

Formulating Sustainable Strategies on Post harvest Losses and Food Security in Nigeria

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Abstract

Post-harvest food losses and waste have been identified as a significant threat to efforts directed at achieving sustainable food security in Nigeria. This study investigated the causes, consequences, and strategies for reducing post-harvest food losses and seeks for measures to enable the achievement of food security in Nigeria. It adopts a qualitative approach, analyzing patterns and deriving outcomes relevant to the Nigerian environment as well as exploring requisite literature on the subject matter through review of reports from relevant agencies as well as perspectives of non-governmental organizations with interests on the challenge of food security in Nigeria. The findings reveal that inadequate food handling practices by farmers as well as consumers, limited and poor storage facilities, market challenges and inefficient supply chain all contribute to post-harvest losses implications on farmers income and livelihood, food scarcity, high food prices amongst other concerns. The study recommends the review of farming systems, from pre planting, handling of post-harvest proceeds, storage and preservation of harvest proceeds, investing in cold storage facilities, enhancing market access, and strengthening regulatory frameworks. It is recommended that implementing these strategies can reduce post-harvest losses, improve food availability, and contribute to sustainable food security in Nigeria.

Keywords: Food Losses, Food Security, Cold Storage, Farming Systems and Livelihoods

INTRODUCTION

The ever-increasing human population in Nigeria and the attendant challenges of economic development have attracted the attention of past and present governments as well as international organizations. Various attempts have been made through the launch and implementation of various programs aimed at improving the livelihood of a great majority of the nation's young and working population whose source of livelihood is in Agriculture and its various sub-sectors and value chain. Programs like Back to Land, Operation Feed the Nation just to mention a few. Nigeria with a projected population of 210 million, 2024 estimates provide a suitable model for a comprehensive insight and investigation into the challenge of food security especially as it concerns post-harvest losses. Post-harvest food losses are a significant threat to food security in Nigeria, resulting in economic losses, food waste, and environmental degradation. Research reports reveal that post-harvest food losses in Nigeria are primarily caused by unsustainable planting approaches, inadequate

storage facilities, poor food handling practices and lack of access to markets. This paper highlights the need for policy interventions, capacity building, and awareness creation to support the reduction of post-harvest food losses in Nigeria. Food security is a fundamental human right, yet millions of Nigerians face food insecurity. Post-harvest food losses exacerbate this problem, accounting for 30-40% of total crop production. Reducing these losses is critical to achieving sustainable food security. Studies indicate that Nigeria records 40 percent post-harvest losses, which indicates that a substantial number of economic losses annually confront farmers and others in the agricultural food chain and by implication impacts food security in Nigeria.

Post-harvest food losses are a significant challenge in Nigeria, with dire consequences for household food security, regional as well as national implications. Inadequate food handling, storage, and transportation of agricultural produce usually led to the spoilage of a substantial portion of crops before they reach markets or consumers. These losses contribute to higher food prices, reduce the quantity of food available for consumption, and affect the socio-economic status and livelihoods of farmers, particularly in rural areas. Millions of Nigerians experience food insecurity as a result, with households unable to obtain enough wholesome food. The national food supply crisis is made worse by the loss of agricultural produce, which also makes it more difficult to maintain agricultural development, enhance nutrition, and become self-sufficient in food. In recent times communal clashes have prevented farmers from accessing their farmlands especially in the middle belt area of the country.

LITERATURE REVIEW

It has been reported that Nigeria's post-harvest losses have risen to over \$9 billion annually which is estimated to be about 50% of foods produced (Nwaoguji, 2017). In fact, crops like fruits and vegetables experience more than 50% decomposition which often happens on the farm, after harvest and during transportation, storage and in the markets. This is further stated by what the Federal Ministry of Agriculture and Rural Development of Nigeria reported that "the demand for tomatoes in Nigeria in 2015 was put at 2.2million tones, the actual quantity harvested was 1.5million and only 800,000 tons were supplied, giving a total loss of 700,000 tons" (Oketola, 2016).

