

Importance of Postharvest Technology

India, one of the largest food producer countries (I in milk production, II in fruit and vegetable production and III in food grain production at world level), possesses the potential of being the biggest with the food and agricultural sector contributing around 26 percent of the Gross Domestic Product (GDP). It is a paradox that people of the country producing such huge quantities of food including fruits, vegetables, milk, cereals grains etc. are still suffering from many nutritional deficiencies in their diet, and even in some places, the stomachs of people remain unfilled for the want of food. The credit of this would predominantly go to the poor postharvest infrastructure as well as knowhow and accessibility to the facilities. All this makes us one among those countries having largest postharvest losses. The reduction of losses occurring during food handling, processing, storage, distribution and use would be an indirect way of increasing the food

production and making the country self-sufficient in nutritional requirements.

Fruit : Botanically fruits are ripened ovary. Fruit is a plant part that may or may not be purely derived from ovary of the flowers, may be fleshy or pulpy in character, often juicy and predominantly sweet with some what acidic taste, fragrant aromatic flavours and generally not consumed cooked during principal part of our meals.

Classification of Fruits

- a. *Simple Fruits*: Fruits which develop from a single ovary of single flower. eg. lemon, lime, citrus, peach, apple, pear etc.
- b. *Aggregate Fruits*: Fruits which develop from many ovaries of a single flower. eg. raspberries, strawberries, black berries.
- c. *Multiple Fruits*: Fruits which develop from many ovaries of many flowers. eg. pineapple

Vegetable : These are the plant parts which are less sweet, generally non-acidic and consumed either cooked or raw during the principal part of our main meals. Vegetable may be fruit, root, stem, leaf or flower of plant or their modifications.

Difference between Fruit and Vegetable

Fruit	Vegetable
1. Plant part generally formed from flower (flower part) or inflorescence	1. It can be leaf, stem, root, flower etc.
2. Generally consumed as raw, not during principal meals	2. Generally consumed as cooked during principal meals
3. Generally acidic in nature	3. Generally non-acidic type food
4. Mostly woody perennials	4. Mostly non-woody annuals or biennials
5. Mostly propagated asexually	5. Mostly propagated by seed.

Production Statistics of Fruits and Vegetables in India**Fruits total excluding melons**

Year	Area (ha)	Area (million ha)	Production (tonnes)	Production (million tonnes)
2007	4398400	4.40	51141800	51.14
2006	4165500	4.17	48045000	48.05
2005	4629075	4.63	42462400	42.46
2000	3800275	3.80	41903120	41.90
1990	2513210	2.51	27358959	27.36
1980	2206514	2.21	20357397	20.36
1970	1822084	1.82	15786680	15.79
1961	1549170	1.55	13372500	13.37

Vegetables and melons total

Year	Area (ha)	Area (million ha)	Production (tonnes)	Production (million tonnes)
2007	5674200	5.67	72544600	72.54
2006	6062400	6.06	75933600	75.93
2005	7913600	7.91	91687500	91.69
2000	5463600	5.46	72283700	72.28
1990	4799957	4.80	48936575	48.93
1980	4350600	4.35	35975100	35.97
1970	3489170	3.49	25985900	25.99
1961	2779350	2.78	18468500	18.47

Source: FAO, 2009

Definition

Postharvest technology/Postharvest management may be defined as the branch of agriculture that deals with all the operations right from harvesting or even the pre-harvest stages till the commodity reaches consumer, either in fresh (grains, apple, mango, tomato fruits) or processed form (flour, juice, nectar, ketchup) and utilization of the wastes (pomace, peel, seed, skin etc.) in a profitable manner (manufacture of fermented beverages, colour extraction, pectin extraction etc.).

Whatever unit operations are done with the crops right from the harvesting stage till the product is consumed, all is dealt with in postharvest technology. Sometimes some specific pre-harvest operations i.e. pre-harvest sprays of calcium and boron on fruits that results in improving firmness (postharvest quality) are also dealt with in postharvest technology as these are not the regular agronomic practices but are done to affect the postharvest quality. In postharvest technology we deal with 3 types of products i.e. fresh produce, processed products and handling and processing wastes.

