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Indiscriminate Food Insecurity: Road Transportation Management Contribution in Low/Middle Income Economy

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ABSTRACT

In the history of human race cultures down memory lane to present day civilization, man has learnt to utilized and preserve numerous agriculture material harvested from the wild, hunt, and even explore sea foods overtime until majority are now be classified as domesticated culture from direct conventional practices back in ages. Although, many were selectively domesticated with interest to their produce, product, nutritional value, among several other benefits. These practices however have contributed a very efficient balance to our ecosystem regardless of the environmental dominance and occurrence, coupled with other applicable man-environment service forming the basis of agricultural practice. Prior to these services, many of these items require transportation (road, sea, etc.) at several point of the supply chain. Unfortunately, the facilities enhancing freshness preservation attached to these road transporting medium (especially trucks and bus the most patronized inland choice) utilized for numerous food items has consistently been ignored on the potential effect it can cause on the shelf stability and freshness based on the unstructured and rugged management associated to the medium (truck and bus) subject in many low/middle income economies. Today, tonnes of imported and local food items have one or more inland trucking and/or buses mobilization within the supply chains they must undergo before they eventually get to the final consumers with significant percentage loss associated to the road transporting medium worldwide. This review aims at creating awareness on existing research in Food Supply Chain (FSC), and the need for redesigned effective storage technology facilities in smaller trucks and buses for all kind fooditems (agricultural produce/product, sea foods etc.) while incorporating risk and sustainability strategies on transportation vehicles network in developing and underdeveloped countries especially, and with this effort, better sustainability on food security is attainable.

Keywords: Agricultural materials, Food commodity, Road transportation, Food Supply Chain, Storage, developing and underdeveloped countries.

1.INTRODUCTION

Food is a general term for anything that can satisfy or breech hunger to the barest minimal with provisionof minute or complete proportion of balanced diet. Foods can be raw or an already processed (ready-to-eat) substance either perishable or non-perishable. Current public trend in determining safe and cost-effective type of food to consume has a large suggested options to how the food items or products are gotten to their immediate environment.One of the major world challenge; starvation (or under-nutrition where there is scarce food or inadequate economic means to provide the necessary food)(Steinkraus, 1994)known to areas of developing and underdeveloped world can be minimized with great caution if the level of food management systems is well organized to the barest minimum on food wastage and spoilage imposed at all point of the FSC. Investigations by Private and Governmental Agencies, or food institutes, often require determination of food composition and characteristics. Trends and demands of consumers, the food industry, national and international regulations challenge food scientists as they work to monitor food composition and to ensure the quality and safety of the food supply. All food items (rawor processed) require a quality management program throughout the development process, from the farm, through processing production, and after produce/product is transported the market. As it is strongly belief, the characteristics of foods (i.e., proximate, physical/chemical properties, organoleptic properties etc.) are implemented in solving specific queries for regulatory purposes and for typical quality control processes(Nielsen, 2017).

Consumers preference regarding their food supply varies among households, and that is when selection on food commodities they purchase distinguishes individual demand with wide variety of products that are of high quality, nutritious, and offer a good value. Also, consumers concern about food safety, has influence screening procedures of foods for contaminants,adulterant, and genetically modified products of food materials, thus, creating awareness for consumers on nutritional content and health claim information from food labels to make purchase choices, preferable in relation between diet and health needs. However, such foods present some unique challenges regarding analytical techniques and in some cases queries of how these components affect the measurement of other nutrients in the food(Spence, 2006), such that, food industry able to meet the immediate consumer'sdemands, remains at the forefront of the competing market. Management of food commodities (raw ingredients and processed final product) quality is essential, as different analytical methods must be applied across the entire food supply chain to achieve the desired final product quality. Meanwhile, food quality management works are often the responsibility of the Food industry employees in teams with other individuals for product development, production, engineering, maintenance, purchasing, marketing, and regulatory and consumer affairs. Thus, analytical information is relevant to address quality associated challenges.

Appropriate decision making, and takingon informed knowledge of the analytical methods and equipment utilization is obtain for quality characteristics. Experimental design in productand process development, requires results assessment, and the operating principles and capabilities of the analytical methods andexperiments depends on analytical data collected, to determine whether product reformulation is needed or what point of the FSC process need to be modified for future tests. The situation is similar in the research laboratory, where knowledge of analytical techniques is necessary to design experiments, and the evaluation of data obtained determines the next set of experiments to be conducted(Nielsen, 2017). As consumers demand for suitable minimally processed/raw healthy foods commodities with "fresh-like" characteristics and a longer shelf-life, the links between the FSC whereroad transportation medium (truck and bus) has effect on the produce/product on a long run are increasingly resulting intofood/agricultural productivity loss in low/middle income economy and needs to be taken with utmost effort. Food items handled with trucking and open buses are majorly exposed to environmental distress (high temperature) from direct sunlight heat, (pressure), unstructured arrangement of commodities and a number of other destructive constraints that can result tosevere damage or deteriorated effect with condition supporting biochemical (i.e. enzyme), chemical, biological spoilage, microbial, or pest invasion which sum up to wastage before arriving their final destinations. This way, the manner to which indiscriminate food mismanagement associate to this network process on the increasing end, declares an immediate reflection on food securityin developing and underdeveloped countries.