The reduction or loss in the quantity and quality of food produced from harvest to consumption is known as postharvest loss. According to Kiaya (2014), quality losses include those that impact a product's acceptability, edibility, and nutrient or caloric composition. Quantity losses are those that cause a quantity to decrease. Developing nations are more likely to experience quantity loss (Oladimeji et al., 2019). Conceptually, FAO (2011) used the term food loss to encompass both food loss and food waste and noted that loss or wastage occurs along the entire food value chain but varies in extent depending on the product and region. The point at which food loss occurs is also different for different parts of the world. For example, in developed countries, food loss arises at the consumer stage and concerns food that is processed and ready to eat whereas in developing countries, food losses occur at the post-harvest stages, during marketing and processing (Godfray et al., 2010).

Food waste is the loss of edible food due to human action or inaction such as taking serving sizes beyond one's ability to consume. Food loss on the other hand, is the inadvertent loss in food quantity because of infrastructure and management limitations of a given food value chain (FAO, 2015). Food losses are measured by decreased weight or volume, while qualitative loss comes in form of a reduced nutrient value and unwanted changes to taste, color, texture, or cosmetic features of food (Buzby and Hyman, 2012). An investigation into varied literature on the challenges of post-harvest food losses and its impact on food security reveals very critical outcomes: Food loss can be identified at various points along the food chain. The significant point of food loss in Nigeria is frequently situated between the agricultural production and postharvest stages (processing, storage,

and distribution). The majority of arable crop farmers experience losses at any point during these stages (Afolabi et al 2021). For instance, the highest losses occur in fruits and vegetables, as well as root and tuber crops during the distribution stage. One reason for this is that immediately after harvest; these perishable crops are transported and sold at the markets without adequate packaging, cooling, or favorable environmental conditions. In most cases, these crops are sold in informal markets including the community markets, where commodities are sometimes displayed on bare floors for lack of sustainable options. The absence of standardized and sustainable storage skills and techniques has resulted in significant losses. The practice of farm storage remains a traditional one (Umeh, 1994). The storage materials, namely sacks, jute bags, and rhombus, lack the capacity to provide a sustainable protective environment for crops. In the event of unfavorable climate conditions, these storage technologies are susceptible to *mycotoxin* infestation and other disease pathogens, which ultimately result in food loss at the storage, stage (Ayeni et al., 2021). Most of the time, the initial contamination of pathogens occurs at the production stage, subsequently manifesting throughout the subsequent stages. For instance, *aflatoxins* in maize affect the leaves during production and after maturation, and they continue to affect the grains during storage (Bankole et al., 2022).

Prolonged dry spells and delayed rains make agricultural production difficult. Water sources are either dry or insufficient to bring crops to maturity. As a result, farmers suffer losses during production (Emeribe et al., 2020). Similarly, during extreme weather conditions, flood-prone areas experience losses that can affect all stages of the food system. (Enete et al., 2016) reported that in flood-prone areas, >80 percent of stored food products could be lost. Rodents such as *Arvicanthis niloticus* (African grass rat) and *Mastomys natalensis* (African common rat) are important agricultural pests. They cause damage to crops in both the nymphal and adult stages. However, they cause more damage in the later stages. The longer the crop remains in the field (late maturing), the greater the susceptibility to rodent infestation. Losses in rice and wheat before ripening can be greater than 40 percent after maturation. Rodents cause more than one million dollars worth of damage to crops each year (Rabiu and Rose, 2017)

