Implication of Food Loss and Waste on Food Security in Nigeria: A Review

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Abstract

Food is lost and wasted to varying extents across all stages of the food value chain and for all types of food, negatively impacting food security. In Nigeria, it has been revealed that a significant quantity of food is lost both before and after storage, with losses of up to 20-30% of all grains, 30-50% of roots and tubers, and a larger proportion of fruits and vegetables. Despite the Nigerian government's primary agricultural policy being to achieve food security and self-sufficiency, the agricultural sector has steadily deteriorated over the years due to inadequate government attention. One of the primary causes of food insecurity, particularly in developing countries like Nigeria, is high postharvest losses and waste resulting from inadequate food processing and storage facilities, as well as negligence or a deliberate decision to discard food. This paper reviews the basic concept of food loss and waste, examines food security and the Nigerian situation, and discusses the challenges to food sufficiency, the implications and potential benefits of food loss, as well as some possible approaches to reducing food loss and waste in Nigeria. Thus, reducing food loss and waste is one of the leading global strategies for achieving a sustainable food future. Practical and cost-effective approaches could be implemented to attain mid-term gains once put into place. The review recommends the development of a food loss and waste measurement protocol and increased investments in reducing postharvest losses in Nigeria.

Keywords: Food security, Food waste, Food value chain, Postharvest loss, Measurement protocol, Self-sufficiency

Introduction

Food is, without a doubt, the most basic of all human survival needs. Although numerous efforts have been made to improve the quality and production of global food supplies, food insecurity remains prevalent, particularly in the southern nations of Asia and Africa. Nigeria, a country of over 200 million people, faces a pressing food security crisis. According to the Food and Agriculture Organization (FAO), approximately 25.3% of Nigeria's population is undernourished. With a rapidly growing population projected to surpass 400 million by 2050, the World Bank estimates that agricultural production must increase by at least 70% to meet the rising demand for food. Yet, despite its fertile land and a predominantly agrarian economy, Nigeria continues to struggle with food insecurity (UNICEF, 2021). Due to the lack of infrastructure facilities, such as good roads, processing and storage equipment, as well as inadequate marketing information, large quantities of agricultural produce go to waste (Gernah et al., 2013).

In Nigeria, it has been revealed that a significant quantity of food is lost both before and after storage, with losses of up to 20-30% of all grains, 30-50% of roots and tubers, and a larger proportion of fruits and vegetables (Abbas, 2018). In 2020, Nigeria's Ministry of Agriculture and Rural Development reported that approximately 700,000 tons of

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tomatoes were wasted each year (Usman et al., 2023). According to Schuster & Torero (2016), plants and animals that are grown or harvested with human consumption in mind but are ultimately not consumed by them are referred to as food loss and waste. It denotes any point in the food value chain where edible food meant for human consumption loses its mass caloric content or nutritional value. Within Sub-Saharan Africa, Nigeria stands out as one of the countries with the highest levels of severe food insecurity. Approximately 39 million Nigerians faced acute hunger in 2020, underscoring the magnitude of the challenge (FSSS, 2024).

Food loss and waste contribute to food insecurity in Nigeria. Each year, nearly 15 million metric tons of food are lost or wasted in the country. This loss occurs across the value chain, from postharvest handling and storage to distribution and consumption (Abbas, 2018). Nigeria is grappling with a high prevalence of chronic undernourishment. Between 2019 and 2021, an estimated 22 million people in the country experienced persistent hunger (UNICEF, 2021). Approximately one in every four calories grown to feed people is not ultimately consumed by humans (Doss et al., 2018). Food is lost and wasted to varying extents across the globe, at all stages of the food value chain, and across all types of food. As a result, overall global food availability is lower than it should be, negatively affecting food security (Adegbola, 2011) and requiring the planet's agricultural system to produce additional food to compensate for the food that people ultimately do not consume.

As a strategy for closing the food gap between the food available today and that needed in 2050 to adequately feed the planet's projected 9.3 billion people, reducing food loss and waste can alleviate poverty and provide gender benefits while reducing pressure on ecosystems, climate, and water (Adegbola, 2011). Until recently, there has been a lack of a uniform definition of food waste and loss (Xue & Liu, 2019). Various definitions have been used in the literature and in policy documents (Bellemare et al., 2017; Fabi et al., 2021). This lacuna hinders analyses of food waste and loss, including its precise measurement at national, regional, and global scales. The FAO, therefore, provides a definition, defining food loss and waste as the "decrease in quantity or quality of food along the food supply chain" (FAO, 2019). In this definition, food losses occur throughout the food supply chain, from harvest to retail, and food waste occurs at retail and during consumption (Cattaneo et al., 2021). Others have expanded the definition to include pre-harvest, as well as quantitative and qualitative, food losses (Delgado et al., 2021). "Food loss" refers to a decrease, at all stages of the food chain before the consumer level, in the mass of food that was initially intended for human consumption, regardless of the cause (Baributsa, 2012).

Food loss typically occurs at the production, storage, processing, and distribution stages of the food value chain, and it is the unintended result of agricultural processes or technical limitations in storage, infrastructure, packaging, and/or marketing. "Food waste" refers to food that is of good quality and fit for human consumption but that does not get consumed because it is discarded either before or after it spoils (Bloom, 2011). Food waste typically, but not exclusively, occurs at the retail and consumption stages of the food value chain and is often the result of negligence or a conscious decision to discard food. Therefore, food that was initially meant for human consumption but is removed from the food chain is considered food loss or waste, even if it is then used as animal feed or bioenergy (Bond et al., 2013).

