Reducing Losses and Extending Availability of Fruits and Vegetables

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About the Horticulture Innovation Lab

Our projects address:

- Production and marketing issues
- Creating better seed systems
- Reducing postharvest losses
- Improving extension and transferring innovative technologies

Fruits and Vegetables

- Nutritious
- Healthy
- Perishable
- Seasonally available

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Increase Quantity, Quality and Seasonal Availability

- Increase proportion that makes it to the consumer (reduce losses)
- Reduce degradation of nutrients and edibility after harvest (maintain quality)
- Extend season of production/harvest
  - Irrigation, protected cultivation, staggered plantings/harvest

Characteristics of Fruits and Vegetables

- Good source of nutrients
- High water content
- Easily damaged
- Alive – a biological system
- Deterioration begins at harvest

Reducing Losses is Key to Sustainability and Food Security

- Highly nutritious products, like fruits and vegetables, are often more perishable
- Investments lost when produce degrades
  - land, energy, seed, fertilizer, water, and labor
- To increase food security, must reduce produce losses after harvest along with enhanced productivity

Postharvest Losses of Fruits and Vegetables

- Quantitative
- Qualitative
  - Loss of acceptability by buyer
  - Loss of weight
  - Loss of caloric and nutritive value
  - Loss of edibility

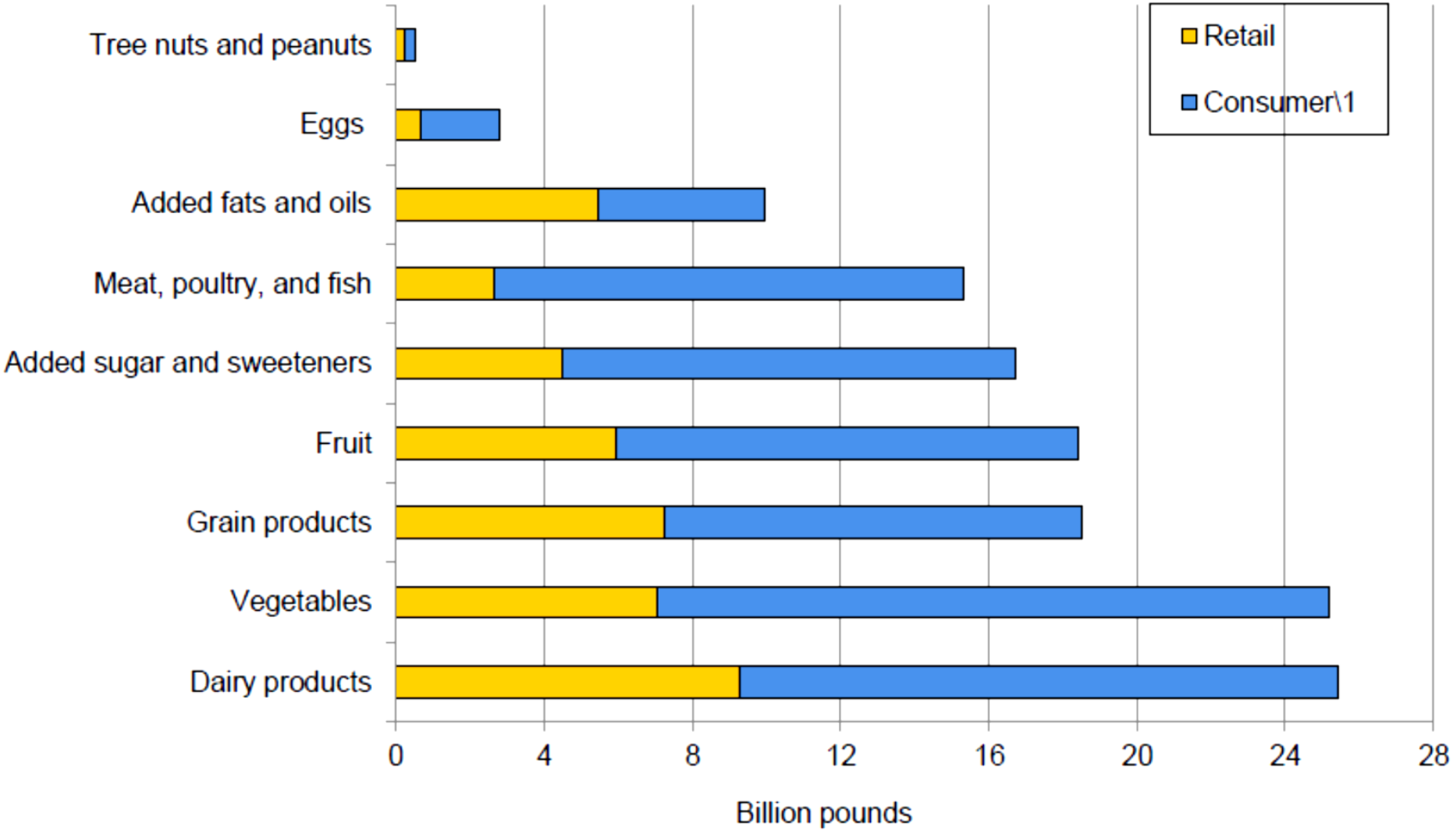
Estimated Postharvest Losses (%) of Fresh Produce