A distinction can be made between natural/environmental causes, social causes, and material causes. On natural causes, seed borne diseases are common in crops propagated by seeds, such as cereals, legumes, and some vegetable crops. Various pathogens affect these crops during the anthesis, seed development, and maturation stages. They cause cob rot in maize, head smut in wheat, seed rot in sorghum, rice blast, mottle in cowpeas, and late blight in tomato (Wada et al.2002). In addition, several plant-parasitic nematodes threaten the production and increase in the yield of cereal crops in Nigeria (Abdulsalam et al., 2021). Although other types of nematodes can infect maize, the most prevalent are root-knot nematodes (*Meloidogyne spp.*) and root-lesion nematodes (*Pratylenchus spp.*). These nematodes also attack wheat plants. They cause various forms of damage, including wilting, stunted growth and/or roots, and leaf chlorosis. Similarly, >50 species of nematode cause various types of damage in both upland and lowland rice varieties. One of the important symptoms is the reduction of chlorophyll content in cultivated rice leaves, which ultimately leads to low yield. Zhang et al. (2018) identified >50 insect pests. They found that different insects are associated with specific crops. For instance, cassava grasshoppers, rice/sorghum-African rice gall midge, *Orseolia oryzivora*, maize/millet stems, and pod borers. The increasing prevalence of these pests has increased the use of pesticides as a critical method of pest and disease reduction and control.

Enete et al. (2012) observed that erratic rainfall patterns and long dry spells contribute to soil degradation, low soil fertility, and the incidence of pests and diseases. The physiological nature of some crops makes them susceptible to disease and pest infestation. For instance, maize's low capacity to extract water from the soil means that erratic weather conditions predispose it to pest and disease infestations that ultimately cause damage (Agoda et al., 2011). Due to extreme weather

conditions, there has been a considerable increase in the incidence of pests and diseases among arable crop farmers in Nigeria, resulting in poor yields. Root rot disease is a major challenge in the production of tuber crops, such as cassava. Okechukwu et al. (2008) reported that no region in Nigeria has a fully resistant plant variety. The longer the cassava tuber remains in the soil, the greater the chance of exposure to root rot disease. The prevalence and stage of the disease vary across different agro-ecological zones of the country. During storage, crops, such as cereals and pulses, are exposed to attack by various mycotoxins such as aflatoxins and trichothecenes. Some mycotoxins catalyse the growth of pests and inevitably cause food contamination (Ngoma et al., 2024). They are often found in stored grain due to the presence of toxigenic fungal spores. In addition to weather instability, which has increased the prevalence of postharvest mycotoxin infestation in cereals, suboptimal stored grains are more susceptible to mycotoxin infestation (Ayeni et al., 2021). In addition, during storage, instability and/or lack of adequate temperature in storage materials or conditions leads to the development.

Cultural, traditional as well as social orientation impact on farming systems in Nigeria and can be observed in the type of technology adopted as well as a clear display of inappropriate management techniques. Both crop farmers and livestock farmers are predominantly subsistence farmers are resistance to modern farming methods and are stuck to using their traditional farming approaches (Chiaka et al., 2022) and these methods predisposes crops and livestock to pathogenic infections leading to shortfalls in output (Abdulsalam et al., 2021). Also, perceptions guide their activities especially in the area of grain drying, a key factor in grain storage, methods such as sun drying and spilling on the ground are popular methods with attendant limitations and challenges occurring during the rainy season, where the grains harvest may not have dried properly. The consequences are usually severe and lead to pathogen and pest infestation (Ayeni et al., 2021) Farmers rarely seek disease-resistant seedlings during pre-planting preparation. They source from informal sources such as open markets, friends and family rather from agricultural outlets managed by various segments of government and stakeholders like Non-Governmental Agencies (Kilinger et al 2020: Mariel et al, 2024).

