Cooling strategies for small farmers

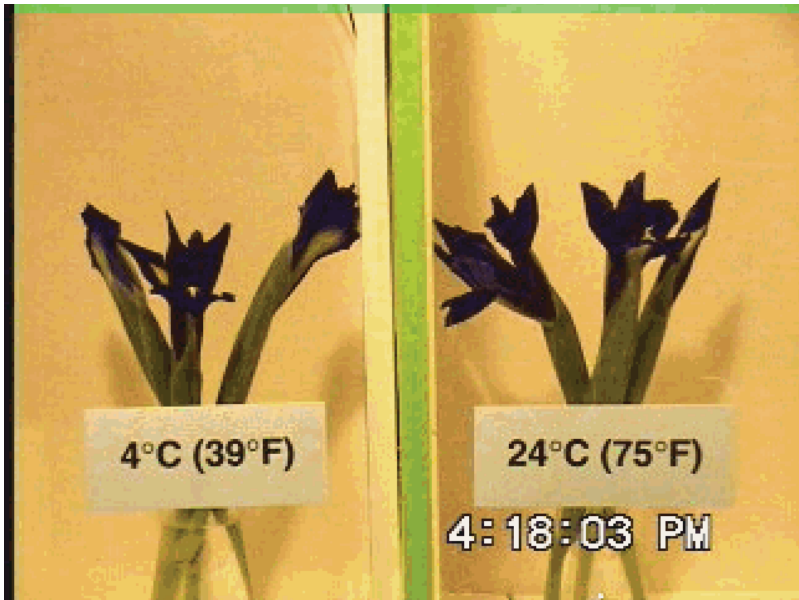
Symposium on Horticultural Science

Royal Agricultural University

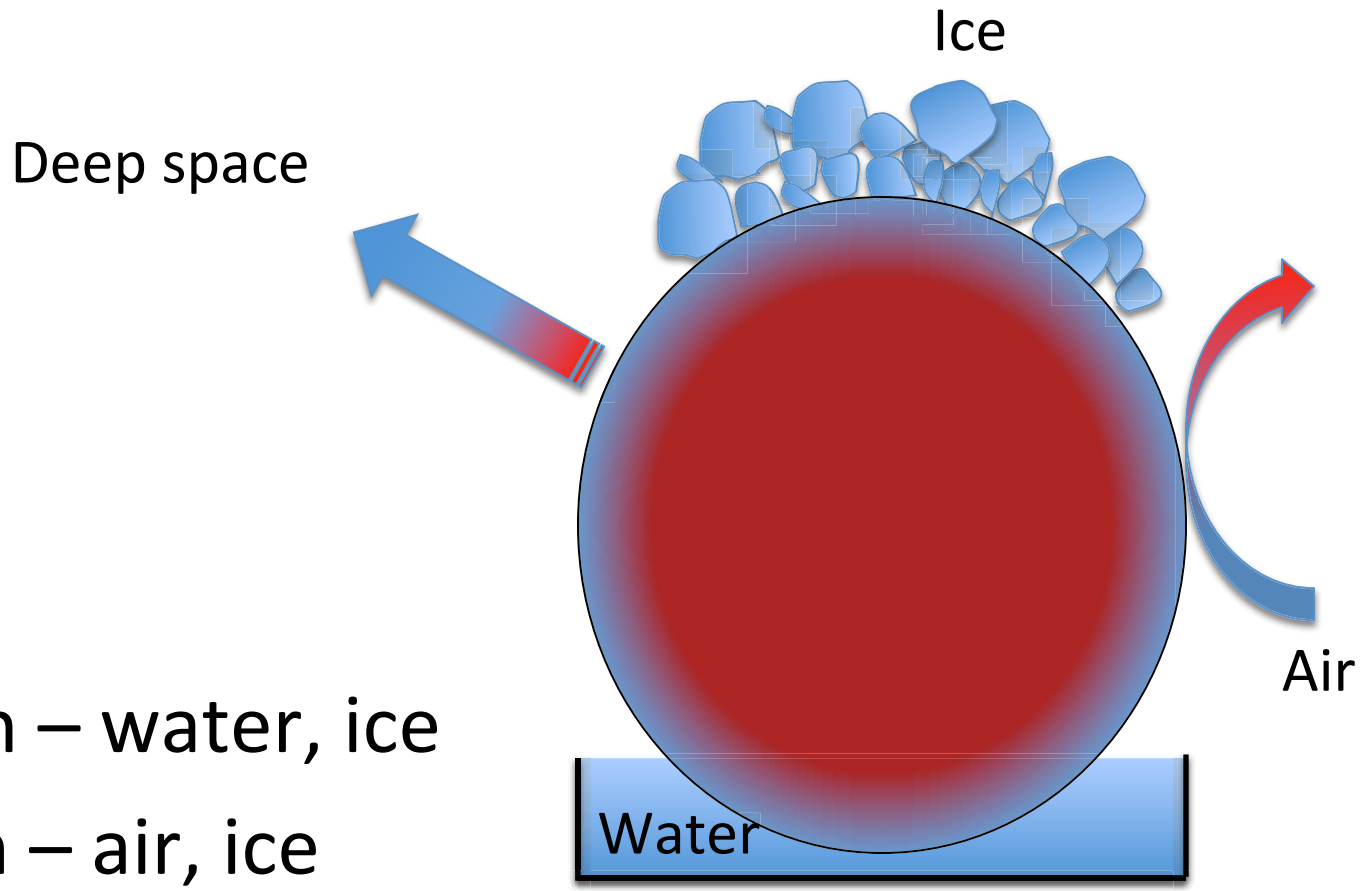
Phnom Penh, March 18 2016

3 most important factors for reducing postharvest losses of perishable crops

- **Temperature**
- **Temperature**
- **Temperature**



Cooling methods



- Conduction – water, ice
- Convection – air, ice
- Radiation – to deep space

What are you cooling?

- Determines the cooling method
  - Can be cooled with water or ice
