



RESEARCH ARTICLE

FARMERS' POST-HARVEST CROP STORAGE WOES IN QUA'AN-PAN LGA OF PLATEAU STATE: IMPLICATIONS TO NATIONAL FOOD SECURITY IN NIGERIA

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ABSTRACT

Post-harvest losses remain a critical impediment to food security in rural communities in Nigeria. This study investigated crop storage systems, associated challenges, and constraints to the adoption of improved storage technologies in Qua'an-Pan Local Government Area (LGA) of Plateau State, Nigeria. A total of 150 farming households were surveyed using a structured questionnaire, and data were analyzed using descriptive and inferential Chi-Square tests at the 0.05 significance level. Results revealed that the majority of farmers were male (91.3 percent), largely uneducated (66.7 percent), and had no formal education, factors that constrained awareness and uptake of improved storage systems. Farmers engaged in full-time farming (73.3 percent) with limited annual income, as 85.3 percent of farmers earned less than ₦550,000 annually or ₦45,833 monthly, which is less than the national minimum wage of ₦70,000. Yam (22.3 percent), sorghum (22.3 percent), and maize (20.7 percent) were the major crops grown. Traditional granaries (58.0 percent) and shelf barns (15.7 percent) dominated storage practices, exposing produce to considerable risk of infestation and spoilage. Boring insects (27.3 percent) were the main constraints to the adoption of improved storage systems. Chi-Square analysis showed significant relationships between: farmers' socio-economic characteristics and storage systems used ($X^2=18.64$, $p=0.005$, < 0.05), storage challenges and levels of post-harvest losses ($X^2=22.37$, $p=0.001$, < 0.05), and constraints to improved storage and food availability ($X^2=19.58$, $p=0.003$, < 0.05). Consequently, all three null hypotheses were rejected, which confirmed that socio-economic limitations, biological challenges, and institutional constraints jointly influence storage practices and food security outcomes in Qua'an -Pan LGA. Policy interventions are needed to strengthen post-harvest management, improve food availability, and enhance food security.

Keywords: Post-harvest, crops, losses, storage systems, food security, Qua'an-Pan.

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1.0. INTRODUCTION

Agriculture plays a basic role in Nigeria's economy, providing food, shelter, revenue, employment, wealth and cash income to about 80 percent of the population (FAO, 2023). Agriculture remains the pillar of Nigeria's rural economy, contributing to livelihoods and national food security. The country possesses vast agricultural potential, with over 70.8 million hectares of arable land, yet food insecurity persists, with an estimated 38.6% of the population facing food shortages and approximately 28.7% suffering nutritional insecurity (World Bank, 2023; FAO, 2024). Post-harvest losses, often overlooked in agricultural policy, significantly reduce effective food supply, particularly for staples such as yam, sorghum, maize, and rice, which form the backbone of Nigeria's food systems (FAO, 2022).

With growth in Nigeria's agriculture, modern storage technologies are becoming more important to ensure the sustainability and profitability of farming endeavors. Food storage plays a crucial role in the food supply chain and economy of Nigeria because it ensures household food availability, bridges seasonal shortages, and protects farmers' incomes. One of the main global challenges is how to ensure food security for the world's growing population while ensuring long-term sustainable production. This can be achieved through the provision of adequate modern storage facilities to rural farmers. The availability of adequate storage facilities are considered essential because it reduces post-harvest losses resulting in food shortage, and allowing for grains from inter-temporal trade due to potential arbitrage opportunities arising out of volatility in food prices.

According to Osunde (2016), crop storage is the art of holding agricultural crops essentially in their preserved original form either natural or artificial to retain their quality or quantity over a specific period of time beyond their shelf life without deterioration. It is part of the post-harvest value chain through which food produce passes on its way from the field to the table. Crop storage facilities are crucial to preserve the quality of harvest crops and reduce post-harvest losses, because most farm produce begin to undergo deterioration as soon as they are harvested, caused by enzymes, environmental conditions, insects and rodents, micro-organisms and metabolism (Osunde, 2016).

The perspective explains in part why the United Nations Development Programme's 2030 Agenda as highlighted in Sustainable Development Goal 12 (SDG 12) has emphasized the need for "Responsible consumption and production" to reduce food losses along production and supply chain and post-harvest by 50%. Gustavsson, Chritel, Sonnesson, Otterdijk, and Meybeck (2011) stated that 1.3 billion tons of food production are wasted or lost each year globally due to lack of adequate storage facilities which has posed a serious threat to food security and nutrition. This implies that post-harvest storage plays a very important role in preserving agricultural produce, stabilizing food supply, and ensuring sustainable rural livelihoods given the fact that 20-40% of harvested crops are reportedly lost due to poor post-harvest storage systems (Affognon, Mutungi, Sangina, & Borgemeiter, 2015; FAO, 2019).

Similarly, Kaminski and Christainsen (2014) corroborated that 32% of global food production is lost after harvest and up to 40% in sub-Saharan African (SSA) countries. They noted that post-harvest losses among smallholder farmers in developing countries particularly, Nigeria have been attributed to poorly developed storage facilities in the rural areas. Consequently, this has adversely affected the income of the farmers and food security. Alliance for a Green Revolution in Africa (AGRA) (2014) affirmed that poor storage facilities has been identified as a major factor affecting Nigerian farmers compelling them to sell off their farm produce earlier than intended.



