

Review Article

## REDUCING POSTHARVEST LOSSES IN NIGERIA'S AGRICULTURAL SECTOR: PATHWAY TO SUSTAINABLE AGRICULTURE.

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### ABSTRACT

The study focused primarily on postharvest losses which are like a recurring decimal in Nigeria's agricultural sector, the driving factors and proactive measures that can be adopted to tackle the problem. Nigeria's population is increasing on annual basis and that is putting tremendous pressure on natural resources such as land, water, forest which means food wastage and loss must be avoided in order to avoid food insecurity especially in the face of unstable food prices and slow economic growth. Nigerian farmers are losing a lot in terms of monetary value occasioned by postharvest losses as many of them are plagued by inadequate storage facilities coupled with the fact that there are insufficient industries to add value to some of their farm produce and power supply is also erratic and this does not allow industries to operate at full capacity. The irony of the whole issue is that Nigeria is a country that produces crops such as cotton and cocoa but imports textile and chocolates from other countries of the world owing to inability to add value to some of her agricultural produce as local manufacturing ability is either very low or virtually non-existent in some areas. It is recommended that efficient and low cost technologies suited to the Nigerian environment should be developed to address the problem of postharvest losses through massive investment in agricultural research by the government, agro-allied industries etc. Farmers are also encouraged to form marketing cooperatives which will enable them to have a central location through which they can market their produce at reasonable prices and also link up with anchor buyers.

**Keywords:** Produce, Storage, Losses, Postharvest, Research, Processing

### INTRODUCTION

In spite of the fact that Nigeria produces oil, gas and solid minerals, agriculture remains the largest employer of labour as significant percentage of the country's population are employed in the sector. Agricultural sector has contributed in no small measure to Nigeria's Gross Domestic Product and that is why it is an important sector as far as the Nigerian economy is concerned. Nigerian farmers especially those in the rural areas produce a lot of crops with some of them also engaging in backyard animal husbandry such as raising of fowls, goats, sheep etc. Nigeria is a country that is blessed with tropical rainforest particularly in the southern part while the northern part is largely dominated by savannah that makes land clearing relatively easy. These varied geographical distributions determine the type of crops that can be grown in each region. Based on these geographical distributions, farmers in the south concentrate more on crops such as cocoa, oil palm, kola nut, coffee, cassava, yam, cocoyam etc. On the other hand, farmers in the north focus on crops such as groundnut, rice, beans, tomato, pepper, wheat, sorghum, potato, carrot, ginger, garlic, turmeric, sugar cane, sesame seed etc. Figure 1 shows some of the farm produce that can be found in Nigeria.



Fig. 1: Selected farm produce in Nigeria.

Source: [1].

Cultivation of these crops has enabled some families to cater for their own needs to a large extent. During harvest season, most agricultural produce in the country used to command low prices because of the glut in the market and this does not allow farmers to get huge returns for their efforts in terms of labour and other resources invested in farming. Even at low prices, some farmers are still unable to sell their produce and as a result, most of them perish as there are inadequate modern storage facilities to store them coupled with the factor that Nigeria is a country that is bedeviled with epileptic power supply. Also, there are insufficient industries to transform or add value to some of these produce so that they can be sold locally or exported to other countries. As a result, a larger percentage of agricultural produce such as tomato, pepper, oranges, mangoes, cashew fruits and so on get wasted from year to year in different regions and areas of the country particularly in remote areas that are very difficult to access due to poor road network. Figure 2 shows some rotten oranges at the popular fruits market in Zuba, Gwagwalada Area Council of Federal Capital Territory, Abuja. This problem poses serious implications for food security in the country as Nigeria is said to be losing about \$9 billion annually due to post harvest losses in the agricultural sector [2]. Putting that in clear perspective and on crop by crop basis and according to a report published in 2013 by [3] on food losses in cassava and maize value chains in Nigeria, the total sum of monetary losses of cassava at the farm gate and during processing, storage, transport and marketing amounted to around ₦144 billion while the total sum of monetary losses in maize value chains amounted to ₦120.4 billion. Also, [4] reported that about 700,000 tons of tomatoes rot as waste annually out of Nigeria's yearly harvest of about 1.5 million tons.