    - Root vegetables
    - Mature fruits
  - Must be cooled with air
    - Flowers
    - Leafy vegetables
  - Cannot be cooled with ice
    - Chilling-sensitve crops
      - Tropical and sub-tropical fruits and vegetables

What is it packed in?

- Water tolerant
  - Wooden boxes
  - Returnable plastic crates
  - Waxed fiberboard cartons
- Water intolerant
  - Fiberboard boxes
  - Packs containing paper

What are your cooling sources?

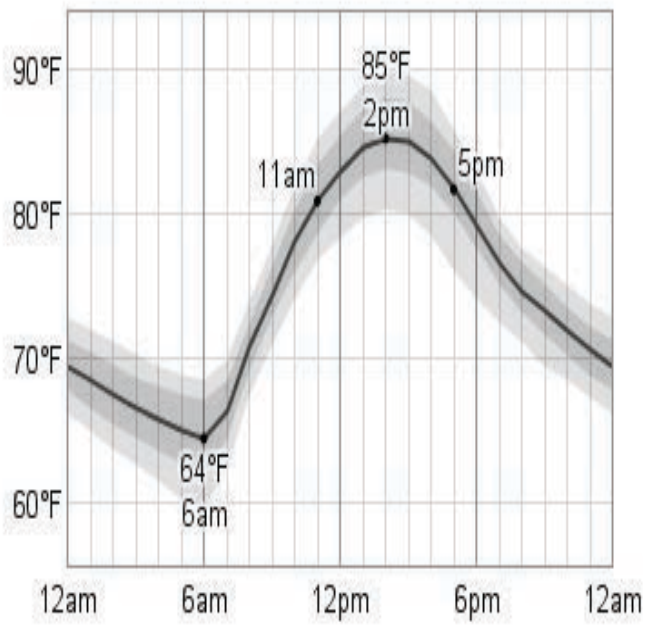
- Electricity?
- Ice?
- Water
  - Volume?
  - Sanitation?
  - Temperature?

