

MANAGING POST HARVEST LOSSES FOR IMPROVED FOOD SECURITY IN NIGERIA: A CONCEPTUAL REVIEW.

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Abstract: The problem of post-harvest losses among Smallholder farmers in developing countries is a recurring phenomenon which affects the socio-economic well-being of farmers. It also determines the achievement of sustainable food security in a given country. Food losses occur during harvesting, handling, processing, marketing, packaging and storage of agricultural produce. In Nigeria, post-harvest losses have risen to over \$9 billion annually which is estimated to be about 50% of foods produced in the country. In fact, crops like fruits and vegetables experience more than 50% of such losses. To this effect, the paper contains a conceptual review on the nature, causes, impact and strategies involved in managing postharvest losses of food crops and products in Sub-Saharan Africa with particular emphasis on Nigeria. Relevant texts, journals, online articles and other publications were selected and reviewed in preparing the paper. The review reveals that post-harvest losses occur at different stages of value chain and they differ based on the type of crops involved. Fruits and vegetables undoubtedly incur the greatest percentage of loss. It also reveals that a significant reduction in post harvest food loss in Nigeria can reduce the need for food importation and significantly increase food availability in the country. Therefore, the challenges of managing post harvest losses are not insurmountable. Suffice it to say that what is needed here is to create awareness among farmers through capacity building, extension services and practical demonstrations of post harvest losses mitigating technologies to ensure quick adoption and wider acceptance. Similarly, relevant stakeholders should collaborate to develop a sustainable and workable eco-system for managing post harvest losses through value added market-driven programs.

Keywords: Post-harvest Losses, Food Security, Food Crops, Food Loss Management, Nigeria

Introduction

Food is undoubtedly a basic necessity in life and a primary determinant of human sustenance. In developing countries like Nigeria, most, if not all, of the food consumed by smallholder farmers in rural areas is obtained from the farm and the scarcity of food at all season may be affected by post harvest food losses, which in turn, leads to food insecurity.

Nigeria is a country endowed with arable land on which variety of food crops are grown, but most of these crops are often lost to insects' attacks, rodents and micro-organisms. Food losses also occur during harvesting, handling, processing, marketing, packaging and storage of these agricultural produce. For example, a study carried out on post harvest food losses in some communities in Nigeria revealed that as much as 20 – 30% of total grain production, 30 – 50% of root and tuber and usually high percentage of fruits and vegetables are lost with a substantial amount recorded during storage (Mijinyawa, 2002). Moreover, 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% which often happen on the farm after harvest and during transportation, storage and in the markets. This is corroborated 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 tonnes, the actual quantity harvested was 1.5million and only 800,000 tons were supplied, giving a total loss of 700,000tons”(Oketola, 2016).

Similarly, it has been reported that in developing countries, 90% of wastage occurs from food losses within the value chain (Rockefeller Foundation, 2015). It directly impacts poor producers through foregone income and impacts poor consumers by reduced food availability, increased prices and decreased nutritional content.

Nevertheless, the causes of food losses in developing countries may not be unconnected with; lack of extension services to build skills in handling and storage; insufficient postharvest storage facilities or on-farm storage technologies and poor market access. With over 70% of African people depending on agriculture for their livelihood, finding feasible solutions for postharvest losses is a sine qua non for enhancing African economic growth and well-being.

Therefore, food availability and accessibility can be improved by reducing food losses. Thus, reduction of post-harvest food losses is a critical component of ensuring future global food security (Bolarin and Bosa, 2015). Reduction in these losses would increase the amount of food available for human consumption and enhance global food security (Trostle, 2010). A reduction in postharvest food losses can also improve food security by increasing the real income for all the consumers and producers alike (World Bank, 2011). Consequently, all efforts to reduce post-harvest losses provide an attractive opportunity to improve food security across the globe, particularly in Sub-Saharan Africa, hence the motivation for the paper.

