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*Shaping Lives...
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Harvesting and Packhouse Operations





HARVESTING HORTICULTURAL PRODUCE

Harvesting is the gathering of plant parts that are of commercial interest. Harvesting of fruits, vegetables and flowers generally involves separating them from the vital sources of water, nutrients and growth regulators. Harvesting also **bring out wound responses like ethylene production and increased respiration in the tissue**. Mature tissue generally shows only small responses to harvesting because it stored carbohydrates reserves and relatively low respiration and transpiration rates, and its destined for natural separation by abscission any way. **Rapidly metabolizing tissue such as leafy vegetables/immature fruits & vegetables exhibits larger responses to harvesting.**

Harvest the produce when the heat load is low, however around-the-clock harvesting is done when machinery are used to meet the cost of the machine and factory processing schedule.

Harvest: is a specific and single deliberate action to separates the food stuff with or without non edible portion from its growth medium.

Eg - Plucking of F, V & Flowers

- Reaping of cereals

- Lifting of fish from water

- Lifting of tuber or roots from soil *etc.*

Important factors conceded while harvesting crops are:

- Delicacy of the crop (soft –grapes/strawberry: hard - melons)
- Importance of speed during/after harvest
- Economy of the harvest operation.

'Remember damage done to produce during harvest is irreparable'.

Improper harvesting leads to shortening of shelf life due to

- ✓ increased respiration and ethylene bio synthesis
- ✓ increased levels of micro organism infection through damaged areas
- ✓ possible increase in physiological disorder

Employing improper harvesting methods will results in damage to crop by

I. **Cuts** - where produce comes in contact with sharp object during harvesting/ handling

II. **Bruising** - is caused by

- Compression**—due to over filling of boxes, over load in transportations and bulky storing.
- Impact** – due to dropping or something hitting the produce
- Vibration** – occur due to lose packing in transportation

An important precaution at harvest is to

- ✓ Avoid contaminating produce with pathogens. Practice such as **allowing the mango stem end down on the ground** to allow the sap to drain should be discouraged.
- ✓ Harvested produce should be kept under **shaded tree or using tarpaulins/shade nets.**



Harvesting can be performed by hand or mechanically. However, for some crops - eg. onions, potatoes, carrots and others - it is possible to use a combination of both systems. In such cases, the mechanical loosening of soil facilitates hand harvesting. The choice of one or other harvest system depends on the **type of crop, destination and acreage to be harvested**.

Fruits and vegetables for the fresh market are hand harvested while vegetables for processing or other crops grown on a large scale are mainly harvested mechanically (peas, beans, potato *etc.*).

HARVESTING METHOD

I. Hand harvesting

It predominates for the fresh market and extended harvest period (due to climate, there is accelerated ripening and a need to harvest the crop quickly) particularly the produce which is more susceptible to physical injury and soft fruit like grapes/litchis/jamun and strawberry and others berries which are borne on low growing plants.

Benefits of hand harvesting

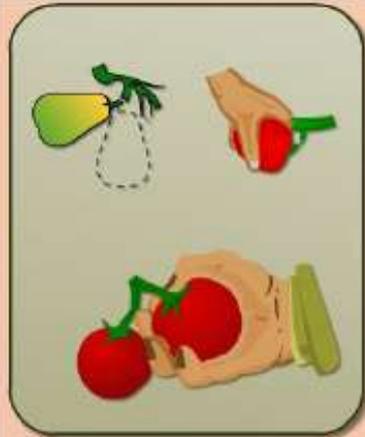
- ✓ hand harvesting is less expensive
- ✓ less damage and harvest rate (times) can be increased,

The main benefit of hand harvesting over mechanized harvesting is that humans are able to select the produce at its correct stage of ripening and handle it carefully. The result is a higher quality product with minimum damage. Examples,

- ✓ Breaking off – twisting off pineapple, papaya, tomato
- ✓ Cutting – snipping off mandarins and table grapes with secateurs and apple, roses *etc*



Different harvesting practices at field



Natural break point



Cooling GLV in the tub at the field



Harvest containers



Harvesting from the sharp tools



Use of sack to break the fall



Use of plastic sheet for collecting fallen fruit

Harvesting methods is also use full reducing incidence of fungal infection in papaya/grapefruit.-When fruit are cut from the tree using clipper shows less infection then the harvesting by twisting and pulling (Fig.).

