

**Review article****Non sustainability of agricultural products, challenges of post harvest losses in Nigeria****H.I. Ifeanyichukwu\* , V.O. Ifeanyichukwu***Federal Polytechnic, Oko, Anambra State, Nigeria.*

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## ARTICLE INFO

## ABSTRACT

*Article history:*

Received 03 September 2013

Accepted 17 September 2013

Available online 29 September 2013

*Keywords:*

Harvest

Fresh fruits

Vegetables

Agricultural products

Losses experienced at post-harvest are very enormous. At every stage of post harvest practice/handling, agricultural products incur damages due to some factors; biological (wildlife), mechanical (machine equipment) etc. almost all the produce properties like physical (shape, density etc), mechanical (compressive, tensile strength) etc are affected. Principal causes of post-harvest losses are buttressed here and solutions were proffered. Reasons for the loss in post-harvest of agricultural products recorded were traced and the attempts that have been made in the recent past by engineers in Nigeria researching towards achieving low or no post-harvest loss are well explained. Results of post-harvest losses in some fresh fruits and vegetables were presented. The harvested produce placed gently into containers with grass cushions and not packed tightly is one solution that could help prevent post-harvest losses at certain stages of agricultural products.

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**1. Introduction**

Post-harvest losses of fruits and vegetables are difficult to predict, the major agents producing deterioration mostly being attributed to physiological damage and combinations of several organisms (FAO, 2003). Post-harvest losses may be grouped broadly into food losses after harvesting and food losses due to social and economic reasons.

However, as a result of increasing world population, the need for increased food supply has become an urgent and important consideration in many developing countries. There has been considerable efforts made in research and extension of food production in Nigeria which resulted in the setting up of Agricultural Programmes (ADPs) and so on. These efforts have yielded some results leading to increased yield due to increased food production.

However, it has been discovered that increased food production only is not the final solution if it is not complemented. With good harvest and post-harvest practices. This is because good harvest and post-harvest practices will lead to reduction in the amount of food losses during and after harvest. The food moved from the farm, through the delivery system to the consumer must be presented in the good and acceptable form with little food loss during the movement. This is the ultimate goal of any food supply chain and not increased food production alone.

The losses at each stage of post-harvest/harvest practices due to improper handling can be large enough to result in a total loss of millions of food every year (FAO, 1990). It is believed that a 50% reduction in post-harvest food loss in developing countries will reduce the need for food importation in these countries and will cause an increase in the food supply to meet the food demands (NRC, 1977). Also loss is far less than the amount of money that will be used to produce the same amount food.

## **2. Principal causes of food losses after harvesting**

All fruits, vegetables and root crops are living plant parts containing 65 to 95 percent water, and they continue their living processes after harvest. Their post-harvest life depends on the rate at which they use up their stored food reserves and their rate of water loss. When food and water reserves are exhausted, the produce dies and decays. Anything that increases the rate of this process may make the produce inedible before it can be used. The principal causes of loss are therefore discussed below, but in the marketing of fresh produce they all interact, and the effects of all are influenced by external conditions such as temperature and relative humidity.

Food losses after harvesting may include losses from technological origin such as deterioration by biological or microbiological agents and mechanical damage. Losses due to technological origin include: unfavourable climate, cultural practices, poor storage conditions, and inadequate handling during transportation all of which can lead to accelerated product decay. Food losses also can either be due to the reduction in weight of food meant for consumption or it could be due to damage of physical spoilage (which is usually reported as a percentage of the food sample since it is difficult to measure it).

Improper harvest/post-harvest practices expose the food commodity to many deterioration agents which lead to food spoilage. There are various types of losses depending on the post harvest practices and deterioration agent. Losses are either as a result of the action of physical, mechanical or biological agent on the food produce. Olorunda and Aboaba (1978) observed that the losses in the delivery system of tomatoes, pepper and onions were up to 20%. These losses were caused mainly by mechanical damage during transportation (Olorunda and Tung, 1985). Food losses lead to a loss or reduction in quantity, quality, nutritional and economic value of the food produce. These losses could either be primary, secondary or tertiary.

### **2.1. Primary losses**

These are the losses that affect the food produce directly. They are during the food delivery chain. They include:

**Biological Losses:** These losses are as a result of the action of biological agents like rodents, insects, birds etc. the agents usually consume the food during storage and causes a reduction in weight and quality of the food.

