Post harvest technology in horticultural crops

Horticulture plays a significant role in Indian Agriculture. It contributes about 30% GDP from 11.73 % of its arable land area. India is the second largest producer of both fruits and vegetables in the world next to China. Despite of being a huge producer of fruits and vegetables, a considerable amount of fruits and vegetables produced in India is lost due to improper post-harvest operations. As a result there is a considerable gap between the gross production and net availability. Furthermore, only a small fraction of fruits and vegetables are utilized for processing (less than 1%) and exported (Fruits – 0.5% and Vegetables – 1.7%) compared to other countries.

Fresh horticultural crops are diverse in morphological structure (roots, stems, leaves, flowers, fruits etc.), composition, and general physiology. Thus, commodity requirements and recommendations for maximum postharvest life vary among the commodities. All fresh horticultural crops are high in water content and are subject to desiccation (wilting, shriveling) and mechanical injury. They are also susceptible to microbial attacks by bacteria and fungi, with pathological breakdown. Biological (internal) causes of deterioration include respiration rate, ethylene production and action, rates of compositional changes (associated with color, texture, flavor, and nutritive value), mechanical injuries, water stress, sprouting and rooting, physiological disorders, and pathological breakdown. The rate of biological deterioration depends on several environmental (external) factors, including temperature, relative humidity, air velocity, and atmospheric composition (concentrations of oxygen, carbon dioxide, and ethylene), and sanitation procedures. Fresh fruits and vegetables play a very significant role in human nutrition, especially as sources of vitamins (Vitamin C, Vitamin A, Vitamin B6, thiamine, niacin), minerals, and dietary fiber. Other constituents that may lower risk of cancer and other diseases include flavonoids, carotenoids, polyphenols and other phytonutrients. Postharvest losses in nutritional quality, particularly Vitamin C content, can be substantial and are enhanced by physical damage, extended storage duration, high temperatures, low relative humidity, and chilling injury of chilling-sensitive commodities.

Post harvest losses in fruits and vegetables are very high (20-40%). About 10-15% fresh fruits and vegetables shrivel and decay, lowering their market value and consumer acceptability. Hence, minimizing these losses can increase their supply without bringing additional land under cultivation. Improper handling and storage cause physical damage due to tissue breakdown. Mechanical losses include bruising, cracking, cuts, microbial spoilage by fungi and bacteria, whereas physiological losses include changes in respiration, transpiration, pigments, organic acids and flavour.

NATURE AND CAUSES OF POST-HARVEST LOSSES:

Losses occurred after harvesting is known as post harvest losses. It starts first from the field, after harvest, in grading and packing areas, in storage, during transportation and in the wholesale

and retail markets. Several losses occur because of poor facilities, poor management, market disfunction or simply the carelessness of farmers.

(a) Extend of post-harvest loss:

It is evident that the estimation of post-harvest loss is essential to make available more food from the existing level of production. It is estimated that production of fruits and vegetables in the country is lost due to wastage and value destruction. Swaminathan Committee (1980) reported the post-harvest handling accounts for 20-30% of the losses at different stages of storage, grading, packing, transport and finally marketing as a fresh produce or in the processed form. According to Chadha (2009) India loses about 35-45% of the harvested fruits and vegetables during handling, storage, transportation etc. leading to the loss of Rs. 40,000 crores per year.

(b) Important sites of post-harvest losses:

Important sites where post-harvest losses are noticed in India are — Farmer's field (15-20%), Packaging (15-20%), Transportation (30-40%), Marketing (30-40%)

CAUSES OF POST-HARVEST LOSSES:

Horticultural crops not only provide nutritional and healthy foods to human beings, but also generate a considerable cash income for growers. However, horticultural crops typically have high moisture content, tender texture and high perishability. If not handled properly, a high value nutritious product can deteriorate and rot in a matter of days or hours.

The causes of postharvest losses can be divided into different categories:

1. **Metabolic:** All fresh horticultural crops are live organs. The natural process of respiration involves the breakdown of food reserves and the aging of these organs.