Locations	Developed Countries		Developing Countries	
	Range	Mean	Range	Mean
From production to retail sites	2-23	12	5-50	22
At retail, foodservice, and consumer sites	5-30	20	2-20	10
Cumulative total	3.5-26.5	32	3.5-35	32

Causes of Food Losses in U.S.

- Grade standards and economics
  - Some crop left in the field, not economical to harvest
- Deterioration during storage
  - Pathological and physiological deterioration
- Transportation losses
  - Packaging failures
  - Temperature mismanagement
- Retail losses
  - Decay
  - Water loss
  - Expiration dates
- Consumer loss and waste
  - Refrigeration deterioration
  - Food left on plates
  - Leftovers

Quantity losses at the consumer level are larger than retail level losses for all categories except added fats and oils



1\ Includes loss in the home and in away-from-home locations. Includes cooking shrinkage and uneaten food.

Causes of Postharvest Loss in the Developing World

- High Temperatures after Harvest
  - Sun exposure, lack of cooling, cold transport/storage
- Water Loss
  - high temperatures, low RH, poor packaging
- Physical Damage
  - poor packaging, inadequate transportation
- Decay
  - high temperatures, poor sanitation, physical damage
- Inadequate drying and dry storage
  - molds, mycotoxins, deterioration

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Approaches to Reduce Losses

- Improved packaging
- Low cost cold storage
- Improved drying technologies
- Other processing methods

High Temperatures after Harvest

- Temperature related to water loss, decay and over-ripening
- Limits time for marketing after harvest
- Farmers must sell in short period
  - Cannot hold product
  - Price takers
- Unable to collect quantities required by some buyers