**Fig. 2: Rotten oranges at Zuba fruits market in Gwagwalada, Abuja.**

Approximately one-third of the food produced (about 1.3 billion ton), which worth about US \$1 trillion, is lost globally during postharvest operations every year [5]. According to [6], food waste and loss is a large and increasingly urgent problem and is particularly acute in developing countries where food loss reduces income by at least 15% for 470 million smallholder farmers and downstream value chain actors, most of whom are a part of the 1.2 billion people who are food insecure. Food waste can be defined as food discarded or alternatively, the intentional non-food use of food due to spoilage/expiration of food [7]. Food loss, on the other hand, represents the amount of edible food, postharvest, that is available for human consumption but is not consumed for any reason and it includes cooking loss and natural shrinkage (e.g., moisture loss); loss from mold, pests, or inadequate climate control; and plate waste [8]. Postharvest loss includes food loss across the food supply chain from harvesting of crop until its consumption [9]. The losses can broadly be categorized as weight loss due to spoilage, quality loss, nutritional loss, seed viability loss, and commercial loss [10]. Magnitude of postharvest losses in the food supply chain vary greatly among different crops, areas, and economies and in developing countries, people try to make the best use of the food produced, however, a significant amount of produce is lost in postharvest operations due to lack of knowledge, inadequate technology and/or poor storage infrastructure [11]. Nigeria is a country that produces and exports agricultural commodities such as cocoa, cotton, coffee to different countries of the world only to end up importing finished products such as chocolate, textile, and coffee (processed) from some of the countries where she has exported these agricultural commodities to at high prices. This is not good for a country that aims to achieve self-sufficiency in terms of domestic food production and other products. As a result of inadequate storage and processing facilities, some jobs that should have been created in the agricultural value chain are being exported to other countries of the world while a lot of Nigerians, particularly the youths go unemployed with the attendant consequences of unemployment being manifested in different forms and different regions of the country with notable examples like the 'Boko Haram' insurgency in the north eastern part of the country, militant activities such as oil pipeline vandalism, oil theft by locals and their foreign collaborators in the Niger Delta region, ritual killings and banditry in the southwest, cattle rustling, kidnapping and other criminal activities such as illegal mining in the north west and north central parts of the country, kidnapping and hostage taking for ransom particularly in the south east and the agitation for independent state of Biafra by the indigenous people of Biafra to mention just a few. In terms of revenue, a lot of farmers have lost a substantial amount of revenue that should have accrued to them if there are adequate storage and processing facilities in the country. A notable example is the fruit sub-sector where fruits such as oranges, mangoes, cashew fruit etc get wasted in large numbers on annual basis as a result of inadequate industries with modern day processing facilities to transform them by adding value to them which would have created jobs for a lot of people. Before the discovery of crude oil, agriculture used to be the mainstay of the Nigerian economy. With the discovery of crude oil and the income it generates, agriculture was relegated to the background and our share of major crops such as cocoa, oil palm, groundnut on the global scene began to wane. Agriculture in Nigeria is plagued by numerous

problems such as inadequate inputs, the use of rudimentary technology, inadequate storage and processing facilities leading to large scale post-harvest losses on annual basis. With more than 60% of Nigerians employed in the agricultural sector, finding practical solutions to post-harvest losses holds the key to sustainable development in the sector. This paper examines post-harvest losses in Nigerian agricultural sector and how they can be corrected with proper measures such as linking farmers to anchor buyers, construction of roads to facilitate easy movement of agricultural produce from the farm gate to different markets, provision of up-to-date storage and processing facilities that can add value to a lot of Nigerian agricultural produce leading to a win-win situation for both farmers and processors and also the number of jobs that will be created in the value chain segment of the agricultural sector is a positive thing that will help to reduce the level of unemployment in the country.

#### Drivers of Postharvest Losses

A lot of factors are responsible for postharvest losses in Nigeria and losses occur from harvesting down to processing stage and at the level of the consumer, losses are also recorded. For instance, harvesting of crops like tubers such as yam and cassava requires digging and at times, some of the tubers break and others get stuck in the soil especially during dry season particularly if the soil is full of small stones, gravel etc. Losses also occur in transportation, storage, marketing etc. According to a report by [3], it was also indicated that the total value of maize (green and grain) and feed lost between harvest and marketing in Nigeria was ₦120.4 billion as shown in Table 1.

