

Postharvest Technology

Mirza Hasanuzzaman
Associate Professor
Department of Agronomy
Sher-e-Bangla Agricultural University
E-mail: mhzsauag@yahoo.com

Concept

Postharvest processing is directed to the conservation of produce, process goods and value adding to make the material more readily usable and economically more remunerative.

The postharvest technology is gaining importance for increasing agricultural productivity and growers intend to become producer-cum-processor by utilizing the technologies of processing.

Postharvest technology is interdisciplinary science and technique applied to agricultural produce after harvest for its production, conservation, processing, packaging, distribution, marketing and utilization to meet the food and nutritional requirements of the people in relation to their needs.

Postharvest technology involves all treatments or processes that occur from time of harvesting until the foodstuff reaches the final consumer. Efficient techniques for harvesting, conveying/transportation, handling, storage, processing/preservation, packaging, marketing and utilization etc. are components of the postharvest chain.

Activities involved in the postharvest system

The postharvest system encompasses a sequence of activities and operations that can be divided into two groups:

- **Technical activities:** harvesting, field drying, threshing, cleaning, additional drying, storage, processing;
- **Economic activities:** transporting, marketing, quality control, nutrition, extension, information and communication, administration and management.

Importance of Postharvest Technology/Processing

- Increasing land and labor productivity to enhance total production.
- Minimizing postharvest losses to make greater amount availability to distribution.
- The purpose of postharvest processing is to maintain or enhance quality of the products and make it readily marketable.
- Postharvest technology has capability to meet food requirement of growing population by eliminating avoidable losses making more nutritive food items.
- This process has resulted in capital drain from rural to urban areas, decreased employment opportunities in the rural areas.
- It helps to generate more employment and income.
- Investment in postharvest measures is more economical and time saving than that the production activity to obtain the same amount of particular commodity.
- Through economic growth and social development poverty will be elevated.
- Enhancement of employment opportunities for rural women.
- Postharvest technology has potential to create rural industries.



Stages of a whole postharvest system

1. Harvesting (Handling)
2. Threshing
3. Drying (Transport and distribution)
4. Storing
5. Processing
 - 5.1. Primary processing (Cleaning, classification, dehulling, pounding, grinding, packaging, soaking, winnowing, drying, sieving, whitening, milling)
 - 5.2. Secondary processing (Mixing, cooking, frying, moulding, cutting, extrusion)
6. Product evaluation (Quality control: standard recipes)
7. Packaging (Weighing, labelling, sealing)
8. Marketing (Publicity, selling, distribution)
9. Use (Recipes elaboration: traditional dishes, new dishes)
10. Consumer preferences (Product evaluation, consumer education)

Main elements of the post-harvest system

Harvesting

The time of harvesting is determined by the degree of maturity. With cereals and pulses, a distinction should be made between maturity of stalks (straw), ears or seedpods and seeds, for all that affects successive operations, particularly storage and preservation. Harvesting before maturity entails the risk of loss through moulds and the decay of some of the seeds.

Pre-harvest drying

It is applicable mainly for cereals and pulses. Extended pre-harvest field drying ensures good preservation but also heightens the risk of loss due to attack (birds, rodents and insects).

Transport

Much care is needed in transporting a really mature harvest, in order to prevent detached grain from falling on the road before reaching the storage or threshing place. Collection and initial transport of the harvest thus depend on the place and conditions where it is to be stored, especially with a view to threshing.

Postharvest drying

The length of time needed for full drying of ears and grains depends considerably on weather and atmospheric conditions. In case of unprotected drying floor the products can be wasted due to livestock, birds, rodents or small ruminants or other factors. On the other hand, if grain is not dry enough, it is vulnerable to mould and can rot during storage.

Moreover, if grain is too dry it becomes brittle and can crack after threshing, during hulling or milling. This applies especially to rice if milling takes place a long time (two to three months) after the grain has matured, when it can cause heavy losses. During winnowing, broken grain can be removed with the husks and is also more susceptible to certain insects (e.g. flour beetles and weevils). Lastly, if grain is too dry, this means a loss of weight and hence a loss of money at the time of sale.

Threshing

If a harvest is threshed before it is dry enough, this operation will most probably be incomplete. Furthermore, if grain is threshed when it is too damp and then immediately heaped up or stored (in a



granary or bags), it will be much more susceptible to attack from micro-organisms, thus limiting its preservation.

Storage

Facilities, hygiene and monitoring must all be adequate for effective, long-term storage. In closed structures (granaries, warehouses, hermetic bins), control of cleanliness, temperature and humidity is particularly important. Damage caused by pests (insects, rodents) and moulds can lead to deterioration of facilities (e.g. mites in wooden posts) and result in losses in quality and food value as well as quantity.

