فناوری پس از برداشت ۷

Postharvest handling for fruits and vegetables:

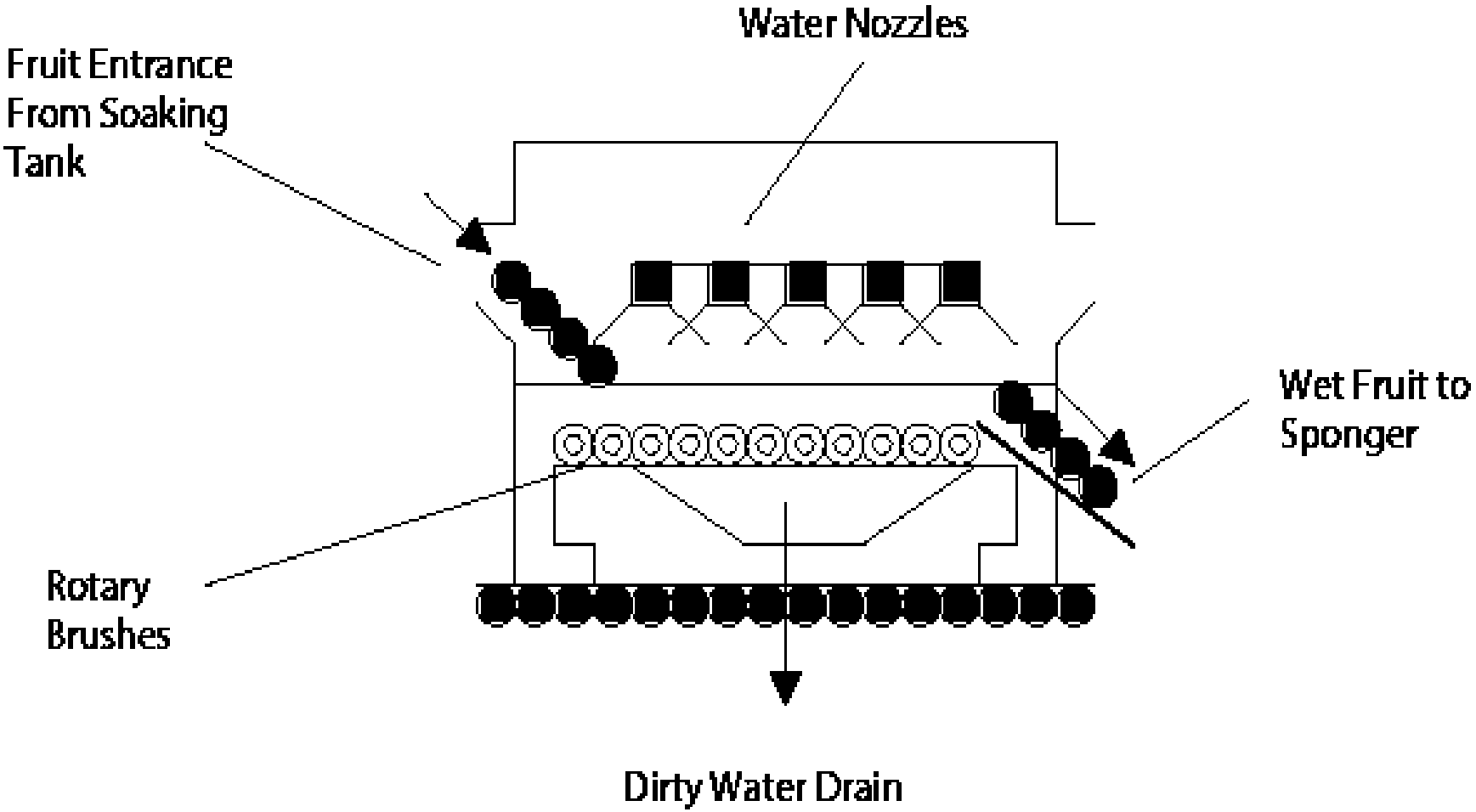
1-Cleaning
2-Disinfection
3-Degreening
4-Grading

Cleaning

Cleaning:

- Most produce receives various chemical treatments such as spraying of insecticides and pesticides in the field. Most of these chemicals are poisonous to humans, even in small concentrations. Therefore, all traces of chemicals must be removed from produce before packing. As illustrated in Figure 2.7, the fruit or vegetable passes over rotary brushes where it is rotated and transported to the washing machine and exposed to the cleaning process from all sides:
- From the washing machine, the fruit passes onto a set of rotary sponge rollers (similar to the rotary brushes). The rotary sponges remove most of the water on the fruit as it is rotated and transported through the sponger.

Figure 2.7 Typical produce washing machine.



Oranges being washed with detergent on a brush bed.

Oranges being dried.