2. **Mechanical:** Owing to their tender texture and high moisture content, fresh fruits and vegetables are very susceptible to mechanical injury. Poor handling, unsuitable containers, improper packaging and transportation can easily cause bruising, cutting, breaking, impact wounding and other forms of injury.

3. **Developmental:** These include sprouting, rooting, seed germination, which lead to deterioration in quality and nutritional value.

4. **Parasitic diseases:** High post-harvest losses are caused by the invasion of fungi, bacteria, insects and other organisms. Micro-organisms attack fresh produce easily and spread quickly, because the produce does not have much of a natural defense mechanism and has plenty of nutrients and moisture to support microbial growth.

5. **Physiological deterioration:** Fruits and vegetable cells are still alive after harvest and continue their physiological activity. Physiological disorders may occur due to mineral deficiency, low or high temperature injury or undesirable atmospheric conditions, such as high

humidity, physiological deterioration can also occur spontaneously by enzymatic action leading to over-ripeness and senescence, a simple aging phenomenon.

6. **Lack of market demand:** Poor planning or inaccurate production and market information may lead to over production of certain fruits or vegetables which can't be sold in time. This situation occurs most frequently in areas where transportation and storage facilities are inadequate. Produce may lie rotting in production areas, if farmers are unable to transport it to people who need it in distant locations.

7. **Consumption:** These losses can be due to inadequate preservation methods at home, methods of cooking and preparation such as peeling, consumption styles etc.

8. **Others —**

- Lack of clear concept of packing house operations.
- Lack of infrastructure and late realization of its importance
- Inadequate technical support
- Wide gap in technologies available; Inadequate post-harvest quality control. Inadequate market facilities; Unorganized marketing.
- Poor storage facilities; Absence of pre-cooling and cold storage.

IMPACT OF POST-HARVEST LOSSES:

Post harvest losses of horticultural crops affect both the nutritious status of the population and economy of the country.

Nutrition: Fruits and vegetables are rich source of vitamins and minerals essential for human nutrition. These are wasted in transit from harvest to consumer representing a loss in the quantity of a valuable food. This is important not only in quantitative terms, but also from the point of view of quality nutrition.

Economy: Careless harvesting and rough handling of perishable fruits and vegetables results in bruise and scar the skin, thus reducing quality and market price. Such damaged produce also fails to attract the international buyers, and incurs less profit to the exporting country. This ultimately results in huge economic losses to the country. For improving the situation, it is essential to create awareness among growers, farm workers, manager's traders and exporters about the extent of losses being incurred and their economic consequences. These groups of people involved in the fruit industry also need to learn the basic principles of fruit handling and storage.

TECHNOLOGIES FOR MINIMIZING THE LOSSES:

Fruits and vegetables are perishable in nature. Scientific harvesting and handling are the practical way to reduce the losses due to physical damage, spoilages, due to insect damages and microbial growth. Various protocols are standardized and available for adoption to get the best result, which will give economic benefits. Similarly, proper storage conditions with suitable temperature and humidity are needed to lengthen the storage life and maintain quality once the crop has been cooled to the optimum storage temperature.

Temperature is the most important environmental factor that influences the deterioration of harvested commodities. Most perishable horticultural commodities last longest at temperatures near 0ºC. At temperatures above the optimum, the rate of deterioration increases 2 to 3 fold. Temperature influences how other internal and external factors influence the commodity. The freezing point of their tissues is relatively high (ranging from -3°C to -0.5°C), and the disruption caused by freezing usually results in immediate collapse of the tissues and total loss of cellular integrity. Some commodities respond unfavorably to storage at low temperatures and so it is necessary to maintain proper temperature to prevent injuries caused by chilling or freezing.

Relative humidity (RH) is the moisture content of the atmosphere at a given temperature and pressure without condensation. The moisture holding capacity of air increases with temperature. An appropriate RH range for storage of fruits is 85 to 95% while that for most vegetables varies from 90 to 98%. The optimal RH range for dry onions and pumpkins is 70 to 75%. Some root vegetables, such as carrot, parsnip, and radish, can best be held at 95 to 100% RH

Greater emphasis need to be given on the training of farmers, creation of infrastructure for cold chain with common facilities for sorting, grading, packing and post harvest treatments in all major markets.

