



PROCESSES IN POSTHARVEST MANAGEMENT SYSTEM



Notes

The primary objective of post-harvest management system is to minimize losses or wastage of agricultural produce. In the current scenario of rising population and slow growth in agricultural production, the challenge is to ensure sustainable food security without harming the environment. Although agricultural crop output has expanded significantly in recent decades, the development and implementation of post-harvest technologies have lagged behind. Mechanical, microbiological, and physiological losses account for approximately 15% of post-harvest losses. The processing and value addition of extremely perishable commodities, such as horticultural produce, require timely attention and special interventions. Therefore, pre-harvest factors, harvesting, market preparation activities (including pre-cooling, sorting, grading, packaging, and on-farm storage), transportation, storage, value addition/processing, and by-product waste management are all crucial components of the post-harvest value chain and an integral part of the post-harvest management system.



LEARNING OUTCOMES

After studying this lesson, the learner:

- identifies various processes of post-harvest management system;
- describes the methods of fruits and vegetables processing; and
- explains the cereal processing techniques.

13.1 PROCESSES INVOLVED IN POST HARVEST MANAGEMENT SYSTEM

From harvest to consumption, food commodities often go through many post-harvest stages and procedures as given below:

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1. Harvesting
2. Threshing (mainly food grains, pulses and oilseeds)
3. Drying
4. Transportation
5. Storage
6. Processing
7. Product quality control and standardization
8. Packaging (sealing, packaging and labeling)
9. Marketing (advertisements and distribution)
10. Product utilization (preparation and consumption of traditional dishes)
11. Buyer preferences (product evaluation, and consumer education)



Fig. 13.1: Processes/steps involved in post harvest management

13.1.1 Harvesting

The harvesting time of a crop depends on the degree of maturity, which is determined by crop-specific maturity indices. The goal of harvesting is to gather the produce from the field at the proper maturity with minimum damage. Maturity indices include 1) skin colour 2) form 3) shape 4) size 5) optical techniques (light transmission), 6) ripening,

and 7) hardness. When assessing the level of ripeness of fruits and vegetables, factors such as size, colour development, basic biochemical analysis, and the number of days from full bloom to harvest (DFFB) are also taken into account. For instance, the maturity index for oranges is the brix:acid ratio.

Harvesting of produce either before or after the optimal maturity stage can increase the risk of loss due to physiological or microbial factors.

13.1.2 Threshing

This procedure involves detaching the grain from the earheads or straw, using methods such as rubbing, beating, striking, or stripping. Threshing can be done either mechanically or manually. Traditionally, groundnuts are shelled by hand, while grains and pulses are threshed by beating them with a stick. The moisture in grains and the husk at the time of threshing is a critical factor. Mechanical and microbial damage are more likely to occur if threshing is done too early, particularly when the moisture content is high.

13.1.3 Pre-harvest drying

Proper pre-harvest field drying of cereals and pulses ensures good-quality preservation. However, it increases the risk of losses due to attack of birds, rodents, insects, moulds, and unfavourable weather conditions. Thus, proper care of the crop is required for protection from insect-pests.

13.1.4 Post-harvest drying

If grains are not dried properly and stored immediately in a granary, they are more prone to storage losses. Thus, it is necessary to bring the moisture content to optimum level (around 14%) through drying processes, such as sun drying, artificial dryers and shed drying. In case of cereals, the time required for drying is significantly influenced by weather conditions. Improper drying methods, such as using terraces, cribs, or unroofed threshing floors, can lead to damage from birds, small ruminants, and rodents. They deteriorate the quality of produce and may make the produce unmarketable.

A. Methods of drying

- ❖ **Natural drying:** This type of drying is done under the natural sun on rocks, mats, plastic sheets, or by hanging above fireplaces.
- ❖ **Artificial drying:** This process involves drying of grains or other produce in controlled environments with forced ventilation of heated air in specially



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designed chambers or dryers. It is faster drying method particularly for high value produce.

B. Monitoring the drying process

Drying can be monitored using methods such as:

- ❖ Touching and tasting the grains
- ❖ Rubbing or walking on threshed grains
- ❖ Pressing grains with thumbs
- ❖ Observing physical appearance
- ❖ Gravimetric analysis
- ❖ Using moisture meter

C. Advantages of drying

Drying offers several benefits i.e. it reduces bulkiness, maintains viability of the harvested produce, lowers agricultural losses, reduces the risk of mould infection and aflatoxin contamination of seeds, minimizes storage grain pest infestation, extends the shelf life, and facilitates shipping and packing.