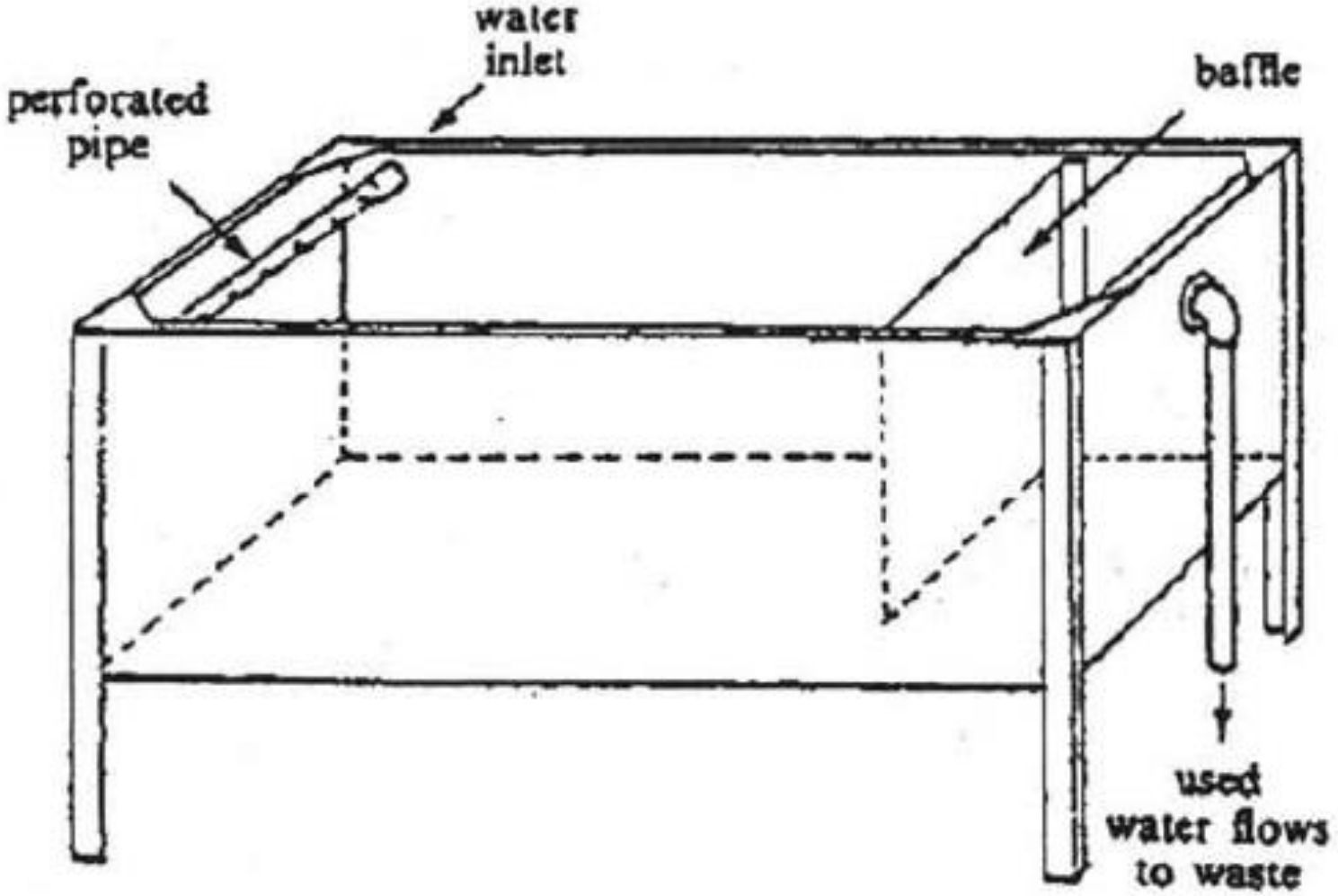


Figure 4. Washing tank

Disinfection

Disinfection:

- After washing fruits and vegetables, disinfectant agents are added to the soaking tank to avoid propagation of diseases among consecutive batches of produce. In a soaking tank, a typical solution for citrus fruit includes a mixture of various chemicals at specific concentration, pH, and temperature, as well as detergents and water softeners. Sodium-ortho-phenyl-phenate (SOPP) is an effective citrus disinfectant, but requires precise control of conditions in the tank. Concentrations must be kept between 0.05 and 0.15%, with pH at 11.8 and temperature in the range of 43-48°C. Recommended soaking time is 3-5 minutes. Deviation from these recommendations may have disastrous effects on the produce, since the solution will be ineffective if the temperature or concentration is too low (Peleg, 1985). Low concentrations of chlorine solution are also used as disinfectant for many vegetables. The advantage of this solution is that it does not leave a chemical residue on the product.

Disinfestation Treatments:

1-Methyl Bromide Fumigation

MB has been widely used for many years for the disinfestation of different horticultural commodities, storage facilities, transport vehicles, shipping vessels and containers, and against quarantine pests both for export or import.MB has been used to control a wide variety of pests in agriculture and shipping, including fungi, weeds, insects, nematodes, and rodents. Fumigation is effective in controlling many insects at different stages of growth (eggs, pupae, larva, and adults) as well as sporulation and growth of mycelia in infected fruit and vegetables. MB is also highly toxic to humans, with either acute or chronic exposure both being potentially fatal. As MB is considered to be an ozone-depleting compound, it was restricted or banned in many countries. With the restriction of MB, other methods of disinfestation like ozone, phosphine, low and high temperatures, and gamma irradiation are increasingly used.

2- Phosphine Fumigation

Phosphine is used as phytosanitary treatment of grain silos, seeds, plant products, dry fruits, dates, and many more products. It is generally used in a gaseous state or as pellets of aluminum phosphide, which reacts with air moisture to release phosphine gas. Conditions of application require relatively tight rooms and a temperature greater than 15°C for the duration of several days to kill all stages of insects. Such long durations and conditions are a limiting factor for the use of phosphine as a fumigant for fresh produce. Phosphine fumigation shows low efficacy of the treatment at temperatures below 15°C. Phosphine can be used as a fumigant based on conditions prescribed on the label for selected crop. Like MB, phosphine is highly toxic to humans.