Performance of Agriculture in Nigeria

Agriculture has been a major contributor to the Nigerian economy since independence. The agricultural sector has been transformed by commercial activities, evolving from small to medium and large-scale market levels. The principal cash crops include cocoa, oil palm, and rubber, while the major staple foods are rice, cassava, yams, maize, taro, sorghum, and millet (Matemilola, 2017). The production of timber and the rearing of livestock, such as goats, sheep, cattle, and poultry, as well as artisanal fisheries, are other common preoccupations of smallholder farmers in Nigeria (Offu & Offu, 2013). Nigerian farmers are predominantly small-scale subsistence farmers, totalling approximately 14 million, with an average farm size of 1 hectare in the south and 3 hectares in the north of Nigeria (Corporate Nigeria, 2011).

Although the Federal Government has neglected the sector since the discovery of commercial quantities of petroleum resources in the 1990s, the significance of agriculture to the Nigerian economy cannot be overstated (Adene & Oguntade, 2006). The type of crop cultivated in various regions of the country depends on soil characteristics and climatic conditions. However, due to the discovery of oil in most of the southern region of the country, agricultural activities have been significantly limited, resulting from the consequential industrialisation and frequent oil spills

(Matemilola, 2017). Also, agricultural activities in the north are sometimes plagued by extreme weather conditions, such as drought and flooding during the rainy season. The south-west and south-east have, over the years, had relatively balanced conditions for agriculture, but unfortunately, these two regions also have the highest levels of education in the country and mostly seek opportunities outside the agricultural sector.

Food Security and the Nigerian Situation

Food security is defined as the availability of food and one's access to it (Wikipedia, 2013). A household is considered food secure when its occupants do not live in hunger or fear of starvation. Food security in a country exists where all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2019). In Nigeria, access to adequate and nutritious food is generally limited by low income and poverty, largely because nutritious food is usually expensive. Food security is crucial on a global scale as it provides essential health, social, and economic advantages to the human population. Therefore, to achieve the Sustainable Development Goal of zero hunger (Goal 2), it is imperative to assess the progress of food security, particularly in developing countries (Onwe et al., 2024).

Within Sub-Saharan Africa, Nigeria stands out as one of the countries with the highest levels of severe food insecurity. Approximately 39 million Nigerians faced acute hunger in 2020, underscoring the magnitude of the challenge (FSSS, 2024). Nigeria is grappling with a high prevalence of chronic undernourishment. Between 2019 and 2021, an estimated 22 million people in the country experienced persistent hunger (UNICEF, 2021). Food loss and waste contribute to food insecurity in Nigeria. Each year, nearly 15 million metric tons of food are lost or wasted in the country. This loss occurs across the value chain, from postharvest handling and storage to distribution and consumption. Addressing this issue requires investment in improved infrastructure, technology, and consumer awareness to reduce food waste and increase efficiency (Adedokun, 2021).

According to Offu & Offu (2013), processing of agricultural materials is very beneficial in several ways and generally ensures food security in the following ways:

- Provision of agro-raw materials, thus reducing wastage;
- Increases economic gains of those involved in the food supply chain;
- Guarantees long-term availability of food products;
- Extension of shelf life of agro-raw materials;
- Reduces import dumping and capital flight in the country.
- Enhance food quality by transforming various food products.

The risk of Nigeria facing a food crisis is real, given the recent surge in the prices of staples and shortages of other food items (World Bank, 2023). The rising food prices have spread across the country, as the prices of staples such as bread, wheat, garri, sugar, edible oil, and onions, among others, have all increased in recent months. With the importation of staple food items, the country is not guaranteed food security (Osaze, 2009). Hence, with population growth and the agricultural sector stagnating, the production of food for domestic consumption is not keeping pace with population growth, resulting in many mouths to feed and less food on the table. Gbadamosi & Akanmu (2024) and Nwokedi et al. (2018) opine that the only option is importation. According to the FAO (2019), Nigeria spent approximately $ 28 billion importing food. Also in the same year, an estimated 3.7 million metric tons of wheat were imported, mainly from the United States and Canada. Nigeria is considered the third-largest importer of wheat in Africa and the largest importer of rice on the continent (Nwokedi et al., 2018). The import-dependent nature of a constant food supply cannot be sustained during times of severe global food crises. This scenario can compromise the country's sovereignty and social stability, as recently observed in Tunisia and Egypt (Osaze, 2009).

Causes of Food Insecurity in Nigeria

Food insecurity is a multifaceted problem. It is quite an uphill task discussing the driving factors for food insecurity in Nigeria. Nigerians often lack enthusiasm for local products and tend to consider them inferior to imported food products (Matemilola, 2017). The emergence of the oil sector marked the decline of the agricultural sector, as the huge revenue generated from petroleum products shifted attention away from agriculture. The government embarked on food importation, and local production shrank away, especially as wealth from oil changed the status and tastes of many Nigerians in favour of foreign goods (Otaha, 2013). Also, socio-political instability, economic downturn, civil war, dwindling human

resource base, gender inequality, education decadence, poor health facilities, and the general loss of good governance have further degraded food accessibility.

Any effort to reduce food loss and waste must begin with a diagnosis of where it occurs. Regionally, about 56 per cent of total food loss and waste occurs in the developed world (North America, Oceania, Europe, and the industrialised Asian nations of China, Japan, and South Korea). In contrast, the developing world accounts for 44 per cent of the loss, with approximately 1,500 kcal per person per day lost or wasted from farm to fork (Lipinski et al., 2013). In terms of stages of the food value chain, 24 per cent of global food loss and waste occurs at production, another 24 per cent during handling and storage, and 35 per cent at consumption. These three stages account for more than 80% of global food loss and waste (FAO, 2019). Food loss and waste apply to food products in the value chain starting from the moment that crops are ripe in the field, plantation, or orchard, animals are on the farm, in the field, sty, pen, shed, or coop, ready for slaughter, Milk has been drawn from the udder, or aquaculture fish are mature in the pond. Wild fish have been caught in the net (Al-Zahrani et al., 2018). The value chain ends the moment food products are consumed, discarded, or otherwise removed from the food chain. Therefore, food that was originally intended for human consumption but is removed from the food chain is considered food loss or waste, even if it is then used as animal feed or bioenergy (Lipinski et al., 2013).