Importance of Postharvest Technology

Worldwide postharvest fruit and vegetables losses are as high as 25 to 40% and even much higher in some developing countries. Reducing postharvest losses is very important, for ensuring that sufficient food, both in terms of quantity and quality is available to every individual in this world. The world population will grow from 5.7 billion (1995) to 8.3 billion in 2025 so, the requirement of food will also increase. Production of a particular crop can be increased to a limited extent by using high yielding varieties and better agronomic practices. Wasting 40% of the production in a certain crop is just like throwing away Rs 4,000/- out of a total salary of Rs 10,000/-, which nobody would ever like to do. Then why do we accept 40% postharvest losses in horticultural crops? For the last many years we have heard and read in many periodicals and books that India ranks second in production of fruits and vegetables in the world, but if we subtract the quantity lost due to postharvest losses, our rank in production of fruits and vegetables in the world would be much lower than what it is at present. Following points shall highlight the importance of postharvest technology.

- a. *Reduction of postharvest losses:* Postharvest technology ensures reduction of losses in what has already been produced. So, reduction of postharvest losses is an alternative way of increasing production of agricultural and horticultural crops.

- b. *Reduction of cost of production:* Postharvest technology reduces cost of production, packaging, storage, transportation, marketing and distribution, lowers the price for the consumer and increases the farmer's income.
- c. *Reducing malnutrition:* Proper postharvest technology ensures availability of sufficient food to all thus reducing malnutrition and ensuring healthy growth of the nation. It also extends the season of availability of a particular commodity.
- d. *Economic loss reduction:* Reduces economic losses at growers level, during marketing and at consumer's end.
- e. *Availability:* Had there been no knowledge of postharvest technology, apples would not have ever reached Kerala and banana in Himachal Pradesh or Kashmir. Today we can get perishable commodities like banana, tomato etc., throughout the year and in almost every place in the country. Apples can be made available through out the year although the cropping season is just for 2-3 months. Thanks to the advancements made in the field of postharvest technology. The increasing exports of fruits and vegetables has become possible only by the interventions made in postharvest technology.
- f. *Employment generation:* The food processing industry ranks first in terms of employment generation with approximately 15 lakhs persons employed. Employment potential in postharvest and value addition sector is considered to be very high. Every Rs. 1 crore invested in fruits and vegetable processing in the organized sector generates 140 persons per year of employment as compared to just 1050 person day of employment per year in Small Scale Investment (SSI) units. The SSI unit in food industry employs 4,80,000 persons, contributing 13% of all SSI units employed.

- g. *Export earnings*: Export of fresh and processed horticultural commodities also attracts valuable foreign exchange.
- h. *Defence and astronaut's requirements*: Defence forces posted in remote border areas as well as astronauts who travel into space have special requirements of ready to eat and high energy low volume food. This requirement is fulfilled by processing industries.
- i. *Infant and sports preparations*: Today special infant and sports drinks and other processed preparations are available for use especially by these people. These preparations are done especially to meet the specific nutritional requirements of their body.

Postharvest Losses

Fruits	Estimated losses (% of total production)	Vegetable	Estimated losses (% of total production)
Papaya	40-100	Potato	35-100
Citrus	20-95	Sweet potato	35-95
Banana	20-80	Lettuce	62
Avocado	43	Tomato	5-50
Stone fruits	28	Cauliflower	49
Grape	27	Carrot	44
Apple	14	Cabbage	37
Overall	30-40 % in different crops	Onion	16-35

Source : Verma and Joshi, 2000

Possible Causes of Postharvest Losses

A significant portion of the world's food harvest is lost to spoilage and infestations on its journey to the consumer. In developing countries, where adverse weather and poorly developed infrastructure contribute to the problem, losses are sometimes of staggering proportions. Postharvest losses occur at all stages beginning with harvesting through handling, storage, processing, marketing till consumption.

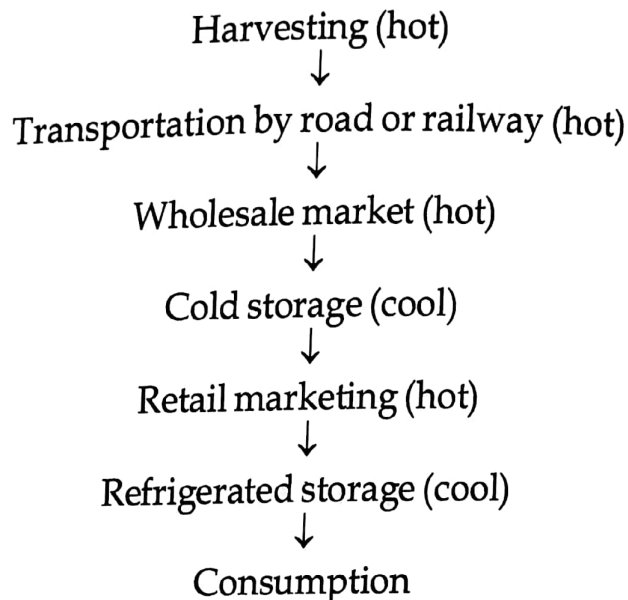
Extent of Postharvest Losses would Depend on the Following Factors

