

The Dry Chain for Seed and Commodity Preservation

Kent J. Bradford



HORTICULTURE
INNOVATION LAB

UC DAVIS
UNIVERSITY OF CALIFORNIA

1/3 of food produced is lost
before reaching the consumer

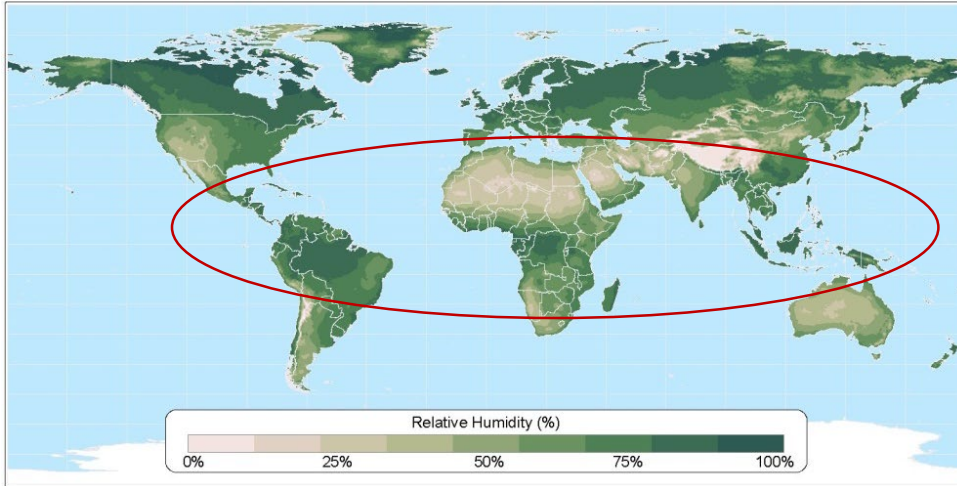


4.5 Billion

people have aflatoxin in their diet



Average Annual Relative Humidity

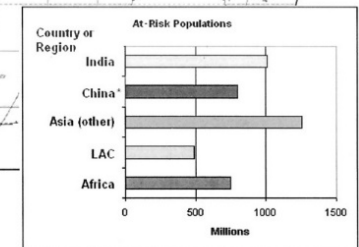
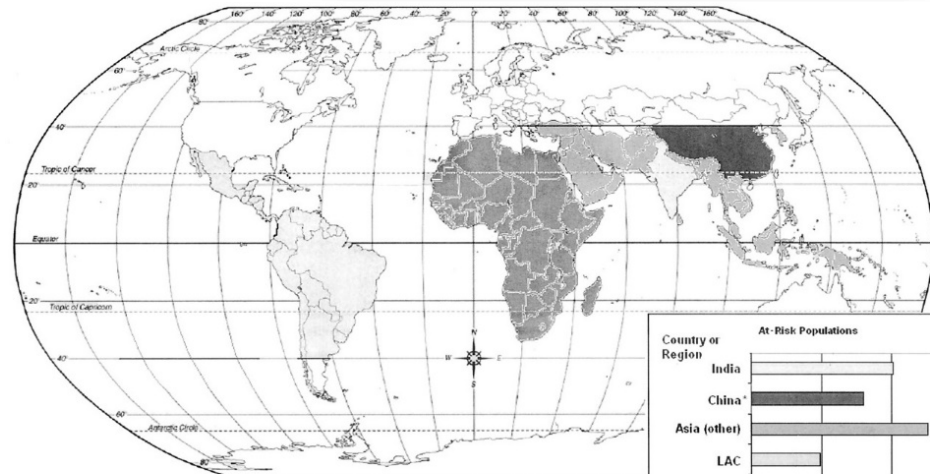


Data taken from: CRU 0.5 Degree Dataset (New, et al.)

