

Fruit and Vegetable Harvest and Postharvest Operations

The following mind maps provide an outline that should be used in conjunction with the provided readings. A excellent additional reference is: “Postharvest Technology of Horticultural Crops” 2nd Edition Edited by A.A.Kader, published by University of California, Publication 3311.

The subjects covered by the mindmaps include:

- harvesting
- Transport to Packhouse
- Packhouse operations
  - Sorting
    - Colour
    - Size
  - Packing
- Quality Assurance
  - HACCP
- Packaging (Additional note)

EXERCISE: Using the Mindmaps as the basis, develop a more detailed summary of the readings provided.

1.0 REFERENCES


Section 15

Wills, R., McGlasson, B., Graham, D. & Joyce, D., 1998. Postharvest. An Introduction to the physiology and handling of fruits, vegetables and ornamentals. 4th Ed., Published by UNSW.


FRUIT CROP HARVESTING AND HANDLING

Traceability

Fundamental Principles Engineering

DEFINE Performance Specification and Engineering

- Quality Assurance
- Value Chain
- Food Safety

System Performance Specification

- Safety
- Product Quality

Harvesting

Principles

Post-Harvest

Quality Assurance
- Quality Attributes
- Physical Parameters
- Physical properties
- Food safety
- HACCP
SUPPLY CHAIN MANAGEMENT

7 Principles

- LEVERAGE MANUFACTURING AND SOURCING
  - S.A.P.
  - J.I.T.
  - T.Q.M.
- INTEGRATE SALES AND OPERATIONS PLANNING
- ORGANISE CUSTOMER MANAGEMENT
- BEGIN WITH CUSTOMER
- MANAGE LOGISTICS ASSETS
- DEVELOP CUSTOMER-DRIVEN PERFORMANCE MEASURES

Strategic Alliance

Relationship Management

FOCUS
Integrated Approach to Handling

Guidelines
- How do preharvest cultural factors affect consumer acceptance?
- How does storage at non-optimal conditions affect quality and consumer acceptance?
- Are handlers who adopt new methods properly rewarded for their improvements?

Quality Management
- Operations Research
- Application of Technology and Engineering
- Clearer spec of quality and packing, value, consumer perspectives
- Preharvest factors = variability in quality and storage
- Mean to predict mathematically (modelling systems) period of optimal marketability – to specific handling conditions

Latent damage
- Early detection important
- Lower quality increased cost of production (transportation and sorting add cost)
- Damage incurred at one step but not apparent until later step.
  - Bruising
  - Quiescent infections
  - Physiological disorders
  - Postharvest stress disorders, e.g. chilling injury

Food Safety
- Agricultural chemicals
- Cosmetic appearance
- Alternative methods, e.g. organic
- Pathogens, e.g. *E.coli* species
- *Listeria monocytogenes* (refrigeration.)
Section 15

TRANSPORTATION FROM FIELD

- In field
- Packhouse

- Customer
  - Flavour
  - Appearance
  - Firmness
- Wholesale buyers
- Sellers
- Special breeding
  - Resistance
    - mechanical damage
    - insect/disease damage
- Harvest
  - uniform maturity
  - once-over harvest

Appearance

Resistance
1. Avoid extended forklift movement
2. Minimise rough handling during loading
3. Grade farm/orchard track – keep smooth
4. Avoid uneven/rough public roads
5. Restrict transportation speeds to minimize free movement of front (vibration)
7. Reduce vehicle tyre pressure

**BRUISING**

- Over filled bins
- Bottom layers
- Shallower bin

**Impact**

**Picking container**
- Fruit type = container type
  - Plastic bucket – softer fruit
  - Bottom dump – less pot for compression damage
  - Delicate – pack directly from bucket (peaches)
  - Very soft delicate – pick into package, e.g. strawberries

**Field container**
- Wooden – vented – cooling – smooth surface
- Plastic liners
- Drop height important (Table 6.2, pp31)
Section 15