Where Food Loss and Waste Occurs in Nigeria

Food loss and waste can occur at each stage of the food value chain. Figure 1 shows some examples of how they can occur at each stage.

Production	Handling and Storage	Processing and Packaging	Distribution and Market	Consumption
DEFINITION				
During or immediately after harvesting on the farm	After produce leaves the farm for handling, storage, and transport	During industrial or domestic processing and/or packaging	During distribution to markets, including losses at wholesale and retail markets	Losses in the home or business of the consumer, including restaurants/caterers
INCLUDES				
Fruits bruised during picking or threshing	Edible food eaten by pests	Milk spilled during pasteurization and processing (e.g., cheese)	Edible produce sorted out due to quality	Edible products sorted out due to quality
Crops sorted out post-harvest for not meeting quality standards	Edible produce degraded by fungus or disease	Edible fruit or grains sorted out as not suitable for processing	Edible products expired before being purchased	Food purchased but not eaten
Crops left behind in fields due to poor mechanical harvesting or sharp drops in prices	Livestock death during transport to slaughter or not accepted for slaughter	Livestock trimming during slaughtering and industrial processing	Edible products spilled or damaged in market	Food cooked but not eaten
Fish discarded during fishing operations	Fish that are spilled or degraded after landing	Fish spilled or damaged during canning/smoking		

Figure 1: Food loss and waste along the value chain
Source: Lipinski, et al. 2013

However, in this review, food loss and food waste do not include:

- By-products, such as bones, organs, skin, seeds, peels, hulls, and bran, could be considered unavoidable food waste because, in a specific supply chain, they are not intended for human consumption and are discarded or used in non-food products.
- Surplus food that is redirected to food banks and subsequently eaten by people.
- Food grown intentionally for feed, seed or industrial use.
- Overconsumption beyond recommended caloric needs.

Challenges to Food Sufficiency

Experts say that the goal of food self-sufficiency will be a mirage if the government fails to adequately tackle the numerous challenges confronting the agricultural sector, especially in food production (Osaze, 2009). Much like other sectors of the economy, such as

manufacturing, the challenges bedevilling the agricultural sector are pervasive in the economy. Experts have highlighted the challenges confronting adequate food production, including a poor infrastructural base, low-capacity utilisation, capital constraints, technical know-how, labour and human resources constraints, as well as policy, environmental, and cultural constraints. The weak infrastructural base undoubtedly negatively impacts the agricultural sector in Nigeria. Additionally, poor electricity and a dilapidated road network pose serious challenges to achieving food self-sufficiency (Al-Zahrani et al., 2018). Farmers often lament the loss of harvested perishable food items due to a lack of electricity in storage facilities and a poor road network that hinders their quick conveyance to urban centres, where they are in high demand. Most rural communities, which are traditionally farming centres, are bereft of electricity and an accessible road. Thus, perishable items such as vegetables, legumes, and fruits are often wasted due to decay.

Osaze (2009) reported that another major challenge to food sufficiency is the shortage of manpower, as most youths have relocated to urban centres in search of better living conditions. The few who form a majority of the farming population are also ill-equipped to take advantage of new technology and farming methods provided by extension officers. This is mostly due to cultural factors, which are often reinforced by illiteracy. "These farmers often hold on to traditional methods of farming and are skeptical about new technologies (Gbadamosi & Akanmu, 2024). Poor funding for farmers is a major constraint to improved food production. Despite the government's efforts to make credit facilities available to farmers, many still cannot access soft loans due to lending policies. Most farmers cannot afford the collateral required for obtaining a loan. "Most farmers are going to have a hard time getting funds from the banks, given the recent CBN posture on risk management. Even the agricultural facility provided by the CBN at a low interest rate was not fully disbursed, as only a few farmers met the requirement to get the loan," says a staff member of a commercial bank who pleaded anonymity. Sub-Saharan Africa, including Nigeria, is reputed to have the least farm irrigation in the world, with approximately 4.5 per cent of farmland receiving irrigation.

Implication of Food Loss and Waste

Food loss and waste have negative economic and environmental impacts. Economically, they equate to a wasted investment that reduces the economic well-being of actors in the food value chain. For instance, food waste at the consumption stage costs an average of US $1,600 per year for a family of four in the United States and £680 (approximately US $1,000) per year for the average household in the United Kingdom (FAO, 2012). Approximately US$32 billion worth of food is discarded in China annually (FAO, 2012). In sub-Saharan Africa, where many farmers earn less than US $2 a day, postharvest losses have a value of up to US $4 billion per year (World Bank, 2023). Environmentally, food loss and waste represent unnecessary greenhouse gas emissions and wasted water and land (Lipinski et al., 2013).

Globally, the amount of food loss and waste in 2009 was responsible for roughly 3,300-5,600 million metric tons of greenhouse gas emission (carbon dioxide equivalent); the upper end of which is almost equivalent to the amount of carbon dioxide emission from energy consumption by the United States in 2011 (Kummu et al. 2012). Food loss and waste are associated with approximately 173 billion cubic meters of water consumption per year, which represents 24% of all water used for agriculture (EIA, 2012). The amount of cropland used to grow this lost and wasted food is approximately 198 million hectares per year, an area about the size of Mexico (Grace et al., 2012), and 28 million tons of fertiliser are used annually to grow this lost and wasted food (Affoh et al., 2022). Beyond these qualified impacts, natural landscapes and the ecosystem services they provide are also adversely affected by the resources that go into producing this lost and wasted food.