Atlas of the Biosphere
Center for Sustainability and the Global Environment
University of Wisconsin - Madison



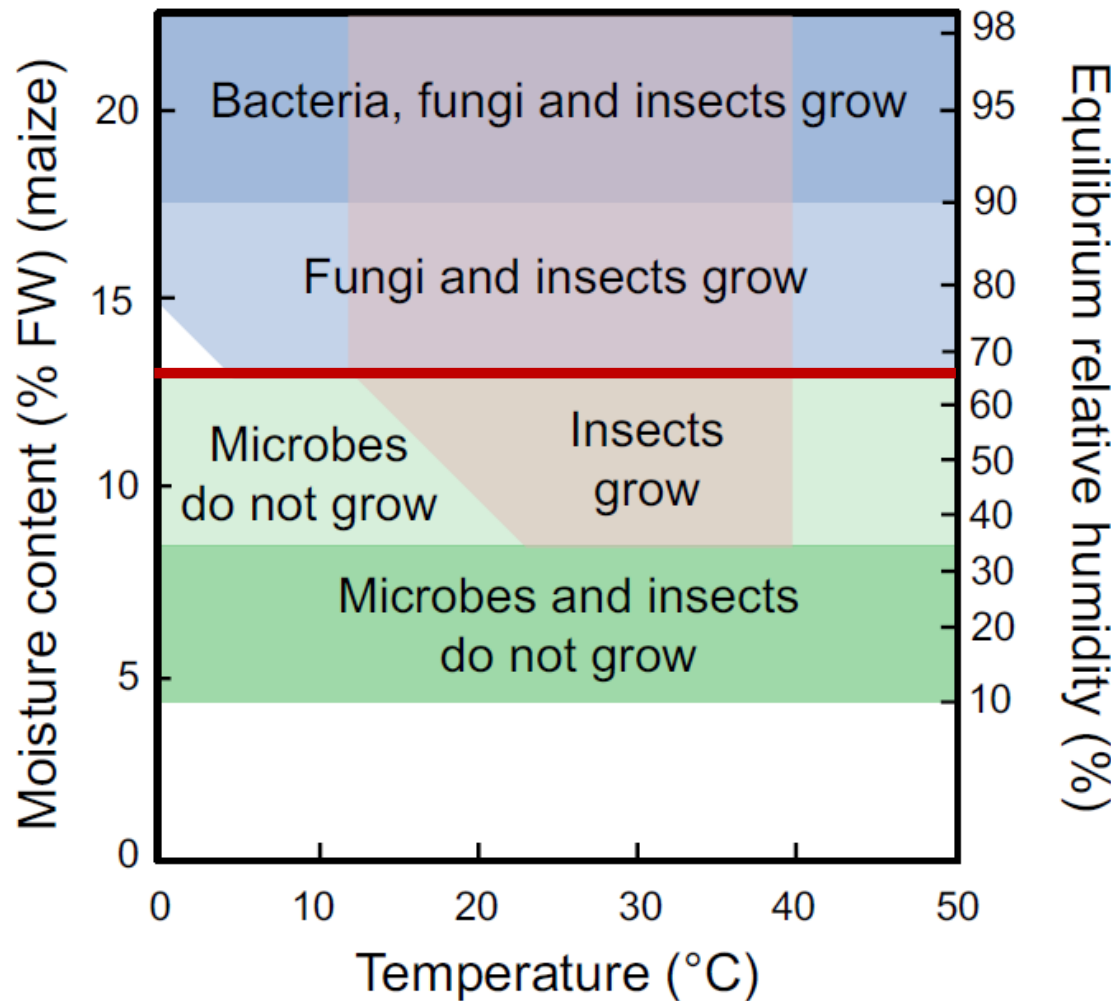
A large and increasing fraction of the world's population lives in areas where high humidity creates problems for seed and commodity storage.