Choosing a cooling method

- The ‘no-brainers’
  - Harvest at the coolest time of the day
  - Including during the night
  - Shade after harvest
    - Mist under the shade, if possible

Cooling starts in the field

- Night-time harvest?



Shade reduces heat gain and water loss

Strategies for inexpensive cooling

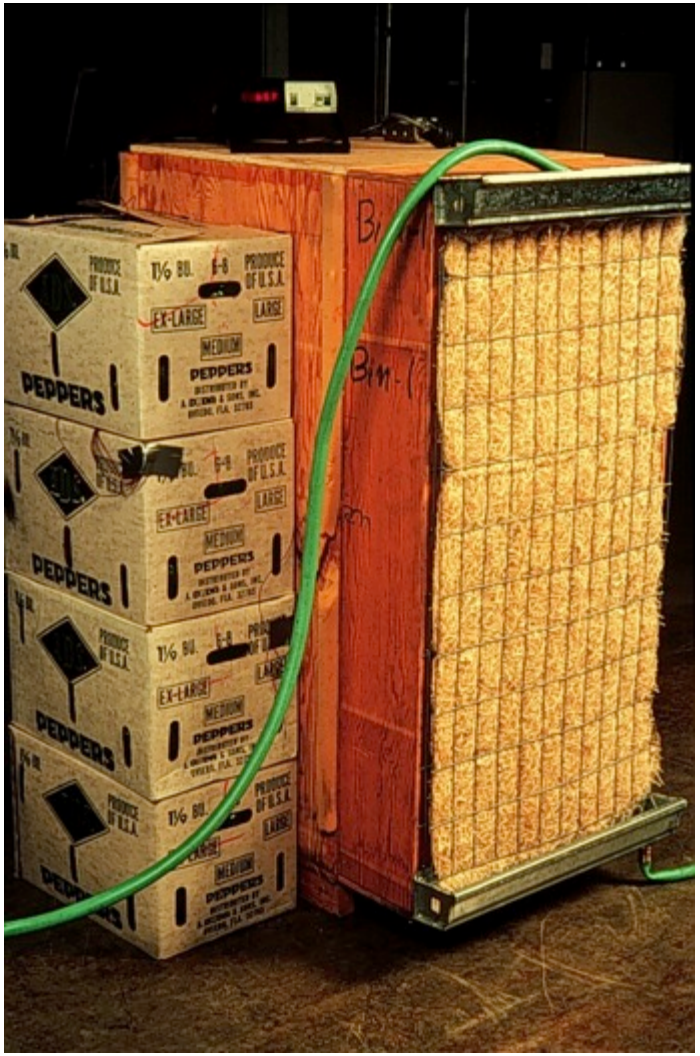
- Use cool media
  - –Night-time air
    - Radiation?
  - –Cold water
    - From well, river, or lake
  - –Ice