Concepts Definition

First, there is the need to understand the whole aspect of post-harvest system in order to appreciate the issue at hand. According to the Food and Agricultural Organization, post-harvest system should be thought of as encompassing the delivery of a crop from the time and place of harvest to the time and place of consumption, with minimum loss, maximum efficiency and return for all involved (Spurgeon, 1976). The term "system" denotes a dynamic and aggregation of logically interconnected functions or chain of operations within a particular sphere of activity. Consequently, in considering the agro-food chain as a whole, harvesting can be seen as the ridge between the pre-harvest post-harvest slopes, extending from harvesting to consumption. Therefore, post-harvest system encompasses a sequence of activities and operations that can be divided into two groups namely technical activities (harvesting, field drying, threshing, cleaning, additional drying, storage, processing) and economic activities (transporting, marketing, quality control, information and communication, administration and management), (FAO, 2004)

Post-harvest Food Loss (PHL) can then be defined as measurable qualitative and quantitative food loss along the supply chain, starting at the time of harvest till its consumption or other end uses (De Lucia and Assennato, 1994; Hodges, Buzby and Bennett, 2011). Food losses take place at production, postharvest and processing stages in the food supply chain (Parfitt, Barthel and Macnaughton, 2010). Food losses are a measurable reduction in foodstuffs and may affect either quantity or quality" (Tyler and Webley, 1979). This presupposes that freshly harvested agricultural produce is a living thing that breathes and undergoes changes during post-harvest handling. Post-harvest loss can occur either due to food waste or due to inadvertent losses along the way (Rockefeller Foundation, 2015). Thus, 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). Similarly, quantitative food losses is 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).

In developing countries, more than 30% of the food produced for human consumption in Sub-Saharan Africa is being lost because of inadequate postharvest management. In Nigeria for example, lack of storage and agro-processing facilities pose great impediments to Nigeria's agric value chain, thereby resulting to a chain of losses and huge wastage of farm produce (Oketola, 2016). Regrettably, both buyers and farmers in third world countries view loss as a cost of doing business which must happen, and therefore they consider it as a necessary evil that must be tolerated.

According to World Bank, food security is defined as physical and economic access to adequate food by all household members without undue risk of losing the access (Omonona, Titus and Adetokunbo, 2007). It describes the condition where all people at all times have access to, and are able to acquire sufficient food to meet their dietary needs for productive and healthy life. According to Ohiokpehai (2003) a working definition of food security should be presented in an equation as Food security = Food availability + Food access and acquisition + Food use.

In Nigeria, efforts being made to increase food production include the rice anchor borrower programme, home grown school children feeding programme, agricultural development programmes and establishment of research institutes. However, increased food production is not the final solution to food security. It has to be complemented by good harvest and post harvest practices to reduce the amount of food loss (Bolarin and Bosa, 2015). A significant reduction in post harvest food loss in Nigeria will also reduce the need for food importation. It is pertinent to note that the agricultural commodities and food imports bills of Nigeria averaged over N1 trillion in 2013 and 2014, with food such as sugar, wheat, rice and fish accounting for 91% of the total cost of imports (Oketola, 2016). Therefore, post-harvest food losses are one of the greatest threats facing food security in Nigeria today, and so all efforts must be geared toward reducing it.

Types of Post Harvest Losses

Post harvest losses occur at different stages of the value chain and they differ based on the type of crops involved. Fruits and vegetables undoubtedly incur the greatest percentage of loss, estimated at 52% of production, or 54 million tons per annum (Gustavson and Sonesson, 2011). These losses generally occur further up in the value chain during processing and marketing. During processing, losses often occur as a result of cleaning, grading, threshing, grinding, soaking, drying, winnowing, sieving, cutting and milling. During distribution, losses are typically caused by delays in transportation, storage, poor packaging and handling, lack of standardization and distribution bottlenecks. Similarly, roots and tubers suffer from a significant volume of loss in terms of absolute production. This loss largely occurs after harvest due to high level of perishability associated with these crops.

Causes and Impact of Food Losses

Food travels along the value chain from harvesting to consumption and losses occur at each stage along the chain and contribute to total post harvest losses. The losses incurred at each step vary depending upon the organization and technologies used in the food supply chain. This loss is caused by different factors in each stage, but the relative importance of a particular stage or factor toward contributing to total food loss will vary across countries and commodities. For example, in less developed countries where the supply chain is less mechanized, larger losses are incurred during drying, storage, processing and transportation.

Factors that contribute to food loss range from mechanization of practices such as harvesting and processing, to weather conditions, production practices, transportation facilities, grading issues, infrastructure, consumer preferences/attitudes, and availability of markets (Aulakh and Regmi, 2013). Other factors include biological and environmental causes such as temperature, relative humidity and sanitation procedures, (Kader, 2005), lack of needed tools and equipment, lack of adequate market information to enhance competitiveness as well as weak government regulations and policies that are geared towards reducing post harvest losses especially in developing countries. In addition, food losses are caused by fruit pest, diseases, poor preservation of harvested produces, bad roads, lack of cold rooms and properly ventilated warehouses (Sunnews, 2017).