2.LITERATURE REVIEW

2.1 Food description

Any substance satiable enough or capable of reducing hunger to the barest minimal with provisionof minute or complete proportion of balanced diet is regarded a food. Thus, the extent to how we describe food based on other organoleptic properties might vary greatly with commodity from one region to another. Food insecurity is supposingly a question of access than a supply difficulty. The FSC efficiency improvement could aid to minimize food cost to consumer and thus increasing accessibility(Nielsen, 2017). As world population increases on an exponential scale, there still remains quite a surprising numbers of forecasts suggesting (with immediate implementation) that food production must increase significantly to meet future global demand(Vogel, Venkateswaran, Satomi, and Gram, 2005).

Worldwide, food commodities are loss, (wasted and/or spoilt) during the postharvest stage down the supply chain before and after getting to the final consumers. Food commodities losses are as high as 30 to 40% and even much higher in some developing and underdeveloped countries. Minimizing losses at all stage is very vital; to warrant food abundance, quantitatively and qualitatively availability worldwide. The prospects are also that the world population will grow from 5.7 billion inhabitants in 1995 to 8.3 billion in 2025. However, proper handling, packaging, transportation and storage reduce the post-harvest losses, and production/manufacturing losses reduces cost of production, trade and distribution, lowers the price for the consumer, increases demands and increases the farmer's income(Rawat, 2015) through the supply chain.

2.1.1 Food loss

Food losses majorly represents a waste of resources used in production such as land, energy, water and other inputs. Indiscriminate food production that eventually often time are not consumed and lost in the supply chain leads to accumulation of harmful gases (i.e. CO_2) that contributes 8% of the world's greenhouse emission (IFCO SYSTEMS, 2020), in addition to loss of economic value of the food produced/product. Managements of food losses have a direct and impactful effect on the income of farmers/consumers and on the economic revenue at large. Given that several low/middle income economies households live on the margins of food insecurity, a reduction in food losses could have an immediate and significant impact on their means of support. For poor consumers (food insecure or at-risk households), the priority is clearly to have access to food produce/products that are nutritious, safe and affordable(Vogel et al., 2005). Facts remains that issue of food losses is significantly important in the efforts to tackle hunger, positively shift incomes (at household, local and international) level and improve food security in developing and underdeveloped countries. Food losses have an impact on food security for poor people, on food quality and safety, on economic development and on the environment.

The exact causes of food losses vary throughout the world and are very much dependent on the specific conditions and local situation in a given country. In broad terms, food losses will be influenced by crop production choices and patterns, environmental stress, internal infrastructure and capacity, marketing chains and channels for distribution (i.e. transportation), and consumer purchasing and food use practices. Irrespective of the level of economic development and maturity of systems in a country, food losses should be kept to a minimum(Rawat, 2015). Food can be loss either through spoilage and/or wastage.

2.1.2 Food spoilage

Food spoilage on the other hand is an irreversible metabolic process that makes food undesirable or unacceptable for human ingestion due to resistible sensory characteristics. Some spoiled foods may be regarded safe, as a result of not being able to cause illness because they are pathogens/toxin free, but resistance in smell, taste, texture, or appearance (sense) cause their removal from diet menu. According to scientific findings by some ecologists, these noxious smells are produced by microbes to repulse large animals, thereby keeping the food resource for themselves(Burkepile et al., 2006). Several factors can effect spoilage (chemical, biochemical, microorganisms, etc.) many of which are induced by manmade mismanagement and handling in the line of post-harvest, transportation, processing, down to the final consumers.

2.1.3 Food wastage

Wastage can be described in accordance to many policy relating to many specific environmental controls. However, it has most readily been defined at the retail and consumer stages of food supply chain where outcome of every agricultural entity are properly classified for human consumption. Some class of specialty define food wastage as a whole edible material intended for human consumption resulting in any stage of FSC that is instead discarded, degraded, lost/consumed by pest (FAO, 1981) or converted for animal food. Other class define food wastage as an inclusive of agricultural by-products of food processing removed from human food and used as animal feed as shown in Figure 1. (Rawat, 2015; Stuart, 2009; Teigiserova, Hamelin, and Thomsen, 2020).

