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Food Waste and Loss Management - Causes, Effects and Possible Solutions from A Nigeria Context

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ABSTRACT

Food waste and loss present significant challenges globally, with Nigeria being particularly affected. This study comprehensively analyzes the causes, effects, and potential solutions to food waste within the Nigerian context. Drawing on extensive research and secondary data sources, the study highlights the pervasive nature of food waste, focusing on key sectors such as tomato, onion, and chili production. It identifies critical factors contributing to food waste, including inadequate infrastructure, pests and diseases, transportation constraints, and policy gaps. The socioeconomic impacts of food waste, such as increased food prices, exacerbated poverty, and environmental degradation, underscore the urgency of addressing this issue. However, amidst these challenges lie opportunities for intervention. Nigeria can significantly reduce food waste, enhance food security, and promote economic development by implementing a holistic approach that encompasses infrastructure development, sustainable agricultural practices, and supportive policies. Additionally, individual actions, such as meal planning and supporting local farmers, play a crucial role in mitigating food waste at the grassroots level. Through collaborative efforts involving governments, businesses, civil society, and individuals, Nigeria can pave the way towards a more resilient and sustainable food system, ensuring equitable access to nutritious food while preserving the environment for future generations. The methodology employed in this study entailed data collection primarily from prior research and secondary sources such as published studies, newspapers, articles, and relevant materials. The study's focal point centered on food waste and loss, with a specific focus on vegetable waste within the Nigerian context.

INTRODUCTION

Food wastage, both in Nigeria and worldwide, presents a significant challenge impacting economies, food security, and the environment. Food waste refers to the reduction in the quantity or quality of food due to actions by food suppliers, including retailers, consumers, and food service providers (Food and Agriculture Organization, 2020). This wastage adversely affects the utilization of crucial resources such as water, energy, climate, biodiversity, and land (Food and Agriculture Organization, 2013), resulting in widespread concern among the public, governments, educational institutions, companies, and Non-Governmental Organizations (NGOs) due to its detrimental impact on environmental sustainability (Kummu *et al.*, 2012; Licciardello, 2017). According to data from the Food Sustainability Index 2017, countries like Australia, the United States, Turkey, Spain, and Japan are the highest contributors to food waste generation, producing 361kg, 278kg, 168kg, 165kg, and 157kg per capita respectively. In contrast, Greece, China, India, Russia, and Colombia exhibit lower levels of food waste creation, with figures ranging from 44kg to 63kg per capita (Magnet, 2018). Despite efforts to address this issue, the household sector remains the primary source

of food waste in the supply chain, accounting for 43%, followed by restaurants (18%), farms (16%), groceries and distribution (13%), institutional and food service (8%), and manufacturers (2%) as of 2015 (Gunders & Bloom, 2017). However, there has been a notable lack of research focusing on the household segment's contribution to food waste, with only limited attention paid to consumer-related factors such as packaging, as highlighted in Helen Williams' work on household food waste causes (Schanes *et al.*, 2018). Thus, there remains a gap in understanding the primary drivers of household food waste within society (Schanes *et al.*, 2018).

However, the growing population presents challenges, including food insecurity. A considerable number of Nigerians struggle to provide adequate meals for their families due to living below the poverty line. It's not uncommon to witness people scavenging for leftovers at events to feed their loved ones. Despite the prevalence of hunger in Nigeria, the wastage observed in marketplaces nationwide is alarming, with substantial quantities of fresh produce like tomatoes and fruits left to spoil. This pressing issue calls for immediate and strategic intervention. One such intervention involves implementing an efficient food waste management

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system to support Nigeria's burgeoning population and secure the well-being of future generations. The research outlined in this paper aims to investigate the root causes, impacts, and potential remedies for effective food waste management in Nigeria.

LITERATURE REVIEW

Global food waste is staggering, estimated at USD 750 billion annually, excluding additional social costs of USD 900 billion and environmental costs valued at USD 600 billion (UN, 2015; FAO, 2014). Despite this, 870 million people globally suffer from undernourishment (UN, 2015). On a national level, 40% of Nigerians live below the poverty line, earning less than 137,430 Naira (\$381.75) per year (NBS, 2020). Moreover, research suggests that Nigerians allocate over 56.4% of their income to food expenses (WEF, 2016). With Nigeria's population estimated at 213 million in 2021, the country struggles to provide for its growing populace. The Food and Agriculture Organization of the United Nations (FAO)

indicates that 690 million people experienced hunger in 2019, a figure expected to rise significantly during and after the COVID-19 pandemic, with an astonishing 3 billion people unable to afford a nutritious diet (FAO, 2020). Given the escalating global population, food waste and food security have become focal points for both researchers and policymakers across developed and developing nations (Chalak *et al.*, 2019). Farmers engage in agriculture for various reasons, including catering to the needs of the rapidly expanding global population. Food is a basic human necessity crucial for survival, yet our consumption habits, disposal practices, and wastage profoundly impact both us and the environment we inhabit. According to national estimates, Nigeria generates approximately 32 million tonnes of waste annually, encompassing all stages of vegetable production (Lantz, 2021). Research indicates that the most prevalent form of food waste and loss occurs in perishable goods such as vegetables.