PACKING HOUSE OPERATION

Design & Operation of sorting equipment
- Optimising
  - Accuracy
  - Sorting
- Evaluation
  - Sorter productivity
  - Quality
- Space
  - Size
- Variable flow
  - Translation speed
  - Product loading
- View product
  - Sorter position
  - Lighting
  - Location of reject chutes and conveyors
- Worker comfort
- Product injury
- Training/supervision

Analysis of sorting operations
- performance
- modelling
- empirical model
- signal detection theory

(1) Sorting

Visual perception
- Brightness
- Product presentation
- Vision difficulties
- Concentration for long periods

Marketing factors
- producer
- wholesaler
- retailers/distributors
- customer
- price quality

Sorting terminology
- Separation (removal of non-useable material)
- Uniform size (free of insects, blemishes, diseases)
- Maturity (firmness, damage levels)
- Sorting (segregation, marketable, quality categories)
  - Mechanical (colour, sizes
  - Manual (visual, tactical)
- Graders – sorting line, not graders (3rd party inspectors e.g. ENZA, meet classification, online, off-line.
- Sample inspection (Q.C.)

Economics
Section 15

PACKING HOUSE OPERATION (A)

1. **Fruit sizing**
   - Colour
   - Image sizers
   - Weight and/or size

2. **Fruit selection**
   - Capacity
   - Accuracy
   - Injury
   - Adjustment ease
   - Incoming fruit change
   - Adjust fruit diversion patterns
   - Ease: cleaning, maintenance

3. **Special treatments**
   - Presizing
   - Cleaning and washing
   - Waxing/coating
   - Disease control treatment

4. **MECHANICAL VOLUME-FILL TIGHT FILL**

5. **OPERATION: Monday**
   (Frank Bollen, Prussia & Lidrow)
   “To transform the highly variable product received from the harvest operation into uniform lots of product for shipments that comply with the requirements of the buyer.”

6. **Wednesday/Thursday - Packaging**

**PACKING FRUIT**
- Volume fill packing system
- Packaging material
  - Delivery
  - Removal when full/packed
  - QC check
PACKING HOUSE OPERATION (B)

MECHANICAL
- Volume fill
- Tight fill

HAND PACKING
- Attractive pack
- Fixed count (even size)
- Immobilization (lateral tightness)

PURPOSE OF PACKING
- Immobilized (vibration)
- Cushioned (shock)

PACKING FRUIT
- Volume fill
- Tight fill

PACKING LINE
- Minimize fruit damage (padding)
- Avoid fruit accumulation
- Final sort (QA/QC check)
- Packaging material (delivery, removal when full/packed)
- Avoid bottlenecks.
**Section 15**

**SORT**

**SIZING**

**AUTO FILLER**

**PACKAGING**

**INSPECTION**

**MARKING**

**VIBRATION (if req'd)**

**PACKAGING LIDS**

**TOP PADS (if req'd)**

**CLOSING**

**PALLETING** (automatic)

**STORAGE**

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**MECHANICAL PACKERS**

**DROP HEIGHT**
- Minimized
- Shock damage
- Major problem

**HIGH SPEED**
- Large volumes
- Sorted, graded fruit required

**PLACE PACKING SYSTEMS**
- Citrus
- Sized fruit
- Pack pattern
- Rubber/plastic cups

**DELIVER CAREFULLY SORTED & SIZED FRUIT AND PACKAGING**
- Inspection
- Marking
- Top padding (closing operation)

**VOLUME FILL**
- Weight as approximation of volume
- Check weights (manual, automatic)

**TIGHT FILL**
- Immobilisation
- Without compression
- Bruising
- Top padding
- Tightly fasten lid
SUMMER
- Rapid cooling and temperature control
  - Successful marketing
- Cooling and cold storage requiring different
- Cooling efficiency
- Modelling systems

TEMPERATURE PROTECTION
- Shade, natural, shade clothe (silver to reflect)
- Prevent warming
- Sun scald

RAPID TRANSPORTATION TO PACKHOUSE
- Covers
  - Silver to reflect
  - Light colour

ROOM COOLING
- Cooling jets
- Cooling bays

FORCED AIR COOLING
- Forced air tunnel
- Cold wall
- Serpentine cooling
- Forced air evaporative cooling
- Container venting

HYDRO-COOLING

PACKAGE-LANG

VACUUM COOLING

COOLING BEFORE PACKAGING

FIELD HEAT

PRE-GRADING AND PACKAGING

POST-GRADING AND PACKAGING

SELECTION

PRODUCT

OPERATING COSTS

OTHER CONSIDERATIONS

limitations

mix

Temperature req.