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Rural farmers in Plateau State predominantly depend on traditional storage systems such as granaries and barns, and polypropylene bags which are highly susceptible to deterioration (Ojo, & Adebayo, 2018). In rural communities of Qua'an -Pan LGA, crop storage practices are predominantly traditional and susceptible to biological agents like insects and rodents, resulting in substantial quantitative and qualitative losses (Afolabi, Adeoye, & Musa, 2024), which, according to NBS (2024), exacerbate food security, inflate food prices, and increase Nigeria's dependence on food imports. These conditions not only reduce the market value of stored crops, but threaten household food security (Ndung'u, Wambugu, & Mathenge, 2020).

Many poverty alleviation and development programmes have focused only on increasing agricultural production through the use of improved seed varieties and chemical fertilizers. However, increasing productivity without proper storage management practices can increase quantity and quality losses. Mason and Smale (2013), and Bezu et al. (2014) asserted that increasing productivity and storage technique can improve the income of the poor households and guarantee food security. This is because reducing post-harvest losses can significantly add a sizeable quantity to national food supply, thereby reducing poverty, hunger and poor nutrition.

In rural communities like Qua'an- Pan Local Government Area (LGA), where farming is predominantly subsistence, food crops are stored at household level in traditional structures either threshed or unthreshed. Over the years, this practice is inefficient thereby resulting in substantial quantities of food crops being damaged by insects, termites and rodents after harvest, attributable to poor storage facilities. The effectiveness of food storage facilities directly influences household food availability and income.

Despite efforts by government and Non- governmental Organisations (NGO) to promote improved post-harvest management, many farmers continue to rely on traditional storage systems. Understanding the socio-economic factors, storage challenges, and institutional constraints that influence storage system adoption is therefore crucial for enhancing food availability and achieving Sustainable Development Goals 2, Zero Hunger by 2030 (United Nations, 2022). This study assessed post-harvest crop storage systems, challenges, and constraints to improved storage adoption in Qua'an -Pan LGA, linking these findings to broader national food security implications.

2.0. DESCRIPTION OF THE STUDY AREA

Qua'an- Pan is one of the 17 Local Government Area (LGAs) of Plateau State, Nigeria. It is situated at the southern fringe of the State which lies approximately between Latitudes 8°25'00"N and 9°08'00"N; and Longitude 8°20'00"E and 9°25'00" (see Figures 1), as described in Dayil (2024). Its land mass is about 2,478km², with a population of 261,805 people based on the 2006 Population Census (NPC, 2006). The climate is tropical characterized by distinct wet and dry seasons, with high temperature reaching between 27°C and 30°C much of the time, which is considered hot.

Rainfall amount ranges from 1200 -1500mm per annum. Wet season is usually from April to October, thereafter the dry season dominates in November to March, often characterized by harmattan winds and dry weather conditions (Daloeng, 2019). The distribution of rainfall and warm temperature have made habitation and farming in the area very possible, even though some features like the rugged terrain of koffiar, Latok, Bong and Bwall may not be good arable land for farming activities and human settlements. The favourable rainfall encourages the cultivation of variety of crops such as yam, sorghum, maize, rice, millet, cassava, groundnut, beans and vegetables.

The Local Government Area is divided into two, namely highland and lowland. The highland is found in Qua'an-Pan North and stretches from Plateau highland, starting from Pankshin and Mangu areas with their characteristic rocky terrain which peaks at Lardang, Bwall, Koffiar, Bong, Latok, Bogolong and terminates at Teng. The lowland area is a belt of low-lying fertile land thickly formed and adorned with trees of economic value. The area slopes slowly further south towards the River Benue with an increasing quantity of trees and bush until it becomes a vast forest around the plains of the River Benue (Daloeng, 2019).

The area is also traversed by many rivers such as Doka- kasuwa, Gwagal, Kalko, Kwande and streams which drain the entire local government area and empty their waters into River Benue to the south (Dayil, 2024). The seasonal streams in the area help to channel the excess water from the Plateau highland into the major rivers in the area.