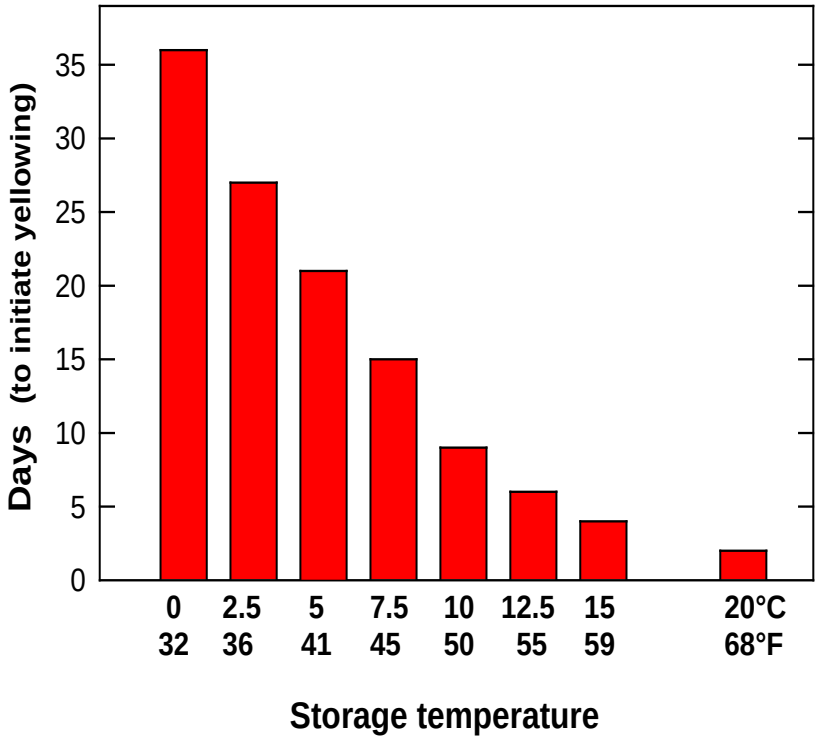
Recommended vs. Measured Tomato Fruit Temperatures

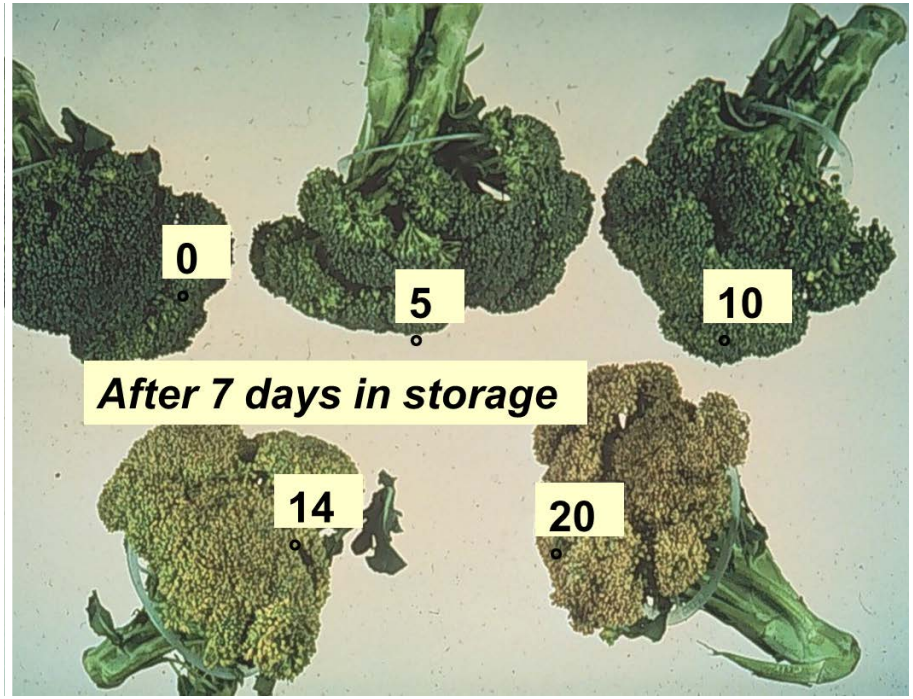
Country	Rec. Temp. °C	Farm	Wholesale Market	Retail
India	15	25.2	30.5	29.1
Ghana	15	31.2	30.2	32.5
Benin	15	28.5	29.1	23.4
Rwanda	15	30.1	22.1	23.4

Kitinoja and Al Hassan, 2010

N=30; 3 reps from 10 random samples per site

Effect of Temperature on Broccoli Quality





Effects of Sun Exposure after Harvest

- Produce in the sun are 3 - 10°C higher than ambient air temperature
- Tomatoes and eggplant in the sun for 1 hour after harvest >15°C hotter than produce in the shade
- Produce left in ambient air with low RH lose moisture up to 100x faster than produce that is cooled