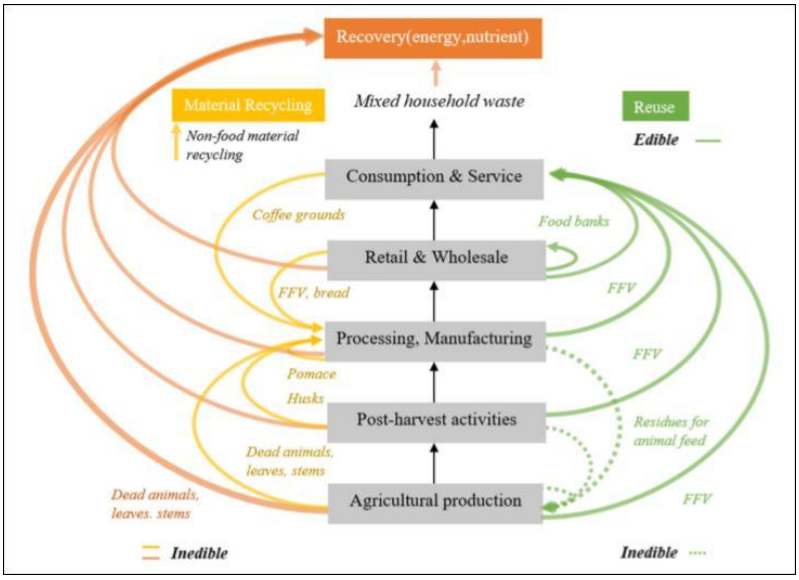

Figure 1. Circular economy framework proposed herein for FSWL in the food supply chain (FSC). Dotted lines: inedible for humans but edible by animals. Only recycling within the FSC is explicitly shown, but recycling may also occur for non-food applications.Adopted from (Teigiserova, Hamelin, and Thomsen, 2020)

2.2 Stages of Food Loss, Spoilage and Waste in FSC

Although loss, spoilage and waste can formally occur at any stage of FSC, relating to particular points of arising and are often framed in relation to specific environmental controls, type of food, and level of economic development as shown in table 1. However, it is most readily defined at the retail and consumer stages, where outputs of the supply chain are self-evidently 'food' for human consumption (Parfitt et al., 2010). Unlike most other commodity flows, foods materials are subject to degradation, and the extent to which the available food crops are used to meet global human needs directly, or diverted into feeding livestock, other use (biofuel) or biomaterials production differentiate them as being loss or waste. At each stage, availability of food is cumulatively reduced for retail outlets or consumption. Below are some outlined FSC stages and the loss, spoilage and /or waste characteristics.

Table: Highlights of FSC stages and the characteristics. adopted from(Parfitt, Barthel, andMacnaughton, 2010).

Stages	**Loss/Spoilage/Wastage characteristics**
1. Harvesting-handling at harvest	Edible crops left in field, ploughed into soil, eaten by birds, rodents, timing of harvest not optimal: loss in food quality crop damaged during harvesting/poor harvesting technique out-grades at farm to improve quality of produce. Loss through poor technique.
2. Threshing	Poor transport infrastructure, loss owing to spoiling/ bruising.
3. Drying-transport and distribution	Pests, disease, spillage, contamination, natural drying out of food.
4. Storage	Process losses. contamination in process causing loss of quality.
5. Processing. primary processing cleaning, classification, de-hulling, pounding, grinding, packaging, soaking, winnowing, drying, sieving, milling. Secondary processing mixing, cooking, frying moulding, cutting, extrusion	Process losses. contamination in process causing loss of quality.
6. Product evaluation-quality control: standard recipes	Product discarded/out-grades in supply chain.
7. Packaging-weighing, labelling, sealing	Inappropriate packaging damages produce grain spillage from sacks attack by rodents.
8. Marketing-publicity, selling, distribution	Damage during transport: spoilage poor handling in wet market losses caused by lack of cooling/cold storage.
9. Post-consumer-recipes elaboration: traditional dishes, new dishes product evaluation, consumer education, discards	Plate scrapings, poor storage/stock management in homes: discarded before serving, poor food preparation technique: edible food discarded with inedible, food discarded in packaging: confusion over 'best before' and 'use by' dates.
10. End of life-disposal of food waste/loss at different stages of supply chain	Food waste discarded may be separately treated, fed to livestock/poultry, mixed with other wastes and landfilled.

2.3 Identified causes of Food Insecurity in Road Transportation Stage in Low/Middle Income Economy

Transportation refers to the movement of people, products and services from one geographical area to another through a mode or modes for a specific purpose (Ajiboye, 1995). Odedoku et al. (2002)also define transportation as a means of moving goods from their place of production to their place of consumption (supply chain) of which improvement in transportation have accounted generally for better inter-relationship and inter-dependence between two parties within and outside the country." It is now easy to transport goods from places of abundance to places of scarcity however, neglecting the importance of minimizing loss by implementing appropriate storage condition for different agricultural material, arrangement pattern and even cross-inspection management has cause more inflicted loss that can sum up the remain part of the supply chain than we can imagine. Knowing this, for an effective distribution of good and service to occur, there must be a good transport system (Ajiboye and Afolayan, 2009; Ajiboye and Ayantoyinbo, 2009). In economy development, requirements for bulk transport systems for certain supply chain, such as, rail, inland water, trucks and buses, airplane cargos, etc. to meet the population daily demands cannot be overemphasized. However, in low/middle income economy, the efficiency of the goods transport process is conditioned by many factors, ranging across: selection of the appropriate type of transport packaging, type and condition of the transport, location and protection of the goods in available space, the availability of handling equipment and its condition, storage space infrastructure, as well as adapting the tactics of driving to the type of transported goods, food mile (distance food travelled before being consumed), etc. (Hill, 2008; Tomaszewska et al., 2016). For instance, Nigeria food security is dependently based on operative transportation system, which implies a wide variety of Nigerian food availability is clinged on the complex transportation network system which most time is designed to mobilize produce/product based on tough and rugged styles of loading and arrangement. On this regards, the importance of transport system cannot be marked out part with obvious reasons that road transportation (the major means of mobilization) is key to economic development in many nations with regard to agricultural commodities (Gbam, 2017).