Ice

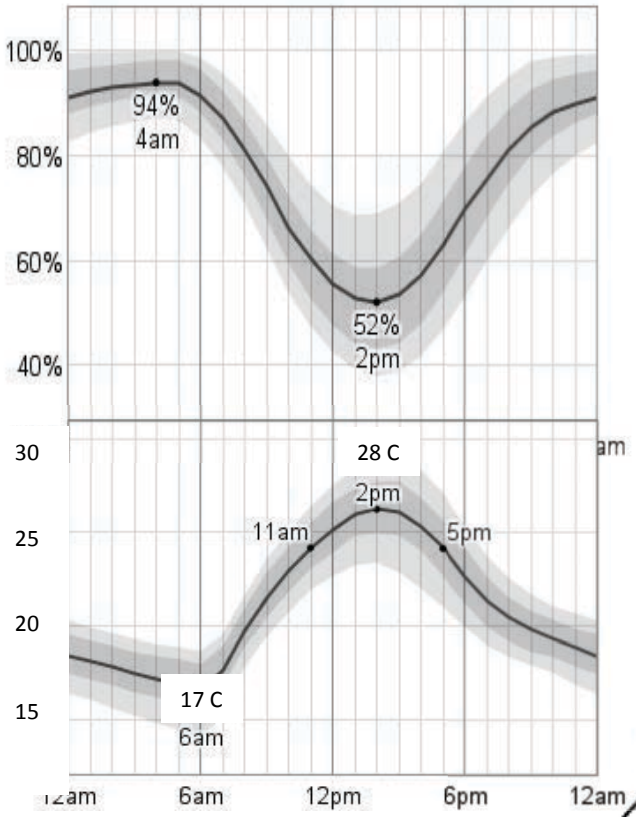

FREE
WiFi
FRESHY
FRESHY
FRESHY
LEO
SINGHA
Phnom Penh Ice-Cream

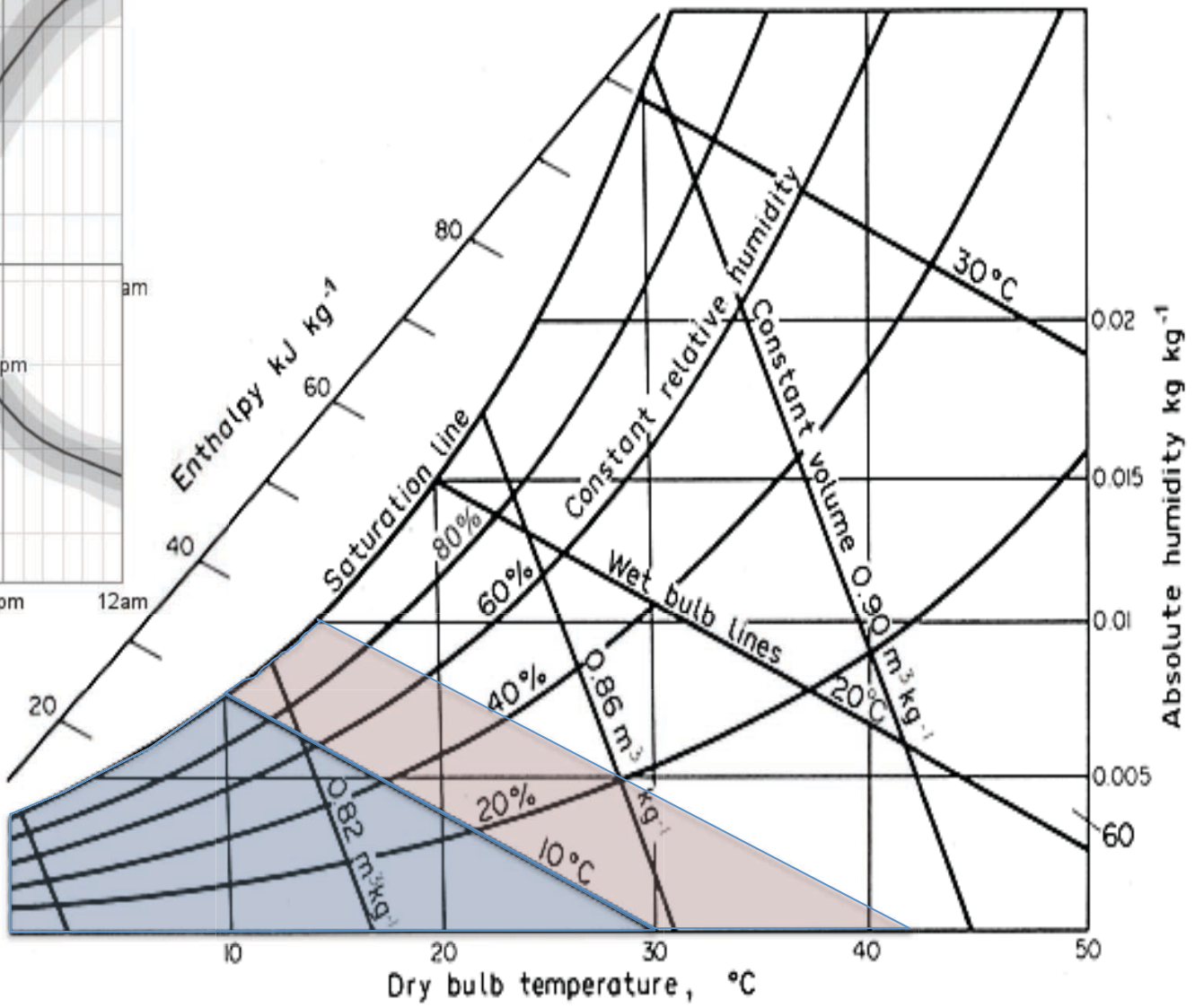
Evaporative cooling

- Conversion of 1 L of water to vapor absorbs 504 kcal
