Implementing Drying Systems to Preserve Seed Quality

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Collaborators

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Jwala Bajracharya, NARC, Kathmandu, Nepal
Rajiv Pradhan, IDE, Dhaka, Bangladesh
Keshavulu Kunusoth, ANGRAU, Hyderabad, India
Ganesh Shivakoti, Asian Institute of Technology, Bangkok, Thailand
Johan Van Asbrouck, Patcharin Taridno, Rhino Research, Phitchit, Thailand
Humid Conditions in Tropical Regions Cause Rapid Loss of Seed Viability

Ambient conditions in tropical regions often exceed 75% RH and 30°C, resulting in rapid seed deterioration in open storage.
High Relative Humidity Shortens Seed Storage Life

Seeds are very sensitive to the ambient relative humidity (RH) of the air.

Seed storage life is dramatically reduced at high RH.

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www.dryingbeads.org  
USAID
Traditional Drying Methods Cannot Reduce Seed Moisture Sufficiently under Humid Conditions

Seeds equilibrate with air humidity. Air drying cannot reduce seed moisture content to safe storage levels in humid climates.
Alternative: Drying with Desiccants

Desiccants can be used to absorb moisture from seeds.

Current desiccants have drawbacks that have prevented their widespread use for seed drying and storage.

Novel seed drying beads based on zeolites (molecular sieves) make it feasible to efficiently dry and store seeds at low RH.
**Novel Desiccant Has Unique Properties**

Zeolite desiccant beads absorb only water and bind it tightly until released by heating.

Improved drying at low RH compared to silica gel.
Beads Efficiently Reduce Air RH without Heat

RH air during cucumber trial on 6 November 2008 - TSA

- control
- T1
- T2
- T3
- T4

- 60%
- 0%

1 hour
Bead Reactivation for Reuse

Heat beads at 200°C for 2 h.

Cool briefly in covered container until safe to handle.

Package for storage in airtight containers.

Can also be reactivated using other heat sources.

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Local Hermetic Containers and Packaging

https://ag.purdue.edu/ipia/pics/

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Indicating Containers (DrumDry)

Hygrometer

Indicator (silica gel)

www.dryingbeads.org
Indicating Containers (BoxDry)

Dry seed

Moist seed

www.dryingbeads.org
Monitoring Relative Humidity

• Monitoring RH is as essential to the “dry chain” for seeds as a thermometer is to the “cold chain” for fresh produce.
• We are distributing the both dataloggers and inexpensive meters for monitoring of RH to our collaborators.
• RH indicator strips are even cheaper and may be adequate.
Technology Support Package

- Basic information on drying and storage methods to preserve quality
- Practical application protocols for using drying beads
  - Electronic, print and video
  - Visually based
  - Multiple languages
- Charts and calculation tools
- Technical information
- Research reports and publications
- Diverse applications
- Educational events calendar
- Sources and distributors
- Contacts

www.dryingbeads.org
<table>
<thead>
<tr>
<th>Common name</th>
<th>Tomato</th>
<th>Temperature (°C)</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bead capacity (%)</td>
<td>17.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tomato</td>
<td>Solanum lycopersicon</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Basis</td>
<td>Initial MC (%) - Fresh Weight basis</td>
<td>13.38</td>
<td></td>
</tr>
<tr>
<td>RH</td>
<td>Initial RH (%)</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Amount of seeds (g)</td>
<td>1000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desired MC (%) - Fresh Weight basis</td>
<td>5.44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desired RH (%)</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beads available (g)</td>
<td>300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beads needed (g)</td>
<td>554.18</td>
<td></td>
<td></td>
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</tbody>
</table>

Repeated Drying needed!
Drying Beads Calculator

Moisture Release Curve and Drying Steps

Repeated Drying

<table>
<thead>
<tr>
<th>Steps</th>
<th>Final RH</th>
<th>Final MC</th>
<th>Beads Needed (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50.4</td>
<td>9.26</td>
<td>300</td>
</tr>
<tr>
<td>2</td>
<td>20.0</td>
<td>5.44</td>
<td>255</td>
</tr>
</tbody>
</table>

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Drying Beads Calculator

Predicted Seed Storage Life

- Initial Germination (%): 89
- Storage Temperature (°C): 25
- Initial MC (FW): 13.38
- Desired MC (FW): 9.21

- Predicted Germination (%)
- Constants:
  - Ke: 7.767
  - Cw: 4.67
  - CH: 0.035
  - Cg: 4E-04

Predictions for illustrative purposes only based on the Ellis-Roberts model. Specific results may vary.