Although, truck and buses in transportation (road) dominates most inland bulk food supply (fresh or processed), especially toward the consumer end of the chains (Erera, 2005), however, its undervalued linkage for food supply convey a significant volume of FLW in some low/middle income economy. Truck transporters are typically involved in moving goods among manufacturers and distributors, distributors and retailers, and even further up the chain between suppliers and production points. Particularly for perishable foods, trucking remains the cheapest and most flexible mode of food transport (Boge, 1996). From a complex food transportation system view, a significant undetected problem can be introduced into the system through trucking and buses, when the level of negligence to the risk (as measured by exposure likelihood and impact) is undervalued; that is, earlier stage problem in the supply chain can flow to other linked distributors, retailers and then to immediate consumers. Today, most parts the low/middle income economy transportation systems are individual owned, with habitual use for multiple food and non-food transport supply as depicted in **Figure 2**, thus, the implication have made it possible to identify potential causes of losses and waste during the transportation operations (Erukilede, 2016).
Firstly, a notable identified causes of losses and waste during road transportation in the low/middle income economy is the human factor. According to Bilska et al.(Bilska et al., 2016), knowledge and qualifications after proper trainings of the food transportation employees can help them make difficult decisions, which may include decisions aimed at the improvement of work efficiency, and consequently reduce the level of losses. An essential element in the process of reducing the risk of errors is also compliance with applicable work procedures and continuous improvement (Lipińska et al., 2019).

Figure 2: A typical truck transporting agricultural material in low/middle income economy. (Erukilede, 2016)

The second identified category of the causes of FLW at the stage of transportation is the environment. These factors the growth rate of microorganisms responsible for the spoilage of transported food, and thus their durability include temperature and ambient humidity (Tanner, 2016). During transportation of food materials, there are probable exposure to a temperature of 15.6 ^{0}C to 30.1 ^{0}C and relative humidity fluctuated between 24.5% to 93.5% depending on the point of loading to offloading distance. This factors fluctuation, however can result to condensation on the surface food material inside the truck, such that, water on food materials (especially fresh perishables) and packaging surfaces may promote the emergence of microbiologically induced produce decay during storage (Buonassisi et al., 2013). Also, the relatively hot weather conditions have a significant effect on the fluctuation of temperature and humidity when not properly planned, or use of the required transport system. Fresh and processed that are perishables products require a continuous refrigeration chain from production to consumption. Therefore, the carrier is obliged to maintain a suitably low temperature during transportation, of which many of the transport supply employee in low/middle income economy are not knowledgeable about as previously stated.

Thirdly, another potential determinant of FLW at the transportation stage, is management, i.e. the inadequate work management processes involving both loading and unloading personnel and managers responsible for the organization of transportation (Bilska et al., 2016). The quality of their work depends on the training carried out by appropriate institutions (e.g. Nigerian Institute of Transport Technology) (Murtala, 2021). To minimize the losses at the stage of transportation, it is important to organize the processes of loading, circulation of the means of transportation and unloading of the transported cargo. It is important to adjust the route accordingly, as the improper placement of goods together with high vibration during transportation causes mechanical damage of the packages.

Fourthly, storage and packaging interrelation of food (Hammond et al., 2015). Commonly, food transportation over long distances supply chain (from farm to market) requires minimal spoilage during the transportation, thus, due to the frequent heterogeneity of food commodities loading and unloading, it is necessary to arrange and safeguard the food (fresh or processed) to avoid loss/waste during transportation. Additionally, as the food miles (distance between primary production plants and food consumption) increases, there are upsurge in food transport from areas of surplus to areas of scares food commodities. A transportation period, that is, food mile increases with relative shelf life decreases, and the longer the food commodities stays on road without proper storage facility installation, the higher the chances of deterioration before it gets to the final retailing outlet or consumers due to numerous delays from checkpoints and boarder inspection agents (custom). Recent study by Gromko and Abdurasulova(Gromko and Abdurasulova, 2019)**,** found that storage switching of fresh perishable food (e.g. tomatoes) during transportation from traditional baskets to plastic crates reduced losses from around 41% to as low as 5%. Thus, for balanced food availability and safety, it is essential for a suiting transport storage system chain for a longer period of time (Priefer et al., 2013). This element is particularly important for perishable products. Meanwhile, consumers are intensively making priorities over food information and physical characteristics in choosing food commodity (European Commission and Health and Consumer Protection Directorate-General, 2006).