But harvesting small fruits and from thorny plants are major obstacle(disadvantage).

Harvesting



Packaging



Storage



Transportation



Marketing

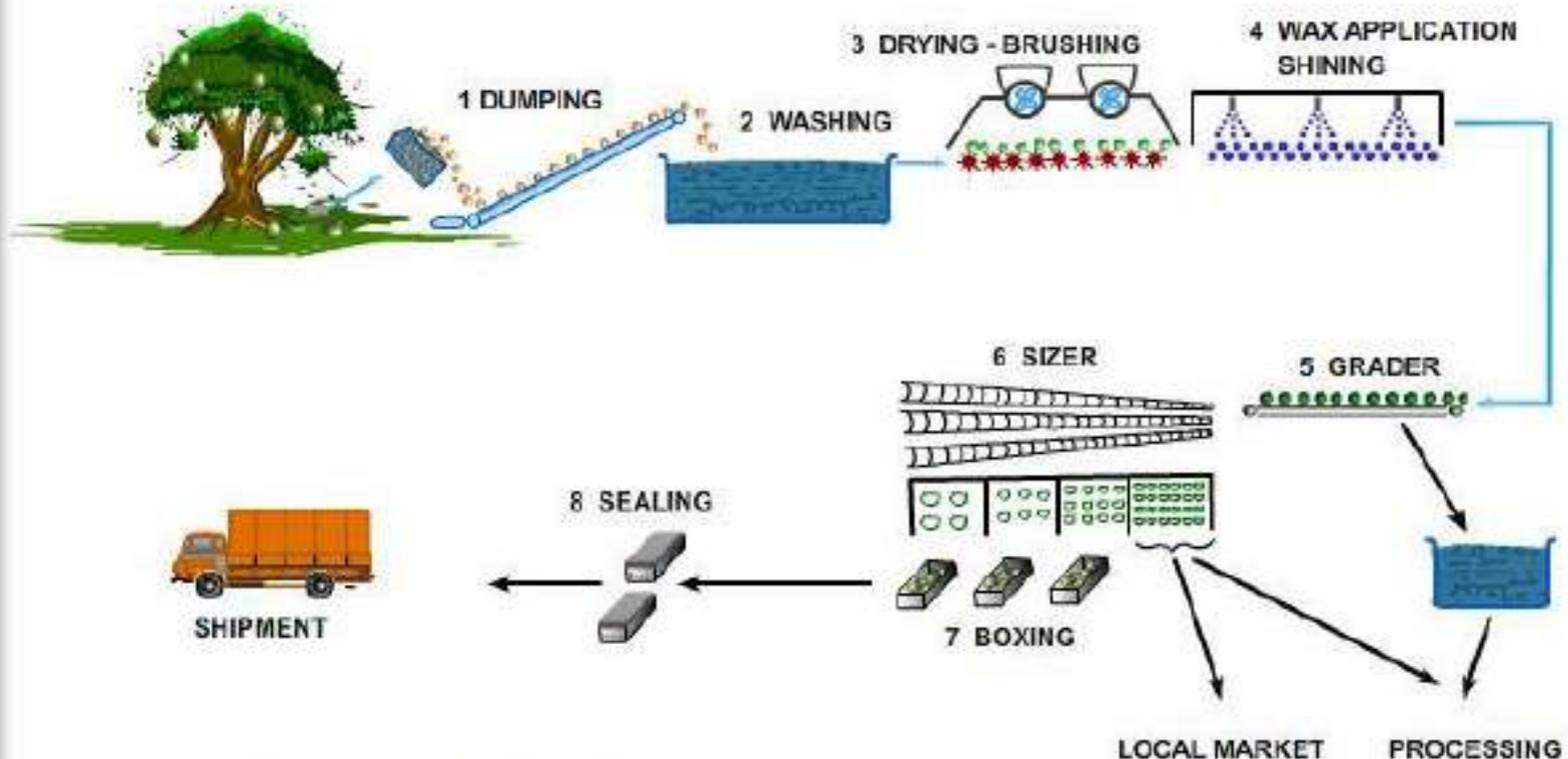


Flow chart for post harvest handling operations of horticultural produce