D. Disadvantages of drying

- ❖ Grain that is over dried becomes brittle and is more likely to shatter during processing (e.g., hulling, milling, or threshing).
- ❖ Damaged grain can be removed with the husk during winnowing and is more vulnerable to some insects and pests (e.g., flour beetles and weevils).
- ❖ Excessive drying of grain can lead to weight loss, reducing the sale value.

13.1.5 Transportation

A fully mature crop must be transported carefully to the threshing floor or collection site. Use elevated areas in field as a site for the threshing floor to avoid spoilage from unexpected rains. The produce must be transported in bags, baskets and open trolleys with proper care from the threshing floor to the grading and packaging facility, and then finally to the distant market. For long-distance transportation, covered wagons, bulk containers, and bags are commonly used. Transportation of perishable commodities is more challenging, and therefore need special care and carriers, such as proper packaging materials in trucks, cold storage, cold chain trucks, etc.

**A. Precautions during transportation**

- ❖ To avoid bruising, storage in godowns and cold stores must be done with proper care.
- ❖ Prevent excessive loading and inadequate handling
- ❖ Ensure adequate aeration while stacking the produce in trucks
- ❖ Take care during loading and unloading of the produce
- ❖ Select appropriate mode of transport and plan route effectively

**INTEXT QUESTIONS 13.1**

1. Maturity indices for orange for harvesting is
 - a. TSS
 - b. % Sugar
 - c. % Acid
 - d. Brix: acid ratio
2. What is threshing?
3. Name any two advantages of drying.
4. Write two precautions to reduce transportation losses.

13.1.6 Storage

For effective and long-term preservation, attention to hygiene, monitoring, and proper storage facilities is essential. Management of cleanliness, temperature, and humidity is particularly crucial in enclosed structures like granaries, warehouses, and hermetic bins. For example, mango, banana, and cucumber should be stored at temperatures of 8°C, 10-13°C, and 4-5°C, respectively. Farmers use various storage options including granaries, jute bags, clay pots, baskets, underground pits, metal drums, and bins or mud plaster bins.

A. Factors affecting the choice of granaries

- a. The quantity of food produce to be stored

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- b. The duration of storage
- c. The cost of storage infrastructure
- d. The expenditure on construction

B. Precautions for a quality store

- a. A quality store should protect the grain from rats, birds, poultry and domestic animals, while also allowing for cooling and drying.
- b. Keep the livestock away from the store and clean any animal droppings from the surroundings to deter rodents
- c. Stores should be located in areas not prone to water logging or natural floods.
- d. Stores should not be positioned next to trees that could provide access points for rats and insects.
- e. Avoid areas prone to strong winds that could harm the buildings or other infrastructure of the storage facility
- f. Prevent roof-top leakage and maintain the store in good condition
- g. The storage bins must be cleaned every time before filling grains. The used bags should be immersed in hot water and dried thoroughly to kill any insects present in it.
- h. Conduct regular inspections of the store, ideally at weekly intervals

13.1.7 Processing

- **Primary processing:** It includes washing/cleaning, grading, sorting, dehulling, grinding, soaking, packaging, drying, winnowing, sieving, and milling.
- **Secondary processing:** This involves mixing, drying, cooking, frying, cutting, and extrusion product preparation.

13.1.8 Cleaning/winnowing

Unwanted, non-consumable substances like stones, soil, debris and other impurities in grains are removed through cleaning and screening operations. Winnowing is done to clean threshed crops by blowing in wind or using winnowing machines.

13.1.9 Sorting, Grading and Packaging:

These operations are majorly used for fruit and vegetables.

- **Sorting:** Removes diseased, bruised, rotten, bird eaten fruits or vegetables
- **Grading:** Ensures uniformity and quality by selecting healthy fruits and vegetables for marketing, sorted by size and colour
- **Packaging:** Fruits and vegetables are wrapped individually or in groups and packed in appropriate containers or boxes.



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13.1.10 Packaging

Packaging is crucial for maintaining the quality of fresh horticultural produce until it reaches the consumer.