Most times, wrong stacking and arrangement of this heterogeneous food commodities influence greenhouse gases generation, easily able to induce biochemical deterioration of perishable food. Also, the subsequent slipping cause food package damage during transportation. Inadequate driving dynamics and precautions denial result in damage that may be caused by displacement of the cargo or an accident. The level of losses and waste of food products during the transportation stage may be caused by inadequate materials used to protected the finished product (primary packages) or the cargo (bulk and/or transport packages) (Lipińska et al., 2019). Thus, consideration such as packaging materials hardness, brittleness, elasticity, durability, gas or water impermeability are important, due to their barriers to damage (Robertson, 2013).

Lastly, the poor technical condition of majority of the machinery (trucks, buses, etc.) as depicted in **Figure 2**(Erukilede, 2016). This is often caused by age and poor or overdue maintenance, rare inspection processes, and poor road networks, which can directly amount into road accidents, causing bulk loss of food commodities (Lipińska et al., 2019).

3.Implication of Road Transportation on Food Security in Low/Middle Income Economy (Nigeria case study)

Nearly majority of low/middle income economy has an implicated effect of FLW amounting from road transport system. In other to outline this, Nigeria will be used as a case study to the implication.

Just like many other low/middle income economies, Nigeria's food chain is majorly informal. This comprise smallholders (small scale producer) in rural areas who rely on middlemen for purchase and whom are better informed about market conditions, especially about the prices further down the supply chain (Inclusive Innovations, 2017). In addition, the different vegetation distribution across the nation (mangrove and swamp rain forest-south and west, Guinea and Sahel Savannah-north, and Montane vegetation-parts of middle belt) influence productivity at all region. Consequently, there is a need for different distribution systems to accommodate the variances. Largely, the transportation and logistics systems play a major role in the value chains as the product will have to pass through different handlers before it can get to the final consumers. However, the only functional transport system that can effectively cater to the distribution chains of this food/agricultural products in Nigeria is the road transport system. Unfortunately, the road transport industry is one of the most poorly coordinated system thought to be critical for agricultural revolution (Nicholas, 2019).

Several regions of low/middle income economy are still characterized by poor road conditions, severe congestion due to traffic accidents or disabled trucks, security checkpoints, and flooding from heavy rain, which can stall cargo for extended periods of time, like the northern areas of Nigeria (Coste, 2014). For example, Kano routes towards the Nigerian border can have a minimum of one security roadblock every two kilometres (Coste, 2014). Although, this serves some safety measures but also extends the transport time. During transportation, perishable food commodities (e.g. Tomatoes) are often subjected to rough handling and transported over rough roads leading to mechanical injuries and damage hence loss of value as the products move through the supply chains(Idah et al., 2007; Mutari and Debbie, 2011). Transport jams and delays prompted by poor road quality, weather and poor coordination of transport operations can cause further losses especially if the produce/products are held in at points without cooling facilities(Njenga, 2015). All of these inefficiencies leave food produce in the transportation stage for much longer than ideal and without cooling, leading to increased losses (World Bank, 2020).

According to World Bank (World Bank Open Data, 2018) and CIA (CIA Factbook, 2019)**,** since the early 1970s, Nigeria's urban population has grown in the range of 4-6% per year, with around 14 million residents in Lagos (largest urban centre) in 2019. Report by United Nation united (United Nations, 2018), estimated a continuous growth at a similar average rate of 3.5% per year to 2030, reaching a population of over 20 million in the city, which is roughly the present size of Mali or Burkina Faso. Currently, local food production near Lagos meets only 10% of the local demand, with the remaining supply fulfilled form elsewhere domestically as well as international imports. Traditional markets are the primary channel for food sales in Nigeria, for both domestic and imported, as well as raw and processed, foods. In fact, more than 90% of domestic staple foodstuffs, and more than 90% of imported food products, are sold at traditional markets. Meanwhile, food sales through supermarkets only account for around 1% of total sales, and 80% of their food stocking is purchased from importers and wholesalers located in traditional open markets (Marras et al., 2017). Due to inadequate infrastructure, legal and bureaucratic restrictions, and customs challenges, produce/product transportation takes a significant amount of time and money to reach urban centres from rural Nigeria. The majority of this transport is done in open, non-refrigerated trucks. In 2014, it was estimated that 50% of losses of plantains and bananas in Nigeria occur during transportation from the farm to market places, and account for 2.5% to 6.6% of wholesalers' potential total revenue (Marras et al., 2017). With a booming urban population, in addition to increasing incomes and shifting diets, Lagos and other urban centres are set to see a rise in the demand for perishables and protein. Without addressing losses and waste along the value chain, this rise in

demand will likely increase losses and waste for Nigeria (World Bank, 2020).