Postharvest Treatments on Horticultural Produces

Combine machine which handle many operations such as washing, waxing and drying, sizing grading and packing are being employed in pack house.

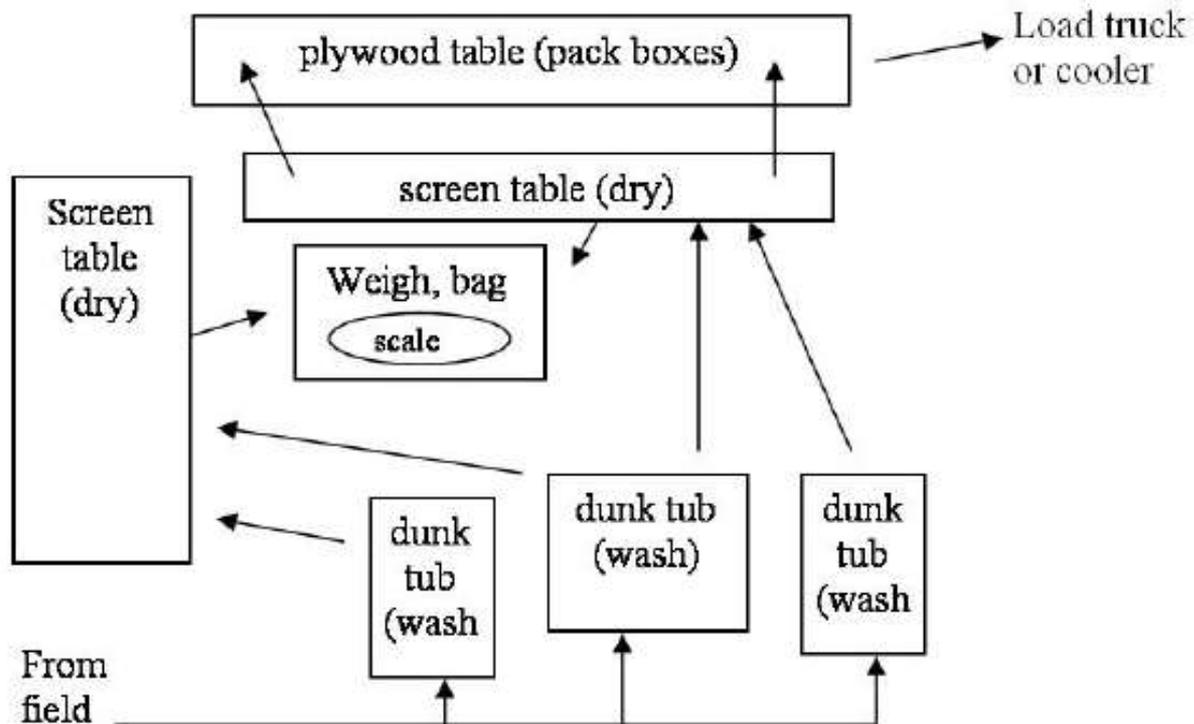


Schematic representation of post harvest operation for fresh produce at pack house