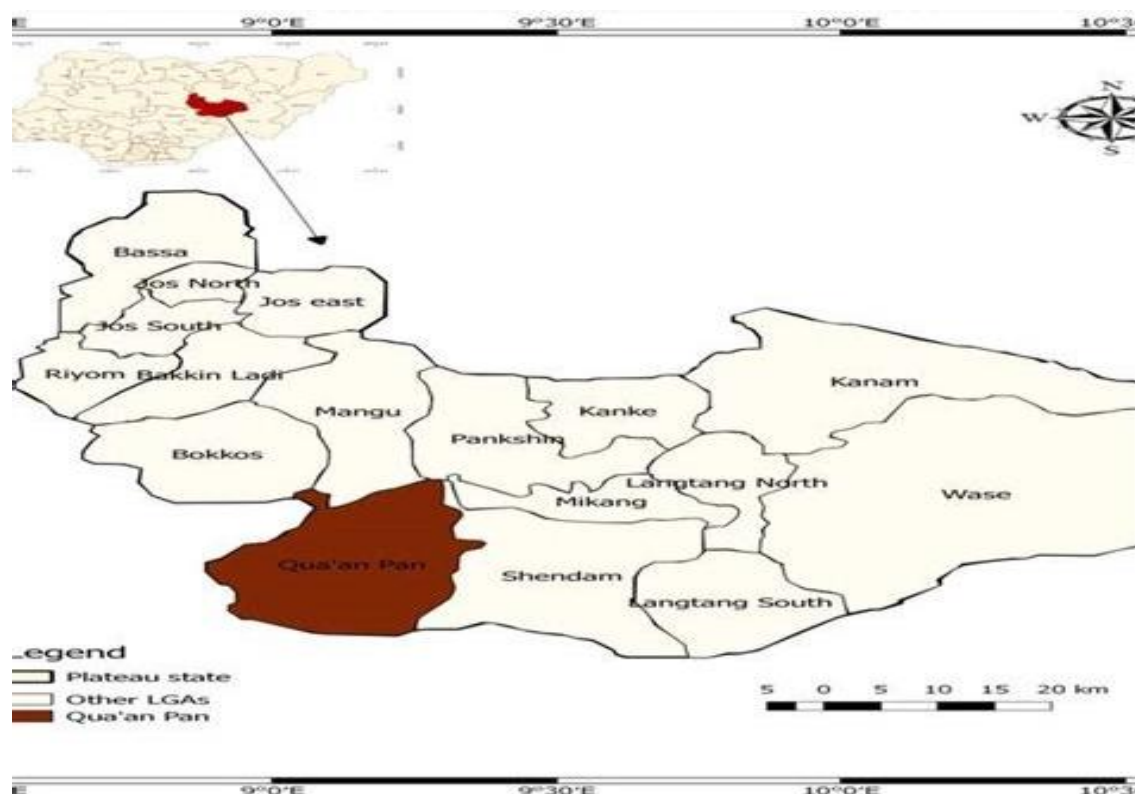


Figure 1: Map of Plateau State showing Qua'an-Pan LGA



The soil types range from sandy, loamy, sandy-clay and clay. These soil types support guinea savanna, where tall grasses are seen interspersing with tree species such as sheabutter, locust bean trees, mahogany, neem and malena. Some of the grass species are elephant grass, spear grass and shrubs. Because of abundant rainfall, vegetation upholds the greenish appearance and is luxuriant during the rainy season. Furthermore, the annual clearance of natural vegetation for crop farming activities transformed the forest into derived savanna.

Quan'an-Pan LGA is inhabited by Pan and Goemai ethnic groups, who are always co-existing with many other ethnic nationalities, most of whom migrated to the area for farming, trading, banking, commerce, teaching and local government administration at Ba'ap. The inhabitants of the LGA take advantage of the climatic conditions, topography and soil characteristics to embark on the cultivation of varieties of tuber, root, legume, grain and fruit crops, but mostly under subsistence. This explains why there is the predominance of farming as the people's major occupation.

3.0. MATERIALS AND METHODS

This study adopted a quantitative research design which enabled a single data collection to be made on demographic and socio-economic information smallholder farmers, their farm holdings and years spent in crop farming, major crops grown, types and conditions of storage facilities, post-harvest storage challenges, and barriers to adoption of improved storage systems. The main instrument used for data collection was structured questionnaire administered to household heads. Stratified sampling technique was employed to select crop farmers from the 8 districts of Qua'an-Pan LGA, namely: Bwall, Doemak, Dokan-Kasuwa, Kwa, Kwalla, Kwande, Kwong, and Namu. Therefore, a settlement each was selected from each district using lottery methods and the following eight farming settlements were chosen and questionnaire randomly administered to households proportionate to the population of households as follows: Nakum (27), Dungdep (23), Yilpia (22), Lardang (20), Chim (18), Gidan-Dabat (17), Tatoeng (12), and Langkaku (11) from the respective districts. The selection of 150 households for the study represents 3 percent of households from the aforementioned eight settlements.

Reconnaissance was carried out prior to data collection and six field assistants familiar with the terrain were selected and trained for data collection exercise. A total of 150 copies of questionnaire were produced, divided into sections A-E, which covered the demographic and socio-economic characteristics of farmers, sizes of farm holdings and farmer's experience in crop farming, major crop types cultivated, and type of storage facilities, post-harvest storage challenges, and barriers to adoption of improved modern storage facilities. Household heads were the target for the study but where absent, any adult member of the household was given the questionnaire to fill. Participants that were not literate enough to fill the questionnaire were duly assisted by the field assistants. All the 150 copies of questionnaire were retrieved.

The data collected were descriptively while inferentially, Chi-Square test was applied to test the following hypotheses:

1. Ho: Relationship between farmers' socio-economic characteristics and the type of crop storage systems used is not significant.
2. Ho: Relationship between storage challenges and the level of post-harvest crop losses is not significant.



3. Ho: There is no significant relationship between constraints to improved storage adoption and food availability outcomes.

The Chi-Square (X^2) uses the formula: $X^2 = \sum (O-E)^2 / E$ ----- Equation 1

where: O = observed frequency, E = expected frequency = row total $\times$ column total / grand total. Expected cell frequencies were sufficiently large to ensure validity of test. The 0.05 level of significance was adopted in line with standard practice in social and agricultural sciences. Chi-Square analysis is widely used in post-harvest and food security studies to assess structural relationships affecting food availability and stability (World Bank, 2022; FAO, 2023).

The Chi-Square (X^2) test of independence was employed in this study to examine relationships between categorical variables, including socio-economic characteristics, storage system uses, storage challenges and food security outcomes. The test is appropriate because data consist of frequency counts classified into mutually exclusive categories, and the study sought to determine whether observed differences in distributions occurred by chance or reflects statistically significant associations. Thereafter, all the analyzed data were presented in Figures and Tables.

