Harvesting & Handling

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Diagram:

- **Harvest** → **Field Pack** (Sort, Grade, etc.) → Accumulate → Transport → Cool → Palletize → Transport
- **Accumulate** → **Transport**
- **Packinghouse**
When to Harvest?

• Are minimum maturity standards met?
• Harvest time is usually a compromise between:
  – Maximum quality
    and
  – The commodity’s ability to survive the marketing chain

When to Harvest?

• Economics
  – Is there a market for the crop? If not,
    • Can the crop be harvested & stored until there is a market?
    • Leave the crop unharvested?

• Supplies, labor, packing & storage facilities, etc. available to harvest & process the crop?
Harvesting

• Fruit often can naturally detach from a plant through the formation of an abscission zone
  – May accelerate or delay abscission by the use of growth regulators e.g.:
    • Ethephon (ethylene)
    • Ethylene inhibitors (e.g. Retain=AVG)

• Most vegetables usually do not develop an abscission zone

From: http://botit.botany.wisc.edu/

Harvesting

• Often the most traumatic time of a commodity’s life
  – Detachment from “food” and water
  – Force required to remove the commodity
    • Fingernail marks, finger pressure
  – Drops/impacts onto branches, harvesting bags, buckets, bins, trailers, other fruit etc.
  – Vibrations and jolts during transport on dirt/rough roads
The Harvesting Process

• **Identify** mature product for harvest using maturity/quality standards
  – E.g. color, size, shape, firmness, lack of defects, etc.

The Harvesting Process

• **Detach** the product from the plant
  – pull, cut, twist, shake, etc.
• **Collect** into picking bags, buckets, etc.
The Harvesting Process

• Accumulate product in field boxes, bins, trailers, etc.
  – Provide shade within the field
  – Minimize time before transport from the field

Plastic vs. Wood Bins

• Plastic bins are generally more expensive to purchase, but are...
  – Lighter
  – Less abrasive to product
  – Have lower maintenance costs
  – Have greater ventilation (e.g., for cooling)
Plastic vs. Wood Bins

• Plastic bins (continued) ...
  – Do not absorb moisture from the product
  – Are easier to clean and sanitize
  – And some can even collapse for less space during transport and storage before use

The Harvesting Process

• Transport product away from field to processing/packing facility
  – Minimize time between harvest & transport
  – Avoid rough roads
Minimizing Injury

- **Careful handling** of all produce containers.
- **Keep all packing equipment clean** to avoid abrasive surfaces.
- Use **bubble plastic liners and top pads** in field bins.
- **Minimize distance** of forklift movement of field bins to loading point.
- **Grade farm roads** and **restrict travel speed** of transport vehicles relative to road quality.
- Use **good (i.e., “air”) suspension systems** on all trucks and **reduce tire pressure**.

Factors Affecting Harvesting & Quality

- **Preharvest Factors**
  - **Genetics**
    - Tree size – e.g. dwarf vs. full sized
    - Uniformity of crop – e.g. harvest one time or spot pick / harvest multiple times
    - Ease of separating product from plant – e.g. maturity, abscission zone formation, etc.
    - Product location on the tree – e.g. inner vs. outer canopy.
• Preharvest Factors (continued)
  
  **Cultural Practices**
  
  • Use of chemicals – e.g.:
    • Ethylene releasing chemicals (Ethephon) => ripening/color change & abscission zone formation
    • Abscission inhibitors (e.g. AVG, “Retain”)
      – inhibits fruit drop
    • Preharvest fungicides
  
  • Pruning
  
  • Planting densities
  
  • Cover crops/plastic mulches
    • Can affect crop maturity, color, insect damage, etc.

• Preharvest Factors (continued)

  **Weather Conditions**

  • Rainfall
    • Too much: increased decay, blue albedo, zebra skin, diluted sugars, etc.
    • Not enough: poor size, wilting, increased plugging, concentrated sugars, etc.
  