**Microbiological Losses:** These losses are as a result of the action of micro-organisms e.g. bacteria, mould and fungi. During the packing of fruits and vegetables into boxes, crates, baskets, or trucks after harvesting, they are mostly subjected to cross-contamination by spoilage from other fruits and vegetables and from containers. These agents produce toxic substances (mycotoxin) which causes food to rot. These losses are more of loss in nutritional value than loss in weight. This occurs mostly during storage and marketing stages.

**Chemical Losses:** These losses are as a result of the reaction of the naturally present chemical constituents in the stored food to cause loss of colour, flavour, nutritional value and texture.

**Losses due to Biochemical Reaction:** Refers to reactions of which intermediate and final products are undesirable. These can lead to significant loss of nutritional value such as rancidity and agrochemical

contamination, and in most cases the whole fruit or vegetable is lost. On the other hand, they are losses as a result of the reaction of chemical and biological constituents of the stored food. These losses give rise to discolouration and softening which leads to reduction of nutritional and economic value of the food product.

**Mechanical Losses (physical injury):** These losses are usually caused by bruises, cuts and excessive peeling of fruits. Mechanical damage is mainly due to inappropriate methods used during harvesting (careless handling), packing and inadequate transportation, which can lead to tissue wounds, abrasion, breakage, squeezing, and escape of fruits (or splitting) on vegetables, thus rapidly increasing water loss and the rate of normal physical breakdown. Skin breaks and other forms of mechanical damages also decay and growth of micro-organisms.

**Physiological Losses:** An increase in the rate of loss because of normal physiological changes is caused by conditions that increase the rate of natural deterioration, such as high temperature, low atmospheric humidity and physical injury. Abnormal physiological deterioration occurs when fresh produce is subjected to extremes of temperatures, atmospheric modification or of contamination. This may cause unpalatable flavours, failure to ripen or other changes in the living processes of the produce, making it unfit to use. Physiological losses on the other hand, refer to the aging of products during storage due to natural reactions. They are as a result of the respiration of food products even after harvesting. This respiration causes a loss of weight and it produces heat which makes the food susceptible to micro-organism attack. Also physiological changes make the food product susceptible to mechanical damage.

**Physical losses:** These losses are mainly caused by the effect of temperature on foods. In closely confined storage, wrong environmental condition can result in microbiological losses.

**Diseases and Pests:** All living materials are subjected to attack by parasites. Fresh produce can become infected before or after harvest by diseases widespread in the air, soil and water. Some diseases are able to penetrate the unbroken skin of produce: others require an injury to cause infection. Damage so produced is probably the major cause of loss of fresh produce.

### **3. Secondary losses**

These are losses that do not affect the produce directly but presents favourable conditions for the actions of primary losses. They are incurred during the food delivery chain. They are usually as a result of inadequate harvesting, packing, transportation, storage and drying facilities and bad quality control of food produce.

### **4. Tertiary losses**

These losses are usually caused by the consumer due to rough and careless handling of the food stuff which can lead to wastage or loss. Various surveys have been carried out to assess the losses of food crops in Nigeria. A qualitative assessment must be made in order to know the post-harvest practices with the greater amount of loss. The type of measures required to reduce the losses and the manner in which the measures should be applied will also be known. A general assessment for food crops cannot be made because the loss of food commodities differs from one food crop to another. The losses depend on the harvest/post-harvest practices which depend on the type of crop, final use, social and cultural setting of consumer, climate, harvesting practices and other factors.

### **5. Loss of food value in fresh produce**

The keeping and the preparation of fresh produce after harvest affects its nutritional value in several ways:

Dry matter content (the energy supply) is reduced with time as the continuation of living processes within the produce uses up stored food reserves.

Cooking partially destroys vitamins C and B1. Raw fruits and vegetables are practically valuable provided they are grown and handled hygienically.

Peeling may cause significant loss of food value, especially in potatoes, where the protein content is beneath the skin.

Water stored in cooking vegetables or fruit contains dissolved minerals and trace elements of the food and should not be thrown out but used in soups or in preparing other foods.