3- Ozone

Ozone is a powerful oxidizing agent that has been increasingly used in the food industry either as a fumigant or as ozonated water for washing, cleaning, and sanitizing fresh produce. The product has various postharvest benefits, which include extending the shelf life of treated produce, ethylene removal, control of postharvest diseases, and delaying spore growth and development in decayed fruit. It is easily applied to disinfect packing house facilities, such as cold rooms or packing areas, by ozone fumigation or spraying ozonated water. Applications of ozone are diverse and include fresh fruits and vegetables. Packaging materials are also disinfected and sterilized using ozone in the processing plant. While not as dangerous as MB or phosphine, ozone is also potentially fatal for humans. Because ozone is sometimes used in storage and transport spaces that workers may enter, the equipment used to apply ozone gas is designed so as not to emit ozone at >0.3ppm, which is the 15-min exposure limit for humans established by OSHA in the United States (the 8-h limit is 0.1 ppm).

4- High Temperatures/Heat Treatments

There are several disinfection treatments against diseases and pests, among them hot water treatments at temperatures from 45°C to 55°C for periods of 3–90min, and vapor heat treatments at temperatures from 43°C to 47.5°C with saturated humidity for periods of 10min–8.75 h. These treatments can be used to control some diseases and insect pests and are usually done prior to packing. However, some of these combinations of temperature/exposure time are injurious to many products. Higher temperatures and shorter durations are usually used to control decay pathogens, and lower temperatures for longer durations are commonly used for insect control. Specifically for mango, hot water treatment at 46.1°C for 65–90min, depending on fruit weight, is used as a quarantine treatment against fruit flies. This treatment is carried out at the beginning of the packing line outside the packing area. Pallets of fruit in plastic field lug boxes immersed in large tanks of heated water with the system computer-controlled so that the water temperature fluctuates minimally during treatment (Fig. 9.36). The packing house must be completely isolated with netting to eliminate pest entry and prevent the fruit from being reinfested. A hot water treatment used to control anthracnose decay on mango prior to packing uses immersion in 48–55°C water for 3–20 min.

5- Low Temperatures

Cold treatments can also be used for quarantine disinfestation for some fruits such as citrus and grapes following the recommendations of the importing countries (e.g., United States and some European countries). Fresh commodities from areas infested with the Mediterranean fruit fly are require to be cold treated. Fruits are exposed to a combination of temperatures and exposure times ranging from 10 days at 0°C, 11 days at 0.6°C, 12 days at 1.1°C, 14 days at 1.7°C, and 16 days at 2.2°C. The length of exposure may increase based on the size and the nature of the fruit. Strict temperature monitoring is needed to comply with the requirements of treatments. Keeping records of temperature and duration are required. Some drawbacks of cold treatment protocol is the appearance of low temperature disorders or chilling injury to crops that are sensitive to low-temperature exposure.

Sanitizers Used in Disinfection of Wash Water

Sanitizer	Activity	Oxidation Capacity (eV)	Concentration	Effectiveness
Peracetic acid	Oxidant	1.81	Up to 80 ppm	pH 1–8, sensitive to organic matter
Hypochlorites	Oxidant	1.36 (for sodium hypochlorite)	1–3 ppm for rinsing 50 ppm for sanitizing	pH 6–7, sensitive to organic matter
Chlorine dioxide	Oxidant	1.57	Up to 5 ppm	pH 6–10, less sensitive to organic matter in comparison with hypochlorites
Hydrogen peroxide	Oxidant	–	0.5%	Sensitive to organic matter
Ozone	Oxidant	2.07	2 ppm	pH 6–8, sensitive to organic matter, breaks down to O_2 rapidly, corrosive to equipment
UV light	Disruption of genetic material	–	40,000 μw. s/cm^2	Independent of pH sensitive to organic matter
Iodophore	Oxidant	–	6–13 ppm of free iodine	pH 2–5, sensitive to organic matter, corrosive

Degreening

Degreening

Ethylene gas used for degreening is sold in compressed gas cylinders containing slightly less than 100% ethylene and has a mild sweetish smell. Some packers are utilizing ethylene generators. Though non-toxic, ethylene can cause asphyxiation under very high concentrations as the gas displaces oxygen in the atmosphere. Ethylene is explosive at concentrations between 3.1% and 32% (by volume) in air.

These are extremely high concentrations (3.1% = 31,000 ppm) compared to normal citrus degreening concentrations of about 5 ppm but may occur through accidental increases in ethylene flow or leaks in ethylene lines or regulators. Occasionally, one reads of an ethylene ripening room exploding that tragically kills and/or injures people. These serve as potent reminders that safety considerations are important when dealing with ethylene. Be sure to follow these important safety rules when working with ethylene:


ETHY-GEN® II CONCENTRATE
ONLY FOR USE WITH A CATALYTIC GENERATOR TO PRODUCE ETHYLENE TO ACCELERATE RIPENING OF:
Avocados, Bananas, Citrus Fruit, Melons, Papayas, Pears, Tomatoes and Tobacco
ACTIVE INGREDIENT: Ethanol 90.00%
OTHER INGREDIENTS 10.00%
TOTAL 100.00%
KEEP OUT OF REACH OF CHILDREN
CAUTION
NOT INTENDED FOR HUMAN CONSUMPTION
FIRST AID
If Swallowed:
Call a poison control center or doctor immediately for treatment advice.
Have person sip a glass of water if able to swallow.
Do not induce vomiting unless told to do so by a poison control center or doctor.
Do not give anything by mouth to an unconscious person.
If Inhaled:
Move person to fresh air.
If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible.
Call a poison control center or doctor for further treatment advice.
If in Eyes:
Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.
Call a poison control center or doctor for treatment advice.
If On Skin or Clothing:
Take off contaminated clothing.
Rinse skin immediately with plenty of water for 15-20 minutes.
Call a poison control center or doctor for treatment advice.
Have the product container or label with you when calling a poison control center or doctor or going for treatment. For additional information in case of emergency call toll free 800-424-9300 (North America) or +1-703-527-3887 (International).
Mfg. By: CATALYTIC GENERATORS, LLC
1160 Pineridge Road • Norfolk, VA 23502
(757) 855-0191 Made in USA
EPA Reg. No. 37433-1 EPA Est. No. 37433-VA-1
Net Contents – 32 Ounces – One (1) U.S. Quart