  • Dew on the crop
    • E.g. oil cell turgidity related to oil spotting
• Preharvest Factors (continued)

- **Weather Conditions** (continued)
  - Temperature
    - E.g. chilling or high temperature injury, color change, shape (sheepnose), etc.
  - Wind.
    - E.g. wind scarring, sand damage, spread of dirt & spores

• Time of Day

- **Temperature**
  - High temperatures increase cooling demand.
    Possible use of night harvesting
  - Chilling susceptibility may change throughout the day
- **Dew on the crop** (e.g. oil spotting in citrus)
- **Food supply within product** (e.g. photosynthate reserves in flowers)
Types of Harvesting

• **Hand Harvesting**
  – Most fresh fruits & vegetables are hand harvested
  – Unique capability of eyes, mind & hand => product evaluation (field grading), rapid harvest and delicate handling
  – Product graded out in the field reduces cost of handling & disposing at the packinghouse (improved sanitation)

• **Assisted Harvesting**
  – Chemicals, ladders, platforms, picking baskets, knives, etc.

Types of Harvesting

• **Mechanical Harvesting**
  – Mostly for dried (e.g. nuts) or processed produce
    • Products are often damaged (bruised, punctured, etc.), but that is not so important for product for processing
  – Less labor needed, but more skilled labor required
  – Sophisticated technology => high unit cost
  – Harvest take less time but the machinery is **not as selective**
    • Includes immature, over-mature, decaying product, leaves, twigs, stems, etc.
Types of Harvesting

• **Mechanical Harvesting** (Continued)
  – May damage trees
  – Requires “once-over harvest”
  – May require plant breeding to withstand mechanical harvesting
    • E.g. mechanical harvesting of tomatoes
  – Rest of handling system must be able to accommodate mechanical harvesting (How does new technology fit with the existing system?)
    • E.g. ability to handle large volumes of fruit
Field vs. Packinghouse Packing

- Field Packing (e.g. strawberries, head lettuce, grapes)
  - Less material to transport and dispose
  - Fewer handling steps => less mechanical damage
  - Smaller initial start-up cost
  - Requires large machinery in the field (soil compaction, trampled product, etc.)
Field vs. Packinghouse Packing

• Field Packing (continued)
  – More dependent on weather
  – Requires skilled labor
  – Product in containers are more difficult to cool
  – Less control over quality
  – Cannot apply many postharvest treatments (e.g. waxes, fungicides, etc.)

Preparation for Market

• Economics must justify any postharvest handling practices. If a step does not add value to the crop, it is a waste of money!

• Objective:
  – Improve the value of the marketable crop
Preparation for Market
Order of events depends on operation.

- Receiving
- Dumping
- Sorting
  - Sizing
  - Grading
- Postharvest Treatments
- Packing
- Assembling – e.g. pallets
- Cooling

Different combinations of events are used depending on the commodity and economic factors.

Receiving

- **Provide shade** to prevent heating and sunburn
  - Shade can also be provided within the field (e.g. cover with palm fronds or use shade cloth)
- **Move into packing operation quickly**
**Cooling**

- Minimize time between harvest and cooling
- **Cooling before grading** (e.g. in field containers):
  - **Positive:**
    - May extend storage life
  - **Negatives:**
    - Extra expense of cooling unmarketable product
    - Energy to cool will be lost if commodity is allowed to warm during packinghouse operations
    - Re-warming & condensation may cause additional decay
- **Often, cooling occurs after packing**

**Dumping**

- **Wet** – immersion or dumping into water.
  - Gentler on the product
  - Sanitation is important
  - Sodium sulfate used to float some products (e.g. pears)
Dumping

- **Dry** – product containers emptied onto a belt or roller conveyer
  - Possibility of more mechanical injury
  - Requires controlled dumping (note hydraulic cover) and padding to minimize impact injury
Removing unwanted material (sorting)