Energy costs

Tradition
Section 15

ROOM COOLING

COOLING BAYS
- Cooling
- Storage

COOLING BAYS
- Slow heat removal

STORAGE SPACE MANAGEMENT

WELL VENTILATED CONTAINERS

AIR FLOW
- 60 tp 120 m/min

LONG ?? PRODUCE
- Common

ADVANTAGE
- Cooling and storage in the same room (minimises transfers)

DISADVANTAGE
- Too slow (most commodities)
- More space than required (good storage)
- Excessive water loss possible
FORCE-AIR COOLING

- Forced air tunnel (Fig. 8.2)
- Wide range produce
- Forced air movement through containers
- Slight pressure gradient forces movement
- Bins
- Volume of air
- H₂O loss prevented by high % RH
- Container renting
  - Req’d SA
- Cold wait (Figs. 8.4, 8.5)
- Serpentine (Figs. 8.6, 8.7)
- Forced air evaporative cooling (Fig. 8.8)
  - (Fig. 8.8)

2-3 degrees above outside wet bulb temperature and % rH + 90%
HYDRO COOLING

Use of cold water

Advantages
- no water loss
- quick cooling
- efficient heat transfer

Disadvantage
- cooling packed produce
- container to pickup
- clean

Bins

Volume of air

H₂O loss prevented by high % rH

Mechanical water cooling

Shower type
- 600 – 1000 L/min/m² SA (L/min².m²)
- low level chlorine (1 – 2 ppm residual)
- produce tolerance

Cooling times
10 min to 1 hour

Inline cooling
- cherries, small fruit

Flume cooling hydro
- conveying
- cooling

H₂O loss prevented by high % rH
Section 15

**Packaging Atmospheric Modification**

- **O₂ Control**
  - Recycling/purge generator
  - Catalytic burners ⇒ N₂ purge \[\text{liquid N}_2\]

- **CO₂ Control**
  - Gases CO₂ – gas cylinders
  - CO₂ scrubbers (lime) – sodium hydroxide, water, activated carbon, brine, molecular sieve

- **Membrane Systems**

- **Activated ND Brominated Charcoal**
  - Potassium permanganate
  - Re, pved C₂H₄

- **Ethylene Removal**

- **CO Addition**
CA/MA STORAGE

ADVANTAGES

- RETARDATION
  - Periderm development

- INSECT CONTROL

- POSTHARVEST PATHOGENS
  - 10 – 75% CO₂
  - Inhibit
  - Botrytis rot on
    Strawberries
    Cherries
    Insects

- REDUCTION ETHYLENE SENSITIVITY
  - O₂ < 8% and/or
  - CO₂ > 1%

- PHYSIOLOGICAL DISORDERS
  - Chilling injury

- INITIATION/AGGRAVATION
  - Physiological disorders:
    - Blackout – potatoes
    - Brown stain – lettuce
    - Brown heart – apple/pear

- IRREGULAR RIPENING (pears, tomatoes)
  - O₂ < 2%
  - CO₂ > 5%

DISADVANTAGES

- RETARDATION
  - Respiration
  - Ethylene production
  - Softening
  - Compositional changes
  - Biochemical
  - Physiological

- PHYSIOLOGICAL DISORDERS
  - Chilling injury

- INSECT CONTROL

- POSTHARVEST PATHOGENS
  - 10 – 75% CO₂
  - Inhibit
  - Botrytis rot on
    Strawberries
    Cherries
    Insects

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- STIMULATION
  - Sprouting, e.g. potato – roots tubers

- OFF FLAVOURS/ODOURS
  - Anaerobic Respiration
  - Very low O₂

- DECAY SUSCEPTIBILITY INCR
  - Low O₂ damage