- Some vegetables like cauliflower and cabbages come from the field in large quantities with large portions of inedible parts. Prior to marketing, these inedible parts can be removed to cut down the transportation costs.
- Various vegetables, such as beans, peas, onion, garlic, okra, and potatoes, as well as many fruits, such as citrus, mango, and cull apples are packed using traditional packaging methods such as bamboo baskets, gunny sacks, and wooden baskets. However, boxes made up of corrugated fibre board are also utilized for packing of fruits like apples, stone fruits, oranges, grapes, sapota etc. whereas, most of the cut flowers are packed in cardboard boxes.

13.1.11 Marketing

Marketing is the last and most important step in the post-harvest system, which involves the movement of agricultural products from farm/field to the consumer. It is essential to form a link between farm products, retail chain, food industries and consumers.



INTEXT QUESTIONS 13.2

1. For the best storage of mangoes, temperature should be
 - a. 6°C
 - b. 8°C

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- c. 5°C
 - d. 3°C
2. The most appropriate packaging material used for cut flowers is
 - a. Plastic boxes
 - b. Caretes
 - c. Wooden boxes
 - d. Cardboard boxes
3. Used bags in store should be immersed in to kill insects.

13.2 PROCESSING OF FRUITS AND VEGETABLES

13.2.1 Primary Processing of Fruits and Vegetables

Fruits and vegetables can be prepared for immediate marketing using straight forward basic processing procedures including sorting, grading, trimming, surface drying, washing, and packaging. Various technologies and equipments are available for these primary processing tasks including farm-level fruit and vegetable washing machines, hydro cooler-cum-washers, basket centrifuges, tamarind dehullers and deseeders, pomegranate aril removers, washing and polishing machines, cleaner-cum-graders. These tools facilitate efficient processing and preparation of produce for market readiness.

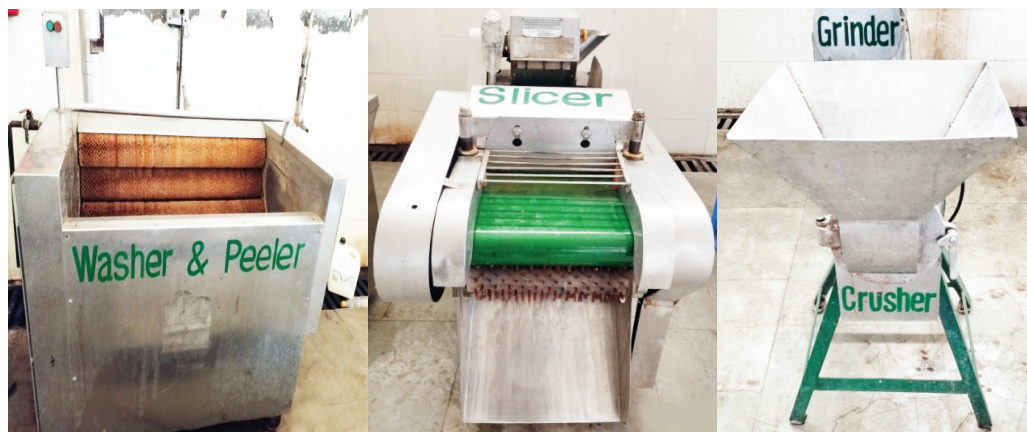


Fig. 13.2 Primary processing equipments
a) washer & peeler b) slicer c) crusher



Notes

13.2.2 Secondary Processing

1. **Drying:** It is a commonly used and cost-effective method for preserving horticultural produce. Aromatic or medicinal plants can be dried using mechanical, poly tunnel, or sun dryers. For example, vegetables are typically dried to a moisture content of 3-5 %.



Fig. 13.3a



Fig. 13.3b

Fig. 13.3 Drying equipments **a)** drum dryer and **b)** spray dryer

2. **Osmotic dehydration:** This process involves the partial removal of water by immersing the produce in sugar syrup, followed by drying in a mechanical dehydrator. Currently, osmotic dehydration is a widely acknowledged method for creating products with satisfactory sensorial quality and intermediate moisture levels.

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3. **Processing of lesser utilized fruits:** Fruits such as aonla, bael, aloe vera, and jack fruit are often processed because they cannot be consumed in large quantities in their natural state. Products made from these fruits include high-fiber and antioxidant-rich drinks, cashew apple powder mixed with 2% cereal flour (for strength), beverages like ripe bael drink, RTS (ready to serve), squash, aloe vera gel, etc.
4. **Value addition:** Fruits and vegetables that cannot be sold fresh can be transformed into a variety of products through value addition. Examples include juice concentrates, canned fruits, fruit-based carbonated juices, pickles, pulp extraction, chutneys, preserves, sauces, sweets, RTS beverages, squash beverages, and appetizers.