On the impact of post harvest losses, Rockefeller Foundation (2015) reports that post harvest losses can have broad economic, health, and environmental impacts. The economic impact of post harvest management comes in two parts. First, it contributes to income creation and economic development by increasing income that can be used towards other important household expenses, such as education, health, agricultural inputs, etc. Secondly, it ensures that returns are maximized on the investments that smallholder farmers make in agricultural inputs such as fertilizer, improved seed, procurement of pesticides, farm implements, etc.

Moreover, the Director General of the Federal Institute of Industrial Research, (FIRO), in Lagos, Nigeria had revealed that the economic value of post-harvest losses in 2017 was \$9 billion (The Guardian, 2018). This covers the whole spectrum of crops from vegetables, fruits and food crops. Invariably, a substantial percentage of farm products are either wasted on the farm, in transit or at commodity markets. A visit to Yan'kaba vegetable market or Na'ibawa fruits market in Kano, for example, would convince anyone that the volume of food wasted in Nigeria is colossal. Tomatoes, banana, leafy vegetables, and watermelons, because of poor handling and storage, are heavily wasted probably because there is hardly any juice company off-taking and processing the products in the area. Consequently, small holder farmers have no choice than to sell most of their food crops at give-away prices. This is further compounded by the fact that most of the farmers do harvest their farms at the same periods, thus creating an over-supply, and hence selling at a price even below production cost.

On health grounds, reducing postharvest losses helps to improve the quantity and quality of relatively nutritious crops sold, while reducing toxins that reach the market from spoiled and infested crops. Selling high quality food products, particularly fruits and vegetables, improves nutritional security by ensuring that greater volumes and variations of healthy crops are consumed. Managing post harvest losses can also reduce the quantity of toxins that hit the market, particularly aflatoxins, which can contaminate grains that have been poorly stored (Rockefeller Foundation, 2015). The Food and Agriculture Organization (FAO) estimates that a quarter of food crops are contaminated with aflatoxins annually (Partnership for Aflatoxin Control in Africa, PACA, 2013). It is further reported that Aflatoxins have been found to be associated with a range of illnesses including liver cancer and cirrhosis, growth retardation and susceptibility to malaria and HIV/AIDS (PACA, 2013). Therefore, managing postharvest Aflatoxins contamination will ensure supply and consumption of safe and healthy food in the economy.

Furthermore, reducing post harvest losses can have significant impact on relieving pressure on the environment by reducing the volume of food wastages as well as land and water pollution. For example, the Food and Agriculture Organisation (FAO) estimated that the carbon footprint of wasted food globally is 3.3 Gigatonnes of Carbon dioxide equivalent, CO₂ (Food and Agriculture Organisation, 2013). Thus a reduction in post harvest losses means that there is less need to convert more land to farmland because production volumes actually make it to market and thus fulfill demand, reducing the burden on deforestation and offsetting the carbon footprint of crops grown (Rockefeller Foundation, 2015). It will also result in more efficient use and availability of clean water.

Strategies for Reducing Post-harvest Losses

The World Food Conference convened in Rome in 1974, drew attention to the concept of postharvest food loss reduction as a significant means to increase food availability, which led to the formation of the Special Action Program for Food Loss Prevention, of the Food and Agriculture Organization of the United Nations (FAO) (Choudhary, 2006). Since then, different strategies on how to reduce post-harvest losses were proposed by various authorities depending on the type of agric produced involved. Perishable crops such as tomato, pepper, fruits and leafy vegetables received the highest attention over the years. For example, Agro Nigeria (2016) suggests the use of paper instead of polythene bags to cover fruits and vegetables, drying, cleaning and dis-infecting as well as proximate processing to prevent losses. Agbota (2007) opts for the use of returnable plastic crates (RPC) for preserving, packaging, storing and haulage of fruits and vegetables to improve post harvest handling of these crops.