Do not move compressed gas cylinders without the cover cap in place (it protects the valve). Only remove the cap when the cylinder is in place and ready to be used. There are vivid stories of cylinders, turned into a rocket when the valve stem breaks.

Securely fasten cylinders to walls, holding cages or other non-tip structures.

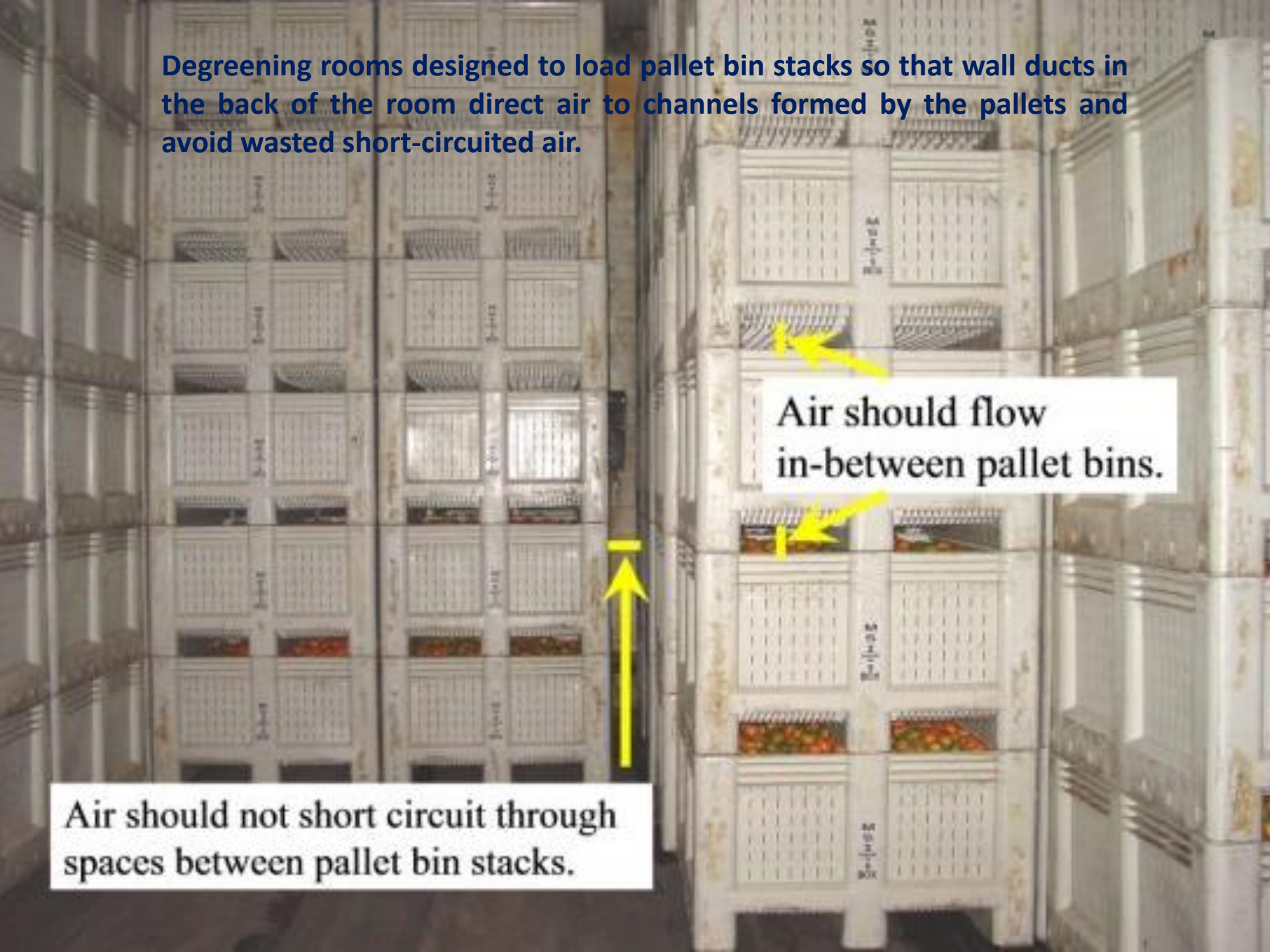

Degreening rooms designed to load pallet bin stacks so that wall ducts in the back of the room direct air to channels formed by the pallets and avoid wasted short-circuited air.
Air should flow in-between pallet bins.
Air should not short circuit through spaces between pallet bin stacks.

Table 1. Flow rates for ethylene to establish a degreening atmosphere of 5 ppm ethylene and minimum CO_2.[z]

Size of Room[y] (field boxes)	Ethylene Flow Rate as			
	Bubbles/min[x]	cc or ml/min	liters/hr	cu ft/hr
500	50	2.5	0.75	0.025
1,000	100	25	1.5	0.05
2,000	200	50	3.0	0.10
5,000	500	125	7.5	0.25
10,000	1,000	250	15.0	0.50

[z] To be combined with continuous ventilation.