Fig 13.4a



Fig 13.4b

Fig. 13.4 Value addition equipments a) grinder and b) pulper machine

*Notes*

5. **Fermented products:** The fermentation of fruits into alcoholic drinks is an established practice for utilization of different fruits.
 - a. Champagne (sparkling wine), Brandy, and Still wine: These are commercially produced from grapes.
 - b. Other fermented beverages: Cider, wine, and vermouth can be prepared from fruits like apples, apricots, plums, wild apricots, strawberries, and peaches.
 - c. Fermented vegetables: Sauerkraut and sauerbraten are prepared from cabbage and turnip, respectively.
6. **By-product waste utilization:** Fruit processing industries generate significant amount of waste in the form of pomace (residue left after juice extraction), stones/pits, seeds, and peel. These by-products can be utilized to create a variety of value-added products:
 - a. The extraction of pectin, dietary fibre, and industrial alcohol using pomace.
 - b. Fruit seeds or stones left after fruit processing can be used for oil extraction, whereas fruit pulp can be used in culinary preparation, and medicines.
 - c. Peel oil, peel candy, pectin powder, and animal feed are some of the products produced from citrus peels.

**INTEXT QUESTIONS 13.3**

1. Sauerkraut is a fermented product of
 - a. Cabbage
 - b. Radish
 - c. Turnip
 - d. Beetroot
2. The byproducts generated after fruit processing are
3. The correct value of moisture content in dried vegetable is

a. 6 %	b. 7 %
c. 5 %	d. 8 %

**Notes**

4. Which fruit is commonly used to make champagne?

13.3 PROCESSING OF CEREALS**13.3.1 Primary Processing of Cereals**

It involves several steps including cleaning, sieving, hulling, grading, milling, tempering, grinding, soaking, parboiling, and drying. The milling process turns grains into flour, which is used to prepare various value added products such as bakery items and extruded products. Cereal flours are essential in the production of bread, breakfast cereals, and snack items (extruded snacks) made from major crops like wheat, maize, rice, oats, barley, millets and sorghum.

A. Wheat Flour

Wheat flour contains protein known as gluten. When preparing leavened bread, the ability of gluten to form elastic network within the dough is quite helpful. The gas that yeast releases during fermentation is entrapped by the protein network. This results in increasing the dough volume and form bread with light texture. When leavened bread is made with low-gluten flour, the gas escapes, resulting in flat and heavy bread. There are many grades of wheat flour depending on how much of the whole wheat grain is removed.

B. Cassava Flour

It is fine white flour that is made from cassava tubers. It is common flour used in the preparation of various fried and baked products, such as bread, biscuits, and cakes.

C. Maize Flour

It is generally used to prepare tortillas, and extruded snack foods.

D. Sorghum Flour

Typically, sorghum flour is used to make porridge.

E. Soy/Composite Flour

Soy/composite flour is used to enhance the protein content and balance the amino acid composition of other cereal or pulses flours, such as maize flour. It serves as both a weaning food and in porridge.

F. Special Baker's Flour

This is also known as bread-making flour. These are used to make bread, rolls, and pastries. It requires a high amount of gluten to be present in baking flour for the creation of light and airy bread.

Various extraction rates of flour can be found in the following:

1. Whole grain flour: 100% extraction (used for brown bread and high fibre products)
2. Wheat meal flour: 90- 95% extraction
3. Straight run flour: 70-72% extraction

13.3.2 Secondary Processing of Cereals

Secondary processing of cereals involves adding value to primary cereal products such as whole grains, flakes or flour. This process uses these base materials to create a variety of products and diversify dietary options.

The common techniques in secondary processing of cereals include baking, fermentation, flaking, puffing, frying, and extrusion.

- A. Puffing:** Puffed grains are often consumed as snacks or breakfast cereals. The process of puffing involves applying extremely high steam pressure to grains, causing them to expand and “pop” (the grain to explode and turn inside out). The puffed grains can be further processed by coating, toasting, or mixing with other ingredients.



Fig 13.5 Puffed rice



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- B. Flaking:** It involves partially cooking of grains in steam to soften them, followed by rolling or pressing them into flakes and drying. The resulting flakes should have a moisture content of less than 7% and be consumed crisp. This process turns grains into ready-to-eat (R-T-E) products.