Potential Benefits of Reducing Food Loss and Waste

In 2002, the European Commission set a target to reduce by 50% the rate of food loss and waste in Europe by 2020 (Gunders, 2012). If this target were extended globally to 2050, analysis suggests that achieving it would reduce the need to produce 1,314 trillion Kcal of food per year in 2050 (Lipinski et al. 2013). In other words, reducing the global rate of food loss and waste from 24 per cent of calories to 12 per cent would close roughly 22% of the 6,000 trillion Kcal per year gap between the food available today and that needed in 2050 (Hazlewood, 2012). Thus, reducing food loss and waste could be one of the leading global strategies for achieving a sustainable food future. Pilot efforts in Benin, Cape Verde, India, and Rwanda have documented reductions in food loss of more than 60% during field trials of various low-

cost storage techniques and handling practices (Hirvonen, 2012). Even if approaches to reducing losses at the production and storage stages in developing countries prove successful, these gains may be offset by increases in food waste at the consumption end of the food value chain as the global middle class expands (WFP, 2013). Nevertheless, the potential scale and multiple benefits of reducing food loss and waste make the effort worthwhile and desirable (Theodore et al., 2023).

Possible Approaches for Reducing Food Loss and Waste

A wide range of approaches for reducing food loss and waste are in use; for instance, building roads and introducing electric-powered refrigeration in low-income countries would likely reduce food losses during the handling and storage phase by enabling fresh food to get to market more quickly and by preventing spoilage (ICIPE & IDRC, 2012). A subset of approaches that are practical and cost-effective could be implemented quickly and achieve mid-term gains once put into place. Some interventions, such as evaporative coolers for storage, directly impact food, whereas others, like consumer education campaigns, indirectly affect food by influencing people's consumption behaviour.

Food redistribution

Food distribution or donation programs are a method of reducing both food loss and waste. Food redistribution means voluntarily giving away food that would otherwise be lost or wasted to recipients, such as food banks, which then redistribute the food to those who need it. This strategy applies at the production stage with crops that would otherwise go unharvested, at the manufacturing stage with overproduced products, and at the distribution and market stage with food left unsold at stores and markets. There are several reasons why edible grains, fruits, and vegetables never leave the field. Some food might go unharvested due to economic realities. If the price of a given crop is too low to even pay for the labour required to pick that crop and the transport cost associated with selling it, it may be economically rational for the farmer to let that food be lost.

Crops may also not be harvested due to weather or pest damage, blemishes, or imperfections relating to shape, size, and colour (Kader & Rolle, 2004). At the manufacturing stage, a good processor might produce a surplus amount of food to meet an order, but then the order is reduced by the retailer. This food is then available to be redistributed to a food bank (Kimenju et al., 2009). At the market stage, surplus food may be generated when a store purchases too much of a certain item that then approaches or exceeds the "sell by" or "display until" date printed by the manufacturer (Kimenju & Groot, 2010). Food is generally still safe to eat after these dates, as it is only a measure of when a food item has passed its peak quality. But stores are unable to sell such items in most places due to local regulations and consumer concerns that the food has expired (Kitinoja, 2010). Additionally, fresh-cooked meals at food retail stores that are not sold by the end of the day are often thrown away (Kitinoja, 2013).

Evaporative coolers

Evaporative coolers extend the shelf life of food and prevent spoilage by keeping food at a lower-than-room temperature without requiring electricity. This low-cost, low-energy technique offers opportunities to store perishable food for longer periods in areas that lack electricity or have low-income farmers. When air passes over a wet surface, water from the surface evaporates into the air. As the water evaporates, it withdraws heat from the surface, creating a cooling effect on that surface (Baributsa et al., 2014). Evaporative coolers harness this effect in various ways, but their general design is similar. One of the simplest evaporative coolers is "zeer", invented by Nigerian teacher Mohammed Bah Abba in 1995. The zeer follows the standard evaporative cooling process, except that the outside vessel is filled with wet sand instead of water, which yields an added insulating effect for the internal vessel. The sand is generally re-wet twice a day. The zeer itself costs less than US£2 (₦4,150) to produce, can hold up to 12 kg, and can be reused for several years before becoming saturated with salt and needing replacement (Theodore et al. 2023).

The zeer dramatically extends the shelf life of items, such as mangoes, tomatoes, and guavas, which might normally expire within two days without proper storage, to last up to 20 days in a zeer (Mali, 2018). Evaporative cooling is a relatively low-cost method of preserving fruits, vegetables, roots and tubers, especially in regions where electric refrigeration is either prohibitively expensive or unavailable due to lack of a reliable electricity supply (Searchinger et al., 2013). Almost all of the costs associated with evaporative cooling are up-front, which provides certainty regarding the expenses of using the cooler. Furthermore, the materials necessary to construct an

evaporative cooler are typically locally available and relatively easy to acquire (Morath, 2018).