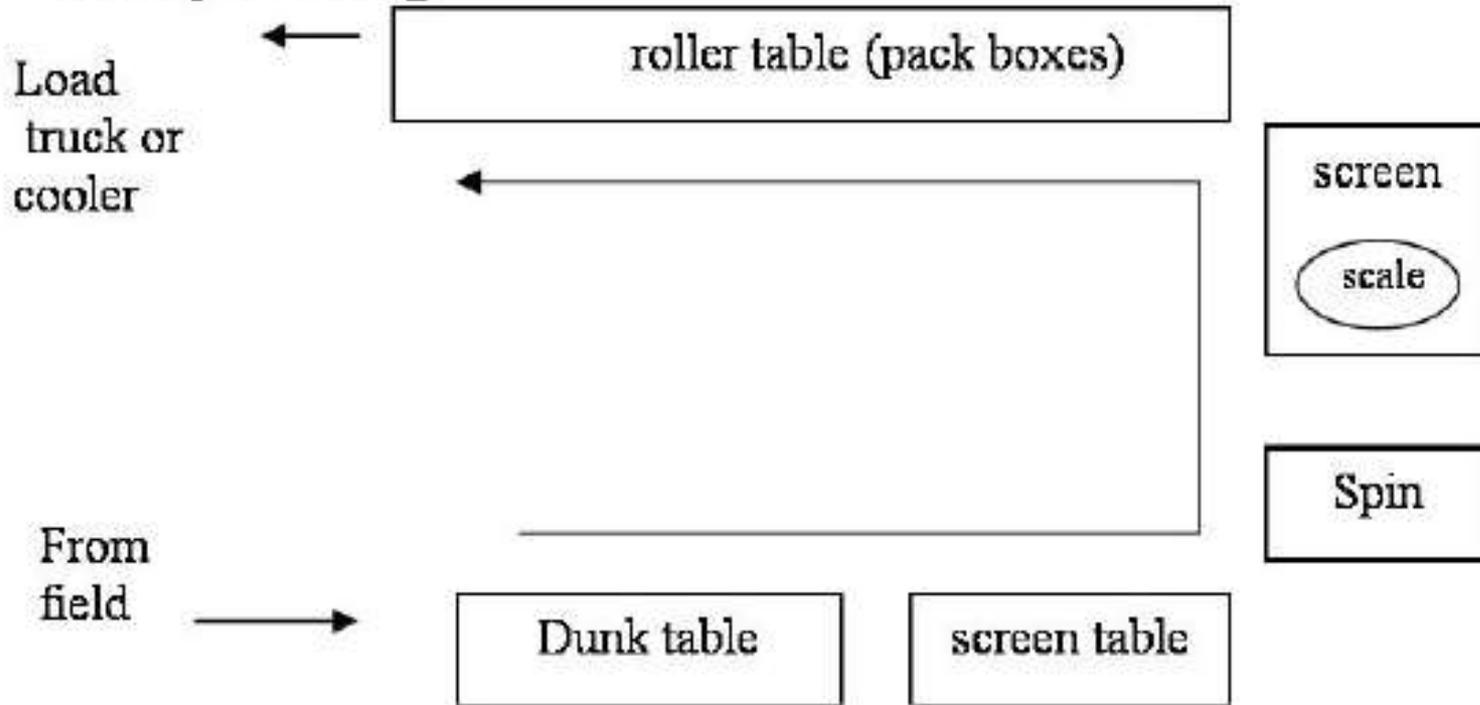
Packinghouse Layout

Packing operations that are done in an unsystematic manner can cause delays, add costs or effect produce quality. You can save time and money by laying out the packing shed in an organized, step-by-step system.