Fig. 13.6 Flaked rice

- C. Fermentation:** A variety of processed products can be produced by fermenting cereal flour. Fermented products include bread, beer, soy sauce, and other items made from cereal flours, grains, and baking batters and doughs.
- D. Extrusion:** Extrusion is the process where dough is heated and forced through a small hole to create specific strands or structures, which are then dried. The extruded products can undergo additional processing such as frying, drying, or boiling. Pastas, noodles, and breakfast cereals are examples of extruded foods.



INTEXT QUESTIONS 13.4

- Flour is produced through the process of
 - Drying
 - Milling
 - Parboiling
 - Sieving
- Protein present in wheat flour is
- Secondary processing of cereal includes

4. Which type of flour is used to increase protein content in cereal flour?
- Soy flour
 - Maize flour
 - Cassava flour
 - Wheat flour

**WHAT YOU HAVE LEARNT**

- In developing nations like India, the expansion and growth of agricultural value chains for domestic and international markets can be seen as a potent tool for eradicating poverty and addressing the problem of food security.
- India is one of the world's major producers of agricultural produce. India is the world's top producer for spices, lentils, sugarcane, milk and also the second-largest producer of grains, fruits, and vegetables. But huge post-harvest losses in crops are caused by several factors, like the perishability of the commodities, the farmers' poor economic situation, the lack of production planning, lack of infrastructure for cultivation, storage, and packaging operations, and inadequate post-harvest handling facilities.
- Post harvest management is a strategy used on agricultural products after harvest for protection, preservation, processing, packaging, distribution, marketing, and utilization to meet the population demands for food, nutrition, and financial security.
- From a broader perspective, it involves a number of operations, including grading, post-harvest processing, waste management, labelling, packaging, storage, and marketing.

**TERMINAL QUESTIONS**

1. Enlist and explain the various steps in post harvest management system.
2. Differentiate between primary and secondary processing techniques.
3. What are the disadvantages of over drying?

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4. How is process of drying monitored?
5. What is flour? Describe various types of flour.
6. What are the factors that need to be considered during the choice of granaries?
7. Discuss secondary processing of fruits and vegetables.
8. What are the techniques for secondary processing of cereals? Explain in brief.

**ACTIVITY**

Conduct the shelf-life study of the following food products. Keep the food product as it is and observe how the appearance of food material changes over the period of time. Take note of number of days required for each of the food to become unfit (rotten/spoiled) for human consumption.

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Food type	Observed changes during the study	Number of days until spoilage
Milk		
Mango		
Apple		
Potato		
Puffed rice		
Wheat flour		

**ANSWERS TO INTEXT QUESTIONS****13.1**

1. Brix: acid ratio (option d)
2. Threshing is a procedure of rubbing, striking, or stripping to separate grain from the plant.
3. Drying decreases the bulk volume of the produce and lowers the risk of mould infestation in seeds.
4. Avoid excessive loading and proper aeration to the stored products

13.2

1. 8°C (option b)
2. Cardboard boxes (option d)
3. Hot water

13.3

1. Cabbage (option a)
2. Pomace, stone/pits, seeds and peel
3. 5% (option c)
4. Grape

13.4

1. Milling (option b)
2. Gluten
3. Baking, fermentation, flaking, puffing, frying, and extrusion
4. Soy flour (option a)

*Notes*

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GLOSSARY

Dehulling: It is the process of removing the hull or outer covering of any grains or seeds. Dehulling can be performed for several types of grain like rice, soybean, etc.

Squash: It is a non-alcoholic beverage containing at least 25% fruit juice or pulp and 40-50% TSS (total soluble solid). Squashes are diluted before serving.

Ready-to-serve (RTS) beverage: This is type of fruit beverage that contains minimum 10% fruit juice and 10% TSS (total soluble solid). This beverage is called RTS because they are not diluted before serving.

Vermouth: This is a type of wine fortified with herbs or botanicals. It is used for medicinal purposes.

Cider: Cider is an alcoholic beverage made from fermented apple juice.

