Harvesting & Handling

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Remember!

• The Commodity is LIVING!

• Delivering a QUALITY product in the form the consumer will purchase!

Harvest → Field Pack → Accumulate → Transport → Cool → Store → Palletize → Transport

Accumulate
Transport
Degreen, Clean, Sort, Grade, Size, Wax, Fungicide, Pack, Ripen, etc.

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 are 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
  - Use air ride suspension systems

Minimizing Injury

- Careful handling of all produce containers.
- 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
- Keep all packing equipment clean to avoid abrasive surfaces

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. AVERAGE, "ReTain")
    – inhibits fruit drop

• Pruning
• Planting densities
• Cover crops/plastic mulches
  • Can affect crop maturity, color, insect damage, etc.

--- 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

--- 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.

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

**Mechanical Harvesting**

![Image of mechanical harvesting process]

*Figure courtesy of Steve Sargent*
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 (continued)

- 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.)

Types of Mechanical Injury

- **Bruises**
  - **Impact: Drops**
  - **Compression: Excessive weight**

- **Cuts, Punctures, Abrasion**
Preparation for Market

- Objectives:
  - Eliminate unwanted material
  - Select/combine items of similar grade
  - Improve the value of the marketable crop

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

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 conveyor
  - Possibility of more mechanical injury
  - Requires controlled dumping (note hydraulic cover) and padding to minimize impact injury

Figures courtesy of Steve Sargent
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

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.)

Shipping Containers

• **Design to fit standard 40” x 48” pallet**
  – Generally 8 or 10/layer

• **Vent holes**
  – 5% container face
  – Must align holes to facilitate cooling

• **Wirebound vs. corrugated vs. returnable**
  – Strength; recyclable?

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

Figure courtesy of Steve Sargent

Suggested floor plan of packinghouse
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