* Estimated 66% of 1.2 billion people

Global Seasonal Humidity Patterns

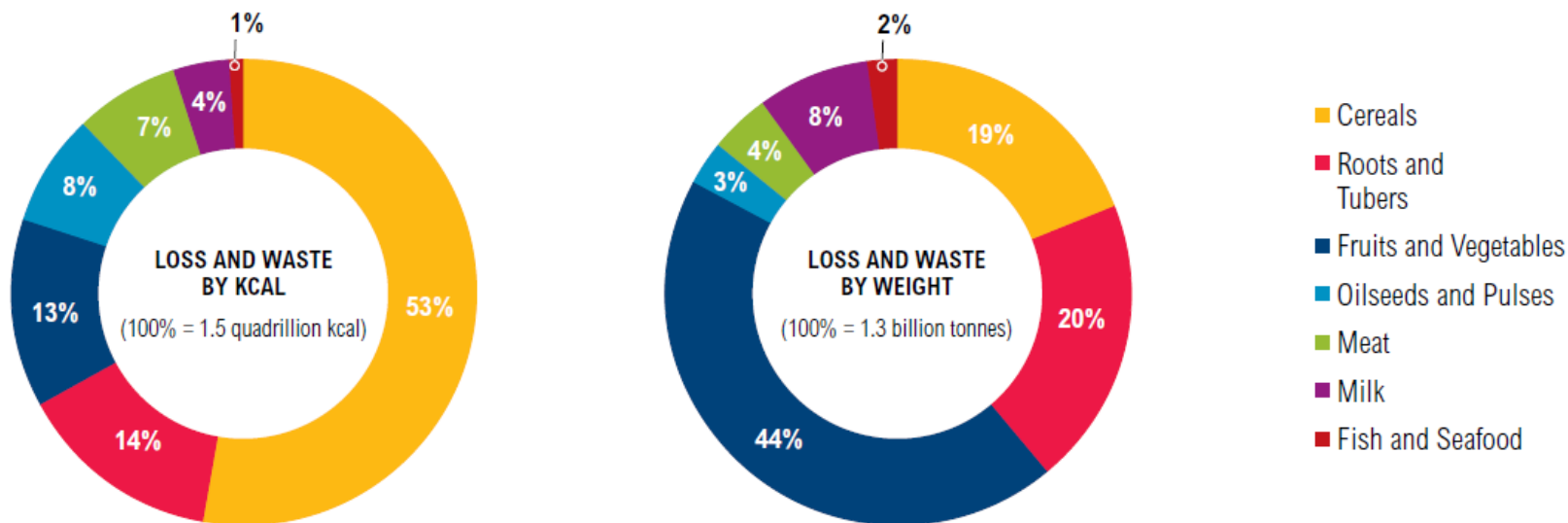




Above a critical moisture content (or equilibrium relative humidity), fungi and insects are able to grow on stored commodities.

Bradford et al. (2018) Trends in Food Science and Technology 71: 84-93.