4.0. PRESENTATION OF RESULTS AND DISCUSSION

4.1. PRESENTATION OF RESULTS

Socio-economic Characteristics of Respondents

Table 1 shows the distribution of respondents according to socio-economic characteristics in the study area. Results revealed that the study population was predominantly male gender (91.3%), and in economically active productive age (30-39 years, 42.0%). This indicates there are more male farmers than their counterpart females in Qua'an-Pan LGA, and reflects labor-intensive nature of drudgeries in farming. This finding also reveals the persistent gender disparities in access to land and productive resources in rural Nigeria. The overwhelming male dominance aligns with the gendered nature of agricultural labor in Northern Nigeria where cultural norms allocate strenuous farm activities and storage responsibilities predominantly to male gender (Ayanwuyi, Ogunlade, & Oyetoro, 2017).

The large size (90.0%) of married farmers as shown in the Table indicates a socially stable society with high responsibility, which is key to any economic progress. This finding is consistent with rural demographic patterns in Nigeria. Marriage increases household labor availability, which enhances farm productivity but also creates greater food storage demand (Ojo & Adebayo, 2018). Education significantly enhances farmers' capacity to understand pest control, moisture management, and structural maintenance (World Bank, 2020). However, results revealed that in Qua'an-Pan LGA, majority (66.7 percent) of the studied farmers were not privileged to have formal education, which may make adoption of improved innovations and technologies difficult.

The outlined finding that there were 15.3 percent who completed their primary school education, 11.3 percent secondary and 6.7 percent tertiary education, perhaps can make it difficulty for them to embrace modern storage facilities such as hermetic bags, metal silos, and improved granaries, which require training for proper crop storage in order to reduce post-harvest losses (Affognon, Mutungi, Sangina, & Borgemeiter, 2015). This finding is consistent with Food and Agriculture Organization's



(FAO) findings on rural farming communities in sub-Saharan Africa, and corroborates earlier findings that low human capital intensifies post-harvest losses in developing agrarian economies (World Bank, 2022; FAO, 2023).

Results further showed that two-thirds (66.0 percent) of farmers had over 15 household size members, indicating they cherish large family size to provide labor force for farming activities that involve land clearing, hoeing, seed planting, fertilizer application, weeding and harvesting. A substantial proportion (22.0 percent) of farmers had 11-15 household members, 7.3 percent had 6-7 members, while 4.7 percent had 1-5 members only. However, large household size suggests high dependency ratios and pressure on stored food reserves, as they are most likely to consume stored produce faster, which may compel farmers to rely on traditional bulk storage systems.

Table 1: Socio-economic Characteristics of Respondents (respondents =150)

S/No	Variable	Frequency (n)	Percentage (%)
1.	Sex: Male	137	91.3
	Female	13	8.7
2.	Age: < 30yrs	49	32.7
	30-39yrs	63	42.0
	40-49yrs	27	19.0
	50+	11	7.3
3.	Marital status: Single	15	10.0
	Married	135	90.0
4.	Level of Education: Non Formal	100	66.7
	Primary	23	15.3
	Secondary	17	11.3
	Tertiary	10	6.7
5.	Occupation : Full -time Farming	110	73.3
	Public /civil servant	20	13.3
	Petty rading	13	8.7
	Others(artisanry, carpentry)	7	4.7
6.	Household size: < 5 persons	7	4.7
	5-9 persons	11	7.3
	10-14persons	33	22.0
	15+ persons	99	66.0
7.	Annual Income (₦):	13	8.7
	100,000-250,000	32	21.3
	250,001-400,000	83	55.3
	400,001-550,000	22	14.7
	> 550,000		

Source: Author's Analysis (2025).



Major Crops Grown in Qua'an - Pan

Farming constitutes the primary occupation of farmers in the study area. Nearly three -quarters (73.3 percent) of farmers engaged in full-time farming as their primary occupation for livelihood, followed by 13.3 percent who engaged in civil service, 8.7 percent in petty trading, while 4.7 percent combined crop farming with other off-farm activities, including masonry and carpentry. The large number of farmers in farming indicates high dependence on agriculture for income and food security.

Despite being in the occupation for some considerable years, many farmers (55.3 percent) earned between ₦400,000- ₦550,000 annually (or ₦33,333 - ₦45,833 monthly), followed by 21.3% that earned ₦250,001- ₦400,000, 14.7 percent above ₦550,000, and 8.7 percent less than ₦250,001 annually. This implies that on average, their monthly earnings from sales of farm produce amounts to about ₦39,583 which is abysmally lower than the national minimum wage of ₦70,000, and limit investment in improved storage infrastructure.

Table 2 showcases common staple crops cultivated in the study area. Results presented shows that yam (22.3 percent), sorghum (22.3 percent), maize (20.7 percent), and rice (18.9 percent) were the most cultivated staple food crops, reflecting the agricultural profile of Qua'an -Pan LGA and their significance to household and national food security. The dominance of these staple food crops reflects both the agro-ecological suitability of the study area and their importance for household food security and income generation, while millet (7.0 percent) and other food crops (8.8 percent) like beans, barbara nuts, cassava, groundnuts and cocoyam were found not very important.