Shading to Protect Produce from the Sun

CoolBot Cold Rooms

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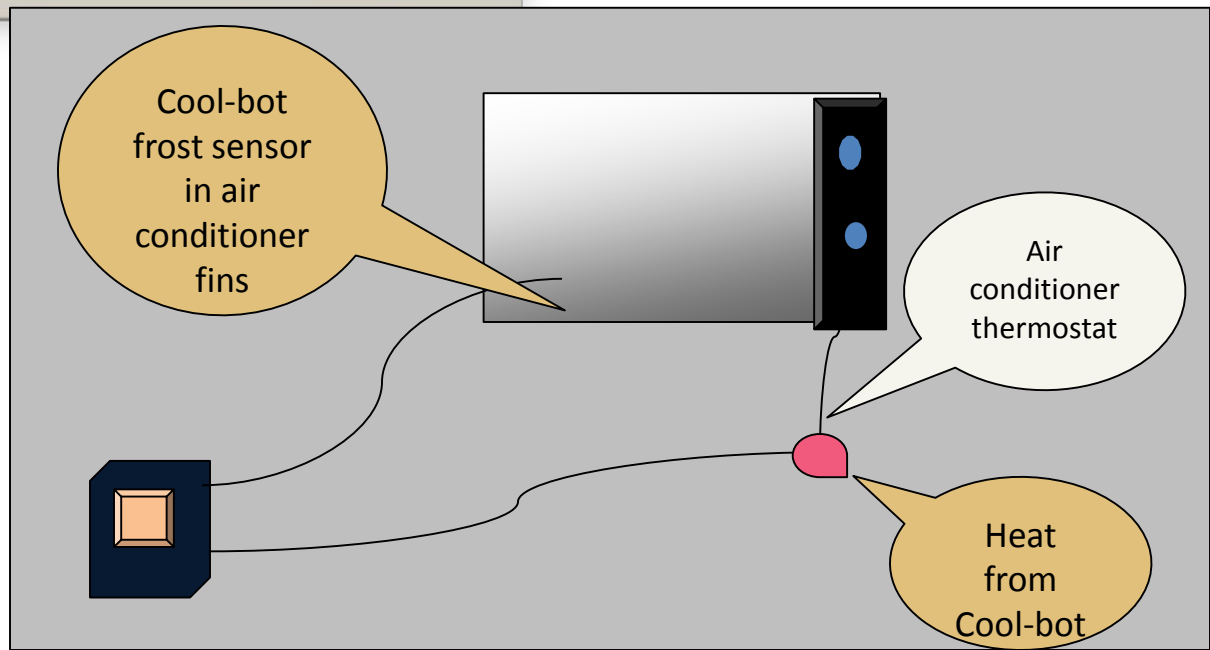
Low-cost Cold Room CoolBot

Store It Cold
http://storeitcold.com

<u>8 MT Capacity</u>
$300 controller
$600 AC unit

90% less than equivalent capacity commercial refrigeration system



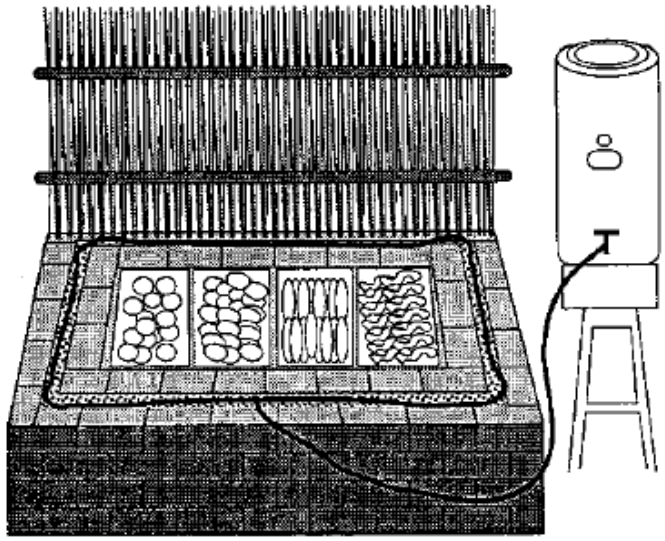
Low-tech Systems using Evaporative Cooling

- Charcoal cooler with wetted charcoal walls
- Pot in Pot System from Nigeria
- Work best in the dry tropics
- Use at farm or household level to hold a few days

Mohammed Bah Abba

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.