Furthermore, the Nigeria Stored Products Research Institute (NSPRI), Ilorin, has developed solar and hybrid multipurpose dryers to preserve and prolong the shelf life of some fruits and vegetables. Wax coating, the institute said, can delay ripening of tomatoes, banana and plantains for a few more days or weeks, without negative health implications. The research activities of NSPRI involve the design, construction and evaluation of various structures, systems and equipment used in post harvest technology in order to reduce post harvest losses. To this end, the Institute has succeeded in the development of the use of ventilated yam barn for the storage of fresh yam tubers, development of Diffuse Light Store (DLS) for storage of potato, development of inert atmosphere Silos for bulk storage of grains, improvement of the "rhumbu" for the storage of dry grains in the dry areas of the country to make them fumigatable, development of evaporative coolers for storage of fresh fruits and vegetables as well as the design, construction and evaluation of different models of fish smoking kilns to enhance quality preservation and shelf life extension (Arc Nigeria, 2016).

In addition to the above strategies, the Rockefeller Foundation (2015) has developed an innovative integrated model consisting of four components in order to reduce food loss. They include the following:

- i. Linking smallholder farmers to market demand of both large anchor buyers and local alternative markets
- ii. Aggregating farmers to train them in postharvest management, promote their adoption of technologies, and aggregate their crops to meet buyer quantity and quality requirements
- iii. Using innovative finance mechanisms to promote agricultural investments and facilitate distribution and acquisition of technologies, particularly among smallholder farmers.
- iv. Promoting the adoption of appropriate loss-reducing technologies to improve crop handling, storage, and processing. To this, the fifth one is added.
- v. Awareness creation and effective market information service.

All five components above are interwoven and should be integrated during implementation in order to optimize the value chain for reducing post harvest food losses. At the heart of the model is the link between market demand and aggregation of farmers' supply. Market demand, the prime mover of this model, must be met with aggregated supply (Rockefeller Foundation, 2015). Without this connection, farmers will have no incentive to acquire or adopt loss-reducing technologies, technology suppliers will have no market for their products and finance providers will not risk lending to value-chain actors with no assured markets. It is a known fact that lack of access to market for their produce is one of the reasons for post harvest losses by smallholder farmers in Sub Saharan Africa. By making this supply-demand link, the various actors in the value chain each plays a part in this integrated system.

Large anchor buyers signal demand by making commitments and arranging contracts with their suppliers (local processors) to purchase specified quantities of smallholder farmers' crops. This link with ready buyers gives the farmers confidence and ensures that produce will be sold immediately after harvest thereby reducing on-farm crop losses that may arise as a result of storage and transportation. This model ensures off-take by selling aggregated processed crops directly to anchor buyers. By reducing the need for storage, the combination of on-farm processing and selling to anchor buyers has the potential to reduce crop losses by as much as 80% (Monitor Deloitte, 2015). Forward supply agreements not only drive consistent supply for off-takers but also help Smallholder farmers' to secure consistent incomes. Existing collection and procurement centers are used (if any), or new centers are established, to create one-stop crop market where traders and off-takers can purchase crops and pass them on to processors or exporters. Similarly, alternative local buyers such as supermarkets, local processors, restaurants, hotels, and grocers are linked to smallholder farmers and aggregation centers. These alternative buyers will spread the adoption of practices that reduce postharvest losses by creating a source of demand for surplus production and processed derivative products, as well as helping farmers adapt to supply fluctuations caused by weather and other factors. The next strategy is to assemble farmers and train them in postharvest management, adoption of post harvest technologies and how to standardize their crops to meet buyer quantity and quality requirements. This plan, if well implemented, will enable smallholder farmers to produce the required quality and quantity of agricultural ingredients and sell them to willing off-takers at acceptable prices.

Another strategy is for the government or relevant private organization to effectively promote the adoption of appropriate loss-reducing technologies to improve crop handling, storage, and processing. Thereafter, Agro-dealers can facilitate distribution and acquisition of these technologies, particularly among smallholder farmers. Individual farmers may not need to purchase or own these technologies but farmers' cooperative societies or other actors in the agribusiness value chain can be encouraged to purchase technologies and lend or lease the technologies to farmers. Participating financial institutions can provide loans to finance farmers' acquisition of post-harvest technologies, using anchor buyers' sourcing commitments as collateral (Rockefeller Foundation, 2015). To achieve this, Central Bank of Nigeria (CBN) can replicate its rice anchor grower's programmes by introducing crop anchor buyers programme to promote quick marketing of agric produce.