Inefficient Design



U-shaped Design



Following are post-harvest treatments in handling and storage of horticultural commodities

1. Pre-cooling (Low temperature)
2. Cleaning, washing and trimming
3. Sorting, grading and sizing
4. High temperature – Curing / Drying / Hot water treatments / Vapour heat treatment /Degreening
5. Chemical treatment - Disinfestations/ Sprout suppressants/Mineral application/ethylene inhibitors(1-MCP)
6. Fruit coating (waxing)
7. Astringency removal
8. Irradiation
9. Regulation of ripening -Control/ethylene scavenging/ Degreening
10. Pulsing and tinting
11. Minimal/ Light processing
12. Cold storage
13. Packing
14. Transportation
15. Quality control



Dumping/ collection

Preparation for the fresh market starts with dumping onto packinghouse feeding lines. Dumping may be dry or in water (fig.1&2). In both cases it is important to have drop decelerators to minimize injury as well as control the flow of product. Water dipping of produce causes less bruising and can be used to move free-floating fruits. However, not all products tolerate wetting. A product with a specific density lower than water will float, but for the produce which sinks, salts (NaCl) are diluted in the water to improve floatation.



Fig.1 Dry dumping of lemons



Fig.2 Water dumping of apple

Cleaning

Most of the fruits and underground vegetables like beetroot, radish, carrot, ginger *etc.* when harvested are with **soil/mud/latex/pesticides/dried/pest infested/diseases and look dirty**. Cleaning and washing makes them marketable. After harvest they should be gently rubbed with wet cloth/dry air and then washed properly to remove all soil and secondary roots. Unclean produce may contain bacteria and fungus which can damage the produce during transit and storage.

- ✓ Very small produce is mechanically removed by mesh screens, pre-sizing belts or chains.
- ✓ Bruised, rotted, mis-shaped produce, wilted or yellow leaves are usually removed by hand.
- ✓ Garlic and onions are topped to remove the dry foliage attached to the bulbs (fig.3).
- ✓ In many crops soil and loose parts are removed by brushing (Fig.4, 5 and 6).



Fig.3: Topping onions before grading



Fig.4: Brushing and hand removal of damaged fruits before grading

For produce such as kiwifruits and avocados, dry brushing may be sufficient to clean the produce. Soft brush bristles are preferred in washing, the stiffness must be just enough to remove the dirt without injuring the fruits. The brush speed should not exceed 200 rpm.



Fig.5 Spiral wound cylinder brushes.

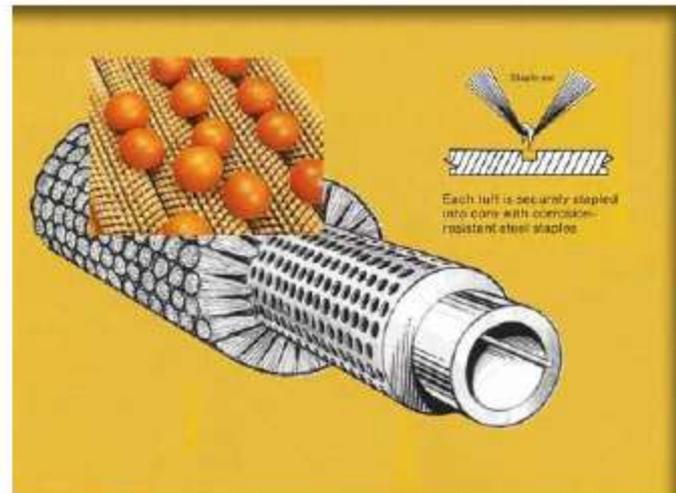


Fig.6 Staple set cylinder brushes (www.industrial-brush.com)

The choice of brushing and/or washing will depend on the type of **commodity and contamination**.