• Sort as soon as possible
  – Money is wasted whenever unmarketable product is handled/treated

• Potentially pre-sort to remove unmarketable fruit and other materials (e.g. twigs, leaves) before wash
  – Also keeps decayed material out of the packinghouse
Removing unwanted material (sorting)

- **Sizing** (weight, volume, length, diameter)
  - By eye
  - Diverging rollers or belts
  - Increasing hole sizes (belts or rings)
  - Digital weight sizers
  - Digital optical (image) sizers

Removing unwanted material (sorting)

- **Quality grading** based on maturity, shape, color, defects, etc.
  - Most still accomplished by hand
    - Requires good lighting, uniform product flow, rotation of product, worker comfort, worker supervision and responsibility
  - Computer controlled machinery
    - Optical (image) grading equipment
    - Light reflectance/transmittance for internal defects or composition (e.g. sugars)
Preparation for Market

Postharvest Treatments

- **Wash** (sprays, brushes, etc.) to remove dirt, residues, etc. Water sanitation is critical
- **Drying** (air, sponge-roller)
- **Wax** application – reduce water loss, enhance appearance, reduce decay (carry fungicide)
- **Fungicide** application
- **Curing** (e.g. potato, dry onions) – wound healing & reduced decay. In field or in rooms
- **Ripening/degreening** treatments
- **Trimming** (e.g. lettuce, celery, cauliflower, etc.)
- **Quarantine (insect)** treatments (e.g. fumigation, hot water or air, cold treatments, controlled atmospheres, etc.)
Packing

• Machine vs. hand pack
• By commodity count or weight

Packing

• Volume fill
  – loose fill
  – tight fill
  – bagging
• Or place pack

http://www.stillwaterorchards.com/images/fruit4.jpg
Packaging
Requirements of the Commodity

- **Protect the commodity**
  - Immobilize the product
  - Protect against crushing (stacking), impacts, vibration damage, etc. Possible use of trays, cups, liners, pads, etc.
  - Withstand packages stacked at least one pallet high
  - Maintain strength under high humidities (or free moisture in some cases)
  - Protect against contamination (fungi, insects, bacteria)
Packaging
Requirements of the Commodity

• Provide (or modify) gas exchange
• Prevent/slow water loss
• Allow cooling and/or insulate from heating
  – Recommended 5% side venting (adequate air flow with good structural strength). ~3% venting in the top and bottom
    • Vents should align even when cross stacking
  – Internal packing should not restrict air movement
  – Provide insulation during non-refrigerated transport (e.g. cut flowers)
Packaging
Requirements of the Marketing Chain

• Advertise the produce
• Provide information about the product (e.g. name, size, weight, grade, special treatments, etc.)
• Attractive package adds to product appeal

Packaging
Requirements of the Marketing Chain

• Appropriate dimensions
  – Fit more than one grade of crop
  – Fit common types of transport (e.g. trucks, rail, shipping containers, etc.)
• Design to fit standard 40” x 48” pallet
  – Generally 8 or 10/layer

Figure courtesy of Steve Sargent
Assembly – Unitizing in pallets, bins, etc.

- Reduces labor of handling individual cartons or products
  - E.g. handling watermelons one at a time vs. in bulk bins
  - Product at bottom must survive
  - Allows use of forklifts, cranes, etc.

Assembly – Unitizing in pallets, bins, etc.

- Protects the commodity (e.g. product shifting)
  - Systems such as gluing, interlocking packages, wrapping pallets, bracing, etc. help maintain unit integrity during transport
Palletizing

- Do not stack boxes beyond pallet edges
  - When cartons overhang, then the weight of the load is not on the corners (strongest part) = collapse of the load
- Use pallets that do not block the bottom vents of cartons

Suggested floor plan of packinghouse

Figure courtesy of Steve Sargent
Quality Control (QC)

• One person should be responsible for an operation’s QC and given enforcement authority

• Effective QC measures must be established throughout the entire postharvest system