### **5. Maize overall losses**

Notwithstanding, losses is a concept which is difficult to define, however, quantitative losses eventually give a broad picture of where the losses are occurring and their relative scale, and how a specific crop is handled during the post-harvest operations. Therefore, some assessments have been done in order to determine total post-harvest losses for maize. For instance, losses are estimated based on post-harvest losses of each stage and assuming that each loss found is a percentage of the amount remaining from the previous stage. Otherwise, if losses are determined on the basis of the original weight of the crop, it can lead to an over estimation of the losses.

On the other hand, there are other losses which are difficult to determine and these losses include: time, manual labour, agricultural inputs, opportunity cost, illusions and hopes. For these reasons many post-harvest specialists agree that the post-harvest losses measure concept has changed. However, for practical reasons, still exist some methodologies which are ideas about the main quantitative and qualitative losses occurring during the post-production system.

## **6. Factors and causes of grain loss**

The maize post-harvest system has several stages at which losses of food can occur. So the main stages of factors responsible for the losses can be grouped as:

Physical factors: temperature, moisture, etc.

Biological factors: produce properties or characteristics; insects and mites; birds, rodents and other wildlife; microorganism: fungi, moulds and bacteria; man.

Mechanical factors: type and efficiency of harvesting tools, equipment and machines; primary processing equipment and machines; drying and storage structures.

Socio-economic factors: financial status of the farm household; farming system and level; storage and marketing system and level.

## **7. Level of loss during maize post-harvest system**

Field Drying and Harvesting: The magnitude of losses at this segment is very likely the highest in the entire post-harvest system for maize and is influenced by:

The time of harvesting which affects subsequently the storage quality of the grain.

Genetic characteristics of the varieties of maize. Generally, traditional varieties are better adopted.

Weather condition: Wetting condition from rain and hot sun in the day may result in lodging, sprouting, moulding, decolouration and fissure, and loss of quality and viability etc.

Harvest practices, especially referred to by hand, machine and when long field exposure of the crop may result in heavy infestation by insect pests and damage by rodents, monkey, baboons, bush pigs etc.

The effects indicated above occurs normally to the storage phase as the crop is made more vulnerable to infestations in storage by pests. The magnitude of losses in traditional methods of field drying and harvesting varies greatly from country to country. It could be as less as 5% for relatively drier areas, to 50% or more in places heavily infested by baboons, monkeys or wild pigs. Average loss rank from 7% to 12% (Agrotech, 1991).

Transport: Losses due to transport of maize grain to, within and off-farm depend on:

Type of transport facility used.

Efficiency of transport facility.

Quantity of maize grain transported.

Ground condition and surface of the terrain etc.

Transport losses are always small, ranking 1 to 2 per cent.

On-Farm Drying: This depends on how much the maize has been dried in the field. The drying methods and climatic conditions during drying are main factors which affect losses. The traditional drying methods can cause the crop to be exposed to proliferation of fungi, moulds, bacteria and therefore, reducing its quality. The crop is also exposed to attacks of domestic animals and birds causing qualitative and quantitative losses. Estimation of losses in traditional drying and storing in a raised barn for up to 4-5 months have been between 7-14%. Improved drying technique, as the crib, can reduce losses mainly due to fungi and insects in approximately 2%; average on-farm drying losses are 3-6% (Agrotech, 1991).

Threshing/Shelling and Cleaning: Damage from these operations is proportional to the moisture content of the grain and depends on the method used. Traditional shelling of maize made by hands cause minimum losses. Use of flails to beat the grain off the cobs can damage the kernel, and the unseparated grain of the cob can be lost with the chaff. Modern equipment not properly used can also cause damage to kernels. Hand shelling has 1% average loss; machine shelling; considering broken kernels and grain lost with chaff into the soil from 2 to 5 per cent.

Storage: Storage losses depend on the following:

Physical factor: e.g. damage during harvesting, transportation and shelling. This makes maize susceptible to attacks by insects pests, mites and moulds.

Temperature and humidity: May encourage mould formation and create conditions for insect population growth. The losses could be minimal in cool dry areas, marked in hot dry areas, high in cool damp conditions and very high in hot damp climates.

Type of storage structure or containers used.

Duration of storage.

The storage management affected prior to and during storage.

Marketing: Before marketing and consumption, maize is subjected to a whole range of loss agents discussed above as a result of which, the following attributes get affected.