- Perishability of the commodity (more losses in perishables)
- Ambient temperature and RH (high temperatures causing more losses)
- Fungal and bacterial decay (increases at high temperature)
- Damage by pests-insects, rodents and birds
- Time elapsed between harvesting and consumption
- Efficiency of postharvest handling, storage and processing operations.

Reasons for High Postharvest Losses

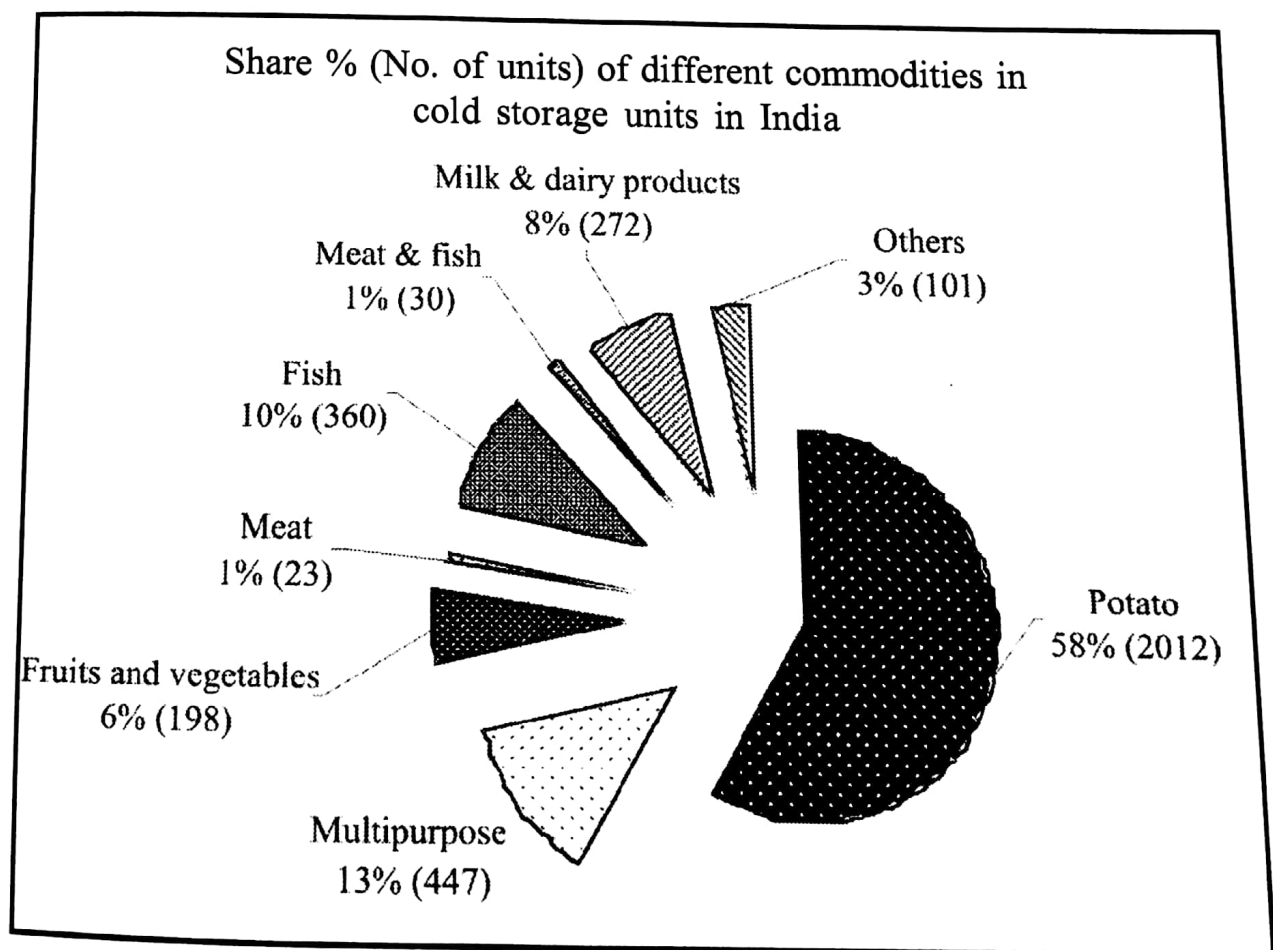
- Unfavourable climate:* India is a country where most of the fruits are available from April to October, which is the hotter part of the year. The high temperature coupled with high humidity during rainy season (June end to Sept) are most congenial for the growth and development of decay microorganisms.
- Poor cultural practices:* In India, farmer does not know that who will be the ultimate buyer or consumer of his produce. He is just producing a particular commodity to sell and earn his living. No cultural practices are practiced to improve the postharvest quality and shelf life. All cultural practices done, aim at improving production and control diseases and pests.
- Improper storage conditions:* We do not have sufficient cold storage facility to store our perishables during the glut period. The "cold chain" in which the commodity is handled at low temperatures from harvesting till consumption and which is often recommended for handling perishables is hardly followed in India. Rather, we sometimes give temperature shocks to the commodity. The commodity is harvested during day time when it is hot, transported in trucks or by railway (un refrigerated),