**Table 1: Summary of quantification of maize losses**

Quantification of maize losses	Value of losses (₦)
Loss of maize cobs (green and dry) at the farm gate	8,235,273,794
Loss of maize grain at the farm gate	11,346,949,196
Loss of maize grain during marketing	85,503,923,120
Loss of maize grain during feed milling	4,118,400,000
Loss of feed during milling and marketing	11,200,000,000
<b>Total losses</b>	<b>120,404,546,110</b>

Source: [3]

Some of the factors that fuel or contribute to postharvest losses in Nigerian agricultural sector include rudimentary technology, unpredictable weather condition, long distances, improper handling and packaging, transportation problem, inadequate storage and processing facilities etc.

**Rudimentary technology:** The use of crude technology is still very much prevalent in Nigerian agricultural sector. Most farmers still depend on the use of cutlasses and hoes to harvest their crops especially crops like yams, cassava, potato and these farm implements create bruises on these crops and these bruises serve as entry points for microbes such as bacteria and fungi which can lead to rapid deterioration or spoilage of these crops after harvest.

**Unpredictable weather condition:** A lot of farmers in Nigeria particularly those in the rural areas still depend largely on the use of sun and air movement to dry their crops particularly cereals and legumes. There is also a limit to the use of sun due to the unpredictable nature of rainfall. If rain falls on produce, it can result in the growth of mold and mycotoxin contamination cannot be ruled out. Grains lying in the open for sun drying are eaten by birds and insects, and also get contaminated due to mixing of stones, dust, and other foreign materials [11]. Unseasonal rains or cloudy weather may restrict proper drying, and when crop is stored at high moisture, high losses due to mold growth cannot be ruled out [11]. Therefore, continuous cloudy conditions when farmers should be drying their produce can result in post-harvest losses.

**Long distances:** Roads leading to most farms are far away from many market locations. Farmers, especially those in the north have to travel long distances to transport their produce especially perishables like tomato, pepper, carrot, cucumber to southern Nigerian commercial cities like Lagos, Port Harcourt, Enugu, Aba and

so on in trucks that take several days to get to their final destinations and some of these farm produce would have started deteriorating on the road and by the time they get to their final destinations, their market value would have gone down drastically with some consumers pricing them far below their production costs. As a matter of fact, some of the produce will not be sold because they have rotten badly and will be dumped at refuse sites thereby leading to environmental pollution.

**Improper handling and packaging:** A lot of farm produce are not handled with care during packaging as most farmers and produce traders use bare hands that may be contaminated and these aid their rapid deterioration during transportation to various market outlets within and outside the primary area of production. Most farmers in Nigeria, for instance, use raffia baskets to package their perishable products such as tomatoes to different markets in different semi-urban and urban areas and these baskets do not give room for adequate or proper ventilation and the interior of these baskets are also rough which can create bruises on produce and thereby lead to deterioration of produce. Also, some farmers use jute sacks to package their oranges as shown in Figure 3 and other sacks for their onions and pepper and other produce to markets hundreds of kilometres far away from the primary areas of production and some of these produce will not get to their final destination until after two or three days. These sacks hardly give room for proper ventilation and contribute to deterioration of these farm produce especially when they are packed on top of one another.



**Fig. 3: Oranges packed in jute sacks at Zuba fruits market in Gwagwalada, Abuja.**

**Transportation problem:** Roads leading to most farms are not motor able and some roads connecting towns and cities are in bad shape. Some vehicles conveying farm produce to markets for sale break down or even get involved in terrible accident on some of these roads leading to some of these produce being wasted before they reach the end users in different towns and cities across the nation. Also, farmers rely largely on the use of trucks to move their produce and some of these trucks take days before they reach their final destination. Some of the farm products like fruits, onions, tomatoes and pepper start deteriorating in transit because of the long journey and number of days it take to get them to their final destinations.

