FEED THE FUTURE INNOVATION LAB FOR HORTICULTURE

WEBINAR

Dry Chain – A solution to dried commodity losses due to moisture and humidity
Storage
A key link in the dry chain

Michael Reid and Jim Thompson
Storage – a key link in the dry chain

- Proper storage maintains quality of grains and pulses, slows development of rancidity and kernel darkening in nuts, and maintains vitality of seeds
- Prevents mold
- Stops insect damage
- Prevents rodent and bird attack
Poor storage!
Good storage?
Maintain the dry chain!

- Storage below 0.65 water activity reduces insect attack and prevents fungal infection
- To prevent rehydration, store in hermetic containers
  - Sealed
  - Plastic bags or drums
  - Steel canisters or silos
Benefits of hermetic storage

- Hermetic storage bags, like the inner polyethylene liner of the Purdue PICS bags, are sealed
- Infesting insects rapidly deplete the available oxygen
- Low oxygen prevents additional insect damage and may reduce mold growth too
- The insects kill themselves!
Number of live A. obtectus adults

Storage period (February - August)

Seed damage (%)
Key Concepts

• Storing products below 0.65 WA slows quality loss and prevents insect and decay damage.
• Hermetic storage can prevent insect infestation and mold growth by maintaining low WA and reducing the oxygen concentration
• Hermetic storage containers are an essential link in the dry chain
Drying technologies

Michael Reid
Leader, Technology and Innovation
Horticulture Innovation Lab
Open air drying is widely used
Problems with open air drying

• Rain – requires covering when rain threatens
• Birds, ducks, hens, RATS, mice
• Flies, wasps
• Dust, dirt, leaves
• Wind?
• Thieves?
Initial drying of a fruit slice

Moisture evaporating rapidly from surface

Mango slice with moisture in it

Moisture on surface (a moisture "pool")

Moisture diffusing to surface from inside of slice
Late in the drying process

Slow evaporation of moisture from surface

Warm Air (containing little moisture)  Warm Dry Air

No moisture "pool" on surface

Mango slice with moisture in it (the centre is indicated by the dashed line)

Moisture diffusing slowly to surface
Effect of slice thickness

The Effect of Thickness on Drying of Apple Slices at 55 C and 0.5 m/s Air Velocities

- 0.4 cm Thick
- 0.6 cm Thick
- 0.8 cm Thick

Weight of Apple Slices vs Time

Time: $t_1$, $t_2$, $t_3$
Effect of air speed

Drying Time for Mangoes in a Tray Dryer at 50 C with 0.2 m/s and 0.5 m/s Air Velocities

Weight of Mango Slices

0.2 m/s Air Velocity

0.5 m/s Air Velocity

Time
Effect of air temperature

Drying Time for Mangoes in a Tray Dryer at Various Temperatures

Moisture Content (% wet basis)

Time

- 50 C
- 55 C
- 60 C

$t_1$, $t_2$, $t_3$
SO:

- Effective drying of high value commodities (fruit, vegetables, fish, meat) requires a system that provides:
  - Thin layers
  - Protection
  - Air speed
  - High temperature
Drying grains and pulses

• The problem
  • Frequently the DryCard shows farmers that their grain is insufficiently dry to be stored safely
  • How can they dry it?
  • On the ground (handling, rain, predation, contamination)
  • Chimney dryer (low capacity)
  • Current dryers (solar, gas, electric) are complex & expensive
## Dryer options (based on rice drying)

<table>
<thead>
<tr>
<th>Dryer</th>
<th>Capacity</th>
<th>Dry time</th>
<th>Operation assumptions</th>
<th>Capacity (MT/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun dry</td>
<td>0.06 MT/m³</td>
<td>2-4 days</td>
<td>17 m³ area</td>
<td>0.25 – 0.5</td>
</tr>
<tr>
<td>Batch</td>
<td>1-10 MT</td>
<td>8-10 hrs</td>
<td>1 batch/day</td>
<td>1-10</td>
</tr>
<tr>
<td>Recirculating batch</td>
<td>4-10 MT</td>
<td>8-10 hrs</td>
<td>1 batch/day</td>
<td>4-10</td>
</tr>
<tr>
<td>Column-continuous flow</td>
<td>10 MT/hr</td>
<td>5 passes</td>
<td>20 hrs/day</td>
<td>40</td>
</tr>
<tr>
<td>Belt-continuous flow</td>
<td>10 MT/hr</td>
<td>5 passes</td>
<td>20 hrs/day</td>
<td>40</td>
</tr>
</tbody>
</table>

**Diagram:**
- **Sun Dry:** Direct sunlight for drying.
- **Batch Dry:** Material is put into a batch and dried batch by batch.
- **Recirculating Batch Dry:** Material is repeatedly circulated through a batch dryer.
- **Column-Continuous Flow:** Material moves through columns continuously.
- **Belt-Continuous Flow:** Material moves on a belt continuously.
The UC Davis Pallet Dryer

- We have developed a simple solar dryer that uses inexpensive materials
  - discarded wooden pallets and a sheet of plywood
  - clear and black plastic
  - a small solar panel and fan
- Estimated cost <US$100