Harvesting & Handling

Mark Ritenour
Indian River Research and Education Center, Fort Pierce
Jeff Brecht
Horticultural Science Department, Gainesville

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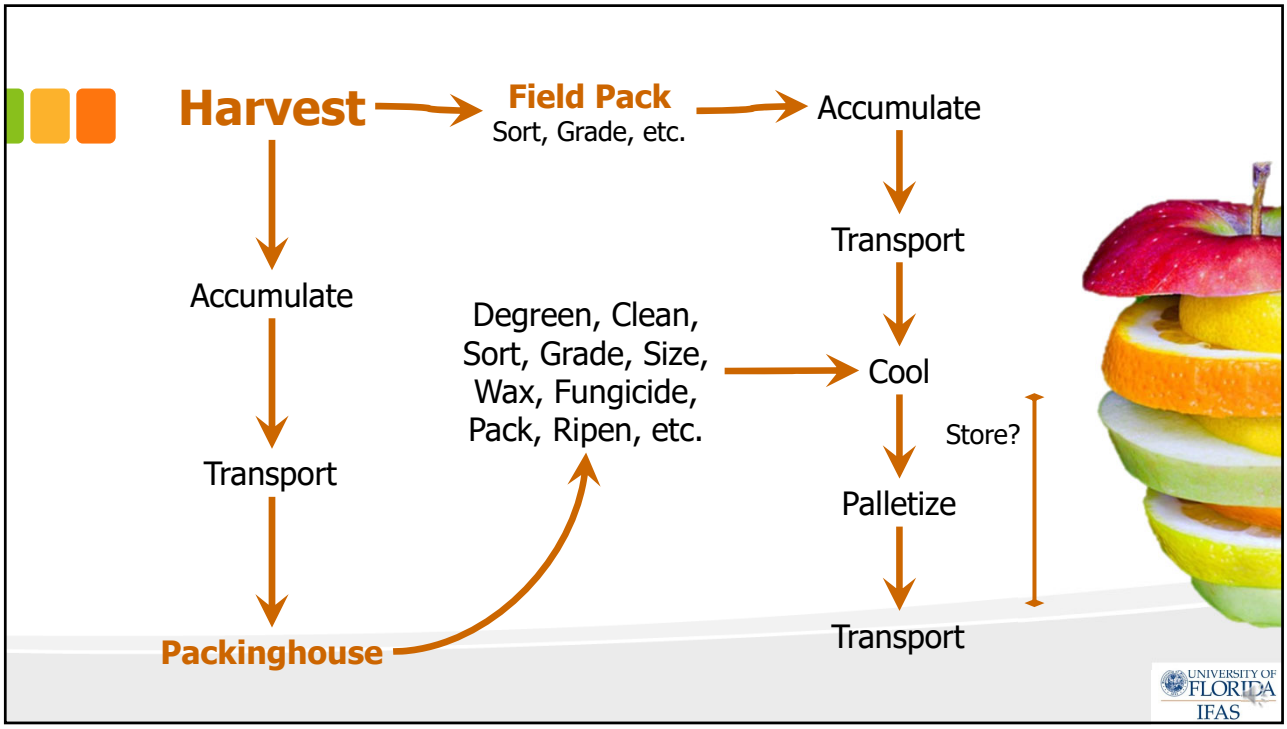
1



2

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

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When to Harvest?

- Economics
  - Is there a market for the crop? If not,
    - Can the crop be harvest & stored until there is a market?
    - Leave the crop unharvested?
- Supplies, labor, packing & storage facilities, etc. available to harvest & process the crop?

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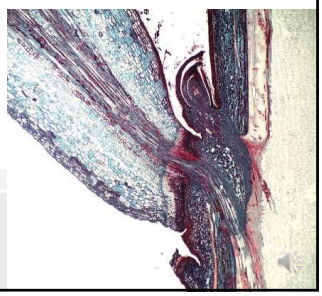
Harvesting

- 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/

5

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

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The Harvesting Process

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

7

The Harvesting Process

- **Detach** the product from the plant
  - pull, cut, twist, shake, etc.
- **Collect** into picking bags, buckets, etc.

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The Harvesting Process

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

9

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)

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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

11

The Harvesting Process

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

12

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**

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13

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.

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- 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.

15

- 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 turgity related to oil spotting

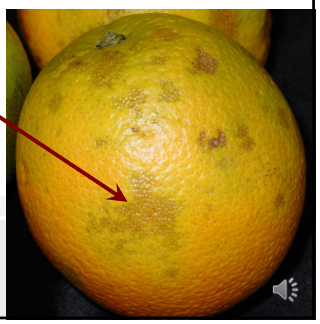
http://alexjonesphoto.com/recent/archive/rainycitrus.jpg

16

- 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

17

- 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)



18

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.

Figure courtesy of Steve Sargent

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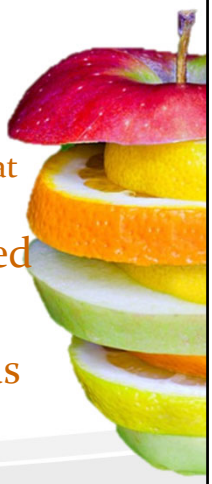
Types of Harvesting

- **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.



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20

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

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Mechanical Harvesting

22

Figure courtesy
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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.)

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24

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.)