However, the last four strategies can hardly succeed if farmers and other stakeholders are not aware of it. For example, most of the smallholder farmers in Nigeria are not aware about the existence of Nigeria Stored Products Research Institute (NSPRI), let alone the various equipments it developed for post harvest management of agric produce. Therefore, awareness creation and effective market information service should be employed.

Market Information Service

Information is vital for farmers, middlemen, buyers and other stakeholders in the market. Dissemination of timely and accurate information to farmers will avail them with market prices, accessible markets as well as demand and supply interplay. Provision of such information can facilitate market operations; improve efficiency on sales and price stabilization operations and smallholders' returns. Stakeholders in the value chain should be able to access better market information and understand how to better use the information optimally.

The most important and the only form of market data is price; price is the value of a product that is usually expressed in monetary terms. Most of the crops produced in Nigeria are sold in an open market through price discovery, bargaining and negotiations. In Kano state of Nigeria for example, fruits and vegetables trading is called *Gwari* (riskiness) because of its price volatility and perish ability. Therefore, timely dissemination of daily prevailing market prices will play a crucial role in reducing post harvest losses by informing farmers where to go and sell their products at better prices. It must be stressed that market information is a two-way flow. That is, the

producer can equally benefit if he or she provides information to the market as well.

In the same vein, government in Nigeria should provide adequate infrastructure in form of good roads, railways and power supply in order to ease transportation and availability of cold chain stores for effective marketing and preservation of perishable crops. In addition, Deloitte (2015) suggested different measures aimed at solving many losses that occur after harvest. These techniques are summarized in the table below.

	Rationale
Table 1: Rationale for Prioritized Solutions for Post harvest losses [PHL]	
Heavy Molded Plastic Containers	Reduces PHL during transporting and handling of nutritious, perishable foods; inexpensive to manufacture and buy
Gum Arabic Coating	Reduces PHL at the storage stage and improves availability of relatively nutritious foods; relatively inexpensive
Warehouse Receipts System	Reduces PHL at the storage stage and assists smallholder farmers in avoiding price troughs; upfront costs can be spread over many years
Zero Fly Bags	Reduces PHL at the storage stage and toxins hitting the market; relatively competitive technology cost
Contract Farming	Increases and stabilizes incomes, while also improving availability of fruits and vegetables.
Direct Sourcing	Improves market linkages, which improves incomes and reduces storage losses; applicable to many crops
Growtainers	Relatively expensive, however may result in significantly more efficient use of agricultural inputs as well as higher yields
Collection Centers	Relatively effective at reducing PHL, improving incomes, advancing health, and applicable across a wide range of crops
Mobile Processing Units	Reduces PHL significantly, however limited to grains and cassava and relatively expensive.

Source: Monitor Deloitte (2015)

The above techniques, if properly implemented, will help smallholder farmers to reduce the volume of postharvest losses in developing countries. For example, with contract farming, farmers are assured of ready-made buyers or off-takers of their crops thereby eliminating any postharvest loss. Presently, most of our farmers just use their intuition to decide the crop to grow and wait for potential buyers after harvest, and because the crops are harvested at the same time coupled with poor storage facilities, there is over supply which leads to market glut. In this situation, particularly on vegetables, farmers often watch as their produce rot down with no potential buyer. Some of them even used to run away from their wares in the market in order to reduce the extent of loss.

Conclusion

The preceding discussions explain the nature, causes and impact of post harvest losses as well as the strategies of managing it. However, reducing the volume of loss after harvest to the barest minimum is a panacea to attainment and sustenance of food security in Nigeria. Therefore, to successfully implement these measures and strategic interventions, and in particular drive adoption of post harvest losses technologies and tactics, there is a need to create awareness among farmers through capacity building, extension services and practical demonstrations of post harvest loss mitigating technologies to ensure quick adoption and wider acceptance. Post harvest facilities should also be affordable and accessible to farmers. Innovative financing in the form of credit extension, no recourse loan, revolving funds and micro-leasing could help to address such hurdles as limited financial collateral and poor credit history. Similarly, improving physical infrastructure as well as leveraging supply chain and marketing channels to disseminate information and distribute post harvest technologies could play a significant role in promoting access.

This clearly shows that the challenges of managing post harvest losses are not insurmountable; and could be sustainably addressed when all the stakeholders collaborate to develop a sustainable and workable eco-system for managing post harvest losses through value added market-driven programs.

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