**Inadequate storage and processing facilities:** These are among the biggest problems facing the agricultural sector in Nigeria. There is plenty of agricultural produce during harvest season but there are insufficient or no storage facilities to store and preserve them so that they can be made available for consumption and other uses during the off season. Another major challenge is inadequate processing facilities to transform the farm produce to either semi-finished or finished product. For instance, during harvest period and on most occasions, there are plenty of fruits such as oranges, mangoes and other produce such as tomato, pepper but a lot of them get wasted because there are no enough processing facilities to add value to them. Sometimes, because these produce are large in quantity, disposing them becomes an issue and at times they are dumped in places where they shouldn't be, and by so doing, constitute an environmental problem oozing out offensive odour to people.

### Effects of Postharvest Losses

**Wastage of resources:** Postharvest losses result in the wastage of resources such as land, water, fertilizer, herbicide, seeds, and seedlings and so on that are used in the production of crops that are not consumed or utilized for other purposes. A study carried out on rice postharvest losses in Nigeria estimated that the lost paddy accounted for 19% of the total cultivated area [12]. On the global scene, about 1.4 billion hectares of land were wasted by growing food that was not consumed in the year 2007, an area larger than Canada and China [13]. Nigerian population keeps growing rapidly on yearly basis and this rapid population growth is not commensurate with food production which means that resources must be judiciously utilized in order to avoid food insecurity in a country that is gradually recovering from economic recession and still facing the menace of 'Boko Haram' insurgency in the north east that has driven a lot of farmers from their homes, farms and fishing activity. Industrialization and urbanization are among the factors that are limiting the availability of natural resources such as land and water that are needed for agricultural activity. Money used in purchasing farm inputs such as fertilizer, herbicides, seeds and also used to hire labour in producing food crops that farmers are not able to sell because of the glut in the market or preserve because of inadequate storage facilities, or process into other forms because there are no processing facilities constitutes a huge financial loss to farmers who used either their personal savings or borrowed funds to carry out farming.

**Quantity and quality reduction:** This is one of the immediate consequences of postharvest losses. Quantity and quality of farm produce depreciate rapidly if they are no buyers for them and if there are no storage and processing facilities to preserve them or transform them into either semi-finished or finished products. Postharvest loss accounts for direct physical losses and quality losses that reduce the economic value of crop, or may make it unsuitable for human consumption and in severe cases, losses can be up to 80% of the total production [14]. In African countries, these losses have been estimated to range between 20% and 40%, which is highly significant considering the low agricultural productivity in several regions of Africa [15]. These losses play a critical role in influencing the life of millions of smallholder farmers by impacting the available food volumes and trade-in values of the commodities [11].

**Environmental problems:** Crops that farmers are not able to sell or preserve particularly fruits and vegetables are dumped indiscriminately and they constitute environmental hazard sending out foul smell and also become home for different categories of microbes such as bacteria and fungi that can be transmitted by air and water and cause diseases for humans thereby making them to spend money on medication. According to [11], unutilized food also results in extra carbon dioxide (CO<sub>2</sub>) emissions, eventually affecting the environment. A report by the Food and Agriculture Organization of the United Nations (FAO) using the life cycle perspective, estimated about 3.3 Gtonnes of CO<sub>2</sub> equivalent emissions due to food that was produced but not eaten, without even considering the land use change [16]. Carbon dioxide is one of the greenhouse gases that are contributing to global warming which is impacting negatively on the climate.

**Rural-urban drift:** Continuous postharvest losses can make farmers to be discouraged and begin to look for alternative means of livelihood. This in particular can make young, energetic and vibrant farmers to abandon farming in the village and move to semi-urban and urban areas to look for job. If the drift to urban centres continues without adequate measures in place to control it, it can lead to a decline in farming activity resulting in low food production and high prices of few available agricultural produce.

