Post-Harvest Handling and Storage
Introductory Vegetable Production

Post-Harvest – WHY?
Ultimate Goal
Storage
Opportunity
Growing Season
Opportunity
Last Spring Frost
First Fall Frost
Average = mid May – early Sept
Peak Harvest

HARVEST

Insta-Poll (Discussion)
“How do you decide when to harvest?”

Harvesting
- What you harvest is what you store!
- Correct timing based on:
  - Crop type
  - Appropriate Ripeness / Maturity
  - Target market
  - Crop readiness
  - Consider environmental conditions
    - Temperature
    - Moisture

Harvest Methods
- Hand
- Machine-assisted
- Mechanically
Pre-Harvest Activities

- Top-killing
- Chemical
- Mechanical
- Windrowing
- Etc.

POST-HARVEST HANDLING / STORAGE
Insta-Poll
(Discussion)
“What is involved in Post-harvest handling?”

Post-Harvest Handling
- Pre-cooling (removal of field heat)
- Curing / Drying
- Washing
- Cooling
- Sorting / Sizing
- Grading / Trimming
- Bagging / Packaging
- Storing
- Treating
  - Waxes
  - Pesticides
  - Sprout inhibitors

Post-Harvest Handling – Key Points
- Harvest produce at correct stage of development (avoid over-ripe or immature)
- Remove field heat a.s.a.p
- Vegetables = living organisms that continue to “breath” / age after separation from plant
  - Respiration influenced by:
    - Age / Health of product
    - Temperature
    - Presence of ethylene (C2H4)

Post-Harvest Handling – Key Points
- Minimize wounding or damage
- Grade to remove inferior/poor quality product
  - Produce quality cannot improve after harvest – must be maintained
- Deterioration can’t be reversed, only slowed
- Washing may (or may not) be beneficial for some crops prior to storage
- Some packaging will be required

Cooling
- Remove field heat
  - Harvest as cool as possible (Early/late; overcast)
- Cool using:
  - Cool temperatures
  - Airflow
  - Misting / Wetting / Dipping / Ice Slurries, etc.
- Prior to low temperature, long term storage, gradually reduce temperatures over time (~1°C/day)
Curing

- Curing has the potential to improve storability of some vegetables
- Ability to heal minor wounds
- Dry down outer protective layers, protecting from moisture loss and disease
- Usually consists of a period of warmer temperatures (2-3 weeks), followed by a gradual cooling
- Recommended for potatoes, onions, garlic and maybe for winter squash

Washing

- Necessary for most vegetables (at some point)
  - May be done either pre-storage and/or post-storage
- Removes dirt and contaminants (surface pathogens, debris, etc.)
- Important – ensure wash water is kept fresh and adequately chlorinated
- Note – some vegetables:
  - Should not be washed prior to storing (e.g. potatoes) or
  - May not require washing (e.g. leafy or stem vegetables, bulb veg, pumpkins, etc.)
Packaging

- Bags, containers, etc.
- Need to consider appropriate packaging method & size
  - Customer preference
  - Suitability for produce type
  - Practicality
- Rules & regulations exist for labels, packaging type, etc.
  - Farm name, language, etc.

Storage Requirements

- Each vegetable can be stored for a finite period of time – will vary with storage conditions
- Each vegetable has different storage requirements / considerations
  - Temperature
  - Relative Humidity
  - Chilling Sensitivity
  - Ethylene (Production & Sensitivity)
  - Respiration rates

Harvest / Post-Harvest Requirements - Peas

<table>
<thead>
<tr>
<th>PEAS</th>
<th>Temperature (°C)</th>
<th>Relative Humidity (%)</th>
<th>Storage Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>95-98</td>
<td>1-2 weeks</td>
</tr>
<tr>
<td>Harvest Timing / Stage</td>
<td>Pre-Storage Conditions</td>
<td>Special Conditions</td>
<td>Comments</td>
</tr>
<tr>
<td>Harvest fully turgid; before seeds deform the hull; harvest regularly to ensure fresh quality</td>
<td>Cool to 0°C quickly by forced air cooling, hydrocooling, etc.</td>
<td>Not sensitive to chilling; Avoid surface moisture; Store better unshelled</td>
<td></td>
</tr>
</tbody>
</table>

Harvest / Post-Harvest Requirements - Beans

<table>
<thead>
<tr>
<th>BEANS</th>
<th>Temperature (°C)</th>
<th>Relative Humidity (%)</th>
<th>Storage Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5-7</td>
<td>90-95</td>
<td>8-12 days</td>
</tr>
<tr>
<td></td>
<td>Harvest Timing / Stage</td>
<td>Pre-Storage Conditions</td>
<td>Special Conditions</td>
</tr>
<tr>
<td>Harvest when mature (8-10 days after flowering); Bright coloured pods &amp; small, tender seeds; Should &quot;snap&quot; audibly;</td>
<td>Cool quickly to preserve quality</td>
<td>Store in waxed cardboard or plastic lined; Avoid contact with ice or water</td>
<td>Chilling sensitive (below 5°C); Gentle/careful handling is required for more tender types</td>
</tr>
</tbody>
</table>