Source: Roy [10]; Illustration from [6].

Costs
1 MT - $1,200
100 kg - $125

Physical Damage

- Skin provides protection from disease and water loss
- Damages increases metabolic rate and rate of deterioration
- Damage makes product less attractive to consumers

Postharvest Handling in Developing World

Examples of Shipping Containers Used in Developing Countries

Good Packaging Essential

- Protection from damage
- Moisture barrier to reduce water loss
- Modified atmosphere packaging ($\downarrow O_2, \uparrow CO_2$)

Reusable Plastic Crates

- Support product
- Washable
- Resistant to moisture

INADEQUATE DRYING AND DRY STORAGE

The Dry Chain

Maintaining the Dry Chain

- Thorough drying of any dried product after harvest
  - Fruits, vegetables, nuts, grains, legumes
  - Challenging in warm humid environments
- Once products are dried to 60 to 70% moisture content, must be kept dry
- Must also prevent increase in moisture content in humid climates
  - Mold and insect activity
  - Aflatoxin contamination (anti-nutrient)

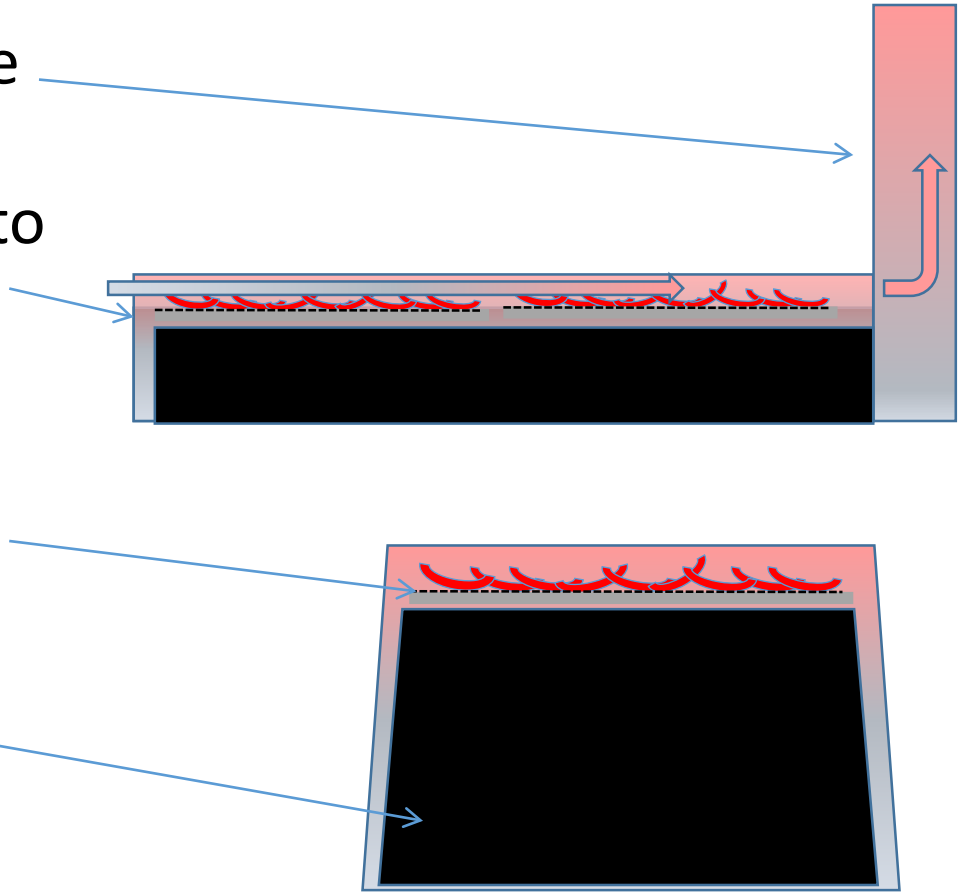


Stabilizing Production with Solar Drying

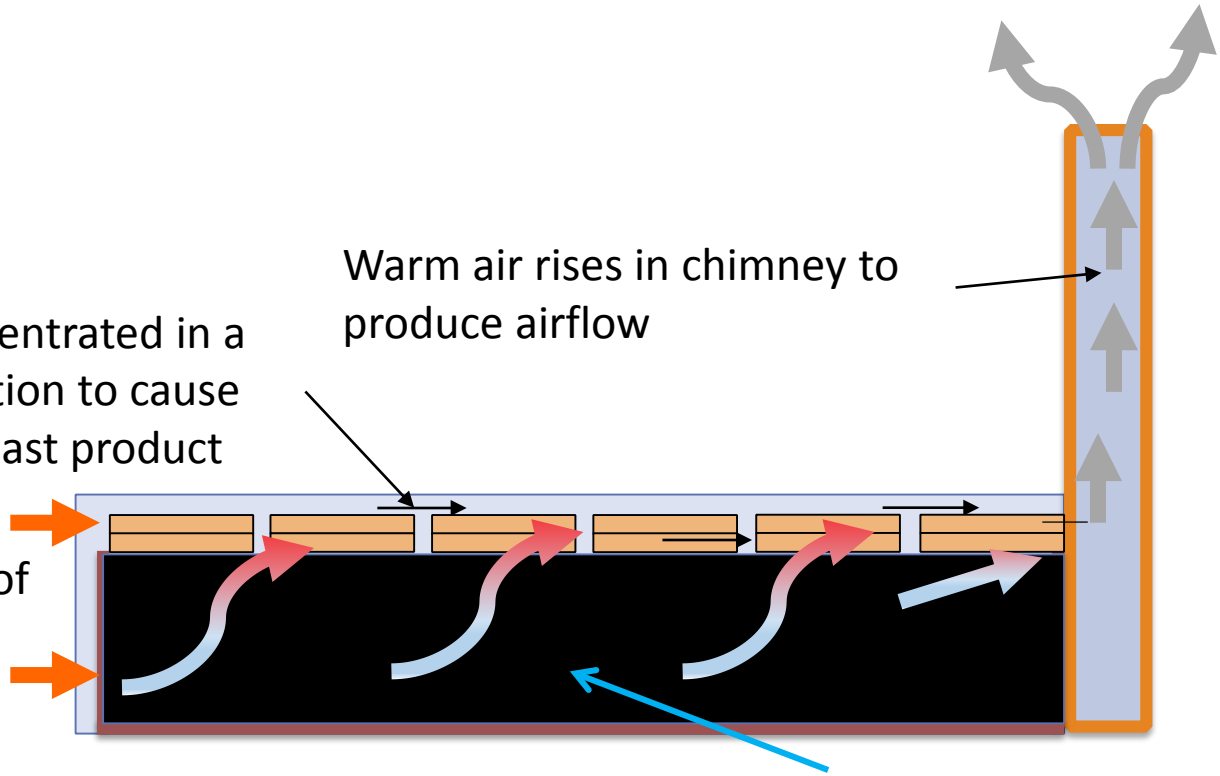
- Drying horticultural crops
  - Adds value
  - Use for excess product
  - Provides off-season nutrition
- Solar drying
  - Cabinet dryers are common
  - Product laid on flat surfaces
- Chilies, spices, mangos, nuts, herbs

The chimney Dryer Concept

- Use a chimney to draw the air through the tunnel
- Use a clear plastic tunnel to collect solar energy – free heat.
- Place the product at the top of the tunnel, where the warmer air is
- Fill unused parts of the tunnel to increase air speed past the product.