Reduction in quantity and quality of the crop.

Reduction in nutritive and germinative attributes.

Reduction in commercial and economic value.

## **8. Post – harvest damages of fresh fruits and vegetables**

Physical damages to fresh produce can come from variety of sources, the most common being:

Mechanical Injury: The high moisture content and soft texture of fruits and vegetables make them susceptible to mechanical injury, which can occur at any stage from production to retail marketing because of:

Poor harvesting practices,

Unsuitable field or marketing containers and crates, which may have splintered wood, sharp edges, poor nailing or stapling.

Over-packing or under-packing of field or marketing containers.

Careless handling, such as dropping or throwing or walking on produce and packed containers during the process of grading, transport or marketing.

Splitting of fruits or roots and tubers from the impact when they are dropped.

Internal bruising, not visible externally caused by impact.

Superficial grazing or scratches affecting the skin and outer layer of the cells.

Crushing of leafy vegetables and other soft produce. Injuries cutting through or scraping away the outer skin of produce will:

Provide entry points for moulds and bacteria causing decay,

Increase water loss from the damaged area,

Cause an increase in respiration rate and thus heat production. Bruising injuries, which leave the skin intact and may not be visible externally cause:

Increased respiration rate and heat production.

Internal discolouration because of damaged tissues

Off – flavours because of abnormal physiological reactions in damaged parts.

## **9. Injuries from temperature effects**

All fresh produce is subject to damage when exposed to extremes of temperature. Commodities vary considerably in their temperature tolerance. Their level of tolerance to low temperatures are of great importance where cool storage is concerned.

Freezing Injury: all produce is subjected to freezing at temperatures between 0 and -2 degrees Celsius (FAO, 2000). Frozen produce has a water – soaked or glossy appearance. Although a few commodities are tolerant to

slight freezing, it is advisable to avoid such temperatures because subsequent storage life is short. Produce which has recovered from freezing is highly susceptible to decay.

Chilling Injury: some types of fresh fruits and vegetable are susceptible to injury at low but non-freezing temperatures, such crops are mostly of tropical or subtropical origin, but a few temperate crops may be affected. See table below.

Summary of Results of Post-Harvest Losses in some Fresh Fruits and Vegetables

Pepper: The high percentage of the harvesting and transportation loss was due to the mode of transporting the pepper. The pepper is packed in bags and the bags are stacked on each other such that the lower bags bear the weight of the bags on top. The distribution and market loss was as a result of physiological losses due to rotting and wilting. The loss due to transportation and harvesting made the pepper more prone to the physiological losses and this accounts for the higher percentage of physiological losses. The two types of losses usually results in a reduction of weight of the pepper.

Tomatoes: Tomatoes are packed in baskets with grass cushions at the bottom. The baskets are placed on one another during transportation such that tomatoes in the lower baskets bear the weight of the top basket. This was responsible for the high percentage of loss during transportation. The market loss in this case is usually low since the produce is sold easily even if it is rotten or wilted.

Onion: Onions are packed in bags and stacked on each other during transportation. However, the losses are lower than that of pepper and tomatoes because onions have a harder surface. The transportation losses are usually as a result of cuts and bruises on the onions surface. The market losses are as a result of physiological and microbiological losses which are caused by fungi and bacteria infection on the bruised parts.

Crop	Marke table		Unmarke table		Total %
	Harvesting and transportation	Distribution and market	Harvesting and transportation	Distribution and market	
Pepper	9-10	10-15	2	4	23-31
Onion	6-7	10-20	-	2	18-19
Tomatoes	10-15	1	3-7	-	14-23
Vegetable	1	2	-	1	4
Mangoes	10-20	-	-	20-40	30-60
Oranges	5-10	10-15	-	10-20	25-45

Source: (FAO, 2000). Some food crops losses in Oyo state, Nigeria.

Vegetable: The market losses of *Amaranthus* (Tete) and *corchorus olitorius* (Ewedu) arise from leaves affected by insects and wilted leaves.

Mangoes and Oranges: A harvesting loss of about 5% and was due to the cuts and bruises on the fruits when the ripe fruits fall from the tree. The mango fruits are packed in baskets or packed directly into trucks with grass cushions (oranges). The transportation loss is due to over ripening of the fruits which cause rottenness and the heat produced during respiration of the fruits. Market losses are usually very high because over ripe fruits rot after a day or two in the market. Also during period of abundance, the fruits brought to the market are usually more than the amount that is sold hence the excess fruits usually becomes spoilt.

