Postharvest Handling Systems for Small-Scale Farmers Throughout the World
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Horticulture Collaborative Research Support Program (Hort CRSP)

Postharvest Principles
• Select good varieties with flavor and shelf life potential
• Harvest at proper maturity
• Avoid sun exposure to reduce water loss and temps
• Cool quickly to lowest safe temperature
• Protect from physical damage
• Maintain cold chain
• Expedite marketing whenever possible
SAME for LARGE and SMALL-SCALE OPERATIONS!!

Small-Scale Operations
• Local food movement
  – Lots of new farmers with small to medium operations
• Small organic operations
• Smallholders in developing countries

Handling of Horticultural Perishables in Developing vs. Developed Countries
• Requirements for maintaining quality & safety are the same
• Extent of adoption of the recommended harvesting and postharvest handling procedures & technologies varies greatly depending on:
  – scale of operation
  – intended market
  – return on investment of each technology
• Attitude about the need for proper postharvest handling varies

Estimated Postharvest Losses (%) of Fresh Produce in Developing vs. Developed Countries

<table>
<thead>
<tr>
<th>Locations</th>
<th>Developed Countries</th>
<th></th>
<th>Developed Countries</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Mean</td>
<td>Range</td>
<td>Mean</td>
</tr>
<tr>
<td>From production to retail sites</td>
<td>2-23</td>
<td>12</td>
<td>5-50</td>
<td>22</td>
</tr>
<tr>
<td>At retail, foodservice, and consumer sites</td>
<td>5-30</td>
<td>20</td>
<td>2-20</td>
<td>10</td>
</tr>
<tr>
<td>Cumulative total</td>
<td>3.5-26.5</td>
<td>32</td>
<td>3.5-35</td>
<td>32</td>
</tr>
</tbody>
</table>

Estimated Postharvest Losses of Cereals (% of total annual production in Africa), 2003-2008

<table>
<thead>
<tr>
<th>Year</th>
<th>Loss (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>17.0</td>
</tr>
<tr>
<td>2004</td>
<td>14.4</td>
</tr>
<tr>
<td>2005</td>
<td>14.3</td>
</tr>
<tr>
<td>2006</td>
<td>14.8</td>
</tr>
<tr>
<td>2007</td>
<td>15.1</td>
</tr>
<tr>
<td>2008</td>
<td>17.4</td>
</tr>
</tbody>
</table>

Postharvest losses of potatoes, tomatoes, and grapes in Egypt based on sampling

<table>
<thead>
<tr>
<th>Marketing system level</th>
<th>Potatoes</th>
<th>Tomatoes</th>
<th>Grapes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm</td>
<td>11.9</td>
<td>9.0</td>
<td>15.1</td>
</tr>
<tr>
<td>Wholesale</td>
<td>1.5</td>
<td>7.9</td>
<td>6.9</td>
</tr>
<tr>
<td>Retail</td>
<td>4.2</td>
<td>16.3</td>
<td>6.0</td>
</tr>
<tr>
<td>Total</td>
<td>17.6</td>
<td>43.2</td>
<td>28.0</td>
</tr>
</tbody>
</table>


Postharvest Losses of Selected Vegetables in Northern Thailand based on Sampling at the Collection Center

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Range of losses (%) due to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Physical Damage</td>
</tr>
<tr>
<td>Head lettuce</td>
<td>21 – 27</td>
</tr>
<tr>
<td>Red leaf lettuce</td>
<td>19 – 27</td>
</tr>
<tr>
<td>Butterhead lettuce</td>
<td>24 – 36</td>
</tr>
<tr>
<td>Spinach</td>
<td>17 – 25</td>
</tr>
<tr>
<td>Cabbage</td>
<td>14 – 19</td>
</tr>
<tr>
<td>Celery</td>
<td>22 – 24</td>
</tr>
</tbody>
</table>

(Boonyakiat, 1999)

Recommended vs. Measured Tomato Fruit Temperatures

<table>
<thead>
<tr>
<th>Country</th>
<th>Rec. Temp. °C</th>
<th>Farm</th>
<th>Wholesale Market</th>
<th>Retail</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>15</td>
<td>25.2±0.6</td>
<td>30.5±2.7</td>
<td>29.1±2.8</td>
</tr>
<tr>
<td>Ghana</td>
<td>15</td>
<td>31.2±2.7</td>
<td>30.2±2.5</td>
<td>32.5±2.6</td>
</tr>
<tr>
<td>Benin</td>
<td>15</td>
<td>28.5±1.7</td>
<td>29.1±1.2</td>
<td>23.4±2.3</td>
</tr>
<tr>
<td>Rwanda</td>
<td>15</td>
<td>30.1±3.0</td>
<td>22.1±1.2</td>
<td>23.4±2.3</td>
</tr>
</tbody>
</table>

Kitinoja and AlHassan, 2010
N=30; 3 reps from 10 random samples per site

Recommended vs. Measured Tomato Fruit Temperatures

Country	Rec. Temp. °C	Farm	Wholesale Market	Retail
India	15	25.2±0.6	30.5±2.7	29.1±2.8
Ghana	15	31.2±2.7	30.2±2.5	32.5±2.6
Benin	15	28.5±1.7	29.1±1.2	23.4±2.3
Rwanda	15	30.1±3.0	22.1±1.2	23.4±2.3

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Can we make coolers portable?

USDA Porta-Cooler
- Designed by team at USDA Beltsville
- 3.5 kW window AC system
- 3.5 to 7 m³ interior space
- Cold air is forced through produce by pressure from a fan in a second wall inside
- Air returns to AC unit through false floor
- Can install a Cool-Bot on this unit to cool to temperatures lower than 15°C
- Approximate cost $1,200 (does not include trailer)

Evaporative Cooling or Swamp Cooler
- Uses evaporation of water to cool air
- Low initial cost and low electrical costs
- Especially effective in arid climates
  - Use 12-volt power to run water pump and small fan
- Cools to few degrees above wet bulb temp
- Could be used on porta-cooler instead of AC unit

Pad = Wood shavings, straw
0.3 m³/s per MT of fresh produce (64 cfm/MT)

Passive Evaporative Coolers

Charcoal Cooler

Mohammed Bah Abba from Nigeria
Pot in Pot

Zero Energy Cool Chamber

(ZECC) is constructed from stacked bricks. A cavity between double walls is filled with sand and the bricks and sand are kept saturated with water. Fruits and vegetables are loaded inside, and the entire chamber is covered with a rush mat, which is also kept moist.

Inside temperature between 15 and 18°C (59 and 65°F) during summer in India.
Costs
1 MT - $1,200
100 kg - $125

Other Cooling Methods
• Night ventilated storage room
  – When night temperatures are significantly cooler than day temps
  – Well insulated building
  – Vents at ground level, open at night, close in morning
  – Fans at top of structure pull heat out and pull cool air through facility
• Use deep well water for hydrocooling

Good Packaging Essential
1. Protection
2. Reuse
3. Moisture barrier

Examples of Shipping Containers Used in Developing Countries

Policy and Trade Issues Affect Choice of Packaging

Plastic RPCs remain strong and can be sterilized before reuse
Mechanism of Utilizing Dry Ice To Generate CO2 for Insect Control in Stored Grains, Dried Fruit and Nuts

For Further Information


Questions?

http://postharvest.ucdavis.edu