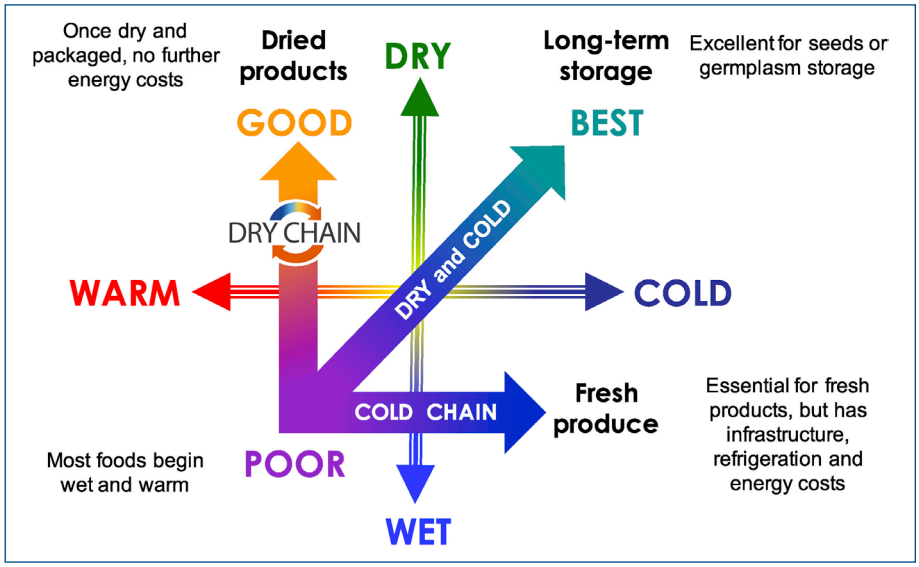
TECHNOLOGIES FOR HORTICULTURAL DEVELOPMENT

‘Dry chain’ reduces losses, toxins in dried foods

Approximately one-third of all food produced worldwide is wasted, and in developing countries the majority of these losses occur before food reaches the consumer, due to spoilage and pests from poor postharvest storage management. One processing technique to extend the shelf life of many foods — including fruits, herbs, vegetables, grains, fish and meat — is drying.



Once fully dry, dried products do not need cold storage, if the “dry chain” is maintained. On the other hand, the cold chain is critical for storing fresh produce safely. Diagram from drychain.org.

Using ‘dry chain’ can prevent mold toxins

But in dried foods that have been inadequately dried or improperly stored, fungi can grow and produce mycotoxins that can lead to serious negative health effects when consumed. One of the most common mycotoxins is aflatoxin, which has been associated with liver cancer and may lead to stunting. Adequately drying foods for storage (to an equilibrium relative humidity lower than 65%) prevents fungal growth and protects food from further contamination with mycotoxins. To continue to protect such dried foods, the products must be stored in a hermetic, low-humidity environment to ensure that food does not reabsorb water, which could allow for mold growth to develop.

The concept of drying products and maintaining their dryness with hermetic storage is called the “dry chain.” Implementing the dry chain can prevent mold growth after harvest and during storage, reducing food losses and exposure to mycotoxins.

Lack of awareness of dry chain, confusion with cold storage

A major challenge for implementing the dry chain has been a lack of awareness that controlling relative humidity during storage of dried products is important. Farmers and traders who suffer losses in storage often assume that the solution is cold storage, as it would be for fresh produce. However low temperatures only slow mold growth in products that are inadequately dried. In addition, the high humidity common in cold storage may result in additional water uptake by food items, increasing the product’s susceptibility to mold growth when again exposed to higher temperatures, such as during a power outage, packaging, or transport. Keeping dried foods in the dry chain is more practical, as it does not require a continuous energy source needed for cold storage.

Further reading

- Bradford KJ, Dahal P, Van Asbrouck J, Kunusoth K, Bello P, Thompson J, Wu F (2018) The dry chain: Reducing postharvest losses and improving food safety in humid climates. Trends in Food Science & Technology 71: 84-93 doi:10.1016/j.tifs.2017.11.002
- See more articles about the dry chain at https://horticulture.ucdavis.edu/dry-chain

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Technologies to maintain the dry chain

Successful implementation of the dry chain requires technologies to not only effectively dry, but also appropriately package, use adequate dry storage, and monitor water activity. The dry chain has been traditionally and very effectively used in dry climates where ambient relative humidity levels are generally low enough to prevent spoilage. However high humidity and high temperatures in tropical regions make drying more difficult, and traditional storage in porous fabric bags allows dried foods to absorb moisture, becoming spoiled by mold growth and contaminated with mycotoxins.

DryCard™

Created by UC Davis researchers for the Horticulture Innovation Lab, the DryCard is a low-cost, simple tool for checking the dryness of products. This tool uses cobalt chloride paper which changes colors depending on the level of relative humidity in the surrounding air. If products are dry and safe for storage, then a blue color will be shown, but a pink color indicates products are not dry enough and are susceptible to mold growth. The DryCard provides an accurate way to determine product dryness, serving as an initial warning for potentially spoiled or harmful foods and potentially indicating a need to improve drying or storage processes.

Drying beads

Drying beads are modified ceramic desiccants that can dry seeds, grains, pulses or horticultural products without heat. Drying beads absorb up to 25 percent of their initial weight in water and can be recharged indefinitely by heating between uses. Product is dried with the beads in a sealed container for a short period of time. Beads can then be removed and reused easily, while the containers continue to provide hermetic storage of the dried products. The Horticulture Innovation Lab has worked to help scale up drying beads, with particular scaling success in Bangladesh where vegetable seed companies have adopted drying bead systems.

Chimney solar dryer

Designed by UC Davis researchers for the Horticulture Innovation Lab, the chimney solar dryer provides a cost-effective and protected method for drying high-value commodities such as fruits, vegetables, meat, and fish. The dryer is composed of a drying table connected to a chimney. Trays of products are placed on the top of the table's black surface and covered by a clear plastic sheet, creating a tunnel. The tunnel traps solar energy, and the connected chimney creates airflow over the product, which increases drying speed. This design also keeps product off the ground and protects against rain and pests. Materials for the chimney solar dryer are locally available and construction is simple, making this technology widely accessible for small-scale farmers.

Storage technologies

Hermetic storage technologies are the final part of the dry chain and are available commercially in many parts of the world. For example, the Purdue Improved Crop Storage (PICS) bags are made of two liner layers inside a durable woven sack to create a protected and hermetically sealed environment when tied closed. Other sources, such as Grain Pro, offer various sizes of hermetic containers to accommodate different commodities and scales. Small containers such as sealed jars or plastic bags can be used for samples, seeds, or personal use, while large containers such as metal or plastic drums and silos can be used for large-scale storage in farming cooperatives or warehouses.