Plastic storage bags

Damage from pests is a major source of food loss during the handling and storage phase of the supply chain. Cowpea, for instance, is an important crop due to its ability to adapt to dry, hot conditions (Think. Eat. Save, 2013). The crop is especially important in the West and Central African regions, which account for approximately 69% of the world's total cowpea production by volume (UNEP, 2013). However, damage to cowpeas from insects can result in lower prices for farmers and even in outright loss of the crop (UNDP, 2011). Researchers at Purdue University in the United States have worked to mitigate this damage by developing a simple, reusable plastic storage bag, known as the "Purdue Improved Crop Storage" (PICS) bags. The bags are triple-layer, hermetic bags used by smallholder farmers to store grains and legumes without the use of chemical pesticides. The bags create a low-oxygen environment that suffocates and kills storage pests, thereby protecting crops from insect infestations, weight loss, and mycotoxins (Williams et al., 2017). PICS bags allow the crop to remain in storage for many months without degradation in quality due to pests. The Purdue Improved Crop Storage (PICS) bag has proven to be an effective alternative to chemical pesticides for stored grain. This bag features two liners made of high-density polyethene (HDPE) and an outer layer composed of woven polypropylene. Together, they create low-oxygen environments that reduce insect development (Anankware et al. 2013).

As much as 98% of all insect pests can be eliminated within just one month of storage, reducing damage and weight loss caused by feeding (Williams et al., 2017). Several barriers exist to the widespread use of PICS bags. The limited availability of PICS bags is a primary constraint in many countries, primarily due to an insufficiently dense network of Agricultural input retailers (Mmereki et al., 2024). For instance, the average distance to PICS retail is nearly 13km in some parts of Niger (World Bank, 2023). In a survey of Nigerian villages not part of any PICS pilot project, only about half of the survey respondents had heard of the PICS bags, suggesting that word of mouth is insufficient to spread awareness of a new technology (World Food Programme, 2013). Extension services play a crucial role in spreading awareness of new technologies, such as PICS bags, and educating farmers on their use.

Small metal silos

Small metal silos, intended for use by one farmer or household and generally holding between 250-1000kg of crops, can be an effective strategy for reducing food loss at storage, especially for cereals and pulses. Insufficient storage is a major source of food loss for farmers, especially in developing countries, where storage structures often do not maintain harvested crops in hermetic or air-tight conditions. Failure to have air-tight storage structures allows moisture and pests to enter containers, potentially causing mould, toxins, or pest contamination of the crops (WRAP, 2013). When farmers do not possess adequate storage capabilities, they may have to resort to selling off their entire crop immediately after harvest, which can mean at low prices since the supply of a crop relative to demand is more likely to be high just after harvest (WRAP, 2013), as a result farmers are not able to retain surplus crop for sale later, when the value of the crop might rise as it becomes less available. Insufficient storage also has consequences for food security, since farm families may need to purchase a large share of their food when self-storage options are limited (WRAP, 2013).

Plastic crates

The use of plastic crates instead of other forms of containerization has demonstrated a significant reduction in food losses during handling and storage, particularly among fruits, vegetables, and other forms of fresh produce. In developing countries, 19% of fruit and vegetable loss occurs during the handling and storage stage of the food value chain (FAO, 2012). Minimising losses at this stage is especially important in reducing overall loss and waste, as external and internal damage and blemishes during this stage can lead to a high rate of deterioration later in the value chain (Adegbola et al., 2011). Many common storage containers used to transport fruits and vegetables can lead to quality losses, such as bruising or even outright food loss due to being crushed or smashed during transport. Sacks and bags, the most commonly used transportation containers in many developing countries, offer little protection against quality loss due to compression, puncture, and impact (Rapusas & Rolle, 2009).

Bamboo baskets offer a higher defence against these sorts of injuries because they are semi-rigid; however, their rough interior surface can still damage produce. Avoiding such damage requires the insertion of an additional lining to protect the produce from basket interiors, which adds material cost and an extra step to

the labour involved in the handling process (Rapusas & Rolle, 2009). Bamboo baskets are often offered as non-reusable or only last a few uses, which means those baskets need to be remade or new ones purchased regularly. Plastic crates avoid many of the pitfalls of these other container types. Plastic crates are reusable for a long period, with many lasting approximately 5 years (Rapusas & Rolle, 2009). Although plastic crates have a higher upfront cost compared to baskets and sacks, they can have a significantly lower average cost per use over the long term. For example, one study found that plastic crates have a lower cost per use and a lower cost per kilogram for tomatoes compared to Bamboo baskets and wooden crates in the Philippines. Likewise, plastic crates increase the value of a kilogram of fruits and vegetables by up to 16% of the total market price when compared to using bamboo baskets for handling and storage (Rapusas & Rolle, 2009).

Plastic crates can also greatly reduce food loss. The crate's rigidity leads to less damage from impact during transport, as the crate limits the amount of collision between the goods. The smoothness of the material also precludes the need for lining to reduce friction (Rapusas & Rolle, 2009). Babarinsa et al. (2018) found that in-transit mechanical damage incurred during tomato haulage from the north to the south of Nigeria, when using raffia baskets, was greatly reduced, on average, from 41.12% to 4.92% in nestable plastic crates. However, there are some drawbacks to using plastic crates. Like all reusable storage technologies, plastic crates can carry and spread crop-eating insects or illnesses, causing microorganisms when improperly cleaned between uses (Rapusas & Rolle, 2009). Farmers may also face difficulties in obtaining crates. In one study of Nigerian farmers, 78% of farmers felt that plastic crates would be preferable to palm baskets and sacks. Yet every single person surveyed reported that plastic crates were unavailable and felt that they were too expensive (Adegbola et al., 2011).