Figure 1 | Share of Global Food Loss and Waste By Commodity, 2009

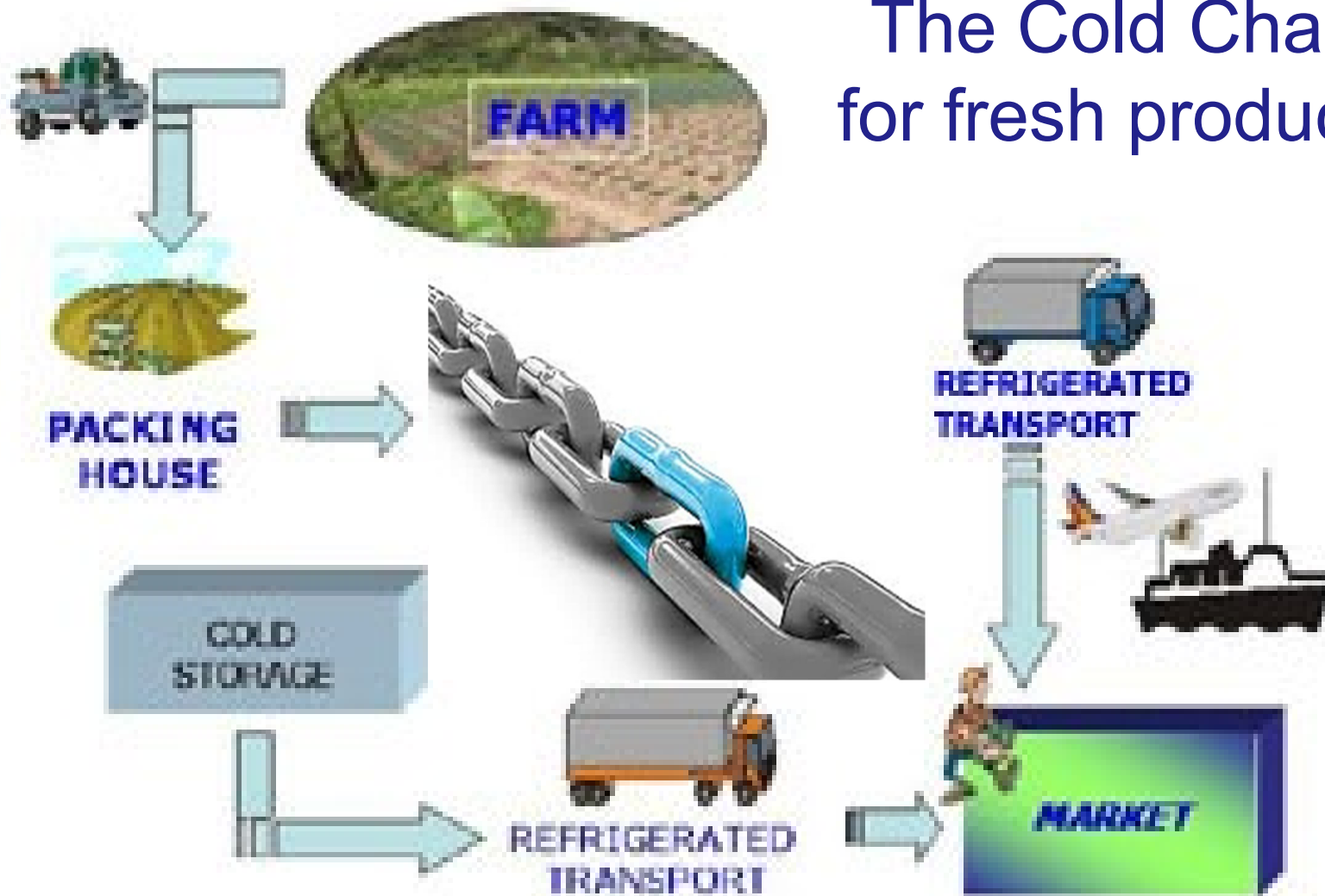


Source: WRI analysis based on FAO. 2011. *Global food losses and food waste—extent, causes and prevention*. Rome: UN FAO.

World Resources Institute, 2013

The largest fraction of food loss by weight is of fruits and vegetables, but in terms of calories, dry commodities (cereals, oilseeds and pulses) represent 61% of food loss and waste globally.

The Cold Chain for fresh produce.



Once dry and packaged, no further energy costs.

Dried products

DRY

Long-term storage

Excellent for seeds or germplasm storage.

GOOD

BEST

DRY CHAIN

WARM

COLD

COLD CHAIN

Fresh produce

Most foods begin wet and warm.

POOR

WET

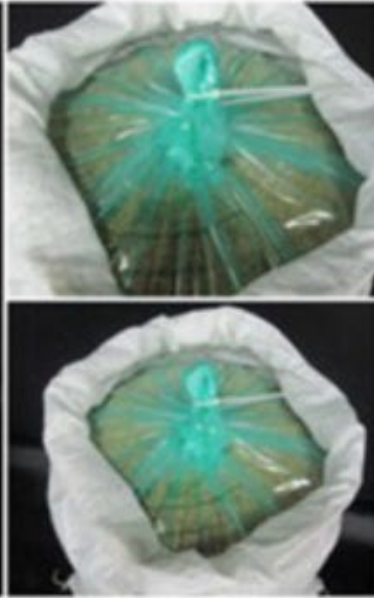
Infrastructure, refrigeration and energy costs.