[y] Ethylene delivery should be proportional to the size of the empty room.

[x] Bubbles from ¼-inch line.

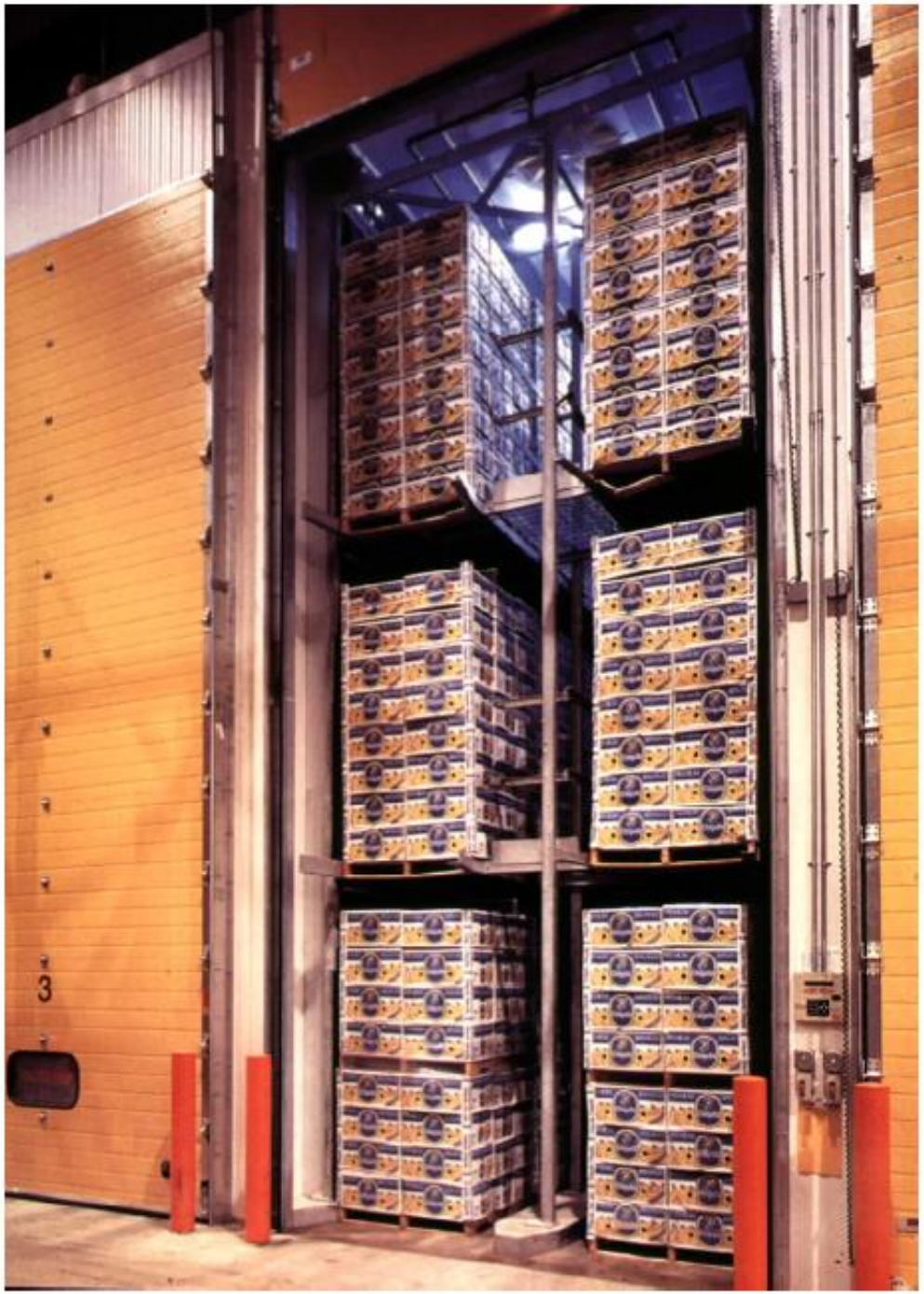


FIG. 9.38 Banana pressure-ripening room.

FIG. 9.37 Citrus degreening room.

Conditions for controlled ripening of some fruits.

	Ethylene concentration (ppm)	Ripening temperature °C	Exposure time to these conditions (hr.)
Avocado	10-100	15-18	12-48
Banana	100-150	15-18	24
Honeydew melon	100-150	20-25	18-24
Kiwifruit	10-100	0-20	12-24
Mango	100-150	20-22	12-24
Stone fruits	10-100	13-25	12-72
Tomato	100-150	20-25	24-48

Typical Conditions for Postharvest Ripening and Color Development of Fruits

Fruit	Ethylene Concentration (ppm)	Temperature (°C)	Time (h)	Application
Avocado	10–100	15–18	12–48	Ripening
Banana	100–150	15–18	24	Ripening
Honeydew melon	100–150	20–25	18–24	Ripening
Kiwifruit	10–100	0–20	12–24	Ripening
Mango	100–150	20–22	12–24	Ripening
Orange	1–10	20–22	24–72	Degreening
Tomato	100–150	20–25	24–48	Color development