### Solutions to Postharvest Losses

In practical terms, it is very difficult to achieve zero losses but measures can be taken to reduce postharvest losses to the barest minimum. Nigerian population keeps growing on annual basis which means more mouths are to be fed and postharvest losses must be curtailed so as to avoid the problem of food insecurity. The

burgeoning human population puts enormous pressure on natural resources that are limited and these resources must be deployed efficiently especially in the production of food. Therefore, postharvest losses must be checked especially in the face of rising food prices. Some of the useful measures or approaches that can be adopted to tackle postharvest losses are constant power supply, establishment of farm produce processing industries, marketing linkages, massive investment in agricultural research, legislation, efficient harvesting, handling and sorting, application of non-toxic chemicals, improving traditional methods of farm produce preservation and processing, improved storage systems, human capacity development and development of the transport sector.

**Constant power supply:** This is a major factor and one of the fastest ways to reduce post-harvest losses especially in a country like Nigeria. Adequate power supply will ensure that industries that make use of farm produce as their raw materials operate maximally and new ones will also come on board. For instance, industries that produce fruit juice will be able to produce and package their juice effectively at a lower cost as compared to excessive spending on diesel or petrol used to power generating set which raises cost of production. Also, those that have cold room facilities will be able to operate efficiently and farmers can keep their produce such as tomatoes there pending the time they will get customers to buy them. [17] reported that most perishable agricultural products such as fruits and vegetables require constant electrical power supply in order to reduce postharvest losses.

**Establishment of farm produce processing industries:** Production of farm produce is not really a problem in Nigeria but produce processing is among the main challenges facing the agricultural sector. One of the quickest ways to reduce postharvest losses in the country is to have enough farm produce processing industries that can add value to some of the agricultural produce that are produced by farmers in different parts of the country. This can only happen when there is a business friendly environment for businesses to thrive and measures that can be adopted for this to happen include provision of basic infrastructure such as constant power supply and good roads, tax rebate for industries, adequate security etc. Provision of these measures will boost investor's confidence in the economy to invest their resources in establishing industries that will add value or transform some of the agricultural commodities that are produced in the country. Industries cannot operate successfully in an economy that is bedeviled with epileptic power supply and insecurity where workers are frequently kidnapped for ransom. Establishment of farm produce processing industries will provide market for farmers and will also ensure value addition to farm produce which will lead to revenue being generated for the processors. [18] suggested that agro-allied industries should be setup to process primary products as value addition to agricultural produce will help the country to earn more from exports.

**Marketing linkages:** Farmers should come together and form marketing cooperatives as this will enable them to have a central location where they can market their produce at reasonable prices and they can also link up with large scale buyers or agro-allied industries through the cooperative society. Linking farmers especially those in the villages to buyers is one of the means through which post-harvest losses can be reduced. Linking farmers to domestic processors, groceries, mini-markets, supermarkets, hotels, restaurants will help farmers to market their produce at reasonable prices. Linking farmers to anchor buyers is another good approach as farmers and buyers are able to reach agreement on some key areas such as producing the right varieties, quantity and quality that anchor buyers want and farmers too will be given the assurance that when they produce, they will not be let down by anchor buyers. When a friendly business relationship is established, anchor buyers can even support farmers with loan to carry out contract farming with the hope that farmers will pay back either in cash or with produce and by so doing a good business bond will be built between farmers and anchor buyers. In summary, contract farming between anchor buyers and farmers will help in reducing post-harvest losses to a greater extent. Marketing cooperatives afford farmers the opportunity to pool their resources together to do a lot of things

such as the buying of harvest equipment and cold system facility together at a reduced cost to individual farmer. The government can be of great help by assisting farmers to source for markets outside the country through export. According to [19], government should encourage more exportation of agricultural output as this in turn will enhance external foreign exchange earnings and improve the competitiveness of Nigerian agricultural produce in the international markets.