Bradford et al. (2018) Trends in Food Science and Technology 71: 84-93.

Drying Methods



Hermetic Containers and Packaging



STORAGE OPTION 1

“PICS” bags
Purdue Improved Crop Storage



STORAGE OPTION 2

Plastic or metal bins



STORAGE OPTION 3



Superbags
GrainPro, Inc.

Dry Chain for Seed and Food Preservation

Use sun drying when possible.

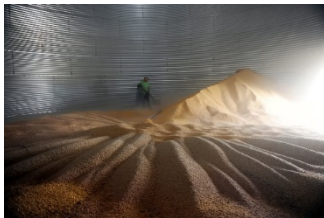
Use additional drying to <70% RH.

Package in moisture-proof containers.

Keep the containers sealed continuously.



Do not store moist bulk seeds/grains.



Do not use porous packaging.



Do not leave packages open.



Do not expose to humid air.



www.drychain.org



Desiccant-based Drying: Drying Beads



Demonstrated effective method for drying seeds and commodities.

Enclosing beads with the commodity transfers water to the beads.

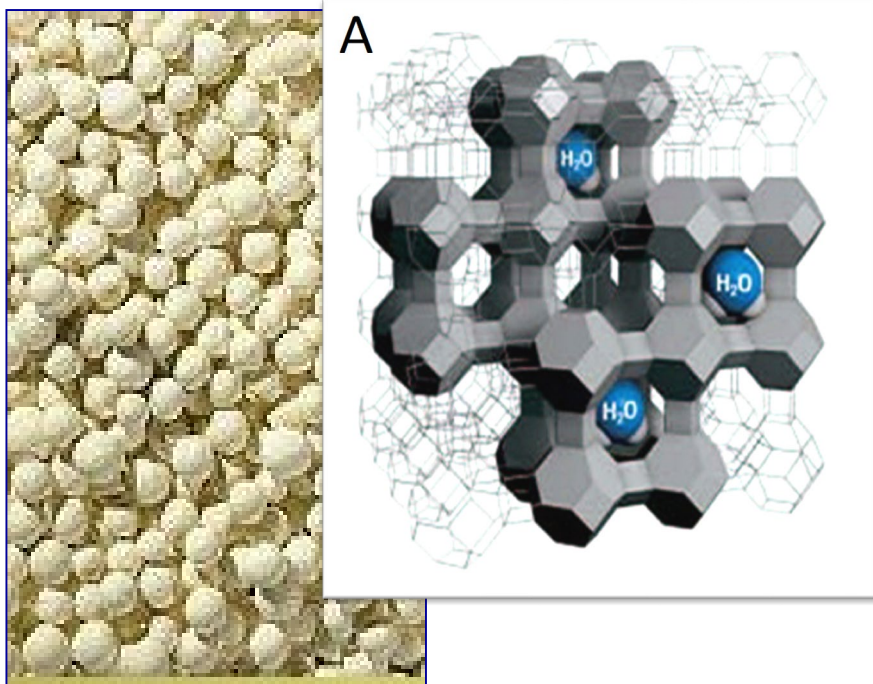
Beads can be heated to reactivate for reuse indefinitely.

