived markets as accessible, qualitative evidence indicated that most rural markets lack basic infrastructure such as shaded stalls, unloading bays, and storage spaces. The implication is that oranges are exposed to direct sunlight and physical damage during marketing, especially when produce remains unsold after one market day. This observation is in line with findings by Adebola and Oyewole (2014), who noted that inadequate rural market infrastructure accelerates spoilage of perishable agricultural commodities.

Electricity supply emerged as another critical infrastructural gap. Only 23.3% of respondents reported the availability of rural electricity, and just 9.5% perceived it as usable for storage, cooling, or preservation of oranges. The absence of reliable electricity prevents the use of cold storage, ventilation systems, or small-scale processing equipment, thereby intensifying heat-induced spoilage. This finding agrees with the observations of Adepoju and Salau (2017), who emphasized that poor rural electrification limits the adoption of post-harvest preservation technologies in Nigeria.

The second objective was to examine the effects of rural infrastructure on post-harvest losses of oranges in Konshisha Local Government Area of Benue State. One major finding

from the study was that high transportation costs significantly contribute to post-harvest losses of oranges. Elevated fuel prices, vehicle hire charges, and long distances to markets compel farmers to delay evacuation of harvested produce, abandon part of their harvest, or sell under distress conditions. These practices expose oranges to prolonged field and ambient conditions, accelerating spoilage. This finding confirms the observation by Ayoola (2013) that high logistics and transportation costs remain a critical bottleneck for smallholder farmers in Nigeria, reducing profitability and increasing food losses.

Seasonal flooding and poor rural road networks identified was found to be a major contributor to post-harvest losses of oranges in the study area. This finding reinforces the work of Igbokwe et al. (2016), who identified rainy-season road inaccessibility as a persistent cause of agricultural wastage in rural Nigeria. Also, the study found that the absence of proper storage facilities emerged as another major driver of post-harvest losses of oranges. Most farmers lack access to ventilated warehouses, cold rooms, or pack houses and therefore rely on open-air storage or poorly constructed sheds. Such storage conditions expose oranges to excessive heat, humidity, pests, and microbial attack, resulting in rapid deterioration. This finding is consistent with FAO (2011), which identified inadequate storage infrastructure as one of the leading causes of post-harvest losses in sub-Saharan Africa.

The study also found that lack of electricity in farm settlements increases orange wastage. The absence of reliable power supply prevents the use of refrigeration, cooling systems, and small-scale processing equipment that could slow down deterioration in harvested oranges. As a result, farmers are forced to rely on traditional preservation methods or hurried sales. This finding supports the argument by Ajao and Ogunniyi (2011) that rural electrification is essential for reducing post-harvest losses of perishable agricultural commodities through improved storage and processing.

The study further showed that there are severe post-harvest losses of oranges due to reliance on motorcycles and bicycles, and on traditional storage methods which are ineffective for preserving oranges over extended periods. The finding aligns with Akinola and Adeyemo (2013), who emphasized that inadequate transport infrastructure and inappropriate conveyance methods increase physical damage and losses during transit among smallholder farmers. Similarly, Adeoye et al. (2009) observed that dependence on outdated storage practices sustains high levels of post-harvest losses in Nigeria's fruit sector.

Conclusion and Recommendations

Post-harvest losses of oranges remain a major challenge for farmers in Konshisha LGA. This is driven primarily by poor roads, weak market linkages, lack of modern storage facilities, and inadequate electricity in rural communities. These losses undermine farmers' income, reduce market supply, and discourage investment in orange production. Addressing these challenges will not only improve farmers' livelihoods but will also enhance food security and promote rural economic growth. Therefore, the study recommends that Benue State Government should channel investments towards upgrading farm access roads, supporting affordable rural transport options, and extending power supply to farming communities in Konshisha Local Government to enable modern preservation. Finally, stakeholders like the Ministry of Agriculture and development partners should work with farmer groups in Konshisha to build affordable storage hubs. Farmers should also be equipped with practical knowledge on how to maintain fruit quality using improved storage and preservation methods.

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