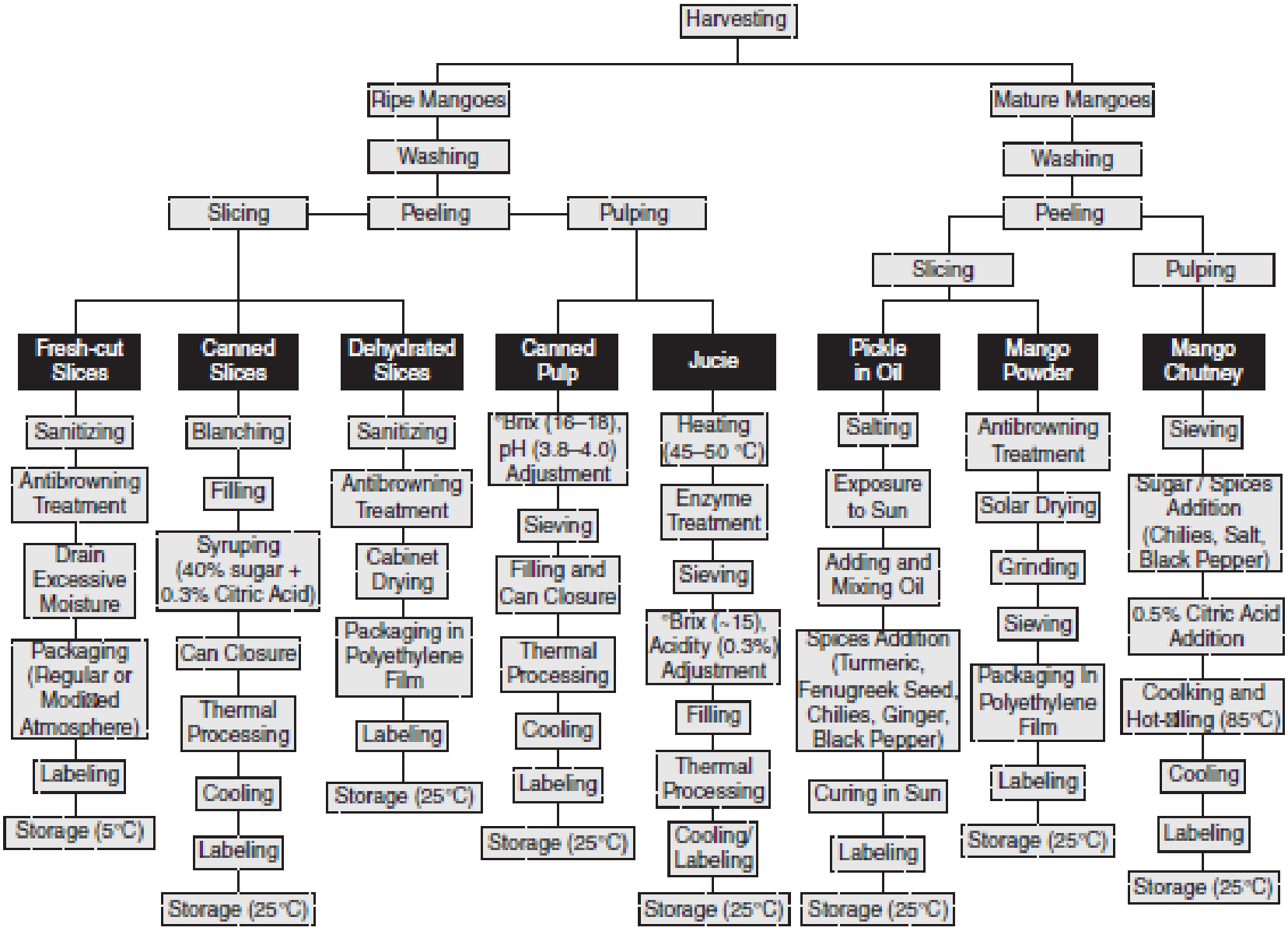


Figure 10.1 Processing steps for the production of different mango products.

Grading

FIG. 9.23 Beans being sorted to remove defective pods.

Advantages of Sorting and Grading

1. It provides common language to producer, buyer and consumer
2. Reduce dispute of quality between seller and buyer.
3. Standardized grades form basis for price fixation and advertisement.
4. Improve marketing efficiency by selling a produce without a personal selection.
5. Assist producers and other intermediaries in preparing fresh horticultural commodities for market with appropriate labelling.
6. Provide a basis for securing incentive price for better quality.
7. Serve as a realistic basis for market intelligence and reporting.
8. Prices and supplies quoted in different markets could only be meaningful if they were based on products of comparable quality/grade.

Additional Benefits

1. Bargaining power is enhanced to get better premium for better grades.
2. Grading the produce into certain size and shape facilitates packing and transportation easy.
3. To eliminate re-sorting or re-packing at wholesale or transit markets.
4. Grading can develop specific market for a specific type/variety or produce

Table 7: Potatoes

Grade	Tuber Size (Minimum Diameter) Oval or Long Varieties (mm)	Round Varieties (mm)
Extra special	41 to 89	45
Special	29 to 83	32

Potatoes should be reasonably clean, healthy, free from serious defects and suitable for human consumption.