www.rhino-research.com

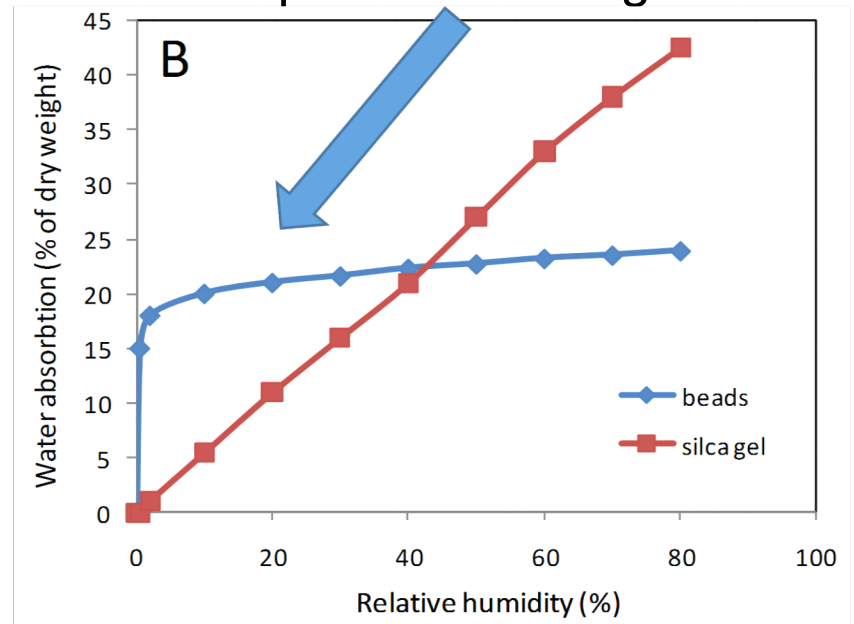
www.dryingbeads.org

www.drychainamerica.com

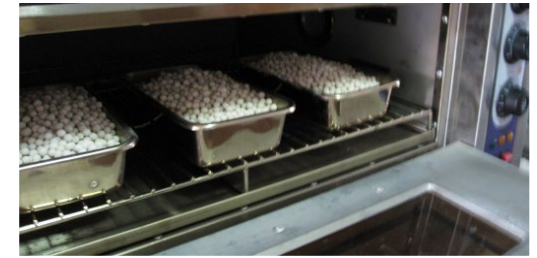
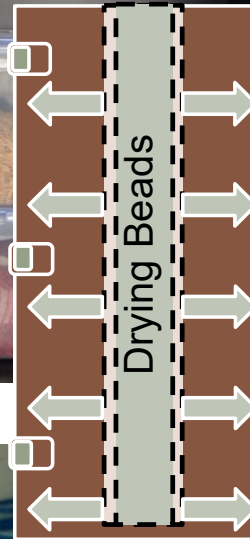
Zeolite desiccant beads absorb only water and bind it tightly until released by heating.



Improved drying at low RH compared to silica gel.



Moisture Absorption and Bead Reactivation



The Dry Chain for Maintaining Seed Quality

- Harvest seeds and sun/air dry to the extent possible.
- Put in hermetic bag or container with drying beads.
- Dry commodity to low MC/RH for extended storage.
- Remove beads for reuse and keep product in hermetic containers or packaging during storage and transport.