Food date labelling

Dates provided on the packaging of food and drinks, such as "use-by," "sell by", and "best before", are intended to provide consumers with information regarding the freshness and safety of the food. However, these seemingly simple dates can actually confuse consumers about how long it is safe for them to store food and when they should dispose of uneaten items. One study, for instance, found that a fifth of food thrown away by households in the United Kingdom is discarded due to food being perceived as "out of date", when it was still suitable for human consumption (WRAP, 2011b). This suggests that while some of this waste may be legitimate due to food safety concerns, there may be room to reduce unnecessary household food waste by clarifying the meaning of these dates and changing the way they are used, displayed, and interpreted by consumers.

Part of the confusion surrounding product dating is that there are several different terms that may appear on packages. For example, three commonly seen terms are "sell-by", "best if used by", and "use-by", none of which are required by law. These dates refer to food quality or the flavour of the food, rather than food safety, which is a measure of whether the food could potentially cause illness when eaten. Food date labelling in Nigeria primarily affects food security through its impact on food waste, as consumers often discard safe food past its "best before" date due to confusion with "use-by" dates. The existing regulations, enforced by NAFDAC, aim to ensure consumer protection by distinguishing between quality and safety dates. However, a lack of clarity regarding the donation of wholesome, but post-quality-date, food contributes to waste. At the same time, improved consumer education and clearer labelling can reduce waste and support food security (Danilola et al., 2019).

Consumer awareness campaigns

Consumer attitudes and behaviour play a large role in determining the amount of food that is wasted in households. Although changing the way people consume and throw out food can be difficult. A communication campaign can help influence consumer behaviour at the household level. Waste of edible food at the household level occurs for a number of reasons; for instance, food leftover on one's plate gets thrown into the garbage. Even if leftovers are saved for later, they may eventually be thrown out (Liegear & Manning, 2020). Interestingly, some consumers do not realise the amount of waste that is actually occurring in their homes. However, signs of progress are emerging on how to reduce food waste at the consumer stage; they are still relatively nascent and concentrated in a limited number of countries. Scaling up will require increasingly rapid replication by consumers and countries.

Reduce portion sizes

For restaurants and other food service providers, food portion sizes can significantly impact the amount of food waste generated within their establishments, as larger portions increase the likelihood that consumers

will not consume all of the food purchased (US EPA, 2013). Reducing portion sizes for consumers in both direct and indirect ways can decrease food waste and save money for the provider. Experience in the United States highlights the problem. Food portion size in U.S restaurants has mostly been increasing since the 1970s (Nielsen & Popkin, 2003). Restaurants use large portion sizes as a selling point to suggest to consumers that they are receiving a bargain for the food they purchase (Young & Nestle, 2002). However, this trend toward large sizes leads to more food waste when consumers are unable to finish a meal, and it also contributes to obesity and excessive food consumption. On average, American diners do not finish 17% of the food they buy at restaurants and leave 55% of these leftovers behind (Bloom, 2011). In other words, approximately 9% of the food purchased at restaurants is disposed of on-site.

Conclusion

According to the Food and Agriculture Organization (FAO), approximately 25.3% of Nigeria's population is undernourished. A significant quantity of food is lost both before and after storage, with up to 20-30% of all grains, 30-50% of roots and tubers, and a larger proportion of fruits and vegetables. In Nigeria, access to adequate and nutritious food is generally limited by low income and poverty, largely because nutritious food is usually expensive. The rising food prices have spread across the country, as the prices of staples such as bread, wheat, garri, sugar, edible oil, and onions, among others, have all increased in recent months. The government embarked on food importation, and local production shrank away, while socio-political instability, economic downturn, a dwindling human resource base, gender inequality, educational decadence, poor health facilities, and the general loss of good governance have further deteriorated food accessibility. Cutting the global rate of food loss and waste from 24 per cent of calories down to 12 per cent would close roughly 22% of the 6,000 trillion Kcal per year gap between food available today and that needed in 2050. Thus, reducing food loss and waste could be one of the leading global strategies for achieving a sustainable food future. Some interventions, such as evaporative coolers for storage, directly affect food, whereas others, such as consumer education campaigns, indirectly affect food by influencing people's consumptive behaviour.

Based on the findings of this review, Nigeria should reduce its reliance on food imports and implement policies that promote domestic food production. Small-scale farmers should receive more funding to increase their resilience and productivity. This includes providing them with access to affordable finance, inputs, and insurance. A "food loss and waste protocol" would provide guidance and requirements on what should be measured, how to measure it, what units of measurement to use, what data sources and quantification methods are appropriate, how to ensure comparability among users and over time, and how to report results, among other features. Armed with this information, countries would be better equipped to identify opportunities for food loss and waste reduction, determine who needs to be engaged to achieve those reductions, identify appropriate strategies, set targets, and track progress over time.

References

Abbas, A. M., Abbas, I. I., & Agada, I. G. (2018). Reducing postharvest losses in Nigeria's agricultural sector: Pathway to sustainable agriculture. Innoriginal: International Journal of Sciences, 5(2), 16–21.

Adedokun, B. (2021). Nigeria's food insecurity and its implications on Sustainable Development Goal (SDG) 2 amidst the COVID-19 era. Journal of Good Governance and Sustainable Development in Africa, 6(5), 48–57.

Adegbola, A., Bamishaiye, E. I., & Olayemi, F. (2011). Factors affecting the adoption of the reusable plastic vegetable crate in three local government areas of Kano State, Nigeria. Asian Journal of Agricultural Sciences, 3(4), 281–285.

Adene, D. F., & Oguntade, A. E. (2006). The structure and the importance of commercial and village-based poultry industry in Nigeria. FAO.

Affoh, R., Zheng, H., Dangui, K., & Dissani, B. M. (2022). The impact of climate variability and change on food security in sub-Saharan Africa: Perspective from panel data analysis. Sustainability, 14(2), 759. https://doi.org/10.3390/su14020759

Al-Zahrani, K. H., Baig, M. B., & Straquadine, G. S. (2018). Food waste in the Kingdom of Saudi Arabia: Implications for extension education. In Climate change, food security and natural resource management: Regional case studies from three continents (pp. 73–101). Springer International Publishing.