Figure 1: Vegetable Waste in Nigeria

Source: Yemisi Odusanya, *The Guardian Nigeria*, 2017

Food Waste: Definition and Effects

Food waste is commonly defined as “food, which was originally produced for human consumption but then was discarded or was not consumed by humans” (Thyberg & Tonjes, 2016). Narvanen *et al.* (2020) characterize food waste as a complex, multifaceted, and persistent challenge, noting its unstructured nature due to difficulties in defining the problem. They also highlight its moral dimension, particularly regarding disparities between the wealthy and the impoverished. Some scholars emphasize the importance of understanding the intricate interactions between human and non-human factors in the conversion of food to waste (Evans, 2018; Hebrok & Heidenström, 2019). Factors contributing to waste vary depending on material types, production methods, and management approaches (FAO, 2013).

With the Food and Agriculture Organization (FAO) projecting a 60% increase in food demand to

accommodate a population of 9.3 billion by 2050 (Da Silva, 2021), concerns about the extensive impacts of food waste on society, the economy, and the environment are escalating. Consequently, various local, national, and international institutions are implementing programs and policies to tackle this issue (Thyberg & Tonjes, 2016). Empirical evidence suggests that food waste comprises a significant portion of global food production, estimated at about one third annually by weight (Hamilton *et al.*, 2005; Hebrok & Boks, 2017). While more prevalent in highly developed economies, food waste is becoming a concern worldwide with increasing economic development, urbanization, and affluence (Gustavsson *et al.*, 2015; Baig *et al.*, 2018; Koch *et al.*, 2018). The detrimental impacts of escalating food waste on the environment and society are widely recognized and extensively discussed in the literature (Park & Lah, 2015; Secondi *et al.*, 2015). These impacts span various levels of analysis, from individual

consumers to national and international food systems, leading to heightened environmental concerns, resource sustainability challenges, and potential future food scarcity (Gustavsson *et al.*, 2011).

Causes, Environmental and Health Implication of Food Waste and Loss

The causes of food waste are diverse and extensively discussed in literature (Oelofse & Nahman, 2013; Neff *et al.*, 2019). Conversely, food loss can occur due to various factors, including inefficiencies in harvesting, transportation, storage, and processing, as well as issues like pests, diseases, and adverse weather conditions. Upstream processes such as crop losses due to disease, pest infestation, and weather fluctuations, combined with strict quality standards in food production, contribute

to 54% of food loss and waste, while the remaining 46% arises from processing operations, distribution, and consumption patterns (Mebratu, 1998). In a study conducted in Ireland, major causes of food waste were identified as expired food, waste from served meals, and spoilage or odor issues (Flanagan & Priyadarshini, 2021). Drivers of food waste in the food service sector have been examined and categorized into various types, including organizational, internal, external, business, and market-specific factors (Hennchen, 2019; Kasavan *et al.*, 2019). Within kitchens, food waste can be generated due to equipment malfunctions, excessive ordering, standards of fine dining, rejection of “ugly” produce, inadequate handling by suppliers, poor sanitation, or excessive planning for business requirements (Pinto *et al.*, 2018; Papargyropoulou *et al.*, 2019; Shao *et al.*, 2020; Filimonau *et al.*, 2021).

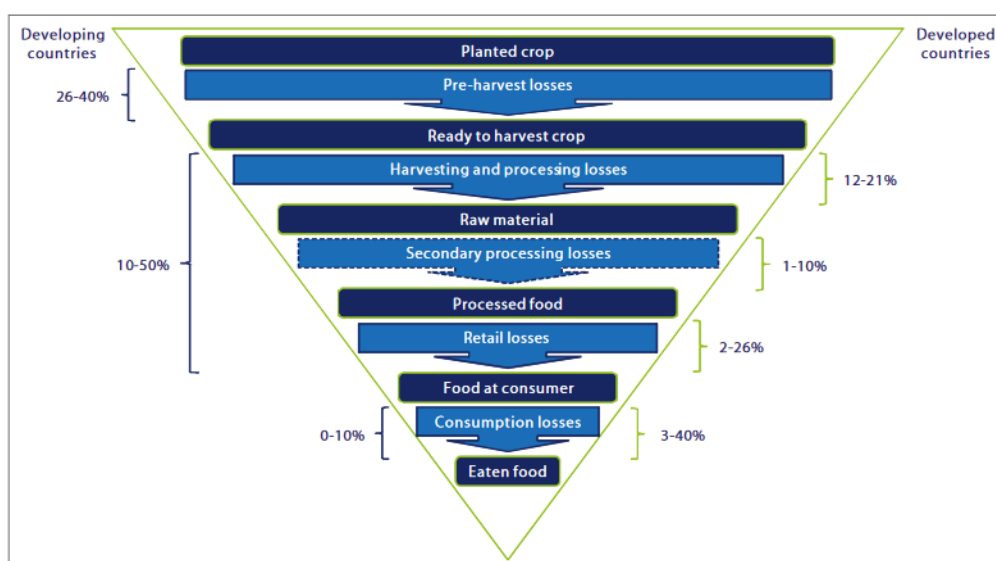


Figure 2: Stages of food waste globally

Source: Oguntade (2014)