Additionally, low/middle income economy like Nigeria, faces serious food safety issues in its food supply and a particularly high burden of foodborne disease. Foodborne diseases in Nigeria is heavily, if not overwhelmingly, attributable to perishable foods, including meat, street foods, vegetables, and seafood, these are being been singled out as major food safety concerns in Nigeria due to their huge consumption rate and will continually grow as incomes rise (Grace et al., 2019). Food safety hazards and risk factors vary by commodity and supply chain; however, one overarching food safety risk factor in Nigeria is the predominance of the informal and traditional sectors in food production, processing, and marketing; sectors that generally lack the infrastructure, know-how, capacity, and incentives to handle food safety (Gómez and Ricketts, 2013). Food rejection concerns on the basis of food safety can be an outburst for FLW, and improvements in food safety risk management associate from the transportation system may be an important means of achieving reductions in losses and waste, the interventions for which are often shared with food safety precautions (World Bank, 2020).

Knowing this, the food sector remains transport-intense, with lot of inputs to food production as well as food products themselves being transported in voluminous amount through long distances. This can sometimes be of great significance for the total life cycle Green-house gases (GHG) emission of a product, but often because transports are belief to contribute relatively little in a life cycle perspective, minute attention are given to other transport associated FLW link (Sonesson et al., 2009). There are some important aspects when discussing transports, such as the transport mode, type of vehicle used, technical state of machineries, etc. For some high value, perishable foods van is used, nonetheless, most foods are delivered by truck, lorries, buses, motorcycle, etc. (Sonesson et al., 2009). These transport modes differ significantly in energy intensity and hence GHG emissions (Sonesson et al., 2009; Ajiboye, 2011). The above mentioned destructive constraints can result to severe damage or deteriorated effect, with condition supporting biochemical (i.e. enzyme), chemical, biological spoilage, microbial, or pest invasion which sum up to loss or waste before arriving their final destinations. This way, the manner to which indiscriminate food loss associate to road transportation management on the increasing end, declares an immediate reflection on food security in low/middle income economy.

3.1 Food Supply Chain Management Remedy for Transportation Influenced Food Loss,Spoilage and Waste in Low/Middle Income Economy

According to Marsden et al. (Marsden et al., 2000) and Blandon et al.(Blandon et al., 2009), production activities, distribution, and consumption, to maximize safety and quality of various food under proficient and operational approaches is describes as Food Supply Chain Management. To distinguish FSCM from other Supply Chains (Furniture, clothing etc.), the important factors (food quality, safety, and freshness) make the supply chain link (farm to consumers) complex and difficult to manage within limited time (La Scalia et al., 2016). The current coordination for FSC (harvest through consumption) is significant to ensure the safety and quality of various food management from inherent and external factors. For example, 492 million tonnes of perishable food (fruit and vegetables) wastage was recorded worldwide in 2011 due to the inefficient and ineffective FSCM (Gustavsson et al., 2011)**.** Therefore, by FSCM, the food (fresh/processed) should be delivered, stored, and possibly purchased by the final customers before due date. Additionally, as the coordination of supply chain becomes complex, the focus from a single supply phase was shifted to the efficiency and effectiveness of whole supply chain, which implies, the resources like trucks, warehouse facilities, transportation routes, and workers within FSC will be used efficiently so as to ensure the food quality and safety through effective efforts such as optimization decisions (Wu et al., 2016). To this end, a robust logistics and FSCM network program was initiated to enhanced focus on food availability and growing number of coordinate outlets for FSC development (Simatupang and Sridharan, 2002).

Today, FSC stockholders including consumers demand transparency and evidence on food integrity through the supply chain, with product traceability demonstration from all links (farmers, processors, processors, retailers, etc.) in the supply chain (Pant et al., 2015). Recent literatures have described traceability as a medium to assure food integrity (Roth et al., 2008; Bosona and Gebresenbet, 2013; Olsen and Borit, 2013; Aung and Chang, 2014; Dabbene et al., 2014; Pant et al., 2015). Provided food item/products are sourced, processed and handled in conformance to the expected standards, traceability can assist food handlers in possession of records relevant, and related to the integrity of products as they go through every integration and transformation processes in the supply chains (Badia-Melis et al., 2015). As a result, food product traceability, safety, and sustainability issues have become a crucial concern across the FSC (Gharehgozli et al., 2017). To ensure food item/product integrity and consumer safety, much regulations, standards and certifications that are imposed must be followed up. Accordingly, Marucheck et al.(Marucheck et al., 2011), Premanandh(Premanandh, 2013) and Swinnen and Vandemoortele(Swinnen and Vandemoortele, 2009) study have highlighted the needs and benefits of these standards and certifications especially in managing transparency, quality and safety in the food industry. However, responsibility on food integrity should not be limited to an individual firm, but covering all actors within the supply chain, including the local food transport owners in low/middle income economies (Elliot, 2013).

