

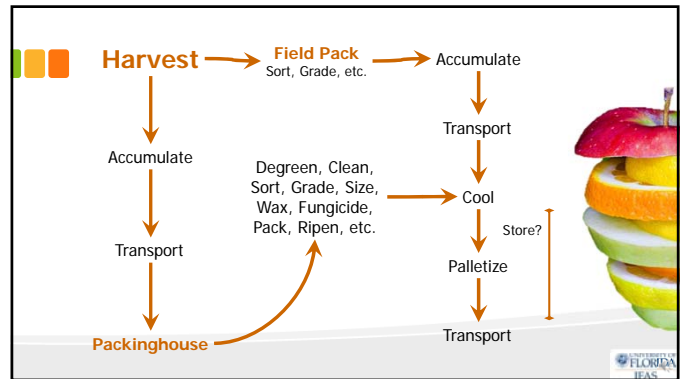
# Harvesting & Handling



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# 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?**

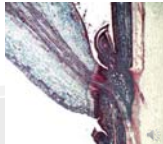


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# Harvesting

- Fruit often 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/>

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# 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.



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## ■ ■ ■ 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



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## ■ ■ ■ 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



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## ■ ■ ■ The Harvesting Process



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



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## 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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## 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.


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## 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






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



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## 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

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## 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)

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## 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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## 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



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Figure courtesy of Steve Sargent



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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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## 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



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## 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)



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### ■ ■ ■ 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






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### ■ ■ ■ 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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## 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.)

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### Packing

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

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### Packing

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

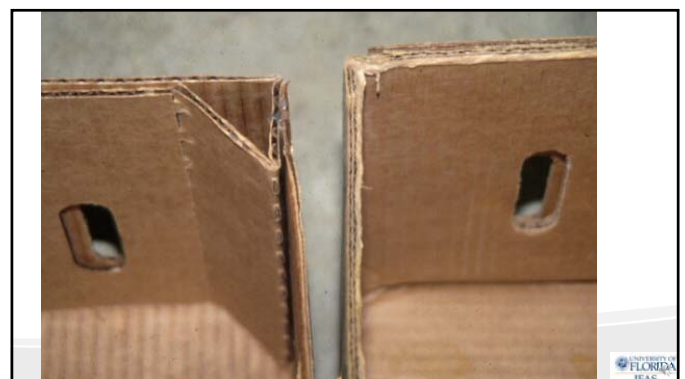
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## Packaging

### 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)




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## 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



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## 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

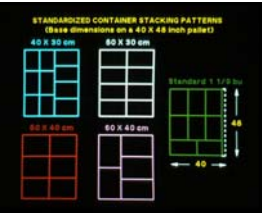


Figure courtesy of Steve Sargent

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## 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.



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## 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





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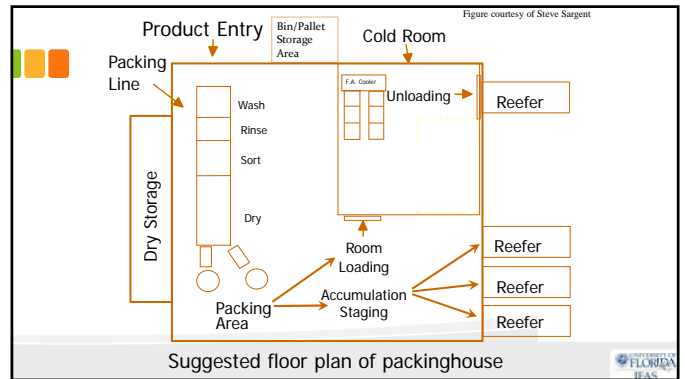


## ■ Palletizing

- 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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## ■ 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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