## 10. Conclusion

The harvested produce should be handled gently. It should produce should be handled gently. It should be placed gently into containers which are with grass cushions and it should not be packed tightly in the containers.

The harvested produce should not be allowed to drop to the ground in the case of the fruits. It should drop on either cushioned surface or into bags tied to the tree branches in order to prevent cuts and bruises on its surfaces.

The fruit should be harvested when it is about to ripe so that during the time of storage it won't become too ripe and spoil. The harvested fruits should also be sorted out as they ripe such that the ripe fruits will be disposed off as fast as possible.

The produce should be transported in containers such that the containers will bear the weight of the produce and the produce does not rest on one another themselves. Wooden or plastic boxes that have high compression strengths which are reusable (to reduce the overhead cost of the containers) can be folded or collapsed when not in use so as to reduce the storage space. The container should have a large portion open spaces so as to allow free airflow to remove the heat produced due to respiration of the produce (especially the bottom layers).

Storage structures which will keep the produce at low temperatures should be constructed at each market. Low-cost structures such as pot-in-pot, tin-in-pot evaporative coolers and others made from clay should be constructed where the market people can keep their produce until it is ready to be sold. This is because low temperatures retard deterioration agents and therefore reduces losses at the market stage.

The produce should be stored in places of high humidity between 90 – 95% which will reduce moisture losses which leads to wilting and softening, however, too high humidity favours microbial spoilage. The high humidity can be achieved by sprinkling water on the fruits inside the transportation or storage structures used for the produce.

Citronella oil obtained from *Cymbopogon winterianus* Jowitt (Java citronella) is one of the industrially important essential oils used in perfumery, soaps, detergents, industrial polishes, and is a known plant based insect repellent (Guenther,1950).

Essential oils, commonly used as fragrances and flavouring agents, are recommended as mosquito repellents and can be applied to humans like conventional mosquito repellents with little or no harmful effects (Mahidol, 2004). Use of natural substances for mosquito repellence is strongly recommended. Citronella oil is reported to be a mosquito repellent.

In India *Cymbopogon winterianus* Jowitt (Java citronella) is cultivated mainly in the lower hills and the Southern State of Andhra Pradesh also makes a significant contribution to the total citronella oil production in the country. CSIR-CIMAP introduced this crop to the hill tribal farmers in the Visakhapatnam district of Andhra Pradesh, India to improve the economy of the ethnic tribal people as part of the rural development programmes of the institute.

Sulphur (S) is involved in the synthesis of amino acids, proteins, fatty acids, increases protein quality (Havlin, et al., 1999), increases nitrogenase activity in soils, nitrogen fixation in sulphur deficient soil (Kandpal and Chandel, 1993) and plays an important role in the synthesis of vitamins and chlorophyll (Jez, 2008). S is accumulated in plants in low concentrations (Scherer et al., 2008; Abdallah et al., 2010) and the deficiency of S is emerging in areas under oilseeds and pulses due to higher removal of S by crops (Singh and Kumar, 2009). Essentiality of sulphur for soybean (Bhuiyan et al., 1998; Dubey and Billore 1995; Fontanive et al., 1996; Srivastava et al., 2000), oilseed crops (Das and Das, 1994) and peas (Kedar and Rajendra, 2003) are very well documented.

S is deficient in rainfed semi-arid tropical (SAT) Alfisols because of low organic-matter content in soil, coarse texture of the soils, more removal of S than its application, and use of fertilizers without any S content. The native plant-available S [0.15% calcium chloride (CaCl<sub>2</sub>) – extractable S] in rainfed Alfisols in the SAT regions rarely exceeds 10–20 kg/ha and the soils are mostly categorized as low to medium in S (Takkar, 1988; Morris, 1987).

There is a gradual increase in pH from 6.9 to 8.1 in experimental site over a period of thirty years. The EC of ground water also increased and this experiment was initiated to study the influence of sulphur as a soil amendment and also to study its role in balanced nutrition. This experiment is a part of the agrotechnology development for improving the herb and essential oil yield of citronella in rural areas inhabited by the tribal farmers.

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