Worthy of note is the fact that almost all the farmers indicated that they grow more than one type of crops in a given season. Most of them grow a combination of two or three crops at a time, sometimes in a mixed cropping practice but more often with different farm plots dedicated to different crop type. However, the high susceptible of these dominant staple crops underscores the importance of effective storage systems in ensuring year-round food availability.

Table 2: Major Crops Grown in Qua'an Pan LGA

Crop	Frequency	Percentage
Yam	150	22.3
Sorghum	150	22.3
Maize	139	92.7
Rice	127	20.7
Millet	47	18.9
Others (nuts, roots)	59	8.8
Total	672	100

Note: There were multiple responses of 672 from 150 respondents

Crop Storage Facilities in Qua'an -Pan

Figure 2 displays the distribution of farmers according to major types of storage facilities. Results showed that traditional granaries (58.0 percent) and shelf barns (15.7 percent) dominated, though bare floor (14.7 percent), polypropylene bags (7.3 percent), and market halls (4.7 percent) were significant.

However, modern storage systems were scarcely used in the study area. These facilities are known to inadequately protect against pests and environmental hazards. This means storage facilities used are inappropriate, as they predispose stored crops such as yam, guinea corn, maize, cassava, cocoyam and bean to post-harvest losses (Adebayo, Olayemi, & Musa, 2020).

Despite their strategic importance, the study has revealed that storage practices remain largely rudimentary. This is further confirmed in Table 3, where traditional granaries (58.0 percent) and shelf barns (15.7 percent) dominate, while modern storage facilities are virtually absent. Storage on bare floors (14.7 percent) and market halls (4.7 percent) exposes produce to moisture, pests and contamination, leading to rapid quality deterioration. Such practices explain why Nigeria reportedly loses 30-40 percent of food produced annually to post-harvest losses, despite rising demand (FAO, 2022). The minimal use of improved storage systems highlights persistent reliance on indigenous methods, which while culturally embedded, are inefficient in minimizing quantitative losses of between 30-40 percent of the harvested crops annually. This explains in part why Ntlokwana (1999), and Golob (2002) argued that inadequate post-harvest storage technology contributes significantly to food loss hence, food insecurity and poor nutrition.

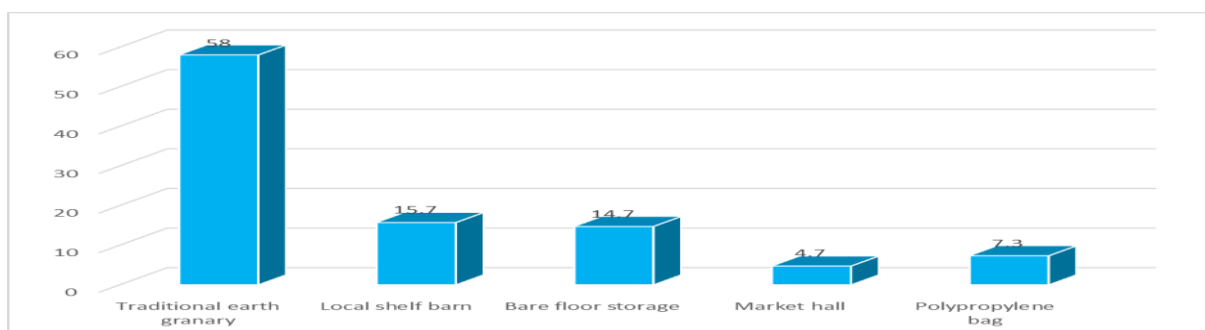


Figure 2: Crop Storage Facilities in Qua'an Pan

Post- Harvest Crop Storage Challenges in Qua'an-Pan LGA

Earlier, this study found that staple crops, particularly yam, sorghum, maize and rice dominated crop production in Qua'an-Pan LGA. While these food crops are central to Nigeria's food basket, yet they are highly susceptible to post-harvest losses when stored under poor conditions, thereby confirming the report by the FAO (2019), which states that large portion of food produce is lost during post-harvest as a result of poor storage facilities in Nigeria. Sequel to this assertion, Figure 3 shows the distribution of farmers based on challenges encountered due to post-harvest storage. Results indicated insect pest (52.7 percent) and rodent attacks (27.3 percent) were the dominant though, moisture damage (14.0 percent), and others (6.0 percent) like insufficient space and theft were importantly contributing to crop deterioration, quantitative and qualitative losses in the study area.

Inappropriate storage facilities in developing countries, including Nigeria is responsible for total post-harvest food crops loss (World Bank, 2011). Corroborating this position, FAO (2018) noted that yam is prone to rot, dehydration, and sprouting when stored in humid environment, and Ndung'u, Wambugu and Mathenge (2020) found maize and sorghum highly vulnerable to weevils, borers, and beetles even as rice grains suffer quality degradation under fluctuating humidity. The predominance of these crops, juxtaposed with poor storage systems suggests that a significant proportion of potential

food supply is lost after harvest. This position further reinforces findings by the World Bank (2022) that post-harvest losses erode gains from increased crop production.