sold in wholesale markets (in hot), then put into cold storages (some perishables), again transported to retail market and sold there in hot, purchased by consumer and put into refrigerators at home and then consumed.



- d. *Inadequate handling during transportation:* Harvesting in many of the crops is not proper and handling during packaging and transportation is rough and non-scientific thus causing a lot of bruising and impact damage to the commodity and inviting decay during marketing and storage.
- e. *Inadequate facilities available for processing:* India processes less than 2% in organized sector as against 50-70% in some developed countries. The reason is inadequate processing facilities and under-utilization of installed capacity.
- f. *Government policies:* This involves the political conditions under which a technological solution for reducing postharvest losses fails to be effective or is unimplementable, eg. lack of a clear policy for facilitating and encouraging utilization of fruits, vegetables and other horticultural perishables and administration of human, economic, technical and scientific resources to prevent postharvest losses.

- g. *Education and resources*: The human, economic and technical resources and efforts for developing programs for prevention and reduction of postharvest losses of perishables are inadequate. There is a lack of awareness and knowledge of technical and scientific technologies associated with preservation, processing, packaging, transporting, marketing and distribution of horticultural commodities.
- h. *Transportation facilities* : Vehicles used in transporting raw fruits and vegetables in bulk, to the distant markets are not equipped with refrigeration systems. Raw fruits and vegetables when exposed to high (fluctuating) temperatures and humidity during transportation experience moisture loss, softening and bruising of tissues, inviting pathogens and ending in rotting.



Cold Storage Capacity in India

Source: Anonymous, 2008a

Type of Postharvest Losses

- a. Loss of moisture, wilting, shriveling etc.
- b. Loss of carbohydrates, vitamins, proteins etc.
- c. Physical damage through pest, disease, insect/rodents (rotting etc.)
- d. Quality loss due to physiological disorders (chilling injury, freezing injury etc.)
- e. Fibre development (beans)
- f. Greening (potatoes), sweetness loss (pea)
- g. Sprouting (root, shoot growth)
- h. Seed germination
- i. Development of off flavours
- j. Changes in surface colour (green vegetables).

Functions

Postharvest technology aims to-

1. Provide longer shelf life to perishable produce
2. Add value in terms of nutrition and money
3. Maintain and /or improve quality
4. Enhance form, space and time utility of the produce for food, feed, fibre, fuel and industrial purposes.
5. Add variety to the regular food
6. Add convenience for utilization
7. Generate employment and nutritional security
8. Reduce losses and indirectly increase total food production
9. Build a healthy nation.

Postharvest Operations Include

- Harvesting,
- On-farm handling,
- Cleaning, trimming, peeling

- Grading, sorting
- Moisture conditioning,
- Pre-cooling
- Waxing,
- Milling,
- Extraction, pulping
- Heating (pasteurization, sterilization, blanching),
- Cooling (freezing),
- Roasting,
- Puffing,
- Flaking,
- Retort processing
- Packaging, wrapping
- Transport and storage

Processing : The fundamental principle of preservation of food by application of heat is known as processing or more precisely "Heat processing". *Processing* is any conscious unit operation resulting in minor or major alterations in the natural shape, size, form, colour, sensory and chemical characteristics of a natural produce and that adds value in terms of preserving or improving the quality and presentation of the produce and convenience of its use.