Food systems contribute significantly to anthropogenic greenhouse gas emissions, accounting for approximately one-third of the world's total emissions (Crippa *et al.*, 2021). Additionally, food waste disposal leads to environmental impacts such as the release of pollutants into the atmosphere and water bodies through dumping and incineration. In landfills, for instance, decomposing food waste generates organic pollutants in landfill leachate, posing contamination risks to surrounding water sources (Ma *et al.*, 2022). Moreover, food waste in landfills contributes to the production of methane, a potent greenhouse gas that exacerbates climate change and serves as a breeding ground for disease vectors. Research by Peter *et al.* (2010) illustrated that one ton of food waste could generate a carbon impact equivalent to over 3.8 tons of carbon dioxide emissions. Therefore, diverting food waste from emission-generating sources presents an opportunity for countries to mitigate greenhouse gas emissions (Thi *et al.*, 2015).

METHODOLOGY

The methodology for this study involved gathering data primarily from previous research, secondary sources such as published studies, newspapers, articles, and other relevant materials. The main focus of the study was on food waste, with a particular emphasis on the Nigerian context streamline to vegetable waste. Data collection primarily utilized the Google Search Engine, employing specific queries such as ‘Food Waste in Nigeria,’ ‘Causes of Food Waste in Nigeria,’ and investigating three common types of food waste in Nigeria: causes, effects, and possible solutions. Additionally, relevant literature and reports were reviewed to provide comprehensive insights into the topic.

RESULTS & DISCUSSION

Food Waste in Nigeria

Food waste poses a significant challenge in developing nations like Nigeria, primarily due to the substantial

proportion of organic waste, particularly from vegetables, in municipal solid waste, especially from households (Oyelola, 2013; LAWMA, 2015). This organic content tends to be three times higher compared to developed economies. National estimates indicate that Nigeria generates approximately 32 million tonnes of waste annually, with a significant portion comprising vegetable waste (Lantz, 2021). Over the past two decades, urban centers in Nigeria have experienced a rapid increase in the volume and complexity of solid waste, including food waste, attributed to factors such as population growth, rising living standards, increased consumption patterns, urbanization, and inadequate environmental management policies (Rathi, 2007).

This surge in food waste coincides with reported cases of hunger, malnutrition, and poverty across various socioeconomic classes, leading to food insecurity within the population (Ojo and Adebayo, 2012). Findings from the 2013 Food and Agriculture Organization (FAO) fact sheets and surveys conducted by the Nigerian Stored Products Research Institute (NSPRI) estimate post-harvest food losses at 51.3 million tonnes across all crops, valued at \$8.9 billion. However, statistics on food waste at the retail/consumer level are not readily available, except for occasional estimates provided by individual or private corporate organizations. For example, at the unveiling of Danfoss Company in February 2016, it was

suggested by the Business Development Manager that approximately 80% of food, equivalent to \$750 billion, is wasted in Nigeria, underscoring the magnitude of the issue. Addressing food waste is crucial for developing a sustainable food system. Akerele *et al.* (2017) reported that households in Nigeria waste approximately 3–7% of the food consumed per month, amounting to an average monthly value of ₦1500, with root and tubers and cereals accounting for the largest percentage of total food waste.

Common Food (VEGETABLES) Waste/Loss in Nigeria

Research indicates that the most prevalent form of food loss and waste in Nigeria pertains to major vegetables. Market areas often exhibit piles of vegetable waste nearby or within nearby dumpsites. Storage challenges, pest and disease infestations, delays in transportation to sales points, and fluctuating temperatures, depending on weather conditions, are among the key factors contributing to this vegetable waste. A value chain study conducted by the Central Bureau of Investigation (CBI) in 2021 highlighted tomatoes, onions, and chili peppers as the primary sources of food waste among vegetables. The table below illustrates the production of these vegetables in Nigeria from 2015 to 2019, measured in tonnes, according to data from the Food and Agriculture Organization (FAO).