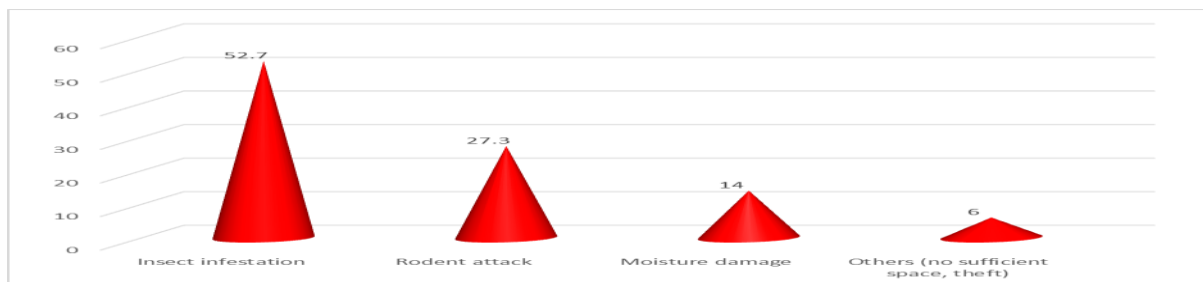


Figure 3: Post- Harvest Crop Storage Challenges in Qua'an Pan

Constraints to Adoption of Improved Storage Systems in Qua'an -Pan

Table 3 depicts barriers to adoption of improved storage facilities in the study area. Results indicated the key constraints to improved storage systems to include: high cost of modern facilities (55.3 percent), lack of sufficient technical know-how (28.7 percent), limited access to credit facilities (11.3 percent), and poor services rendered by extension workers (4.7 percent). The weak extension services juxtaposed with low literacy level among farmers in Qua'an -Pan LGA undermine the economic and informational modernization of post-harvest practices.

This finding agrees with Yusuf and Dauda (2021) who found that major constraints to adoption of improved storage technologies by rural farmers in North- central Nigeria are high cost of modern facilities and lack of technical knowledge to handle the facilities. A study conducted by Okonkwo, Nwosu and Akinyemi (2018) confirmed that rural farmers in Nigeria do not have the prerequisite capital to purchase modern storage technology and lack basic knowledge to adopt the modern storage technologies because of poor extension services delivery due to poor roads accessibility in the rural areas.

Table 3: Constraints to Adoption of Improved Storage Systems in Qua'an -Pan LGA

S/No	Barrier	Frequency	Percent (%)
1.	High cost of modern facilities	83	55.3
2.	Poor extension services	7	4.7
3.	Lack of technical knowledge	43	28.7
4.	Limited access to credit facility	17	11.3
	Total	150	100

Source: Authors Analysis (2025).

Relationship between Socio-economic Characteristics and Crop Storage Systems

Table 4 shows the Chi-Square test between socio-economic characteristics of respondents and the type of crop storage systems used in the study area. From the Table, the result $X^2 = 18.64$, $p = 0.005$ ($p < 0.05$), indicates the association is significance. This means that farmers' education and income significantly influence the type of storage systems used in Qua'an -Pan LGA. Low socio-economic status limits adoption of improved storage facilities. The rejection of null hypothesis implies that socio-economic factors are critical determinants of storage practices. Farmers with low education and income overwhelmingly rely on traditional storage methods thereby reinforcing post-harvest losses in the study area.

**Table 4: Relationship Between Socio-economic Status and Storage Systems**

Variables compared	X ²	df	P-value	Decision
Socio-economic status x storage system used	18.64	6	0.005	H0: rejected

Source: Authors Analysis (2025).

Relationship between Storage Challenges and Post-harvest Crop Losses

Table 5 shows the Chi-Square test between storage challenges and the level of post-harvest losses in Qua'an -Pan LGA. The result was $X^2 = 22.37$, $p = 0.001$ ($p < 0.05$), which indicates that the relationship is significant. This implies insect infestation and rodent attacks significantly increase post-harvest losses, confirming the inefficiency of traditional storage systems. The rejection of null hypothesis confirms that biological storage challenges are not random occurrences, but structural problems directly linked to crop losses. This finding explains why increased agricultural output often fails to translate into food sufficiency at the national level.

Table 5: Relationship between Storage Challenges and the Level of Post-harvest Crop Losses

Variables compared	X ²	df	P-value	Decision
Storage challenges × level of post-harvest losses	22.37	4	0.001	H0: rejected

Source: Authors Analysis (2025).

Relationship between Constraints to Improved Storage Adoption and Food Availability Outcomes

Table 6 shows the Chi-Square test between storage constraints to improved storage adoption and food availability outcomes in Qua'an -Pan LGA. The obtained result was $X^2 = 19.58$, $p = 0.003$ ($p < 0.05$), indicates the relationship is significance. This means high cost of facilities and limited technical knowledge significantly, negatively affecting household and national food security. The rejection of null hypothesis demonstrates that institutional and financial constraints significantly affect food availability. Without affordable storage technologies and effective extension services, post- harvest losses persist, undermining national food security objectives.

Table 6: Relationship between Constraints to Improved Storage Adoption and Food Availability Outcomes

Variables compared	X ²	df	P-value	Decision
Storage challenges × level of post-harvest losses	19.58	4	0.003	H0: rejected

Source: Authors Analysis (2025).

4.2. IMPLICATIONS OF FINDINGS TO NATIONAL FOOD SECURITY IN NIGERIA

Nigeria is endowed with abundant agricultural resources and vast arable land estimated at about 70.8 million hectares, yet food insecurity remains a persistent national challenge. In spite of this endowment, a significant proportion of the population continues to experience hunger and malnutrition due to low agricultural productivity, widespread poverty, and inefficiencies within the food system, particularly at post- harvest stage. These constraints to food production has not kept pace



with rapid population growth, as empirical evidence has shown that over 38.0 percent) of Nigerians are currently food insecure, while about 28.7 percent, especially children under five years old suffering from malnutrition and stunted growth (Maton, Dayil, Audu, Bot, Ibimode, & Baklit, 2024).