- i. Wash before cooling and packing- Carrot(soil), cucumbers, leafy greens, tomatoes
- ii. Wash to remove latex, reduce staining – mangoes(sap), bananas(debris/sap)
- iii. Wash after storage - sweet potatoes, potatoes, carrots
- iv. Dry brush after curing or storage - onions, garlic, kiwifruit
- v. Brushing and wiping – Melons
- vi. Do not wash -strawberry, beans, melons, cabbage, okra, peas, pepper,summer squash *etc.*

Washing

- ✓ Washing of fruits and vegetables is done to remove adhering dirt, stains, insects, molds and sometimes spray residues.
 - ✓ Washing not only help in cleaning and making the vegetables/fruits fresh and also improves appearance, it also helps in extending the shelf life of the produce.
 - ✓ Washing is done manually under tap water or in a wash tank using soft muslin cloth.
 - ✓ Produce should be thoroughly washed with clean water (preferably with 100 – 150 ppm hypochlorite/chlorine) or soap or calcium hydroxide. Most efficient detergent used is sodium meta bisulphate.
 - ✓ After washing they are then wiped with dry muslin cloth or air-dried to remove excess surface moisture. Under automated systems, the produce passes under a spray washer on a moving conveyor rollers.
 - ✓ Thumb rule is to use 1 to 2 ml of chlorine bleach per liter of water gives 100-150 ppm of Cl. pH of the water must be around 6.5 to 7.5.
 - ✓ Sanitation is essential, both to control the spread of disease from one item to another, and to limit spore buildup in wash water or in the packinghouse air. Fungicide may be used as post harvest dip to control diseases and disorder.
 - ✓ Excess water should be removed from the produce to avoid rotting.
 - ✓ In crops where water dipping is possible, differential floatation could be used to separate rejects.
 - ✓ Root and tuber vegetables are often washed to remove adhering soil.
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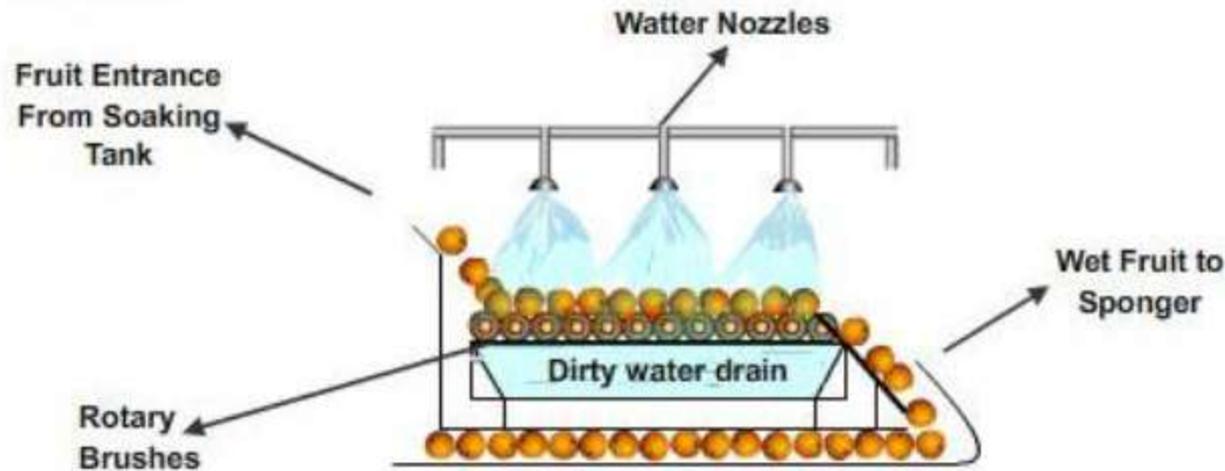


Fig.: A typical fresh produce washing machine

Dry cleaning

In some cases cleaning is done by dry brushing instead of washing.

Eg. Removal of white cottony mealy bugs attached in between the surface holes of custard apple fruits.

Some fruits and vegetables are just wiped with clean dry cloth.

Fruits and vegetables which are not suitable for washing are: onion, garlic, okra, grapes, strawberry, mushrooms, *etc.*

Dressing

Removal, trimming and cutting of all undesirable leaves/ stem/ stalks/ roots/ other non edible or unmarketable parts is called dressing. Dressing makes vegetables attractive and marketable.