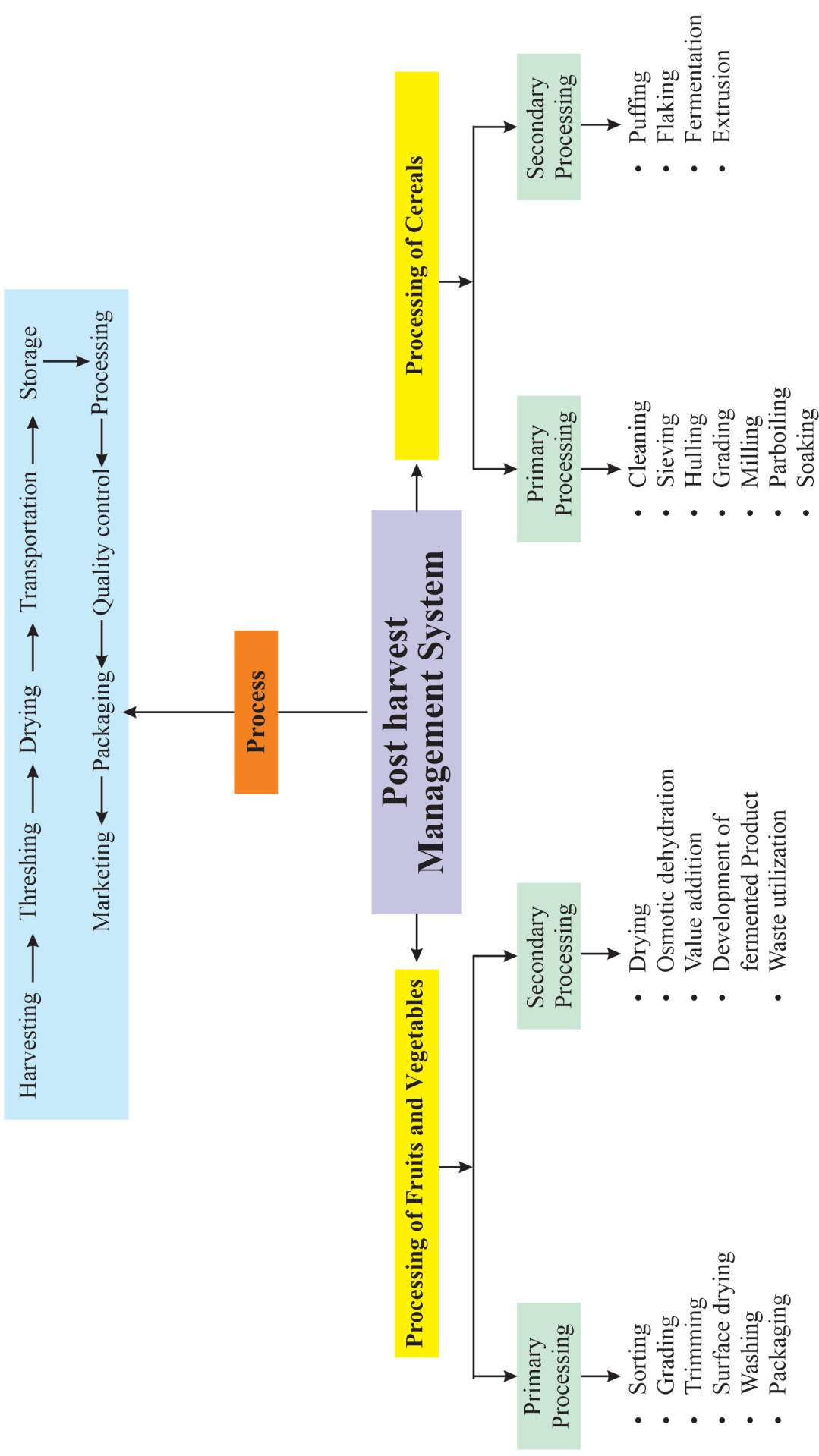
Tortilla: A thin, circular unleavened/unraised flat bread made from maize flour.

Porridge: A soft and thick dish made from boiling grains or legumes in water or milk. Usually, it is served hot during breakfast. Most common example is oatmeal or oat porridge.

SUGGESTED READINGS

1. Scott, S. (2022). *Introduction to Postharvest Management*, Murphy & Moore Publishing, USA.
2. Baxter, E. (2019). *Postharvest Management*, Callisto Reference, USA.
3. Hasanuzzaman, M. (2014). *Postharvest Technology*, www.hasanuzzaman.webs.com. (https://hasanuzzaman.weebly.com/uploads/9/3/4/0/934025/postharvest_technology.pdf)

WHAT YOU HAVE LEARNT





NOTE

This image shows a blank sheet of white paper with horizontal ruling lines. In the top-left corner, there is a small graphic of a red binder ring holding a piece of paper with diagonal lines. The rest of the page is filled with evenly spaced horizontal lines for writing.