Developed by:

UC Davis
Department of Plant Sciences
College of Agricultural and Environmental Sciences
Centor Brasil

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Predicted Seed Storage Life

Step 2 = 20% RH

Initial Germination (%) = 89
Storage Temperature (°C) = 25
Initial MC (FW) = 13.38
Desired MC (FW) = 5.44

Constants:

<table>
<thead>
<tr>
<th>MC</th>
<th>Cw</th>
<th>CH</th>
<th>Cg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ke</td>
<td>7.767</td>
<td>4.67</td>
<td>0.035</td>
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UCDAVIS
DEPARTMENT of PLANT SCIENCES
College of Agricultural and Environmental Sciences

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Trials and Demonstrations

• Kenya
  – Spider plant, groundnut, green gram, amaranth, maize

• Tanzania
  – Amaranth, African eggplant, onion, green gram, nightshade, tomato

• Nepal
  – Cucumber, bean, okra, onion, tomato, pea, cauliflower, maize, rice, wheat

• Bangladesh
  – Tomato, chili, okra, soybean, green gram, radish, bittergourd

• India
  – Drying beads have been approved for research study by the Indian National Seed Program

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Onion Seed Storage in India

Open bags

With beads

Stored for 1 year by farmers

Seed MC reduced by 4% with beads.

Germination decreased by 45% in open bags vs no change with beads.

1 year of storage

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Seed MC and Longevity

A
Effect of beads on sunflower MC at ANGRAU, India

B
Effect of beads on sunflower germination at ANGRAU, India

A
Effect of beads on soybean MC at ANGRAU, India

B
Effect of beads on soybean seed germination at ANGRAU, India
Safe Storage at Low Moisture Content

Drying below ~35% eRH prevents all storage pests, and the production of mycotoxins in stored commodities.


www.dryingbeads.org
Drying Prevents Insect Damage

Six months storage

Without beads
69% infestation

With beads
0% infestation

Bead-dried seeds were not consumed by bruchids.
Keshavulu Kunusoth, ANGRAU, Hyderabad, India
Potential for Mycotoxin Reduction

- Mycotoxins (e.g., aflatoxin) can accumulate in storage.
- Drying at harvest and maintenance of a “dry chain” could dramatically reduce postharvest losses and improve health.
Many Commodities Can Be Dried

Flowers, spices, fruits, vegetables, shrimp, meat, etc.
Potential Economic Benefits

- Surveys and market analyses by Krishna Timsina (PhD student) and Ganesh Shivakoti (Co-PI) in Nepal indicate that preservation of seed quality would result in:
  - **Onion seed**: $35 per kg net increase in income and $7.1 million national incremental return
  - **Chili seed**: $514 per kg net increase in income and $4.1 million national incremental return
Demonstrations and Education

Many local workshops have been conducted with farmers in the target locations.

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Community-Based Approaches

A key feature of drying beads is that they are only needed for a short period to absorb moisture, then can be removed, reactivated and reused.

A local agro-vet or seed vender could invest in beads and an oven and could “rent” the beads with the user only paying for the drying cost.

Similarly, a community or cooperative could invest in beads and an oven and lend beads to users who would return them for reactivation.
International Workshops

- Invite a broad range of participants
  - Govt. agencies, NGOs, seed companies, researchers
- Demonstrate use of drying beads
- Invite additional collaborators
- Initiate new demonstrations and trials

Completed international workshops:
- Dhaka, Bangladesh, 30 January 2012
- Bangkok, Thailand, 7 February 2012
- Nairobi, Kenya, 14-15 February, 2012
- Bangkok, Thailand, 25-26 October 2012
- Nairobi, Kenya, 9 May 2013

*Associated with HortCRSP Innovation Centers
Drying Beads Showcase
Bangkok, Thailand  October 25-26, 2012

HRH Princess MahaChakriSirindhorn

www.dryingbeads.org
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