The lack of the necessary attention or commitment may result in a reduction of the quality of transported goods or a delay in delivery. According toGromko and Abdurasulova (2019), majority of losses occurs during the transportation segment of the supply chain in Nigeria, meaning that addressing transportation losses could be most impactful amongst other measures. To maintain the required low temperature of the transported dairy products, the processes of loading and unloading to/from the means of transportation should be carried out very efficiently. The maintenance of appropriate conditions of transport operations during the hot season is particularly important. At that point, prolonged loading/unloading leads to an undesired increase in the temperature in the cargo area. Environmental conditions are not so significant when the ambient temperature is low and transient long-term handling processes do not have a significant effect on the temperature inside the means of transportation. The necessity of transporting food over greater distances increases the need of supply management measures. FLW have significant negative food-security, economic and environmental impacts. FLW may decrease food availability in the market, which may in turn increase food prices and reduce the capacity of low-income consumers to access food. Moreover, if the quality of food deteriorates so badly that the food has to be sold at a lower price or even discarded, the livelihood of farmers and producers is adversely affected.

Some of the studies aimed at minimizing FLW at some other point in the supply chain includes; Nahmias (1982, 2011) and Silver et al. (1998) extensive reviews on the inventory management of perishable products.Glen (1987) andLowe and Preckel (2004) reviewed on farm planning. In addition,Lu¨tkeEntrup (2005) discussed thoroughly how to integrate shelf life into production planning within three sample food industries (yogurt, sausages, and poultry),Akkerman et al. (2010) quantitative operations management applications in food distribution management, also Lucas and Chhajed (2004) s**urvey** presented applications related to location problems in agriculture and recognized the challenges of strategic production-distribution planning problems in the agricultural industry. Investigation on the influence of postharvest disinfection treatments on selected microbiological quality parameters of tomatoes during storage after delivery from two sites in Limpopo to Pietermaritzburg, South Africa (>1,000 km) by non-refrigerated trucks, using crates or boxes as packaging (Sibomana et al., 2017) among several others.

3.2 Strategies of Improving Transported Food Commodity and Implication on Quality

The word "sustainable" was described as an action aimed at satisfying current needs without compromising the ability to meet the needs of a future generation(Baldwin, 2009).Several scholars researched the decision-making related to the effective storage management of agricultural produce/products. The majority of existing studies focus on the link of freshness from the view of the supply chain of agro-produce/products. Cai et al., (2010) and Cao et al., (2018)proposed to encourage suppliers in the supply chain storage management many of which the transportation medium play a significant role and strengthen cooperation by devising effective incentives on contract basis. On this basis, Yue et al., (2016)explored the optimal decision-making for inputting efficient storage choice in the supply chain using the differential games method for produce/product freshness. Thus, a return sharing contract based on the considerations of loss control and of ensuring the freshness of fresh agricultural produce/products, with the aim of stimulating the input of storage management at every link of the supply chain (i.e. transportation essential links) was designed by Lue et al., (2010).

Feng et al., (2015)explored how to improve the freshness of food commodity, utilizing the special facilities and expert skills of third-party logistics (TPL) service providers, and studied the supply chain link mechanism of a TPL-dominated supply chain (Feng, Wu, and Yu, 2016). Furthermore, Yao et al.(2018)explored how to incentivize TPL service providers to keep the agricultural products fresh in the outsourced logistics service from the perspective of retailers. Xu and Song (2017) studied how TPL service providers may fail to provide an adequate fresh-keeping service in the secondary supply chain composed of e-commerce and logistics service providers of fresh agricultural products, and proposed to design coordination contracts using cost sharing and return sharing schemes to enhance the fresh-keeping service of logistics service providers.

Meanwhile, Olamigoke(2013)opined that a state and the local economy development is enriched by adequate, reliable and efficient transportation system. The provision of service from transportation system is a profitable venture that sustains local farmers (Crossley, Chamen, Kienzle, Food and Agriculture Organization of the United Nations, and Rural Infrastructure and Agro-Industries Division, 2009) and rural settlers at large. This is possible where the service is available, effective and efficient through adequate transport planning. The efficiency of road transport structure will facilitate the development of agriculture and the socio-economic status of the people, based on road trucks and buses services as the major means of moving produce to various consumers (Orakwue, Umeghalu, andNgini, 2015), who make payment for their consumption in large quantity. Rural areas represent the headquarters of food production and major supplier of raw materials for agro-industrial based companies (GbadamosiandOlorunfemi, 2016) as such, the survival of man is grossly dependent of this factor. Olorunfemi(2017)opined that transportation challenges had served as impediment to the production of food as contributed by increased cost of transport, and difficulties in moving agricultural products from the farm areas to urban centres where there is high demand for food.

In agreement with above, Adesanya et al., (2000) had observed that, rural mobilization and transport in most rural areas in low income economy still take place with great difficulties thereby compounding and worsening the problem of rural productivity and rural poverty. Ajiboye(1995)observed that inadequate supply and high cost of food is as a result of inefficient transportation, inappropriate storage management choice and distribution constraints of farm produce. Through provision of adequate road, for better vehicular system, with efficient standard storage facilities in specialized trucks and buses through the transportation cycle, farmers can access the needed farm inputs like fertilizers to promote and enhance productivity and at the same time, open urban markets for farmers to promote their agricultural produce with less food loss (Umoren, Ikurekong, Emmanuel, andUdida, 2009).