Anankware, J. P., Obeng-Ofori, D., Afreh-Nuamah, K., Oluwole, F. A., & Ansah, F. A. (2013). Use of the triple-layer hermetic bag against the

maize weevil, Sitophilus zeamais (Mots) in three varieties of maize. Journal of Biology, Agriculture and Healthcare, 3(12), 67–73.

Babarinsa, F. A., Ogundele, R. B., Babarinsa, O. A., & Omodara, M. A. (2018). Evaluation of plastic crate as replacement for raffia basket to prevent in-transit damage of packaged tomatoes. Journal of Postharvest Technology, 6(3), 70–79.

Baributsa, D., Abdoulaye, T., Lowenberg-DeBoer, J., Dabiré, C., Moussa, B., Coulibaly, O., & Baoua, I. (2014). Market building for postharvest technology through large-scale extension efforts. Journal of Stored Products Research, 58, 59–66. https://doi.org/10.1016/j.jspr.2014.02.001

Baributsa, D., Baoua, I., Lowenberg-DeBoer, J., Abdoulaye, T., & Murdock, L. L. (2019). Purdue improved cowpea storage (PICS) technology. Gates Open Research, 3, 111. https://doi.org/10.12688/gatesopenres.12874.1

Bellemare, M. F., Çakir, M., Peterson, H. H., Novak, L., & Rudi, J. (2017). On the measurement of food waste. American Journal of Agricultural Economics, 99(5), 1148–1158. https://doi.org/10.1093/ajae/aax034

Bloom, J. (2010). American wasteland: How America throws away nearly half of its food (and what we can do about it). Da Capo Lifelong Books.

Bond, M., Meacham, T., Bhunnoo, R., & Benton, T. (2013). Food waste within global food systems. Global Food Security.

Cattaneo, A., Sánchez, M. V., Torero, M., & Vos, R. (2021). Reducing food loss and waste: Five challenges for policy and research. Food Policy, 98, 101974. https://doi.org/10.1016/j.foodpol.2020.101974

Corporate Nigeria. (2011). The business, trade and investment guide. Corporate Guide International Publications.

Danilola, S., Omotesho, O., & Animashaun, J. (2019). Consumer awareness of the use of food labels in Lagos State, Nigeria. International Journal of Food Studies, 8(2), 53–64. https://doi.org/10.7455/ijfs/8.2.2019.a6

Delgado, L., Schuster, M., & Torero, M. (2021). Quantity and quality food losses across the value chain: A comparative analysis. Food Policy, 98, 101958. https://doi.org/10.1016/j.foodpol.2020.101958

Doss, C., Meinzen-Dick, R., Quisumbing, A., & Theis, S. (2018). Women in agriculture: Four myths. Global Food Security, 16, 69–74. https://doi.org/10.1016/j.gfs.2017.10.001

Energy Information Administration. (2012). U.S. energy-related carbon dioxide emissions. http://www.eia.gov/environment/emissions/carbon/

Fabi, C., Cachia, F., Conforti, P., English, A., & Moncayo, J. R. (2021). Improving data on food losses and waste: From theory to practice. Food Policy, 98, 101934. https://doi.org/10.1016/j.foodpol.2020.101934

FAO. (2012). Save Food: Global Initiative on Food Losses and Waste Reduction. FAO.

FAO. (2019). The state of food and agriculture 2019: Moving forward on food loss and waste reduction. http://www.fao.org/3/ca6030en/ca6030en.pdf

FSSS. (2024). Food security in Nigeria: Understanding the issues. http://www.fsssolusions.org/agric-insights/food-security-in-nigeria-understanding-the

Gbadamosi, K., & Akanmu, A. (2024). Food security and population growth in Nigeria: The urban agriculture. In A festschrift in honour of Professor Jacob Funso Olorunfemi (pp. 30–43).

Gernah, D. I., Ukeyima, M. T., Ikya, J. K., Ode, F. K., & Ogunbande, B. J. (2013). Addressing food security challenges through agro–raw materials processing. Agricultural Science Research Journal, 3(1), 6–13.

Grace, J., Ugbe, U., & Sanni, A. (2012). Innovations in the cowpea sector of Northern Nigeria: Research into use Nigeria. World Resources Institute.

Gunders, D. (2012). Wasted: How America is losing up to 40 percent of its food from farm to fork to landfill. Natural Resources Defense Council (NRDC).

Hazlewood, P. (2012). A framework for integrating sustainability and equity into a post-2015 development agenda. World Resources Institute.

Hirvonen, M. (2011). Research into use: An institutional history of the RIU Nigeria country programme (Discussion Paper No. 20).

ICIPE & IDRC. (2012). Postharvest losses in Africa – Analytical review and synthesis: Report of project inception workshop held at ICIPE. IDRC.

Kader, A. A., & Rolle, R. S. (2004). The role of postharvest management in assuring the quality

and safety of horticultural produce (Vol. 152). FAO.

Kimenju, S. C., & De Groote, H. (2010). Economic analysis of alternative maize storage technologies in Kenya. Paper presented at the 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference, Cape Town, South Africa.

Kimenju, S. C., De Groote, H., & Hellin, H. (2009). Preliminary economic analysis: Cost effectiveness of the use of improved storage methods by small scale farmers in East and Southern Africa countries. CIMMYT.