Figure 3: Nigeria Field Survey on Tomato Production

Source: *Knowledge Transfer*, 2023

The brief explanation to the table 1 below suggests that, from 2015 to 2019, Nigeria witnessed fluctuations and changes in the production of various vegetables. In 2015, the country harvested 4,083,500 metric tonnes of tomatoes, 235,000 metric tonnes of green onions, 985,400 metric tonnes of dry onions, 741,260 metric tonnes of green chili peppers, and 60,299 metric tonnes of dry chili peppers. Moving to 2016, there was a slight increase in tomato production to 4,229,330 metric tonnes, while the production of green onions remained

relatively stable at 235,276 metric tonnes. However, there was a notable increase in the production of dry onions to 997,900 metric tonnes. Similarly, the production of green chili peppers increased to 745,855 metric tonnes, and dry chili peppers saw a slight rise to 65,004 metric tonnes. Transitioning to 2017, there was a decline in tomato production to 3,412,650 metric tonnes, which could be attributed to various factors such as weather conditions, pest infestations, or fluctuations in agricultural practices. However, the production of green onions and dry onions

remained relatively stable compared to the previous year. In contrast, there was a slight decrease in the production of both green and dry chili peppers. By 2018, Nigeria experienced a rebound in tomato production, reaching 4,100,000 metric tonnes, which might be attributed to improved agricultural practices or favorable weather conditions. The production of green onions remained stable, while there was a slight decrease in the production of dry onions. Additionally, there was a slight increase in the production of both green and dry chili peppers compared to the previous year. In 2019, although tomato production decreased slightly to 3,913,993 metric tonnes,

the production of green onions and dry onions saw a marginal increase. Similarly, both green and dry chili peppers witnessed a slight rise in production compared to the previous year. Furthermore, the fluctuations in vegetable production from 2015 to 2019 could be influenced by various factors such as weather patterns, changes in agricultural practices, pest infestations, market demand, and government policies. Additionally, challenges such as inadequate infrastructure, access to quality inputs, and post-harvest management practices could have also contributed to the observed variations in production levels across the years.

Table 1: Production (tonnes) of Tomatoes, Onions, and Chilli Pepper for 5 Years in Nigeria

Vegetables	2015	2016	2017	2018	2019
Tomatoes	4,083,500	4,229,330	3,412,650	4,100,000	3,913,993
Onions (Green)	235,000	235,276	243,195	243,544	245,201
Onions (Dry)	985,400	997,900	1,014,810	971,110	938,417
Chilli Peppers (Green)	741,260	745,855	744,064	745,715	747,367
Chilli Peppers (Dry)	60,299	65,004	67,197	69,034	70,871

Source: CBI, 2021

Brief History of Tomato, Onion, and Chili Pepper in Nigeria

Tomato

Nigeria holds the position of the 14th largest tomato producer globally and the 2nd largest within Africa. The primary tomato-producing regions are Kaduna and Kano states, jointly responsible for over 50% of the country's total tomato output (NBS, 2010-2011). Nevertheless, tomatoes are cultivated across nearly all states in Nigeria, with 24 out of the 36 states, including the Federal Capital Territory (FCT), engaging in their production. Cultivation practices often involve intercropping and rotation with other vegetables like onions, peppers, lettuces, carrots, cabbages, and peas to mitigate susceptibility to pests and diseases. Despite significant domestic production, Nigeria ranks as the 13th largest importer of tomato paste globally and the 2nd largest within Africa. In 2019 alone, Nigeria produced over 3.9 million tonnes of tomatoes. However, the tomato production sector faces numerous challenges, including pest and disease outbreaks such as the notorious *tuta absoluta*, extreme weather events exacerbated by climate change, market price fluctuations leading to reduced demand, encroachment by herders resulting in delayed harvesting and potential food loss due to cattle damage, insecurity and armed robbery along transport routes, and transportation delays caused by truck stoppages and extortion by law enforcement officers. These issues collectively pose significant obstacles to the tomato industry in Nigeria.

Onions

Nigeria holds the distinction of being the largest onion producer in West Africa, with a total production exceeding 1.1 million tonnes. Onions are exclusively cultivated in the northern states of Nigeria, with Kaduna, Kano, and

Sokoto being the predominant states involved in onion production. Over the past five years (2015–2019), onion production has remained relatively stable, with the green onion segment experiencing growth while the dry onions segment has witnessed a slight decline in the last three years. The reasons behind this trend would be further explored through engagement with sector experts during the field research phase. The Onion Producers and Marketers Association of Nigeria (OPMAN) asserts that onion cultivation in the country has the potential to generate approximately USD 420 million annually. However, onion farmers encounter storage challenges, leading to the loss of approximately 50% of harvested onions due to inadequate storage systems. In 2019, many farmers suffered substantial losses of onion crops due to a fungal infection known as Purple Blotch. Similar to the tomato industry, onion production in Nigeria faces comparable threats, with the exception of pest and disease incidents. Notably, a fungal infection, Purple Blotch, caused severe crop destruction in 2019, highlighting the vulnerability of onion cultivation to such diseases (CBI, 2021).