Trimming is done especially in vegetables and flowers to remove unwanted, discoloured, rotting and insect damaged parts (e.g., cabbage, cauliflower, spinach, lettuce, rose, chrysanthemum, gladiolus, tuberose *etc.*) or parts that may favour deterioration or damage during later handling. In case of grapes, trimming of bunches is done to remove the undersize, immature, dried, split and damaged berries. Trimming and removal of decaying parts are preferably done prior to washing. Trimming enhances visual quality, minimizes water loss and other deteriorative processes. Trimming reduces the likelihood of diseases or their spread, facilitates packaging and handling, and reduces damage for other produce.

SORTING, SIZING AND GRADING

Sorting

Sorting is done by hand to remove the fruits and vegetables which are unsuitable to market or storage due to damage by mechanical injuries, insects, diseases, immature, over-mature, misshapen *etc.* This is usually carried out manually and done before washing. By removing damaged produce from the healthy ones, it reduces losses by preventing secondary contamination. Sorting is done either at farm level or in the pack-houses. **In sorting, only sensory quality parameters are taken into consideration.**



The following illustrations represent three types of conveyors used to aid sorting of produce.

- The simplest is a belt conveyor, where the sorter must handle the produce manually in order to see all sides and inspect for damage.



- Push-bar conveyor causes the produce to rotate forward as it is pushed past the sorters.



- Roller conveyor rotates the product backwards as it moves past the sorter.

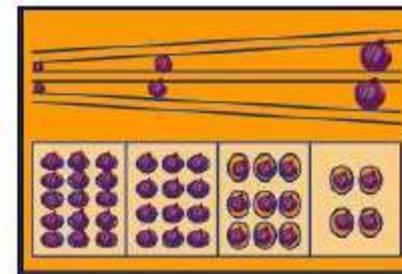


Fig. 8 Sizing onion bulbs by diverging belts/rope



Sizing

Before or after sorting, sizing is done either by hand or machine. Machine sizers work on two basic principles; weight and diameter. Sizing on the basis of fruit shape and size are most effective for spherical (oranges, tomato, certain apple cultivars) and elongated (Delicious apples and European pears are of non-uniform shape) commodities, respectively.

Mechanisms/Types of sizing

- A. **Diverging belts/rope grader** - the different speed of belts makes produce rotate besides moving forward to a point where produce diameter equals belt/rope separation. Eg. cucumbers, gherkins, pineapples and large root vegetables(fig.8).
- B. **Sizing rollers** - with increased spaces between rollers (fig.9) Eg. Citrus
- C. **Hand held template**-Sizing can be performed manually using rings of known diameter (fig.11).
- D. **Sizing by weight** - sorting by weight is carried out in many crops with weight sensitive trays. These automatically move fruit into another belt aggregating all units of the same mass. Individual trays deposit fruit on the corresponding conveyor belt (fig.10). Eg. Citrus, apples and pear and irregular fruits
- E. Mesh screens - eg, potato, onion, anola *etc.*





Fig.:9 Sizing by rollers of increasing distance between them.



Fig.:10 Sizing by weight.

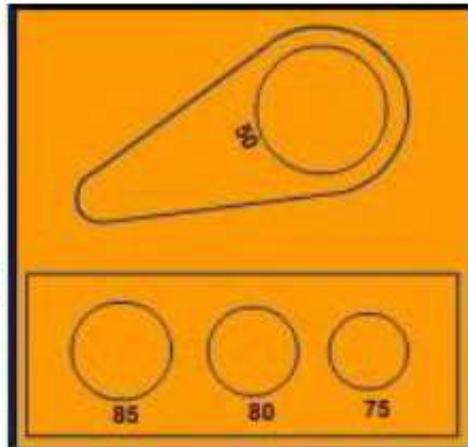


Fig.:11 Sizing with rings of known diameters



Grading

The produce is separated into two or more grades on the basis of the surface colour, shape, size, weight, soundness, firmness, cleanliness, maturity & free from foreign matter /diseases insect damage /mechanical injury.