The study's findings, as contained in from Tables 1, 2, and 3, and Figures 2 and 3 revealed that post-harvest crop storage systems in Qua'an-Pan LGA pose constraints to Nigeria's national food security, particularly in terms of food availability, stability and affordability (ASA), as significant quantities of harvested crops are lost annually due to inadequate modern storage facilities, pest infestation, spoilage, and poor handling practices, which reduce food availability and farmers' cash income.]

Although, Qua'an -Pan LGA is characterized by economically active farming population, cultivating major staple crops such as yam, sorghum, maize and rice, the dominance of traditional storage systems severely undermines the effective supply of food. The heavy reliance on traditional granaries, shelf barns, and bare -floor storage exposes harvested crops to insect infestation, rodent attacks, and spoilage. The storage-related losses directly reduce the quantity and quality of food available to household consumption and market supply. Furthermore, at the national level, such losses compound Nigeria's food deficit, contributing to rising food prices and increased dependence on food imports. Food and Agriculture Organization (FAO) (2024) reports that Nigeria loses up to 40.0% of harvested food annually to post-harvest inefficiencies, a trend clearly reflected in Qua'an-Pan findings.

Socio-economic limitations, particularly low educational attainment and income further constrain farmers' ability to adopt improved storage technologies. This perpetuates a cycle in which increased production does not translate into improved food security outcomes. The constraints identified in Table 3, especially high cost of storage facilities and lack of technical knowledge highlight institutional and policy gaps in Nigeria's agricultural system where post-harvest management receives far less attention than production enhancement (World Bank, 2023). Overall, the findings suggest that Nigeria's food insecurity challenge is not solely a production problem but a post-harvest management crisis. Strengthening storage infrastructure and farmer capacity would significantly improve national food availability and price stability, advancing progress toward Sustainable Development Goal 2 (SDG 2), which is "Zero Hunger" by 2030.

The severity of these losses is reinforced by Figure 3, which identifies insect infestation or boring insects (52.7 percent) and rodents attack (27.3 percent) as the most significant storage challenges. These biological losses directly reduce marketable surplus, exacerbate food shortages, and drive food price inflation, an issue already evident in Nigeria's rising food import bill and household food expenditure exceeding 56.0 percent of income (NBS, 2023; FAO, 2024). Agricultural contributions to Gross Domestic Product have steadily declined and although domestic rice production has recorded marginal improvements, it remains far below national demand (Maton et al., 2024).

Furthermore, Table 3 showed that high cost of storage facilities (55.3 percent) and lack of technical knowledge (28.7 percent) are major constraints to adopting improved systems. This underscores the structural neglect of post-harvest management within national agricultural policy, where emphasis is disproportionately placed more on production rather than on storage and value preservation. This finding agrees with Yusuf and Dauda (2021) who found that major constraints to adoption of improved storage technologies by rural farmers in North- central Nigeria are high cost of modern facilities and lack of technical knowledge to handle the facilities.



Rising food prices and inflation in recent past have forced households to spend over half of their cash income on food, deepening poverty and hunger. A study conducted by Okonkwo, Nwosu and Akinyemi (2018) confirmed that rural farmers in Nigeria do not have the prerequisite capital to purchase modern storage technology and lack basic knowledge to adopt the modern storage technologies because of poor extension services delivery due to poor roads accessibility in the rural areas. Addressing post-harvest crop storage problems is therefore essential for improving food availability, enhancing farmers' livelihoods, and supporting Nigeria's commitment to Sustainable Development Goal 2, which seeks to end hunger and promote sustainable agriculture by 2030.

5.0. CONCLUSION AND RECOMMENDATIONS

The study has established that post-harvest crop storage systems in Qua'an-Pan LGA are largely traditional, inefficient, and inadequate for safeguarding staple food crops, particularly yam, sorghum, maize, and rice. Insect infestation and rodent attacks remain the leading causes of storage losses compounded by high costs and limited technical knowledge that hinders the adoption improved storage technologies crucial in ensuring that the commodities produced are in high quality all year round. However, the near absence of simple, efficient modern and cost effective technical equipment and facilities for crop storage have consequently resulted in significant post-harvest crop losses in the study area. These losses directly undermine the food availability, household income, inflate food prices and national food self-sufficiency.

The findings of this study imply that Nigeria can substantially improve national food security by prioritizing post-harvest management. Policies should emphasize subsidized modern storage facilities, strengthening extension services, and targeted capacity -building programs for rural farmers. Addressing post-harvest losses represents a cost-effective strategy for enhancing food availability, stabilizing prices, and reducing dependence on food imports. Therefore, access to post-harvest storage facilities can help to ensure and guarantee the quality of agricultural produce because it reduces the risk of spoilage to staple food crops and guarantee food security among the rural communities and the Nigerian nation in general.

Conflict of Interest

The authors declare that no conflict of interest exist in this manuscript.