Chili Pepper

Nigeria ranks as the 7th largest producer of chili peppers globally, with peppers cultivated in over 80% of the country. The states of Kaduna and Kano contribute significantly to the production of peppers, tomatoes, and onions, accounting for 36%, 43%, and 50% respectively (Christine *et al.*, 2019). Chili pepper production volume stands at approximately 818,000 tonnes and has exhibited steady growth over the past five years. Industry experts anticipate this upward trajectory to continue, attributing the sector's boost in 2018 to the introduction of a new pepper species known as yellow pepper, locally referred

to as Ose Nsukka, which is exclusive to the soil of Nsukka in the Northern zone of Enugu state. This particular pepper species has garnered high demand from buyers across the country. Despite its promising outlook, the chili pepper industry in Nigeria faces similar challenges to those encountered in the production and supply of onions and tomatoes. These challenges include storage difficulties, market price fluctuations, transportation delays, security concerns, and the threat of diseases such as the aforementioned Purple Blotch fungal infection. Therefore, while the chili pepper sector shows considerable potential for growth, it remains vulnerable to various risks and uncertainties inherent in agricultural production and trade in Nigeria.

Food Waste in Nigeria

Food waste, as defined by Parfitt *et al.* and Lipinski *et al.* (2013), refers to food that is still of good quality and suitable for human consumption but is discarded at the distribution and consumption stages of the food chain.

In contrast, Food loss refers to the reduction in edible food mass occurring at various stages such as production, post-harvest, and processing of vegetables like tomatoes, onions, and chili peppers before reaching the consumer (Vilarinho *et al.*, 2017). For countries in Sub-Saharan Africa, including Nigeria, the issue of food waste and loss signifies a squandering of scarce natural resources, which can exacerbate food and nutrition insecurity and deepen poverty. According to research by the Food and Agriculture Organization (FAO, 2015), approximately 690 million people worldwide suffer from hunger, comprising 8.9 percent of the global population. FAO projections suggest that by 2030, this number may rise to 890 million, affecting around 9.8 percent of the global population. Depending on economic growth scenarios, FAO estimates that between 83 and 132 million more individuals could be undernourished globally. Addressing food loss and waste is therefore crucial for tackling food insecurity and promoting sustainable development in regions like Sub-Saharan Africa.

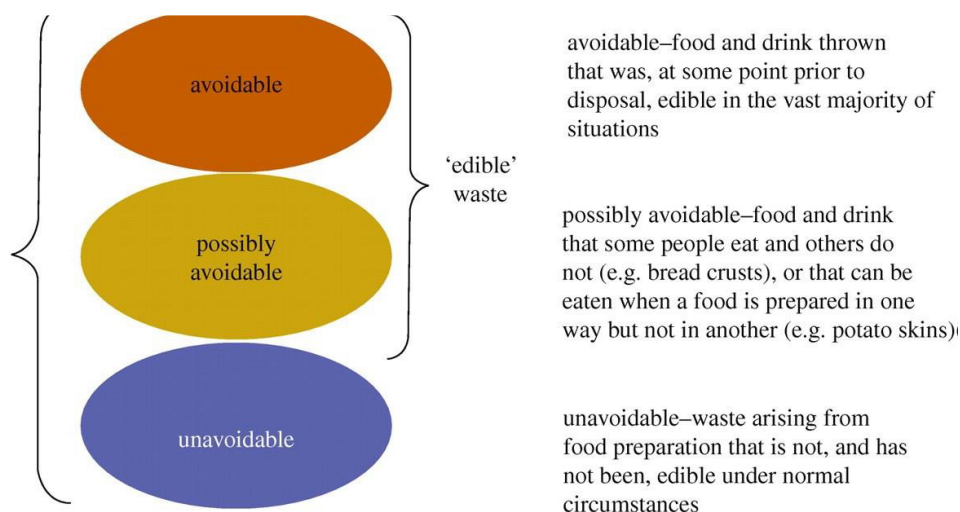


Figure 4: Classification of Food Waste & Loss
Source: WRAP (2009)

The issue of food waste remains a significant challenge for Nigeria, with reports indicating that the country generates approximately 32 million tonnes of waste annually across all stages of vegetable production to consumption. Various factors contribute to this problem, particularly in the production and processing of key vegetable products such as tomatoes, onions, and chili peppers. These sectors lack advanced techniques, equipment, technology, and governance structures, hindering their efficiency and productivity. Additionally, there is a dearth of enabling policies to stimulate the development of these essential food products. Stakeholders and influencers in the vegetable supply chain have often failed to take a holistic approach when proposing interventions or solutions to address food loss. For instance, the Tomato Growers Association of Nigeria (TOGAN) reported that its members lose approximately 40 percent of their total annual production, leading to significant economic losses.

In 2018 alone, tomato farmers suffered losses exceeding USD 10 billion due to market challenges and the absence of guaranteed off-takers. Calls have been made for the Federal Government of Nigeria to implement the Tomato Policy outlined in 2017. This policy aims to promote local production and processing by increasing tariffs on tomato concentrate imports, introducing additional levies, classifying greenhouse equipment as agricultural equipment to attract zero import duty, and implementing restrictions on tomato paste imports and other related measures. However, despite these efforts, the full implementation of the tomato policy has yet to be realized. In summary, addressing food loss in Nigeria requires comprehensive strategies encompassing improved production and processing techniques, supportive policies, and effective implementation mechanisms to enhance the efficiency and sustainability of the vegetable supply chain.