Preservation : Extending shelf life of fresh or processed food by using various methods of preservation i.e. asepsis, low temperature, high temperature, drying, chemicals, irradiation, high pressures, electric fields, fermentation, anaerobic conditions, packing etc.

FAO has Categorized Food Processing into 3 Sectors

- a. *Primary Processing*: involving basic processing of natural produce i.e. cleaning, grading, sorting, washing, dehusking etc.

- b. *Secondary Processing*: involving elementary modifications of natural foods i.e. packing, waxing, pulping, juice extraction, preparation and preservation of semi-finished products for later use, hydrogenation of edible oils etc.
- c. *Tertiary Processing*: involving high levels of modifications to considerably alter the natural produce and to make it ready to eat. i.e. ketchup, RTS beverages, ice creams etc.

As far as reduction of postharvest losses is concerned, adoption of primary and secondary processing can alone create a marked difference and would open a number of new avenues for the tertiary processing to be followed.

Today the food processing sector in India has been facing the problems of erratic, inadequate and fluctuating supply of good quality raw materials, inadequate infrastructure, inadequate investment in organized sector, fragmented and unorganized research and development, inadequately trained human resource, lack of quality testing and certification laboratories, lack of short marketing channels, high costs of working capital and taxation and under-utilization of the installed capacity.

Status of Food Processing Industry in India

Food processing is a large sector that covers activities such as agriculture, horticulture, plantation crops, animal husbandry and fisheries. It also includes other industries that use agricultural inputs for manufacturing of edible products. Food processing industry which is worth Rs 350 thousand crores including Rs. 99 thousand crores worth of value added products ranks 5th in terms of production, consumption, export and expected growth in the country.

Processed food industry in India contributes 6.3% of the GDP, and accounts for 13% of export and 6% of the capital investment. India produces about 600 million tonnes of farm produce annually as detailed in the Table ahead.

Production Statistics of Different Agricultural Commodities

Commodity	(in million tonnes)	Rank in the world
Food grains	210	3 rd
Oilseeds	26.1	
Sugarcane	232.3	
Fruits	51.1	2 nd
Vegetables	72.5	2 nd
Milk	90.7	1 st
Fish	6.3	7 th
Eggs	45,000 million Nos.	5 th
Poultry	489 million stock	6 th
Livestock	483 million Nos.	1 st
Meat	6.0	
Honey	9,000 t	
Mushrooms	40,000 t	
Spices	4.1	
Tea	0.83	
Coffee	0.281	
Loose flowers	0.73	
Cut flowers	2060 million Nos.	

Food Processing Industry (FPI) has been recognized as a sunrise industry of the country. Estimated to be about USD 70 billion in 2007, the industry is heading for a fast growth. The important sub sectors of the FPI are fruits and vegetables, milk and milk products, grains, packaged drinks, beer and alcoholic beverages, meat and poultry, fisheries and packaged & convenience foods. Considering the meager level of processing being done at present, the FPI of the country possess a lot of opportunity and scope for growth. It also provides an opportunity to the growers and other stake holders in the agricultural sector to enhance their income through postharvest processing value addition and export. Among all the individual processed food items, milk products account for maximum

value at Rs 4 billion in 2006-07. Fruits and vegetables together constituted Rs.25 billion in 2007. However, export of processed feed like processed meat, milk products, animal casings do fluctuate and do not rise constantly.

Export of Different Processed Food Items from India (Rs billion)

Item	2005-06	2006-07
Fruits and vegetables	24.5	25
Processed meat	0.024	0.068
Milk products	5.5	4
Other processed Food	26.3	36.3

Source : APEDA.

Government Initiatives

- The national policy on food processing aims to increase the level of food processing in organized sector from 2% to 10% in 2010 and 25% in 2025.
- For 100% export oriented units government has decided to levy zero import duty on capital goods.
- For new industries in fruit and vegetable processing, income tax rebate of 100% on profits made during initial 5 years and 25% rebate in the following 5 years has been decided.
- Government also proposes to build terminal markets in 8 major cities i.e. Mumbai, Nasik, Nagpur, Chandigarh, Rai, Patna, Bhopal and Kolkata
- 60 agri-export zones are to be setup for end to end development of exports
- 53 food parks are approved for enabling small and medium food and beverage units.
- National Bank for Agriculture and Rural Development (NABARD) has set aside Rs. 1,000 crore, especially for agro-processing infrastructure and market development.