For eg.: Apple I. Extra Fancy II. Fancy III. Standard IV. Cull (for processing).

Grading may be done manually or mechanically. It consists of sorting product in grades or categories based on weight/size.

Systems of grading : Static and Dynamic.

A. Static systems - are common in tender and/or high value crops. Here the product is placed on an inspection table where sorters remove units which do not meet the requirements for the grade or quality category (fig.12).

B. The dynamic system - here product moves along a belt in front of the sorters who remove units with defects (fig.13). Main flow is the highest quality grade. Often second and third grade quality units are removed and placed onto other belts. It is much more efficient in terms of volume sorted per unit of time. However, personnel should be well trained. This is because every unit remains only a few seconds in the worker's area of vision. Eg. Onion grading
There are two types of common mistakes: removing good quality units from the main flow and more frequently, not removing produce of doubtful quality





Fig.12 Static quality grading system



Fig. 13: Dynamic quality grading system

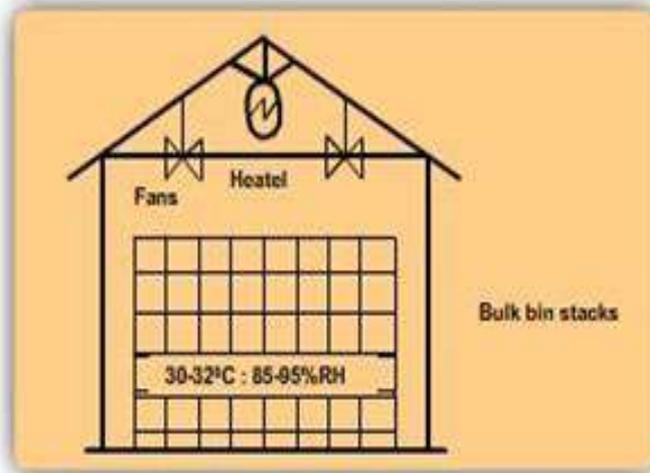
New Innovation in grading systems

- i. Computerized weight grader – operate on the basis of tipping buckets that drops to release the pre weighed item at a particular position. – Apples, citrus
- ii. Video image capture & analysis – used for size, colour & external defect grading – coffee bean, apple
- iii. NIR Spectrometers – to assess the TSS non – destructively in apple and stone fruits
- iv. X-ray imaging and Computer aided tomography
- v. MRI - Magnetic Resonances Imaging
- vi. Spectroscopy
- vii. Acoustic methods
- viii. Volatile emission analysis

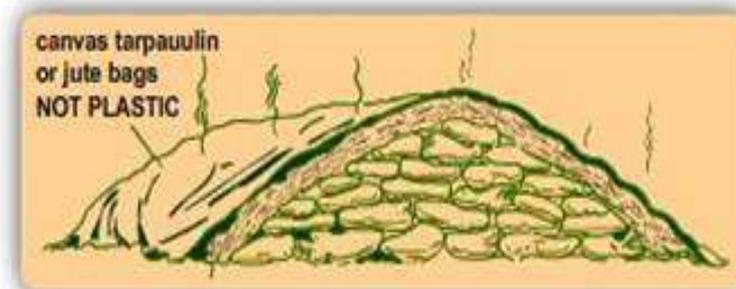


Table: Optimum condition for curing of vegetables

Commodity	Temp(o C)	RH (%)	Days for curing
Potato	13-17	>85	7- 15
Sweet potato	27-33	>90	5- 7
Yam	32-40	>90	1- 4
Cassava	30-35	>80	4- 7
Garlic and onion	35-45	60-75	0.5-1 warm forced air



Typical curing houses for roots and tubers



Field curing of Yams