Major Causes of Food Waste in Nigeria

Lack of Quality Inputs

The absence of good quality seeds, fertilizers, and agrochemicals is a primary cause of food losses in Nigeria's vegetable production. For instance, around 80% of tomato seeds planted by farmers are generic varieties of low quality with limited post-harvest shelf-life (Technoserve, 2020). Similarly, onion farmers often cultivate local landrace varieties with low shelf-life, leading to losses (World Vegetable Center, 2018).

Low Skills in Crop Management

A majority of smallholder farmers lack adequate skills in crop management and handling during and after harvesting. Capacity building and training in these areas are crucial for enhancing product yield and reducing losses at production and harvesting stages.

Diseases, Pests, and Rodents

Frequent pest and disease outbreaks in the tomato, onion, and chili pepper sectors result in significant harvest losses. For instance, the devastating pest, *tuta absoluta*, led to the loss of up to 80% of tomato yields in 2015/2016 (Sanda *et al.*, 2018). Additionally, rodents and insects contribute to postharvest losses in onion production.

Poor Crop Handling and Storage

Inadequate technical knowledge in crop handling during harvesting and rudimentary storage techniques lead to spoilage and losses. Drying and storage facilities are often insufficient to preserve crops, resulting in spoilage and wastage.

Security Incidents

Incidents of violence and insecurity, particularly in the northern regions of Nigeria, disrupt farming activities and lead to on-farm and post-harvest losses. These incidents include herdsmen encroachment on fields and armed robberies during transportation.

Poor Vehicle Condition and Road Conditions

Overloading of trucks and poor packaging materials during transport contribute to food waste and loss. Additionally, the poor condition of roads, especially during the rainy season, exacerbates transportation challenges, affecting product quality.

Lack of Efficient Refrigeration

Inadequate refrigeration facilities during transport and at marketplaces result in spoilage and rotting of perishable goods. The absence of efficient cold chains leads to the deterioration of fresh produce before reaching points of sale.

Traffic Constraints and Rough Offloading

In major vegetable markets like Mile 12 in Lagos, rough offloading and traffic congestion lead to significant losses. The lack of proper waste disposal systems exacerbates environmental challenges in these markets.

Other Causes of Food Waste in Nigeria

Food Gets Lost When Production Exceeds Demand

This occurs when farmers produce more food than is needed or consumed by the population. When there's an oversupply, food may not be harvested in time, leading to spoilage in the fields or during transportation. Additionally, excess food often ends up in landfills, contributing to environmental issues like greenhouse gas emissions. This inefficiency in distribution exacerbates food waste problems.

Premature Harvesting of Crops

Sometimes, crops are harvested before they reach their optimal ripeness or maturity due to various reasons such as labor shortages, weather concerns, or market demands. Premature harvesting not only affects the quality and taste of the produce but also reduces its nutritional value. Consumers may reject such produce, leading to further waste along the supply chain.

Poor Storage Facilities

Inadequate storage facilities can result in food spoilage due to factors like temperature fluctuations, pests, and improper handling. This is particularly problematic in regions with high temperatures or humidity where perishable items deteriorate quickly. Proper storage infrastructure, such as cold storage units or warehouses with controlled atmospheres, is essential to minimize food losses during storage.

Purchase and Preparation of Too Much Food

Individuals, households, and businesses often purchase or prepare more food than they can consume. This can occur due to bulk buying habits, improper meal planning, or misjudgment of portion sizes. Leftovers from oversized portions may end up being discarded, contributing to food waste at the consumer level.

Lack of Appropriate Planning (e.g., food timetable)

Without proper planning, individuals and institutions may struggle to manage their food resources efficiently. A lack of meal planning, both at the household and institutional levels, can lead to excessive purchasing, cooking, and subsequent waste. Implementing food timetables or meal plans helps in organizing food consumption, reducing impulse buying, and ensuring that perishable items are used before they spoil.

Over-preparation of Food in Restaurants, Hotels, and the Food Service Industry

Food establishments often prepare more food than necessary to meet potential demand, especially during peak hours. While this practice aims to avoid shortages and maintain customer satisfaction, it often results in surplus food that goes unsold. Over-preparation contributes significantly to food waste in the hospitality sector.

Over-merchandising and Over-ordering in Food Stores and Supermarkets

Food retailers may overstock their shelves or order excessive quantities of perishable goods to attract customers and meet potential demand. However, this can lead to food spoilage and waste if products remain unsold past their shelf life. Additionally, marketing strategies such as bulk discounts or “buy one, get one free” offers can encourage consumers to purchase more than they need, contributing to food waste at the retail level.