Although there exist gearing direct causes of food loss, such as mechanical damage and pest and disease infestation less emphasis is placed on indirect causes usually resulting from human decision errors like suboptimal planting and post-planting strategies that results in food loss (Morris et al., 2018). (Agoda, et al., 2011) Traditional storage and preservation methods are clearly inadequate for controlling insects, rodents and pathogens. Also, climate change is prevalent and deployment of traditional methods is inadequate but it remains preferred options amongst subsistence farmers in Nigeria. Inefficient supply chains as a result of logistics issues are a significant contributory factor to the challenge of post-harvest food losses in Nigeria, identified issues include poor road facilities and network. For example, a number of communities in Agoi region of Yakurr Local Government, Cross River State cannot be easily accessed due to the condition of the roads and inability of high-volume carrying vehicles to ply the roads. The farmers resort to the use of motorcycles as a means of transport, to convey their food proceeds to markets in the area on designated market days. Inadequate logistics like produce packaging as well as limited market information can lead to spoilage and gluts which could affect pricing and by implication the livelihood and earning power of farmers. Lack of market access: Lack of finance, infrastructural facilities such as electricity, durable roads and effective storage facilities impact storage, marketing channels and mode of distribution of crops(Afolabi et al., 2021)Asides the challenge of logistics and movement of harvest proceeds to markets, the agricultural policies, present restrictive market regulations thus making it difficult for farmers to sell their products most times causing gluts and surpluses as there exist limited opportunities to present food produce to possible buyers. This could be as a result of certain limitations or barriers, amongst which are physical barriers, economic

barriers, communication or information barriers as well as institutional barriers: weak or inadequate regulatory frameworks, limited access to agricultural extension services: training and advisory services as well as lack of updates on innovations on new trends in farming systems. The over dependence on human labor during planting, simple farm implements like cutlasses for harvesting, open area drying and storage in jute bags and rhumbu are inadequate for long term crop storage are easily susceptible to infestation and contamination (Ayeni, et al., 2021). Also, the inability to engage off-takers for farm proceeds creates uncertainty in the minds of the farmers as in the event that there is bountiful harvest the farmer is informed about marketing options for his/her produce thus being forced to reduce price as a way to avoid farms crops getting bad as they are often perishable products.

Limited technological adoption, Farming systems in most agricultural regions in Nigeria are limited in the deployment of requisite equipment and technology. In most parts of Nigeria, tractors, fertilizers and other methods are not available or are either inadequate, which aside from hindering seamless crop cultivation and livestock development greatly constitute a huge challenge for attaining food security. Inadequate use of irrigation systems can result in crop damage or loss due to drought or water logging; In Nigeria the northern parts engage in all-year farming and a great advantage is taken of the various river basin authorities in farming while in the southern parts rain-fed farming is still a major farming option with most of the river basin authorities not optimized in the cultivation of crops. The deployment of cooling systems, drying technologies as well as packaging technologies are either totally lacking or inadequate are strong evidence of limited technological adoption in not only crop cultivation but also in preserving and prolonging the life span of harvested foods.

Economic losses for farmers are one of the grievous consequences of post-harvest food losses. Farming in its various forms and levels in terms of either crop cultivation: cash and food crops as well as livestock: poultry and animal husbandry is a major source of livelihood for a huge percentage of Nigeria's working population and any adverse outcomes from post-harvest losses will have a devastating effect on the economic fortunes of the farmers and their families as well as other interests in the food value chain (Balana et al., 2021: Chiaka, et al., 2022 and Agoda et al., 2011). Any fallout emanating from reduced food availability is yet another consequence of post-harvest food losses. It results from reduced output and volume of food leading to reduced income due to loss of produce, affecting livelihoods and farmers' ability to further invest in farming. A short fall in food output would translate to increase in the prices of food stuff. This portends corresponding negative impacts on nutrition, food quality and quantity as well as the health and well-being of the people. Post harvest food losses and waste have grave food security consequences: food insecurity, malnutrition and dependence on food imports further depleting the foreign exchange reserves of Nigeria. All of these invariably lead to hunger amongst the Nigeria population and consequently, rural –urban migration especially among the youths who are supposed to constitute a major part of the farming labor force (Eruola et al. 2013).