Air flow in the Chimney Dryer



Apricot drying in Uzbekistan

Fruits and vegetables in Tanzania
Ready to be dried

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Chimney Dryer Setup

Drying for 4 hours under cloudy skies

	Initial wt (gr)	Final wt (gr)	% loss
Capsicum	1000	667	33
Amaranthus	129	49	62
Broccoli	505	315	38
Tomato	1000	610	39
Pawpaw	491	209	57
Carrot	750	439	41
Moringa whole	100	39	61
Moringa crushed	84	22	74
Beans	614	505	18

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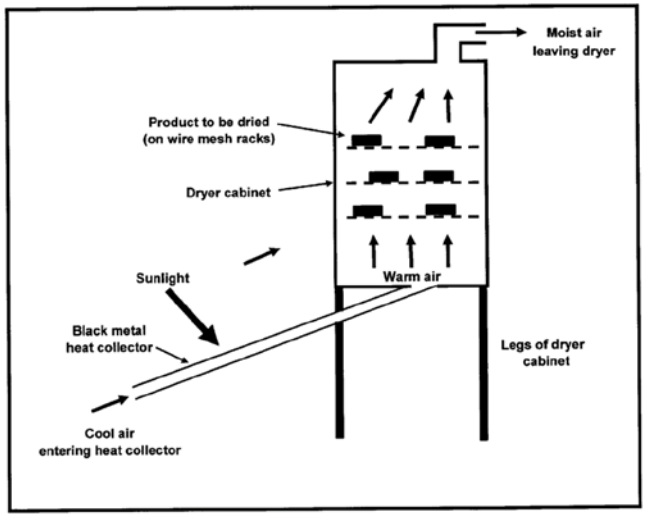
How does drying affect nutrient content?

- Solar cabinet dryer
- Drying bead drying at ambient temperatures (20°C)