Some technologies for minimizing post-harvest loss or extension of shelf life of fruits and vegetables are:

1. Curing of certain root, bulb, and tuber vegetables to encourage wound healing and drying of outer tissues. This is an essential step for reducing water loss and disease infection during subsequent storage.
2. Cleaning followed by removal of excess surface moisture to avoid creating a microenvironment that is favorable to growth of decay-causing pathogens during subsequent storage and distribution.
3. Waxing or any other protective surface coatings for fruits and vegetables can help in reduction of loss in moisture and rate of respiration which ultimately results in prolonged storage life.

4. Heat treatments (hot water or air, vapor heat) may be used for decay control (such as anthracnose on mango and crown rot on banana) and/or for insect control to meet quarantine requirements for some commodities, such as mango and papaya.
5. Treatment with postharvest fungicides (in the wax or separately) at concentrations that assure that the residue level is below the maximum residue limit (MRL) allowed by the regulatory authorities.
6. Special chemical treatments (sprout inhibitors, scald inhibitors, calcium, growth regulators, ethylene –action inhibitors, such as 1- methylcyclopropene, and/or postharvest fungicides)
7. Fumigation (with methyl bromide or phosphine) or irradiation for insect control to satisfy quarantine requirements of the importing country.
8. Ethylene treatment to de-greening citrus fruits (1-5 ppm ethylene in air), and for ripening climacteric fruits, such as avocado, banana, mango, and tomato (100-150 ppm ethylene in air).
9. **Pre-packaging:** This technology controls the rate of transpiration and respiration and hence keeps the commodity in fresh condition both at ambient and low temperature.
10. **Cold storage:** These structures are extensively used to store fruits and vegetables for a long period and employ the principle of maintaining a low temperature, which reduces the rate of respiration and thus delays ripening.
11. **Modified atmosphere packaging (MAP):** These packaging modify the atmosphere composition inside the package by respiration. This technology is successful to extend the shelf life of (Cavendish banana, carrots, capsicum, green chilli and tomatoes by 15, 14, 13, 8 and 15 days as against 5, 7, 8, 4 and 7 days in control respectively, under ambient conditions. Storage of Papaya can be extended 4 weeks when stored at 10-12 °C under modified atmosphere (MA) conditions by wrapping them in low density polyethylene (LDPE) bag. Using this technique, the fruit can be transported to different markets. Fruits ripen within 3-4 days after arrival when placed at ambient temperature. While using optimum low temperature, storage life of Cavendish banana, capsicum, green chili and tomato can be extended to 42,21,28 and 30 days in comparison to 21, 10,21 and 15 days respectively.
12. **Controlled Atmosphere (CA) storage:** It is based, on the principle of maintaining an artificial atmosphere in storage room, which has higher concentration of CO2 and lower concentration of O2 than normal atmosphere. This reduces the rate of respiration and thus delays aging. This method of storage is very effective when combined with low temperature storage and may be used to extend the postharvest-life of some commodities, such as apple, avocado, cabbage, cherry, mango, pear, persimmon, pomegranate, and tomato.
13. **Irradiation:** It is the newer technologies that can be gainfully employed during storage to reduce post-harvest losses and extend storage life of fruits and vegetable. When fruits and vegetables expose to ionizing radiation (such as gamma-rays) at optimum

dosage delays ripening minimizes insect infestation, retards microbial spoilages, control sprouting, and rotting of onion, garlic and potato during storage. It is also used as a disinfection treatment and controls fruit fly on citrus, mango seed weevil and papaya fruit fly.

14. **Edible coatings:** These are continuous matrices prepared from edible materials such as proteins, polysaccharides and lipids. They can be used as film wraps and when consumed with the food, become an ingredient of the food. They not only minimize the post harvest losses but also need for energy intensive operations and controlled atmosphere storage. They can control migration of gases, moisture, oil, fat, and solutes, as well as retain volatile flavouring compounds. An edible coating improves structural integrity and mechanical handling and carry product so that they help to maintain quality and inhibit microbial growth causing deterioration of the product.