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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

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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

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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

28

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

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Dumping

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

30

Figures courtesy of
Steve Sargent

31

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

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33

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

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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

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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)

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Figure courtesy of Steve Sargent

37

Preparation for Market

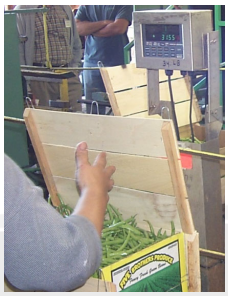
Postharvest Treatments

- 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.)

38

Packing

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



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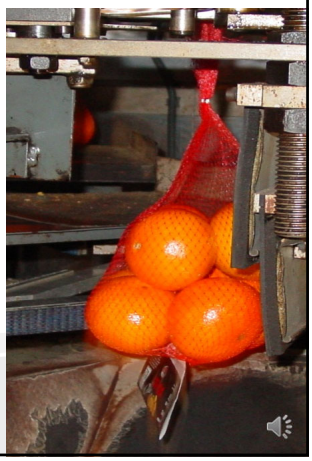
39

Packing

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



http://www.stillwaterorchards.com/images/fruit4.jpg

40

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)

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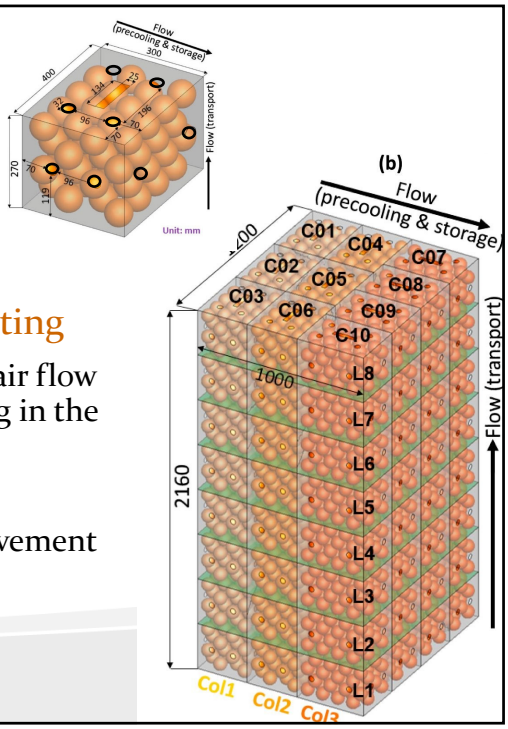
Packaging
Requirements of the Commodity

- 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)



43

44

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

45

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

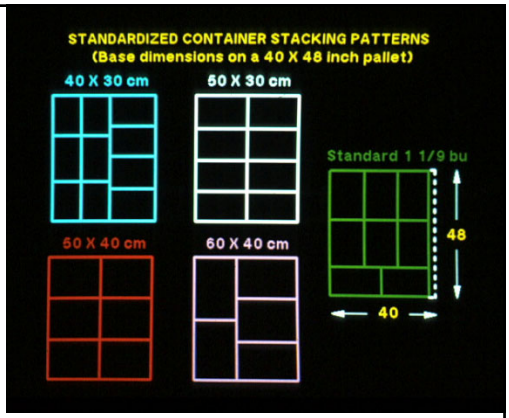


Figure courtesy of Steve Sargent

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46

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.

47

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

48

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

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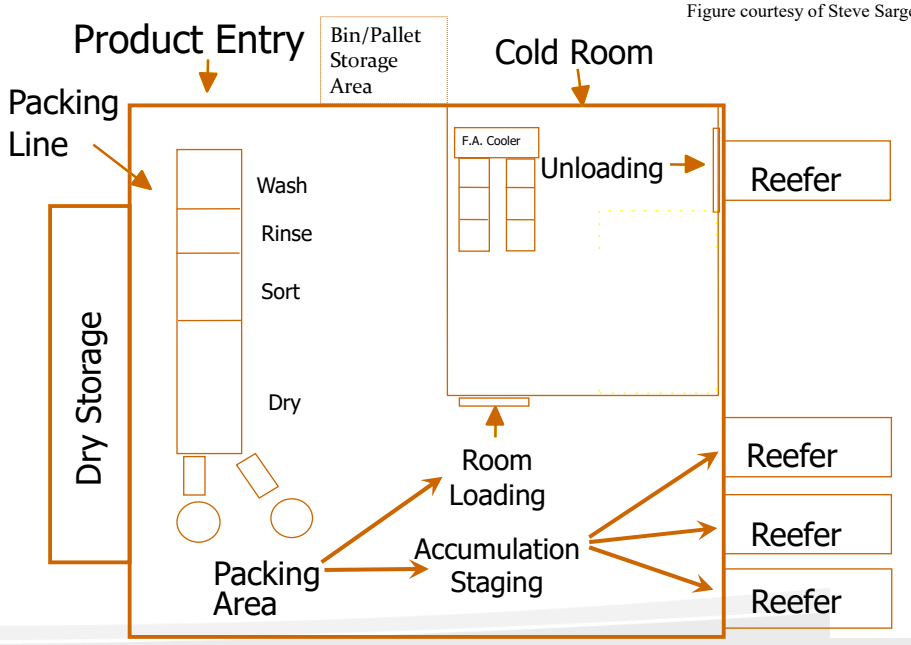
49

Figure courtesy of Steve Sargent



Suggested floor plan of packinghouse

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50

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

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51