Food Waste Effects

Food waste has multifaceted implications, extending beyond mere economic loss. Firstly, it represents a substantial monetary loss. Secondly, its social impact is profound, contributing to the escalation of food prices and exacerbating food inaccessibility, particularly for the most vulnerable populations, thus increasing the prevalence of malnutrition (Graham-Rowe *et al.*, 2014; Stuart, 2009). Thirdly, food waste is a significant contributor to the degradation of natural resources, thereby amplifying greenhouse gas emissions (FAO, 2013 and 2014; WRAP, 2011). Moreover, food loss exacerbates poverty, particularly in developing countries like Nigeria. Studies indicate that the deterioration in the quality of food products results in reduced quantities available for sale, leading to diminished economic gains, especially for millions of smallholder families and low-income farmers in these regions. The World Bank (2013) highlights that in Sub-Saharan Africa, a mere one percent reduction in postharvest losses could save \$40 million annually, which could be redirected towards addressing various dimensions of poverty. By mitigating post-harvest losses, income opportunities could be amplified for 470 million smallholder farms globally, representing a significant stride towards global poverty alleviation, food security, and sustainability. To catalyze action towards reducing food waste and achieve Sustainable Development Goal (SDG) 12.3, it is imperative to accurately assess the extent of food waste. Such measurement not only provides insights into the magnitude of the problem but also delineates the scope for intervention, thereby offering a baseline against which progress can be gauged (FAO, 2024).

Environmental and Health Problems Associated with Food Waste

Resource Depletion: Both food loss and food waste represent a significant waste of resources, including water, land, energy, and agricultural inputs such as fertilizers and pesticides. This wastage contributes to environmental degradation and resource depletion.

Greenhouse Gas Emissions

When food is lost or wasted, it rots in landfills, releasing methane, a potent greenhouse gas that contributes to climate change. Additionally, the production, transportation, and disposal of food generate carbon dioxide emissions, further exacerbating climate change.

Health Risks

Rotting food can attract pests such as rodents and insects, which can spread diseases. Additionally, food waste in landfills generates methane, a potent greenhouse gas, and contributes to environmental and air pollution.

Land Use

Agriculture is a major driver of deforestation and habitat destruction. Food loss and waste intensify the pressure on land resources as more agricultural land is required to produce food that ultimately goes unconsumed.

Water Scarcity and Contamination

Agriculture is a significant consumer of freshwater resources. Food loss and waste exacerbate water scarcity by increasing the demand for irrigation and processing water, leading to over-extraction of water from rivers and aquifers. Food waste dumpsite can bring about water contamination and even leachate. According to Omokaro *et al.* (2024a), waterborne diseases like cholera and dysentery which can spread through contaminated water sources, impacting communities relying on them for drinking and sanitation.

Biodiversity Loss

Deforestation and habitat destruction associated with agriculture contribute to biodiversity loss. Food loss and waste further exacerbate these impacts by increasing the demand for agricultural land, leading to the conversion of natural habitats into farmland.

Food Security

Food loss and waste reduce the overall availability of food, exacerbating food insecurity and malnutrition, particularly in regions where food availability is already limited. This can have profound health implications, including stunted growth, micronutrient deficiencies, and increased susceptibility to diseases.

Economic Costs

Food loss and waste represent a loss of economic value throughout the food supply chain, from farmers to consumers. This has economic implications for both producers and consumers, as resources invested in producing food that goes unconsumed are wasted, and consumers may face higher prices due to decreased supply.

Possible Solution

It should be known that, there exists significant potential for job creation, particularly for millions of Nigerian women and youth, within the production, processing, and trade of tomato, chili, and onions. In Nigeria, these sectors are predominantly operated by women and youth. For instance, the Nigerian Government envisions that a well-implemented policy aimed at boosting local production and processing of fresh tomato could potentially reduce tomato wastage by 40 percent and generate 60,000 direct employment opportunities (NIPC, 2017). This underscores the pivotal role that targeted policies and interventions

can play in harnessing the economic potential of these agricultural value chains while simultaneously addressing the challenge of food waste and enhancing livelihoods. To address food wastage and loss in Nigeria, there needs to be concerted effort (supporters and influencers) and a holistic strategy. For instance, intervention to curb food loss in Nigeria should include action on all of the following, amongst others:

- Financial support to improve roads, energy infrastructure as well as the machinery used in the food production and supply sector,
- Institutional arrangements and reforms to facilitate access of private sector investment for improved production and value-added processing in the food production and supply sector and Introducing government actions and policies to discourage food loss,
- Circular economy approach: focus on the causes of food loss as well as the consequences, regional and country differences; ideas and solutions as well as the stakeholders and actors involved, and
- Communication and education campaigns targeted to reduce food loss particularly at farm level, processing sites as well as during transport and distribution.

Reduce Your Personal Food Waste, The Change Should Start From You

Individuals can make a significant impact by being mindful of their food consumption habits. This includes planning meals, buying only what is needed, properly storing perishable items, and consuming leftovers before they spoil. By taking responsibility for their own food waste, individuals contribute to reducing the overall amount of food that ends up in landfills.

Take Part In Food Waste Challenges Both Online And Offline

Participating in food waste challenges encourages individuals to actively engage in reducing food waste. These challenges often provide practical tips, recipes, and resources to help participants minimize waste in their daily lives. By joining such initiatives, individuals become more conscious of their habits and learn new strategies to prevent food waste.