- Besides reducing excise duty upto zero in some products, cess on coffee export @ Rs. 500 per tonne was abolished. Additional excise duty levied on tea during 2005-2006 is also withdrawn
- Presently, different sectors of food and food processing are regulated by 13 different laws and regulatory orders. Efforts are being made to integrate them.

Level of Processing in Food Processing Sector in India

Item	Level of processing in organized sector	Level of processing in unorganized sector	Total processing
Fruits & Vegetables	1.2%	0.6%	1.8-2.2 %
Milk & Milk products	15%	22%	35-37 %
Meat	21%		21 %
Poultry	6%		6 %
Marine fisheries/ products	1.7%	9%	8 - 10.7%
Shrimps	0.4%	1%	1.4%

Source: Cygnus Report, Indian Food Processing Sector, 2005, MoFPI 2005

Public Private Investment in Postharvest Management and Agricultural Marketing in India During 2006 (in Rs billion)

	Public sector	Private sector	Total Investment
Agri export zone	2	4	6
Cleaning and grading	19	1	20
Cold storage	68	202	270
Fruit and vegetable market	10	-	10
Processing and value addition	375	1125	1500
Refer van	1	5	6
Rural periodic market	21	-	21
Storage	27	27	54

Source: Anonymous, 2008b

Level of Processing in Fruits and Vegetables in Different Countries

UK and USA	60 %
Malaysia	80 %
Thailand	30 %
India	1.8-2.2 %

There are 7,521 regulated markets and 27,294 rural periodic markets (Haat) in the country for handling agricultural produce.

The estimated installed capacity of fruit and vegetable processing industries has increased from 20.8 lakh tonnes (1998) to 21.0 lakh tonnes (1999). The production of processed fruits and vegetables in the country has increased from 9.4 lakh tonnes in 1998 to 9.8 lakh tonnes in 1999 during which the number of licenses issued under Fruit Product Order (FPO), 1955 has increased to 5198 from 5112.

Important Processed Products Manufactured in India

Fruit pulps and juices, fruit based ready-to-serve beverages, canned fruits and vegetables, jams, squashes, pickles, chutneys and dehydrated vegetables. Recently, products like frozen pulps and vegetables, frozen dried fruits and vegetables, fruit juice concentrates and vegetable curries in retortable pouches, canned mushroom and mushroom products have been taken up for manufacture by the industry.

POINTS TO REMEMBER

- ✓ India is the second largest producer of fruits and vegetables and third largest producer of food grains in the world
- ✓ India is the largest producer of milk in the world
- ✓ India ranks 6th in poultry production in the world
- ✓ The processing level of fruits and vegetables in India is 1.8-2.2 %

- ✓ The national policy on food processing aims to increase the level of food processing in organized sector from 2% to 10% in 2010 and 25% in 2025
- ✓ Botanically fruits are ripened ovary. *Fruit* is a plant part that may or may not be purely derived from ovary of the flowers, may be fleshy or pulpy in character, often juicy and predominantly sweet with somewhat acidic taste and fragrant aromatic flavours and generally not consumed cooked during principal part of our meals.
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- ✓ Vegetables are the plant parts which are less sweet, generally non-acidic and consumed either cooked or raw during the principal part of our main meals. Vegetable may be fruit, root, stem, leaf or flower of plant or their modifications.
- ✓ Postharvest technology may be defined as the branch of agriculture that deals with all the operations right from the harvesting or even the pre-harvest stages till the commodity reaches the consumer either in fresh or processed form and utilization of the wastes in a profitable manner.
- ✓ NABARD is National Bank for Agriculture & Rural Development
- ✓ Processing is any conscious unit operation resulting in minor or major alterations in the natural shape, size, form, colour, sensory and chemical characteristics of a natural produce and that adds value in terms of preserving or improving the quality of the produce and convenience of its use.
- ✓ Preservation is extending shelf life of fresh or processed food by using various methods of preservation i.e. asepsis, low temperature, high temperature, drying, chemicals, irradiation, fermentation, high pressures, electric fields, anaerobic conditions, packing etc.

- ✓ FAO has categorized food processing into 3 sectors i.e. primary processing, secondary processing and tertiary processing
- ✓ Food Processing Industry (FPI) has been recognized as a sunrise industry of the country
- ✓ Highest number of cold storages (2012) out of the total in the country are being used for potato in India.