Processing

Excessive hulling or threshing can also result in grain losses, particularly in the case of rice (hulling) which can suffer cracks and lesions. The grain is then not only worth less, but also becomes vulnerable to insects such as the rice moth (*Corcyra cephalonica*).

Marketing

Marketing is the final and decisive element in the post-harvest system, although it can occur at various points in the agro-food chain, particularly at some stage in processing. Moreover, it cannot be separated from transport, which is an essential link in the system.

Types of postharvest processing

The post-harvest system encompasses a sequence of activities and operations that can be divided into two groups:

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Comparison between properties of cereals and roots and tubers regarding their storage capacity

Non-perishable food crops	Perishable food crops
• Harvest mainly seasonal, need for storage of long duration	• Possibility of permanent or semi-permanent production, needs for short-term storage
• Preliminary treatment (except threshing) of the crop before storage exceptional	• Processing in dried products as an alternative of the shortage of fresh products
• Products with low level of moisture content (10-15% or even less)	• Products with high level of moisture in general between 50-80 percent
• Small "fruits" of less than 1 g	• Voluminous and heavy fruits from 5 g to 5 kg or even more
• Respiratory activity very low of the stored product, heat limited	• High or even very high respiratory activity of stored products inducing a heat emission in particular in tropical climates
• Hard tissues, good protection against injuries	• Soft tissues, highly vulnerable
• Good natural disposition for storage even for several years	• Products easily perishable, natural disposition for storage between some weeks up to several months (strong influence of the varieties)
• Losses during storage mainly due to exogenous factors (moisture, insects or rodents)	• Losses due partly to endogenous factors (respiration, transpiration, germination) and partly to exogenous factors (rot, insects)

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Post-harvest losses

- In developing countries, where nearly 65% of lost food occurs at the production, processing and postharvest stages.
- Depending on the crop, between 15 and 35% of food may be lost before it even leaves the field.
- Food spoilage and waste account for annual losses of US\$310 billion in developing countries.



Fig. Typical ranges of weight losses for various links in the postharvest chain

Losses are measurable reduction in foodstuffs and may affect either quantity or quality (Tyler and Gilman, 1979).

Loss should not be confused with damage, which is the visible sign of deterioration, for example, chewed grain and can only be partial. Damage restricts the use of a product, whereas loss makes its use impossible.

Damage: Damage is a clear deterioration in the product, e.g. broken or pitted grain, which affects more its quality than its quantity and can in the long-term result in a definite loss. Both damage and loss should be quantified in terms of weight and cost.

Grains may be lost in the pre-harvest, harvest and post-harvest stages.

Pre-harvest losses occur before the process of harvesting begins, and may be due to insects, weeds and diseases.

Harvest losses occur between the beginning and completion of harvesting, and are primarily caused by losses due to shattering.

Postharvest losses occur between harvest and the moment of human consumption. They include on-farm losses, such as when grain is threshed, winnowed and dried, as well as losses along the chain during transportation, storage and processing.

Types of losses

Quantitative loss: Quantitative loss is a loss in terms of physical substance, meaning a reduction in weight and volume and can be assessed and measured.

Qualitative loss: Qualitative loss is concerned particularly with the food and reproductive value of products and requires a different kind of evaluation.



Direct loss: Direct losses occur when the disappearance of a foodstuff is caused by leakage (for example, spillage from bags) or consumption by pests (insects, rodents, birds).

Indirect loss: Indirect losses occur when a reduction in quality leads to the consumer's refusal to purchase.

Weight loss: While weight loss is easy to observe and measure, it does not necessarily mean food loss, since it can result simply from a reduction in moisture content. Moisture loss during drying is therefore not a food loss. On the other hand, an abnormal increase in weight through moisture absorption following rainfall on stocks left in the open can cause serious damage resulting in loss.

Weight loss can be caused by leakage, during transport for example, if sacks have holes or are insecurely attached. It is often the result of prolonged infestation and consumption by insects, rodents and birds or poor packaging.

Quality loss: Quality criteria cover a wide range and are concerned both with external features, shape and size and with odor and taste. The cultural factors that can influence diets and food habits must also be borne in mind.

The cleanliness and healthy condition of a product are primary concerns for the market and correspond to what is referred to as a "sound, legal and merchantable" product in commercial law. Many other objects can be mixed in with a foodstuff and reduce its value: bad grain, scraps of straw or other plant residue, soil, pebbles, bits of glass, etc. All such objects are hard to remove but some of them represent a greater risk of contamination than others: the soluble excreta of pests, oils, pesticides, pathogenic organisms spread by rodents and toxins from fungi and moulds.