The increase in population at a rate considerably higher than the rate of increase in food production has continued to widen the gap between domestic food supply and domestic demand. The interaction of these factors has led to food insecurity and the idea of self-sufficiency is becoming more and more difficult to achieve due to declining agricultural production and inefficient food marketing system (Helleiner, 1996). This problem is not pertinent to low income economy alone but also felt in some developed country of the world. The major issue discovered from the literature seems to focus on agriculture productivity and marketing, food security and the little on the role of transportation medium storage facilities. It is therefore evident that, a study that will reveal road transportation storage facilities challenges as it affects food security in low income economy be carried out.

Discussion

Fresh and processed food and agricultural materials require transportation to move the products between the producer and the packing shed, then to wholesalers, retailers, farmers' markets, or the export market. Domestic foodcommodities are transported from growing areas to markets via truck and buses most especially in developing country. Trucks account for the vast majority of the domestic movement of fresh and processed produce of94% for fresh produce/product and 90% for processed produce/product. Transporting products to market can be difficult and costly coupled with less effort on storage arrangement(Casavant et al., 2010) in several low/middle income countries. In contrast to Figure 2, Moving farm products often requires quick and efficient transportation because of their perishable nature, and fresh material needs to be kept at the correct temperature, humidity to ensure it arrives in the best condition possible for better shelf strength. Processed products (canned, dried, and frozen) may be moved to other processing firms, which add further value by repackaging the products into consumer packs, combining them with other products to be sold as meals, or further refining them into final products.

Several food commodities may be shipped in the well-constructed transport trucks or buses under controlledphysical and technical condition, coupled with different levels of packaging to conserve quality by controlling temperature or humidity during transit. An efficient transportation system supports rural economic development. In an efficient rural economy, the cost of inputs to agriculture and the cost of living for inhabitants of rural areas decreases, the net price to producers and manufacturers increases, market access and competitiveness increases, and job opportunities are increased. Successful businesses and farmers contribute to the quality of life and increase opportunities for rural residents. Transportation does not stand alone but is one of several key elements that contribute to a strong rural economy; many other elements work with transportation to support a high quality of life in rural communities(Casavant et al., 2010).

Transportation smoothens agricultural development, allowing production to be specialized, rural communities to develop, and economies to grow. Truck and buses were the most patronized inland mode of transportation widely available in many nations. Its ease of accessibility everywhere with flexible service make many supply chain solely depends on this choice without much consideration on the storage facility attachment for food

produce/product. The major concerns between the road transport industry and agriculture/rural areas are focused on the capacity and services that this trucks and buses sector can mobilize. More so, it serves a faster network from the farm (site of production) through to the final consumer with flexible timeline, and door-to-door service in some instance for both perishable and non-perishable food and other agricultural produce/products.

Conclusion

The review is meant to notify agricultural sector and agencies on how to restructure the current transport medium (trucks and buses) storage facilitiescondition in networking knowledge applicable to cause food loss, in order to expand the concept of the evaluation of their freshness. In fact, it can be concluded that consumers' perceptions of agricultural produce/product freshness vary, but most with a higher choice of balanced diet. Based on the reviewed literature, it can be argued that more elements interact with freshness perception particularly, of the following; genetic modification, farming practices, organic attributes,presence of nanomaterials and other environmental factors(even during the transport networks/mobilization) may play significant role in food loss. Many of which will not be able to satisfy some international exchange policy requirements for exportation and as such results to outnumbered rejection in the local market due to damage, spoilage and wastage thus, mounting the loss volume in developing parts of the continent where list of issues concerning food insecurity, malnutrition and hunger still linger every single day.

Furthermore, the case studies presented confirm the need for an expanded and integrated evaluation system in the transportation networks of trucks and buses with proper installationof storage facility throughout the course of the mobilization within the supply chain. Moreso, this element would minimize depletion of gases contributing great amount to global greenhouse effect on a significant scale.All food category may present freshness issues that shall therefore be addressed by the business operators constituting the different supply chains, thereby including, for example, feed supply chain operators. It also appears that there could be a role of information to consumers in this sense, that could change their perception in relation to food freshness. This is key, as perception of freshness is not always seen in relation with the technical (transportation) and legal need for safe, stable and availability of food.

Finally, improvement in transportation can encourage farmers to increase production as the relation between food loss and storage on transportation facilities needs to befurther studied in order to reduce this increasing food loss gap, as well as influence of different types of processing, logistic services and consumer awareness on food perception. This review will present benefits to agencies within agricultural industries and policy makers for better improvement to further minimize the rising food loss in developing and underdeveloped countries.

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Abbreviations: FFV: Fresh Fruit and Vegetable; FSC: Food Supply Chain;TPL: Third-Party Logistics.