**Massive investment in agricultural research:** Support for agricultural improvements across sub-Saharan Africa is fairly robust, but only 5% of investments in agricultural research over the past 30 years has been directed towards preventing postharvest losses [6]. Investment in agricultural research to develop low cost and efficient technologies will go a long way in reducing postharvest losses. Government, donor agencies, non-governmental organizations, agro-allied industries should finance research institutes and tertiary institutions where agriculture is being studied to produce cost effective technologies that help in reducing postharvest losses to the barest minimum. Example of these technologies include air-tight bags, metallic silos, smaller and mobile farm produce processors, solar energy enabled or mechanical dryers, efficient harvesters particularly for roots and tubers, grain threshers etc. A grain dryer incorporating a solar air-dryer and a photovoltaic power-assisted fan has been designed in Malawi to dry maize. The dryer can dry 90 kilogrammes of maize grain per batch and is considered cost effective, with a payback period of less than one year if surplus grain is dried and sold in the market [20]. Local technologists such as blacksmiths should be encouraged by the government with grants to produce more metallic silos and inventors who produce low cost evaporative cooler such as the pot-in-pot cooler should also be encouraged with grants too so that they can improve on it and produce more. Appropriate technologies will help to reduce post-harvest losses and also lead to job creation in the area of farm produce processing, marketing and distribution. Production of improved, disease and pest resistant seeds and seedlings that will produce durable crops that will not deteriorate after harvest even without refrigerating them or putting them in special storage device for some days is also a key factor in curtailing postharvest losses. Production of low cost technologies and high quality crops with expanded shelf life require funding of research institutes and it is therefore important, that the government must wake up to its responsibility.

**Legislation:** Government can introduce a legislation that will compel local industries especially agro-allied industries to source a certain percentage of their raw materials locally. This will boost farmer's confidence to produce more because there is an assurance that they will be able to sell their produce.

**Efficient harvesting, handling and sorting:** Harvesting of crops particularly grains should not be too early so as to avoid the problem of high moisture content which can make crops to take longer time to dry and harvesting should not be too late in order to avoid stealing by thieves; or attack by pests such as birds, insects, rodents that can infect these crops. Harvesting of crops particularly roots and tubers should be carried out carefully in order to prevent bruises and punctures to them and thereby ward off germs such as bacteria and fungi which can easily gain entry into these crops through these bruises and punctures. According to [21], harvesting should be carried out as carefully as possible in order to minimize mechanical injury such as scratches, punctures and bruises to crops. After harvesting, handling and sorting must also be done carefully in order to keep produce in safe and hygienic conditions until they get to the market or end users and also to avoid contamination which can lead to rapid deterioration. Careful handling of farm produce especially fruits and vegetables to minimize bruising and breaking of the skin likewise is a well-known method of reducing postharvest losses according to [21]. [6] also suggested the adoption of appropriate loss-reducing technologies to improve crop handling in order to reduce food loss. Damaged produce must be sorted out and kept separate from the good ones so as to preserve the good ones and enhance their market value.

**Application of non-toxic chemicals:** As part of measures to reduce post-harvest losses, non-toxic chemicals can be applied to produce such as cereals, grains and legumes after drying in order to prolong their shelf lives. These chemicals must be applied in the right dosage in order to prevent toxicity on the part of the end-users or final consumers. [21] suggested that the application of postharvest chemicals should be done in a manner that ensures that the dosages and residues conform to internationally recommended maximum levels e.g. of the Food and Agriculture Organization/World Health Organization Codex Alimentarius Commission.

**Improving traditional methods of farm produce preservation and processing:** Traditional methods of preserving farm produce, such as using the sun to dry them in order to reduce the moisture content is a good approach, although limited by unpredictable rainfall. According to [20], in some locations where rain is possible at the time of harvest, tarpaulins have been supplied to cover crops particularly grain during rainfall; this approach will become increasingly important as climate change makes erratic and unpredictable rains more likely. Government can assist farmers in preserving their produce by making tarpaulins available to farmers at a subsidized rate and farmers can spread their produce such as cereals, grains and others on these low cost tarpaulins for proper drying and also use them to cover their produce in the event of rain. Farmers should ensure that some of the produce they use sun to preserve are not spread on sand, roadside or any other place that is not hygienic as shown in Figure 4. For instance, the peeling and cutting of roots and tubers such as ginger, cassava, potato and yam into thin slices must follow good and safe hygienic practices such as removal of infected roots and tubers and thorough washing before drying them on a neat place in order to ensure that the end users have safe and nutritious food substances for their dietary needs. Good hygienic practice must be applied to farm produce before drying them.