Table 8: Mangoes (Variety Alphonso)

Grade	Weight of Each Fruit		Definition of Quality
	Min(g)	Max(g)	
I	280	338	1. The fruits shall be firm and entirely free from damage, blemish or malformation
II	222	280	
III	163	222	2. Each fruits shall be olive green in colour without trace of yellow at the time of packing

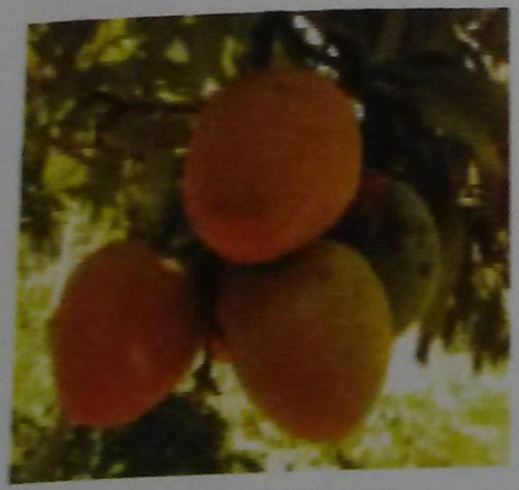
Table 9: Mandarins

Size Grade of Mandarin	Size Variation (diameter)
Big	7.50–8.50cm
Medium	6.50–7.49 cm
Small	5.50–6.49 cm

Big – 8.5 –7.5 cm

Medium –7.49-6.5 cm

Small – 6.49 – 5.5 cm



Poor– <130g

Average –131-170 g

Good – 171–200 g

Excellent– >200 g

Figure 13: Excellent (Page No. 41)

Small– <1 kg

Medium–1 –2 kg

Large–>2 kg

Figure 14: Large (Page No. 41)

A class–1500-1800 g

B class–1100-1500 g

C class–900-1100 g

D class–700-900 g

Small–< 25 g

Medium–25-50 g

Large–50-75 g

Extra large–> 75 g

Figure 17: Weight Graders

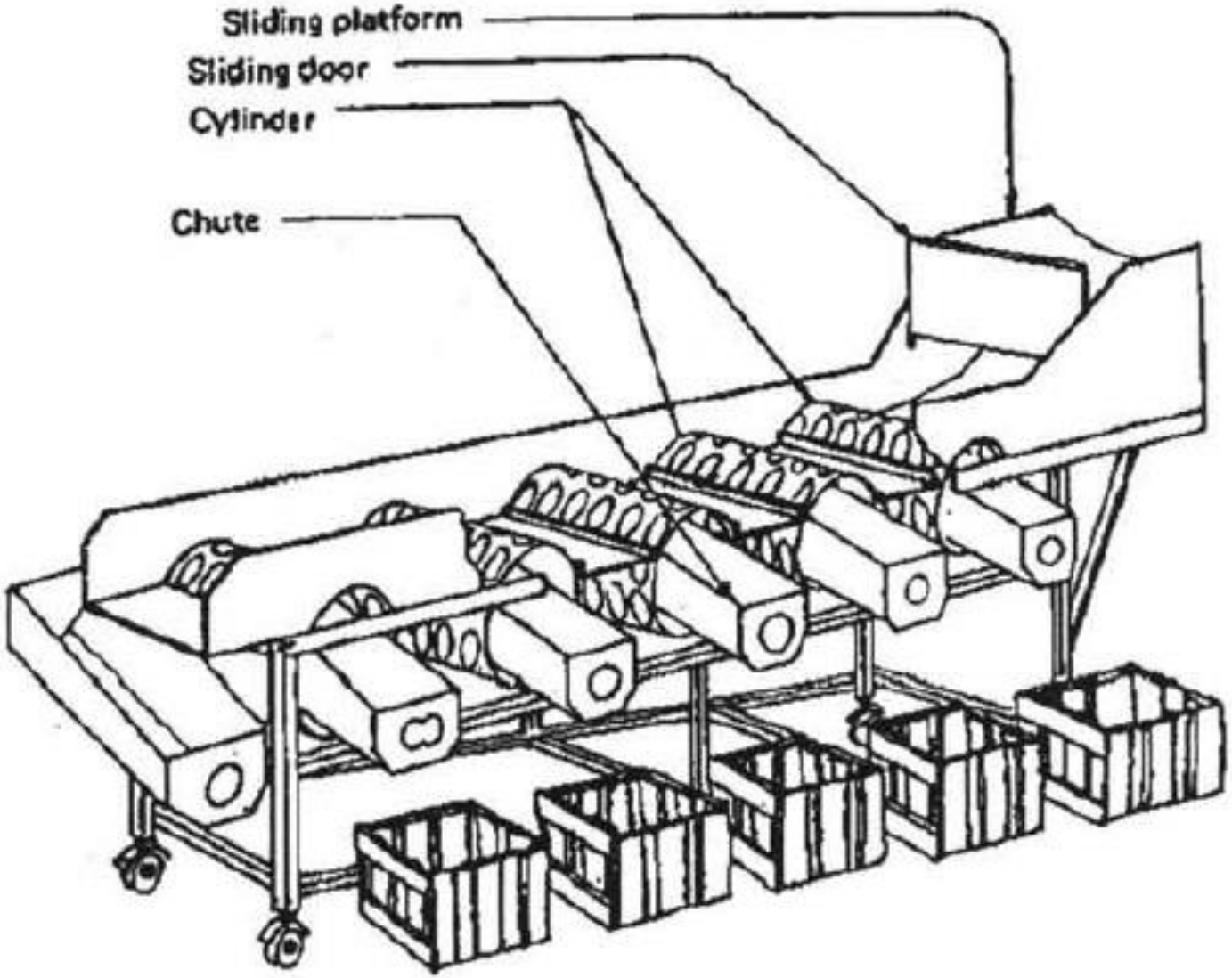


Figure 14. Rotary cylinder sizer

Figure 17: Weight Graders (Page No. 50)

Figure 18: IIHR Electronic Weight Grader
1: Grading unit; 2: Singulation unit; 3: Control unit; 4: Weighing unit (Page No. 51)

Figure 21: IARI Potato Grader (Page No. 55)

(A)

(B)

FIG. 9.24 (A) Oranges being sized with a diverging roller. (B) Oranges being weight sized.