Harvest / Post-Harvest Requirements – Cole Crops

<table>
<thead>
<tr>
<th>COLE CROPS</th>
<th>Temperature (°C)</th>
<th>Relative Humidity (%)</th>
<th>Storage Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>95+</td>
<td>14-18* - 6mo*</td>
</tr>
<tr>
<td>Harvest Timing / Stage</td>
<td>Pre-Storage Conditions</td>
<td>Special Conditions</td>
<td>Comments</td>
</tr>
<tr>
<td>Depends on specific crop, but generally they should be full coloured, firm, turgid &amp; not over developed (bolted, split, etc.)</td>
<td>Cool quickly, unless harvested at cool temperatures; Remove loose/excess wrapper leaves of cabbage</td>
<td>Cabbage should be stored with a small amount of light; Broccoli should be covered with an ice slurry</td>
<td>Depends on type/species/degree of ripeness</td>
</tr>
</tbody>
</table>
## Harvest / Post-Harvest Requirements - Carrots

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Relative Humidity (%)</th>
<th>Storage Duration</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>95+</td>
<td>5-7 months</td>
<td></td>
</tr>
</tbody>
</table>

### Harvest Timing / Stage
- Pre-Storage Conditions
- Special Conditions

- Depends of type of carrot; harvest when mature (varies) & well developed
- Most carrots have the tops removed prior to storage; immediate washing & cooling is recommended
- Generally, do not cut into the crisp tissues; Store as cold as possible, without freezing

## Harvest / Post-Harvest Requirements - Potatoes

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Relative Humidity (%)</th>
<th>Storage Duration</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-8*</td>
<td>95</td>
<td>2-12 months</td>
<td></td>
</tr>
</tbody>
</table>

### Harvest Timing / Stage
- Pre-Storage Conditions
- Special Conditions

- Harvest when mature (depending on market); Harvest can occur whenever tubers have formed
- Top kill or allow tops to die down, waiting 2 weeks before harvesting (allows skins to toughen & heal); Cure tubers for 3 weeks at 15°C prior to storing; Store potatoes dirty
- Applications of sprout inhibitors may be required for fresh market tubers; Ensure tubers are turgid, free from defect or damage

* depends on type

## Harvest / Post-Harvest Requirements - Leafy Greens

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Relative Humidity (%)</th>
<th>Storage Duration</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>95</td>
<td>Up to 3wks</td>
<td></td>
</tr>
</tbody>
</table>

### Harvest Timing / Stage
- Pre-Storage Conditions
- Special Conditions

- Harvest at appropriate degree of maturity (depends on type); Cool as quickly as possible after harvest; product may be wetted to speed cooling but should not remain wet
- Baggng is possible, but do not allow moisture to build up
- Leaves should be crisp & turgid & free from defect

## Harvest / Post-Harvest Requirements - Cucurbits

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Relative Humidity (%)</th>
<th>Storage Duration</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-15</td>
<td>50-95*</td>
<td>10* – 6mo*</td>
<td></td>
</tr>
</tbody>
</table>

### Harvest Timing / Stage
- Pre-Storage Conditions
- Special Conditions

- Harvest at appropriate size & maturity (depending on type); Some cucurbits may be ripened post-harvest (e.g. pumpkins)
- Cucs – treated more as a short term fresh product (stored slightly cooler); Squash/Pumpkins – store longer
- All are chilling sensitive; Cucs – should be turgid, dark green, unwrinkled; Squash/Pumpkins – should be fully developed & have tough skin

* depends on type/variety/degree of ripeness

## Harvest / Post-Harvest Requirements - Onions

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Relative Humidity (%)</th>
<th>Storage Duration</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>70-75</td>
<td>6-9 months</td>
<td></td>
</tr>
</tbody>
</table>

### Harvest Timing / Stage
- Pre-Storage Conditions
- Special Conditions

- Harvest when bulbs are mature, & 50-80% of tops have fallen; Necks should be dried down & thin
- Curing at warm temperatures (25°C) for several weeks will improve scale drying & skin set; Cool gradually to final storage temperature
- Duration of storage varies with type of onion

## Harvest / Post-Harvest Requirements - Sweet Corn

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Relative Humidity (%)</th>
<th>Storage Duration</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>95+</td>
<td>1-2 days</td>
<td></td>
</tr>
</tbody>
</table>

### Harvest Timing / Stage
- Pre-Storage Conditions
- Special Conditions

- Harvest when ears & kernels fully formed; husks fresh & tight; silks are brown & dried down; most types will have milky juice (except sh2 types)
- Very rapid removal of field heat is critical to preserving post-harvest quality;
- Corn may be held longer than is ideal, however quality will decline
### Harvest / Post-Harvest Requirements – Tomatoes

<table>
<thead>
<tr>
<th>TOMATOES</th>
<th>Temperature (°C)</th>
<th>Relative Humidity (%)</th>
<th>Storage Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvest Timing / Stage</td>
<td>Pre-Storage Conditions</td>
<td>Special Conditions</td>
<td>Comments</td>
</tr>
<tr>
<td>Harvest at physiological maturity or later</td>
<td>Cool to desired temperature depending on whether ripening is required</td>
<td>Fruit should be firm &amp; turgid, free from defect; fruit will change colour after harvest; Chilling sensitive</td>
<td></td>
</tr>
</tbody>
</table>

### Storage types
- Root Cellar (rudimentary)
- Bulk
- Palletized
- Not all storages are “cold” storage
- Some may be cool or slightly warm (depends on crop needs)

### Canada Plan Service (Series 6000)
- [www.cps.gov.on.ca/english/planmenu.htm](http://www.cps.gov.on.ca/english/planmenu.htm)

### Cooler / Cold Storage

### QUESTIONS???

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