**Fig. 4: Pepper being sun-dried on the road side at Gwagwalada, Abuja.**

**Improved storage systems:** Storage facilities should be clear of rodents, insects or any other pest that can contribute to postharvest losses and traditional storage facilities that are not fully air tight should be improved upon to make them hermetic which will help in suffocating any pest that wants to cause damage to stored produce as there is little or no amount of oxygen inside. [11] reported that various hermetic storage options such as metallic silos, Purdue Improved Cowpea Storage (PICS) bags, super-grain bags have been developed and widely promoted in the last few years. These bags are being considered practical and cost-effective storage technology, and are becoming very popular in several countries [22]. Barns, rhumbu (traditional storage house made of clay and roofed with stubble or grass) and other storage devices should be protected from fire incidence, the use of flammable materials like straw, stubble as roof over the rhumbu should be discouraged, and metallic roofing sheet can be used instead. Areas around the storage devices should be clear of bushes or any other material that can easily be gutted by fire. These farm produce storage devices should be air tight, well secured and monitored to guard against pests, and thieves breaking in and stealing the produce.

**Human capacity development:** Government at all levels, research institutes, agro dealers, non-governmental organizations, universities of agriculture and other tertiary institutions that offer

agricultural courses should organize regular training, seminars and workshops for farmers on the latest developments in agriculture especially about farm produce preservation and what consumers want so that farmers can easily market their produce. Research findings should be disseminated to farmers in the language that they understand and their capacities to use modern day agricultural equipment especially those that help in minimizing post-harvest losses should be developed through on-farm or on-site demonstration and not only through series of lecture. [11] reported that government agencies and organizations have to ensure the development of facilities to provide information and training about the use and maintenance of technologies that minimize postharvest losses in the local language for successful adaptation and effective usage. [3] suggested that a comprehensive education and training policy is necessary to improve the capacity of stakeholders in production, post-harvest handling and storage, processing and marketing. It was also reported by [3] that through partnership with donor agencies, the public sector agencies could implement interventions to reduce post-harvest losses, such as providing training to farmers, marketers and processors on how to conduct their businesses in such a way that postharvest losses can be minimized.

**Development of the transportation sector:** Government should embark on road construction especially in rural areas where majority of the farmers reside so as to facilitate easy movement of farm produce from different farms to markets in different semi-urban and urban areas. [11] emphasized the importance of good road in their study in which they pointed out that transportation losses are relatively very low in the developed countries due to better road infrastructure and engineered facilities on the field and processing facilities to load and unload the vehicles rapidly with very little or no damage. The rail system should be developed in order to make the transportation of crops such as tomato, onion, pepper, potato and livestock such as cattle, goat and sheep from the far north to major cities in the south in few hours as compared to the use of trucks that take days before reaching their final destinations. The aviation sector should be developed in such a way that large scale farmers will be able to afford to transport their farm produce that easily perish using jumbo-size aero plane from one state to the other.

## CONCLUSION

Although, it is very difficult to achieve zero losses in agricultural production but much more can be done to reduce post-harvest losses to a large extent particularly through the establishment of adding value farm produce processing industries and having adequate storage facilities all over the country. Industries can only come up and succeed when there is a business friendly policy by the government and provision of basic infrastructure such as constant power supply, good road network etc. Farm produce processing industries with adequate and modern processing facilities will ensure value addition to some of the crops that are produced in the country that end up at dump sites and numerous jobs will be created along the value chain of some of these crops. Even some of the cash crops that are exported to other countries of the world at not too encouraging prices will be processed locally with up-to-date processing facilities so that we can stop the irony of exporting agricultural commodities only to end up importing finished products from these countries at high prices. Huge investment in agricultural research by the government and agro-allied industries is another positive factor that contributes greatly in addressing postharvest losses which have plagued the Nigerian agricultural sector for many years. Through research, cost effective technologies can be invented and these will go a long way in stemming the tide of avoidable losses in the agricultural sector. If postharvest losses are reduced to the barest minimum, it also means that inputs such as labour, land, chemicals (such as fertilizer, herbicide, pesticide), irrigation water, seeds, seedlings and so on that are used in farming are also not wasted.

## Conflict of interest

There is no conflict of interest.

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