Kitinoja, L. (2010). Identification of appropriate postharvest technologies for improving market access and incomes for small horticultural farmers in Sub-Saharan Africa and South Asia. WFLO/ Bill & Melinda Gates Foundation.

Kitinoja, L. (2013). Returnable plastic crate (RPC) systems can reduce postharvest losses and improve earnings for fresh produce operations. The Postharvest Education Foundation.

Kummu, M., De Moel, H., Porkka, M., Siebert, S., Varis, O., & Ward, P. J. (2012). Lost food, wasted resources: Global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use. Science of the Total Environment, 438, 477–489. https://doi.org/10.1016/j.scitotenv.2012.08.092

Lipinski, B., Hanson, C., Lomax, J., Kitinoja, L., Waite, R., & Searchinger, T. (2013). Reducing food loss and waste (Installment 2 of Creating a Sustainable Food Future). World Resources Institute.

Mali, V. S. I. (2018). Evaluation of low-cost evaporative cooling technologies for improved vegetable storage in Mali. In 2018 IEEE Global Humanitarian Technology Conference (GHTC) (pp. 1–8). IEEE.

Matemilola, S. (2017). The challenges of food security in Nigeria. Open Access Library Journal, 4(12), 1. https://doi.org/10.4236/oalib.1104185

Mmereki, D., David, V. E., Jr., & Wreh Brownell, A. H. (2024). The management and prevention of food losses and waste in low- and middle-income countries: A mini-review in the Africa region. Waste Management & Research, 42(4), 287–307. https://doi.org/10.1177/0734242X241227139

Morath, S. J. (2018). Regulating food waste. Texas Environmental Law Journal, 48, 239.

Nielsen, S. J., & Popkin, B. M. (2003). Patterns and trends in food portion sizes, 1977–1998. JAMA, 289(4), 450–453.

Nwokedi, M. E., Emeka, C. I., & Reuben, O. O. (2018). Globalisation of trade in agriculture under the WTO regime: Reflections on the agreement on agriculture and food security in West Africa. Journal of Alternative Perspectives in the Social Sciences, 9(4), 759–792.

Offu, A. K., Sr., & Offu, A. K. (2013). The Nigerian dependent management & leadership development in the post World War II colonial Nigeria. Author House.

Onwe, J. C., Makuachukwu, G. O., Mohammad, S., & David, F. (2024). Food security in Nigeria amidst globalisation, economic expansion, and population growth: A wavelet coherence and QARDL analysis. Journal of Agriculture and Food Research, 18, 101413.

Osaze, O. (2009). Confronting food security challenges in Nigeria. The Economy. http://www.theeconomyng.com/profile.html

Otaha, I. J. (2013). Food insecurity in Nigeria: Way forward. International Multidisciplinary Journal, 7, 26–35.

Rapusas, R. S., & Rolle, R. S. (2009). Management of reusable plastic crates in fresh produce supply chains: A technical guide. FAO.

Schuster, M., & Torero, M. (2016). Toward a sustainable food system: Reducing food loss and waste. In 2016 Global Food Policy Report (pp. 22–31). International Food Policy Research Institute (IFPRI).

Searchinger, T., Hanson, C., Ranganathan, J., Lipinski, B., Waite, R., Winterbottom, R., Dinshaw, A., & Heimlich, R. (2013). The great balancing act. World Resources Institute.

Theodore, A. I., Sunday, A. E., & Olusuyi, I. L. (2023). Agricultural productivity, population growth and food security in sub-Saharan Africa. Innovations, 72, 235–247.

Think Eat Save. (2013). Women winning the war against food waste and food loss. http://www.thinkeatsave.org/index.php/women-winning-the-war-against-food-waste-and-food-loss

UNEP, FAO, & WRAP. (2013). Reducing and preventing food and drink waste in businesses

and households: A toolkit for governments, local authorities, businesses and organisations.

UNICEF. (2021). The state of food security and nutrition in the world 2021. FAO.

UNPD (United Nations Population Division). (2011). World population prospects: The 2010 revision, highlights and advance tables (Working Paper No. ESA/P/WP.220). United Nations.

US EPA. (2013). Food waste production and prevention. http://www.epa.gov/foodrecovery/fd-reduce.htm

Usman, A. H., Makwin, L. L., Mubarak, Z., Emmanuel, E. A., Samaila, M. D., Taiye, A. G., Jibrin, G., Suleiman, A. G., Shuaibu, S. M., Emery, M., & Don, E. L. (2023). Food loss and waste in Nigeria: Implications for food security and environmental sustainability. Advances in Food Security and Sustainability, 8, 217–233.

Wikipedia. (2013). Food set. https://en.wikipedia.org/wiki/Food_set

Williams, S. B., Murdock, L. L., & Baributsa, D. (2017). Storage of maize in Purdue improved crop storage (PICS) bags. PLoS ONE, 12(1), e0168624. https://doi.org/10.1371/journal.pone.0168624

World Bank. (2023). Overview of Nigeria economy. https://www.worldbank.org/en/country/nigeria/overview

World Food Programme (WFP). (2013). Women and hunger: 10 facts. http://www.wfp.org/our-work/preventing-hunger/focuswomen/women-hunger-facts

WRAP. (2011). Consumer insight: Date labels and storage guidance. http://www.wrap.org.uk/sites/files/wrap/Technical_report_dates.pdf

WRAP. (2013). Reducing household food waste in the UK.

Xue, L., & Liu, G. (2019). Introduction to global food losses and food waste. In Saving Food (pp. 1–31). Academic Press.

Young, L. R., & Nestle, M. (2002). The contribution of expanding portion sizes to the US obesity epidemic. American Journal of Public Health, 92(2), 246–249. https://doi.org/10.2105/AJPH.92.2.246