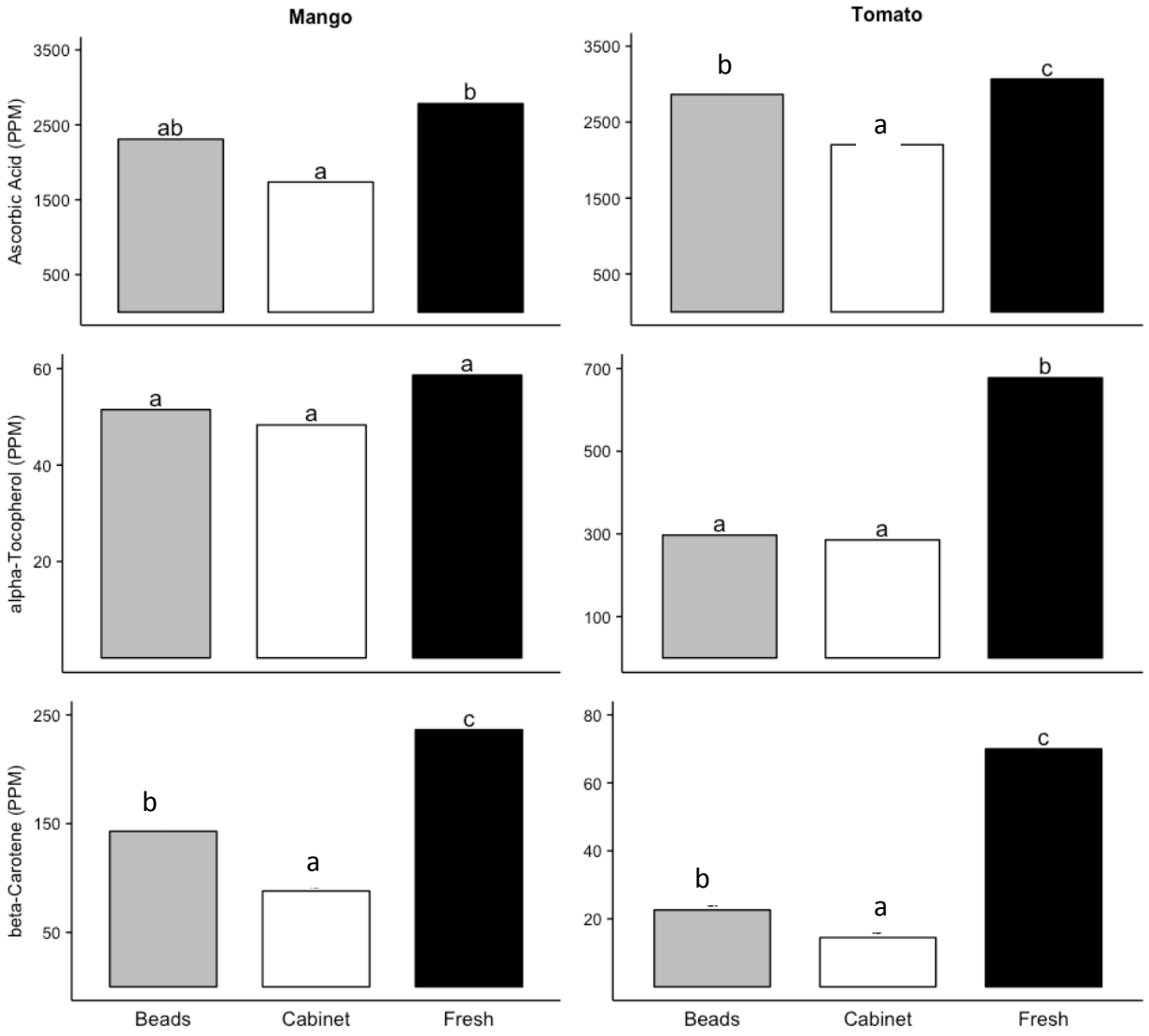


Solar Cabinet Dryer
Peak Temp. 53°C

Drying Beads
Peak Temp. 23°C

Drying Beads are a product of Rhino Research, Thailand

Nutrient Content in Mango and Tomato Following Solar and Drying Bead Drying



Source: Jamey Smith, Horticulture Innovation Lab

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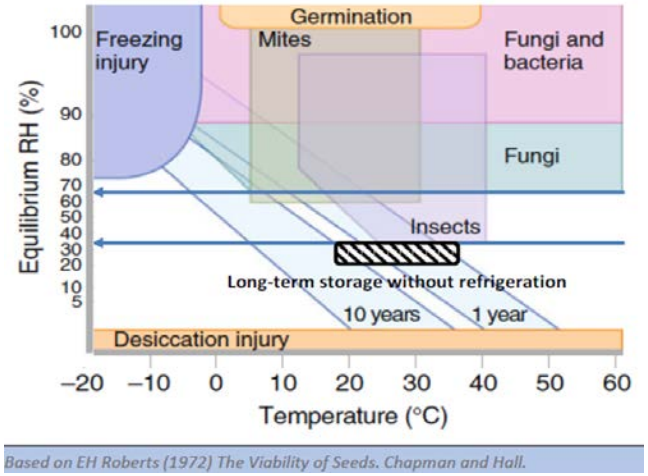
How can you tell if your product is dry enough?



- The DryCard™ is a simple, inexpensive visual tool to raise awareness about the level of dryness of any dried food.
- Actively searching for entrepreneurs and donors!

Despite everything we know, why have postharvest practices remained so poor?

Reasons for Low Adoption

- Lack of incentives/market
- Lack of resources/capital
- Lack of information among farmers, handlers and marketers
- Policies that inhibit best practices
- Others?


PRODUCE

Questions?

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