Start A Food Waste Campaign In Your Community

Launching a food waste campaign in the community can raise awareness and foster behavior change on a larger scale. By educating neighbors about the consequences of food waste and providing practical tips to reduce it, individuals can inspire others to adopt more sustainable practices. Over time, the ripple effect of this campaign can lead to widespread awareness and action within the community.

Plan Your Meals Instead of Buying Whatever You See on The Shelves And Stalls

Meal planning is an effective strategy to minimize food waste. By carefully planning meals based on what is already available and what needs to be purchased, individuals can avoid overbuying and ensure that all purchased food items

are used efficiently. This not only reduces food waste but also saves money and time spent on grocery shopping.

Start Composting

Composting food scraps, such as fruit and vegetable peels, is an eco-friendly way to divert organic waste from landfills and create nutrient-rich soil for gardening. Even individuals with limited space can engage in composting using small-scale methods like vermicomposting or composting bins. By composting food waste, individuals contribute to reducing greenhouse gas emissions and promoting soil health.

Establish A Food Bank

Setting up a food bank in the neighborhood provides a platform for redistributing excess food to those in need. When individuals realize they have surplus food that may otherwise go to waste, they can donate it to the food bank instead. This ensures that edible food is utilized to its fullest potential and helps address food insecurity within the community.

Volunteer And Organize Small Farmers

Collaborating with local farmers to educate them about food waste prevention techniques can have a significant impact on reducing losses at the production level. By organizing workshops, training sessions, or farm visits, volunteers can share best practices for harvesting, storing, and transporting crops to minimize spoilage. Empowering farmers with this knowledge not only improve their efficiency but also contributes to a more sustainable food supply chain.

Further Interventions

- Composting offers a promising solution to address food waste by converting it into valuable organic manure for agricultural production in Nigeria. The Nigerian government should initiate a systematic food waste collection process across each state and establish organized landfills dedicated to composting food waste. This initiative will promote the widespread use of organic manure throughout the country. Research conducted by Omokaro *et al.* (2023; 2024b) on the perception of organic manure by local farmers in two Nigerian states revealed that approximately 80% of farmers prefer using organic manure over inorganic alternatives. However, the availability of organic manure was cited as a challenge, leading some farmers to resort to inorganic options. By implementing a robust composting infrastructure for food waste, the supply of organic manure can be significantly increased, meeting the demand expressed by farmers and fostering sustainable agricultural practices nationwide.

- Engaging the Nigerian Government to address some of the challenging political economy issues, to ensure a better enabling environment for the farmers and traders to operate in. Such as: support the Nigerian Government to develop a central strategy on food loss from agri-food productions; provide financial and technical support to strengthen tomato, onion and chili associations or groups (CBI, 2021).

Financial Support and Infrastructure Improvement

Providing financial support to improve roads, energy infrastructure, and machinery used in production can enhance efficiency and reduce losses during transportation and processing. Access to Finance for SMEs by ensuring access to finance and offering financial capacity development programs for small and medium enterprises (SMEs) in vegetable production can make them investment-ready, fostering growth and sustainability in the sector (CBI, 2021).

Promotion of Circular Economy

Stimulating the adoption of circular economy principles within the food value chains can help minimize waste by repurposing by-products and promoting resource efficiency.

Communication and Education Campaigns

Launching communication and education campaigns aimed at raising awareness about food loss and waste reduction practices among stakeholders, including farmers, processors, retailers, and consumers, can foster behavioral change and promote best practices.

National Hackathon

Organizing a national hackathon focused on developing innovative solutions to tackle food losses in vegetable production can leverage the creativity and expertise of diverse stakeholders to generate actionable ideas and initiatives.

Support for Local Initiatives

Providing support for the scale-up or further development of existing local initiatives aimed at reducing food losses can facilitate knowledge sharing, collaboration, and the implementation of proven strategies and technologies.

CONCLUSION

Food waste and loss represent complex challenges with profound implications for Nigeria's economy, food security, and environmental sustainability. This study has thoroughly examined the causes, effects, and potential solutions to food waste within the Nigerian context. Various factors contribute to the pervasive problem of food waste across the country, from inadequate infrastructure and transportation constraints to socioeconomic disparities and policy gaps. However, amidst these challenges, there are clear opportunities for intervention. By adopting a holistic approach that addresses the root causes of food waste and promotes sustainable practices throughout the food supply chain, Nigeria can make significant strides towards reducing food waste, enhancing food security, and fostering economic development. Additionally, individual actions, such as prudent consumption habits and support for local farmers, are integral to mitigating food waste at the grassroots level. It is imperative that governments, businesses, civil society, and individuals work together collaboratively to implement innovative strategies and policies that promote a more resilient and sustainable food system in Nigeria. By doing so, Nigeria can not only alleviate food insecurity

and poverty but also contribute to global efforts towards building a more equitable and sustainable future for all.

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