Commercial loss: Commercial loss is the translation of the various types of loss into economic and monetary terms. Although the price of a foodstuff is usually based on weight, many other factors play a part. This applies especially to the qualitative elements emphasized above, starting with cleanliness and purity, which will be all the more sought after if supplies are abundant in the market-place.

Although this kind of market-oriented attitude depends on an individual's skills, it also has some collective aspects that deserve development. For the present, we would note that the ability to capitalize on a product depends on a number of technical and economic factors.

Irreducible losses and compensation: While loss of weight during drying is normal and measurable, there are other, said "irreducible" losses, which arise basically from respiration of the product and mechanical rubbing of grain against itself, as well as the breakage inevitable with certain machines. It should therefore always be remembered that losses, whether pre-harvest or post-harvest (i.e. in production, distribution, storage or marketing) cannot be materially reduced to zero and that they have to be compensated for through extra production.

Factors affecting postharvest losses

- Pre-harvest production practices
- Harvesting and field handling
- Packing or packaging
- Storage
- Transport
- Market handling
- Perishability of the produce.

Pre-harvest production practices

Pre-harvest production practices may seriously affect post-harvest returns in quality and quantity and result in the rejection or downgrading of produce at the time of sale. Some of them are:



- Water supply (Irrigation)
- Soil fertility (use of fertilizers)
- Cultivation practices
- Use of agro chemicals (pesticides and herbicides)

Harvesting and field handling

- Quality cannot be improved after harvest, only maintained; therefore it is important to harvest fruits and vegetables at the proper stage and size and at peak quality
- Harvest should be completed during the coolest time of the day, which is usually in the early morning, and produce should be kept shaded in the field.
- Handling should be done carefully and gently. Crops intended for storage should be as free as possible from skin breaks, bruises, spots, rots, decay, and other deterioration

Harvesting damage can be prevented by:

- training harvest labor to handle the crop gently;
- harvesting at proper maturity;
- harvesting dry whenever possible;
- handling each fruit or vegetable no more than necessary (field pack if possible);
- installing padding inside bulk bins; and avoiding over or under-packing of containers.

Packing or packaging

For the most part, the preparation of produce for market is carried out in a packing house, which may range from a simple, on-the-farm thatched shed to an automated regional packaging line handling large tonnages of a single commercial crop like citrus fruit.

Pack house handling includes:

- Sorting: removes foreign matter (stones, leaves, debris)
- Cleaning and washing: hand washing or on a line use only clean running water
- Fungicide treatment: post-harvest application of fungicide is usual on crops such as bananas, yams and citrus fruit which are to be stored for a long period or those which undergo long periods of transport to distant markets.
- Quality selection and grading: manually or on a packing line

Suitable packages and handling techniques can reduce the amount of damage to which fresh produce is exposed during marketing. Packaging should be designed to prevent physical damage to produce, and be easy to handle.

Storage

Temperature is the single most important factor in maintaining quality after harvest. Refrigerated storage retards the following elements of deterioration in perishable crops:

- Aging due to ripening, softening, and textural and color changes;
- Undesirable metabolic changes and respiratory heat production;
- Moisture loss and the wilting that results;
- Spoilage due to invasion by bacteria, fungi, and yeasts; undesirable growth, such as sprouting of potatoes



One of the most important functions of refrigeration is to control the crop's respiration rate. The higher the storage temperature, the higher the respiration rate will be. For refrigeration to be effective in postponing deterioration, it is important that the temperature in cold storage rooms be kept as constant as possible. Storage rooms should be well insulated and adequately refrigerated, and should allow for air circulation to prevent temperature variation

Transportation

- Transportation is a big and often the most important factor in the marketing of fresh produce.
- Ideally, transport would take produce from the grower directly to the consumer
- Losses directly attributed to transport conditions can be high

The damage and loss incurred during non-refrigerated transport are caused primarily by mechanical damage and by overheating. Mechanical damages reduce the storability and quality in storage. Overheating promotes natural breakdown and decay, and increases the rate of water loss from produce.

Causes of mechanical damage:

- careless handling of packed produce during loading and unloading;
- vibration (shaking) of the vehicle, especially on bad roads;
- fast driving and poor condition of the vehicle;
- packages stacked too high; the movement of produce within a package increases in relation to its height in the stack

Causes of overheating

- the use of closed vehicles without ventilation;
- close-stow stacking patterns blocking the movement of air between and through packages, thus hindering the dispersal of heat;
- the lack of adequate ventilation of the packages themselves; exposure of the packages to the sun while awaiting transport or while trucks are queuing to unload at their destination.

Market handling

Improper handling may cause damages to crops, especially perishable products.

Perishability of the produce

The products which are more perishable are more sensitive to postharvest damages.