REFERENCES

- Adebayo, S. O., Olayani, T. A. & Musa, I. (2020). Traditional food storage practices and their impact of food security in rural Nigeria. *Journal of Agricultural Extension*, 24(2), 45-53.
- Afolabi, S. Adeoye, B., & Musa, H. (2024). Post-harvest management challenges in rural Nigeria. *Journal of Agricultural Sciences*.
- Affognon, H. D., Mutungi, C. Sanginga, P. & Borgemeis, C. (2015). Unpacking post-harvest losses in sub-Saharan Africa: A meta-analysis. *World Development*, 66, 49-68. <https://doi.org/10.1016/j.worlddev.2014.08.002>.



- Alliance for Green Revolution in Africa (2014). *Enabling the status of Post-harvest losses and storage for major staple crops in eleven African countries (Phase II), Nairobi, Kenya.*
- Ayanwuyi, E., Ogunwale, A. B. & Oyetoro, J. O. (2017). Gender roles in agricultural production and post-harvest management in Northern Nigeria. *Nigerian Journal of Rural Sociology*, 17(1), 15-22.
- Bezu, S., Kassie, G.T., Shiferaw, B. & Ricker- Gilbert, J. (2014). Impact of Improved Maize Adoption on Welfare of Farm Households in Malawi: A Panel Data Analysis. *World Development*, 59, 120-131.
- Daloeng, H. M. (2019). *Climatic factor and disease incidences in the highland and lowland Plateau State, Nigeria.* Unpublished Ph.D Thesis, University of Jos Nigeria.
- Dayil, C. D. (2024). *Effects of physical infrastructure on agricultural development in Quaan- Pan Local Government Area, Plateau State, Nigeria.* Unpublished Ph.D Thesis, University of Jos, Nigeria.
- Food and Agricultural Organisation (FAO) (2018). *Improving storage and handling of perishables in tropical countries.* Food and Agricultural Organization of the United Nations. Rome: FAO.
- Food and Agricultural Organization (FAO) (2019). *The state of food and agriculture: Moving forward on food losses and waste reduction.* Food and Agricultural Organization of the United Nations. Rome: FAO.
- Food and Agricultural Organization (FAO) (2022). *Reducing post-harvest losses.* Food and Agricultural Organization of the United Nations. Rome: FAO.
- Food and Agricultural Organization (FAO) (2023). *The state of food and agriculture.* Food and Agricultural Organization of the United Nations. Rome: FAO.
- Food and Agricultural Organization (FAO) (2024). *The state of food and agriculture.* Food and Agricultural Organization of the United Nations. Rome: FAO.
- Golob, P. (2002). Hemcial Physical and Cultural Control of Prostephanus Truncates, Integrated Post Management. *Review*, 26:187-198.
- Gustavsson, J., Chrittel, C., Sonnesson, U. L. F., Otterdijk, & Meybeck, A. (2011). Global Food Losses and Food Waste. FAO (UN) Study Report.
- Kaminski, J., & Christiansen, R. (2014). *Post- harvest loss in Sub – Saharan African: What do farmers say?* Policy Research Working Paper 6831. World Bank, Washington, D.C.
- Manson, N. M. & Smale, M. (2013). Impact of Subsidized Hybrid Seed on Indicators of Economic Well- being Among Small- holder Maize Grower in Zambia. *Agriculture Economics* 44(6), 659-670.
- Maton, S. M., Dayil, C. D., Audu, J., Bot, E. T., Ibimode, A. A., & Baklit, G. (2024). Relative participation of Nigerian adult females in drudgery-prone farm activities on national food security. *Humanity Jos Journal of General Studies*, 2024, 15(1), 88-95.
- Ndung'u, M., Wambugu, P. & Mathenge, M. (2020). Post- harvest losses and food security in East Africa: A review of evidence. *African Journal of Agricultural and Resource Economics*, 15(1), 56-70.



- National Bureau for Statistics (NBS) (2023). *Food prices watch and inflation report*. Abuja, Nigeria.
- National Population Commission (2006). *Population estimates for local government areas in Plateau State*. Jos: NPC.
- Ntlokwana, B. (1999). *Personal communication senior extension officer, Kwa- Zulu- Natal Piefer-Maritzburg*. Department of Agricultural and Environmental Affairs.
- Ojo, S. O. & Adebayo, P. F. (2018). Traditional grain storage technologies and implications for food security in Nigeria. *Journal of Sustainable Development in Africa*, 20(1), 89-104.
- Okonkwo, C., Nwosu, E. & Akinyemi, T. (2018). Determinant of Storage Technology Adaption among Grain Farmers in Nigeria. *African Journal of Rural Development*, 3(4), 21-30.
- Osunde, Z. D. (2016). *Food and crop storage engineering*. Landmark University, Nigeria, Department of Agric and Biosystems Engineering.
- United Nations (UN) (2022). *Sustainable Development Goals Report*. United Nations.
- World Bank (2011). Missing food: The case of post-harvest losses in Sub- Saharan Africa. *Report 60371-HFR, 1-97*. Washington, DC World Bank.
- World Bank (2020). *Addressing post- harvest losses in Africa: Policy pathways and investment priorities*. Washington, DC World Bank.
- World Bank (2022). *Transforming food systems for resilience in Africa*. Washington, DC World Bank.
- World Bank (2023). *Transforming food systems for resilience in Africa*. Washington, DC World Bank.
- Yusuf, A. & Dauda, B. (2021). *Constraints to adoption of improved storage methods by rural farmers in North- Central Nigeria*. *Nigeria Journal of Rural Sociology*, 22 (1) 49-58.