Environmental consequences in resource waste, greenhouse gas emission and soil degradation. Social consequences as observed in poverty, migration, social unrest as a result of hardship. Food waste, infestation and decay from households and farmlands lead to various environmental degradation ranging from pollution of the environmental as well affecting ground water sources thus having a debilitating effect on water quality and wellbeing of majority of the human population especially in the periphery of urban areas and most prevalent in the rural areas of Nigeria. (Ebin, et al 2021), (Eteng, et al 2021). A fallout of these events is that majority of the population depend largely on the environment for sustenance and lives below the poverty line. It is therefore important that interventions and policies focus strongly on reducing food loss at the pre-consumption stages as it affects vital aspects of the environment (Afolabi et al., 2021)

In spite of the various forms identified as causes of post-harvest food losses and waste, the Nigerian Government have over the years invested over N66 billion towards the establishment of 33

silo complexes as well as 25 grain segregation centers and 9 units of Blumbery warehouses across the six geo-political zones of the country. When completed it is expected to provide storage for only 5 percent of national produce output. (Kader & Roller 2004; Kader 2005) reported that only 5 percent of investments in agricultural research in over 30 years have been directed towards preventing post-harvest losses. A major challenge is the issue of measurement difficulties in ascertaining actual produce loss as well as non-deployment of technological innovations by many farmers- fallout of long-held beliefs and the issue of cost of acquiring most of the equipment and innovations introduced to them further aggravated by lack of credit facilities to farmers.

QUANTITATIVE EVIDENCE OF POST HARVEST FOOD LOSSES IN NIGERIA

TABLE 1: QUANTITY AND PROPORTION OF POST HARVEST LOSSES BY CROPS

**Average Quantity Ave/loss kg Quantity
Harvested/Purchased(kg) of Average loss (percentage)**

Crops	Farmers	Processor	Marketers	Farmers	Processors	Marketers	Famers%	Processors	markets
Yam	3,826.6	3,320.6	13,218.4	1,175	694	1,150	24.8	0.2	6.4
Cassava	9,632.7	187.056	579.200	2,388	50.131	49,232	22.6	1.8	5.1
Maize	3,255.4	30,659.9	99,988.6	745	6,040	8,799	23.1	3.7	5.7
Rice	7,851.9	109,016.9	62,544.8	1,774	25,837	8,381	21.6	8.0	7.3
Cowpea	840.4	2,070.1	65,397.1	182	797	4,447	30.7	1.5	4.2
Average	5,081.4	66424.7	164,069.8	1,245	2,019	9,680	24.5	3.1	5.7

Source: NISER Post Harvest Food Loss Survey 2013/14

The above data set adopted from Nigeria Institute of Social and Economic Research in her 2013/24 report focused on Nigeria's staple foods mainly Yams, Cassava, Maize, Rice and Cowpea and indicated losses resulting from farmers, food processors, as well as marketers all players in the agricultural food chain. As it concerns yams out of harvested figures of 3,826.6 kilograms average quantity losses amounted to 1,175 kg representing percentage loss of 24.8. For Rice the processing stage witnessed over 109,000 kg output but with over 25,000 in losses, averaging 8 percent, representing the highest figures along the food chain and as a key consumer product among majority of the populace, government resort to the importation of rice to meet the food needs of Nigerians: a key avenue for the loss of our foreign exchange earnings.

TABLE 2: PROPORTION OF FOOD CROP LOSSES DUE TO FARM LEVEL ACTIVITIES

FARM ACTIVITIES	YAM	CASSAVA	MAIZE	RICE	COWPEA	ALL CROP AVERAGE
Harvesting	11.4	7.9	5.7	6.9	5.9	7.6
farm Storage	7.4	7.1	6.9	3.4	7.2	6.4
Transportation	6.0	3.5	1.8	1.6	2.7	3.1
Drying	-	4.1	3.1	3.1	4.5	3.0
Threshing	-	-	3.3	3.8	4.2	2.3
Winnowing	-	-	2.3	2.8	6.2	2.3
Total	24.8	22.6	23.1	21.6	30.7	24.5