Table 2A Schedule of Canadian Grade Standards: Fruits

Commodity	Grade	Grading attributes
Apples	Canada Extra Fancy Canada Fancy Canada Commercial Canada Commercial Cookers Canada Hailed Canada No. 1 Peelers Canada No. 2 Peelers	Variety, color, striping, russeting, properly sized, appropriate to variety, shape, freedom from decay, insects, bruises. Properly packed. More leniency as grade decreases. Sizes and colors are specified in a table.
Apricots	Canada No. 1 Canada Domestic Canada Domestic Hailed	Varietal character, color, size, freedom from damage, insects, punctures. Properly packed. More leniency as grade decreases.
Blueberries	Canada No. 1	Typical coloration, size, freedom from insects. Properly packed.
Cantaloups	Canada No. 1	Typical of variety, mature, freedom from injury and insects.
Cherries	Canada No. 1 Canada Domestic Canada Orchard Run	Typical of variety, color, maturity, size, stems, freedom from damage.
Crabapples	Canada No. 1 Canada Domestic	Typical of variety. Color, maturity, size, freedom from damage, insects. Are properly packed.

Table 2A Schedule of Canadian Grade Standards: Fruits

Commodity	Grade	Grading attributes
Cranberries	Canada No. 1 Canada Domestic	Color, size, and maturity. Freedom from insect and other damage. Are properly packed.
Grapes	Canada No. 1 Canada Domestic	Typical of variety, color, size. Freedom from insect and other damage. Properly packed.
Peaches	Canada No. 1 Canada Domestic	Size, shape, color, maturity. Freedom from damage, insects. Properly packed.
Pears	Canada Extra Fancy Canada Fancy Canada Commercial	Typical of variety, size (defined for varieties), shape, color, maturity. Freedom from insect or other damage (bruises, hail, russeting), disease.
Plums, prunes	Canada No. 1 Canada Domestic	Size (defined for variety), shape, color, freedom from cracks, insects, physical damage. Properly packed.
Field rhubarb	Canada No. 1 Canada Domestic	Color, freshness (wilting), size, freedom from pests, disease, physical damage. Properly packed.
Strawberries	Canada No. 1	Color, shape, maturity, calyx attached. Freedom from disease, insects, or physical injury. Properly packed.

Source: Adapted from Canada Agricultural Products Act.

Table 2B Schedule of Canadian Grade Standards: Vegetables

Commodity	Grade	Grading attributes
Asparagus	Canada No. 1 Canada No. 1 slender Canada No. 2	Color, maturity, limited white stalk, diameter (specified), length, perception of freshness.
Beets	Canada No. 1 Canada No. 2	Varietal character, texture (lack of woodiness), size (defined), freedom from decay, disease.
Brussels sprouts	Canada No. 1 Canada No. 2	Texture (firmness), color, size, freedom from decay, disease.
Cabbages	Canada No. 1 Canada No. 2	Varietal character, texture (firmness), properly packed, freedom from decay, disease.
Carrots	Canada No. 1 Canada No. 2	Color, texture (lack of woodiness, softness), shape, not trimmed into crown, freedom from sunburn, decay, damage.
Cauliflowers	Canada No. 1 Canada No. 2	Size, color, ''richness,'' maturity, freedom from decay, damage.
Celery	Canada No. 1 Canada No. 1 Heart	Freshness, maturity, size, properly packed, freedom from decay, disease, damage.
Sweet corn	Canada No. 1	Maturity, texture, size, freedom from decay, disease, damage.
Field cucumbers	Canada No. 1 Canada No. 2	Freshness, maturity, texture, color, size (specified), freedom from decay, disease, damage.

Table 2B Schedule of Canadian Grade Standards: Vegetables

Commodity	Grade	Grading attributes
Greenhouse cucumbers	Canada No. 1 Canada No. 2	Texture and other attributes as for field cucumbers.
Head lettuce (iceberg)	Canada No. 1 Canada No. 2	Texture, varietal character, trimming, shape, size, freedom from decay, disease, damage.
Onions	Canada No. 1 Canada No. 1 Pickling	Varietal character, dried neck, texture (firmness), size, freedom from decay, disease, damage.
Parsnips	Canada No. 1 Canada No. 1 Cut Crowns Canada No. 2	Texture (woodiness), trimming, shape, maturity, size (specified), uniformity, freedom from decay, disease, damage.
Potatoes	Canada No. 1 Canada No. 1 Large Canada No. 2	Texture (firm), size, shape, cleanliness, skin loosening, freedom from decay, disease, damage.
Rutabagas	Canada No. 1	Texture (firm), maturity, size, trimming, cleanliness, freedom from decay, disease, damage.
Field tomatoes	Canada No. 1 Canada No. 2 Canada No. 1 Picklers Canada No. 2 Picklers	Maturity, size, shape, cracks, varietal character, freedom from decay, disease, damage.
Greenhouse tomatoes	Canada No. 1 Canada No. 1 Extra Large Canada Commercial Canada No.2	Maturity, size (specified), shape, varietal character, texture (firmness vs. softness), extent of ripening, freedom from decay, disease, damage.

Source: Adapted from Canada Agricultural Products Act.