Harvest



Air-dry



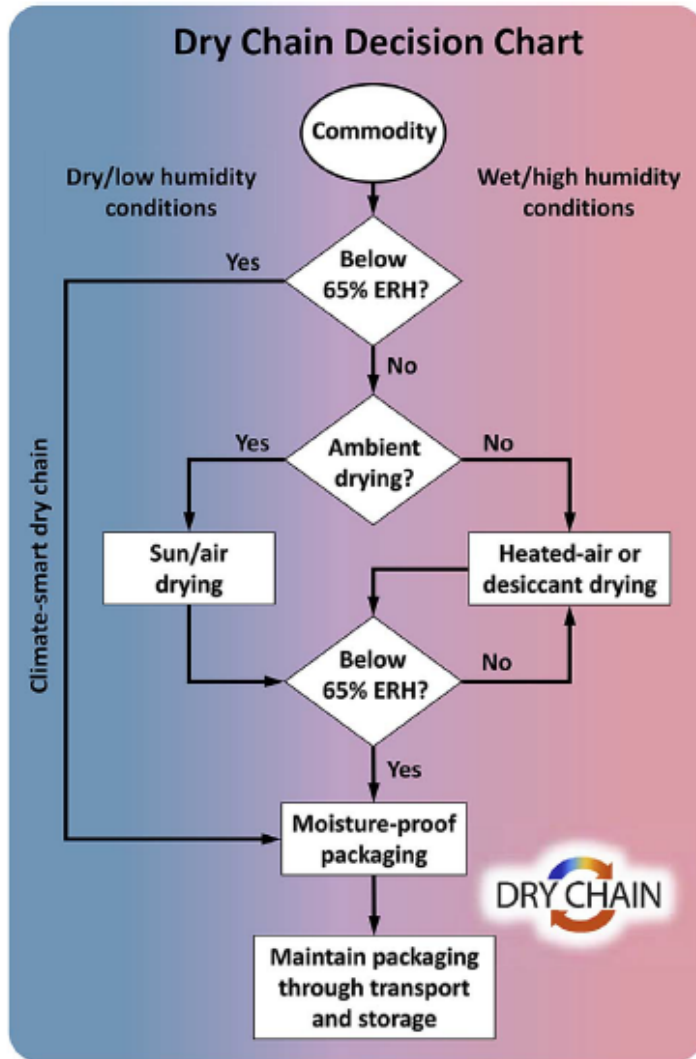
Bead-dry

Store in
water-proof
containers



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

Decision Chart for Seed and Commodity Drying



Seeds and food products should be dried at least to <65% eRH to prevent mold growth.

This can be achieved by air drying, but if not, additional drying is required.

Heated air or desiccant drying can lower commodity moisture to safe levels.

After drying, storage in sealed containers or in controlled RH facilities is necessary to prevent absorption of water from the air in humid climates.

Bradford, K.J., et al. 2018. Trends in Food Science & Technology 71: 84-93.

Opportunities for Local Germplasm Banks



Nepal



India



We worked with Bioversity International (CGIAR) to implement drying and hermetic storage systems with local community germplasm banks in India and Nepal.



10:00 am

Dr. Denise Costich, Head of Germplasm Conservation Lead at CIMMYT in Mexico, is using Drying Beads and DryCards to assist communities in Guatemala to better store their local maize seed.



11:00 am

A quick test indicates that these seeds are too moist and will lose viability rapidly and be attacked by insects and molds in storage.



 **CIMMYT**^{MR}



First Low-Energy Seed Gene Bank Inaugurated at ICAR-IIVR, Varanasi



Drying and packaging provides a low energy method for medium-term storage of germplasm and planting seeds, as refrigeration and dehumidification are not required.

<http://www.iivr.org.in/first-low-energy-seed-gene-bank-inaugurated-icar-iivr-varanasi.html>

Scaling-up Project in Bangladesh



Implementation program by Rhino Research supported by USAID

- Companies buy beads, equipment and containers
- Project provides in-depth training for employees on all aspects of use

Today, 3 companies are fully commercial:

- **Lal Teer** – drying capacity per season of 5,000 kg seed, expanding now to 25,000 kg
- **Getco** – drying capacity per season of 2,000 kg seeds
- **Metal Seeds** – drying capacity per season of 1,000 kg seeds

Several other companies and governmental agencies are starting:

- Malik Seeds – completed program – expected capacity of 10,000 kg
- ACI Seeds – completed program – expected capacity of 5000 kg
- BADC – completed program – expected capacity of 5,000 kg
- BARI – completed program – investigating possibilities
- BRR1 – germplasm storage – complete setup for breeder and foundation seed – supported by BMGF

Lal Teer Adopts Drying Bead Technology



“ ... Lal Teer tested this new technology, and concluded that these beads are drying our seeds faster and deeper, obtaining a better quality that results in a longer storage potential, and all this with lesser costs. Therefore Lal Teer made the executive decision to move ahead with implementing these beads for all our seeds and crops as soon as possible...”

Mr. Tabith M. Awal, DCEO, Lal Teer Seed Ltd, Bangladesh

Scaling-up Project 2016 / 2017

8 drying experts

100 trainers

800 seed farmers

100,000 farmers (indirect)