Source: NISER Post Harvest Food Loss Survey 2013/14

For food crop losses due to farm level activities, harvesting accounts for 7.6 percent on the average for the cropping season under review and on farm storage represents 6.4 percent of average food loss. Other avenues through which losses are incurred as a result of farm activities include during transportation to market places, drying, Threshing as well as Winnowing all amounting 24.5 percent as compared to 5.7 percent due packaging and marketing activities as listed in Table 3. Going by projections on the challenge of food losses in Nigeria as put forward by concerned stakeholders like the Food and Agricultural Organization (FAO) and the World Bank

TABLE 3: PROPORTION OF FOOD CROP LOSSES DUE TO MARKETING ACTIVITIES

ACTIVITIES	YAM	CASSAVA	MAIZE	RICE	COWPEA	AVG. ALL CROPS
Transportation	1.7	1.4	2.0	3.0	1.2	2.0
Packaging/Repackaging	1.4	1.5	1.5	1.4	1.6	1.5
Storage/Warehousing	3.3	2.2	2.2	2.9	1.4	2.4
TOTAL	6.4	5.1	5.1	7.3	4.2	5.7

Source: NISER Post Harvest Food Loss Survey 2013/14

SUMMARY AND CONCLUSION

In summary, identified causes of food losses and waste (FAO 2019) includes late harvesting which can lead to produce attack by birds and other pests ;inadequate drying of grains which often leads to the development of moulds and insect attack; traditional threshing methods which can lead to moulds, insect, rodents and pests infestation; poor transport conditions and defective packaging can cause damage and results in quantitative and qualitative losses and other factors like poor marketing prices; inappropriate and inadequate sector(agriculture) policies and ill-conceived socio-economic issues can adversely affect farmers income and invest capabilities. (Adewunmi, et al 2019) indicated long distance market locations, storage periods, and marketing and logistics expenses, poor handling of produce, vehicle breakdown and perishable nature of some agricultural produce.

As part of strategies aimed at fostering a sustainable increase in agricultural productivity and addressing the challenge of post-harvest food losses and waste, there are interventions and innovations, like the Nigeria Incentive-Based Risk Sharing System for Agricultural Lending NIRSAL aimed at de-risking agricultural financing. Technological innovations: through the introduction of solar-powered cold storage hubs by private enterprises. International partnership initiatives: through collaboration with the Food and Agricultural Organization, IFAD and WFP to improve post-harvest infrastructure and farmer education. Aside these interventions challenges still pervade concerning stakeholder coordination and need for intergraded approaches, issues with scalability and sustainability. The following strategies are recommended as action plans that needs close monitoring and evaluation with key performance indicators to enable a focused approach for maximum results. Governments at various levels: Federal, State and Local Government should set out a programmed massive investment in rural roads, cold storage facilities and structured markets to ensure food produce move from farmlands to markets as quickly as possible after harvesting. Government and all stakeholders both local and international should intensify training on post-harvest handling, encourage value addition and develop business skills integrated into agricultural extension services. Research and innovation on low-cost storage and preservation technologies adaptable to local farming systems be intensified. Policy and institutional reforms be implemented that would on enforcing food quality standards, encourage private sector participation and creating price stabilization mechanisms to enhance price stability and guarantee food security. Strengthen cooperatives and value chains forming produce unions that can help farmers' pool resources for better storage, transportation and market access.

In conclusion, addressing the challenges of post-harvest food losses and waste is critical to achieving sustainable food security in Nigeria. This indeed requires a comprehensive, multi-dimensional approach involving government at various tiers, the private sector, research establishments and local communities. With a focused and coordinated action in infrastructure development, education, technology and policy reforms, Nigeria can significantly reduce food losses and waste, enhance agricultural productivity and guarantee food availability for her rapidly growing population.

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