- Enough to cool 50 kg of product from 20°C to 10°C



How to decide if it's useful

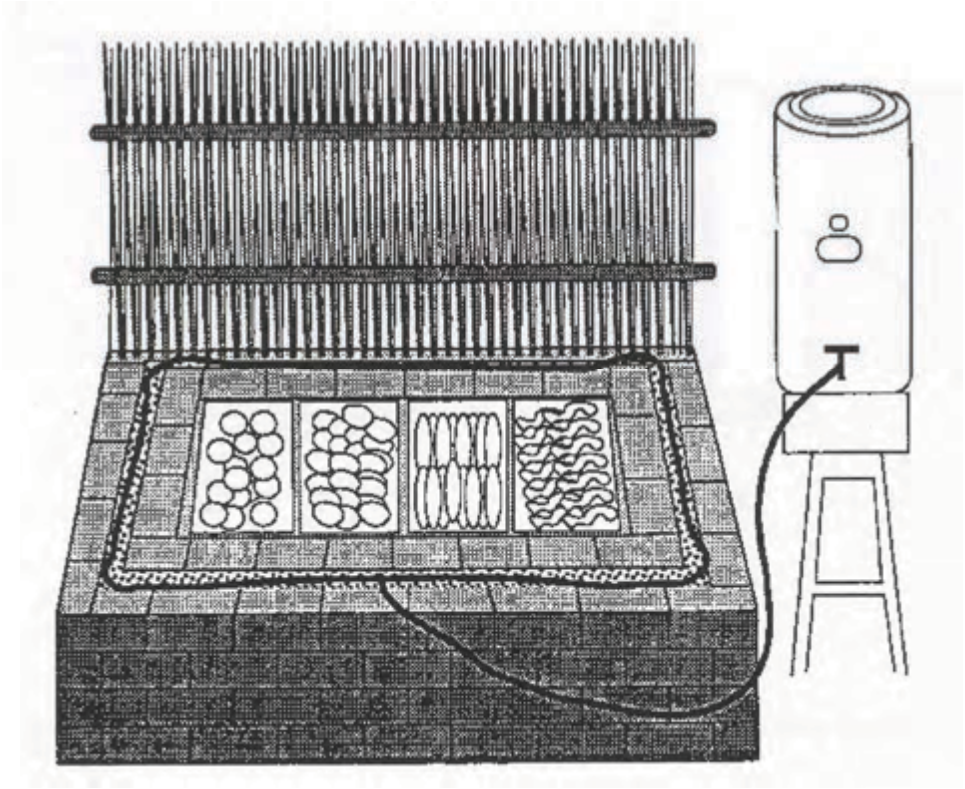




Low-tech systems for evaporative cooling

- Room with wetted charcoal walls
- The zero energy cooler

Results from India

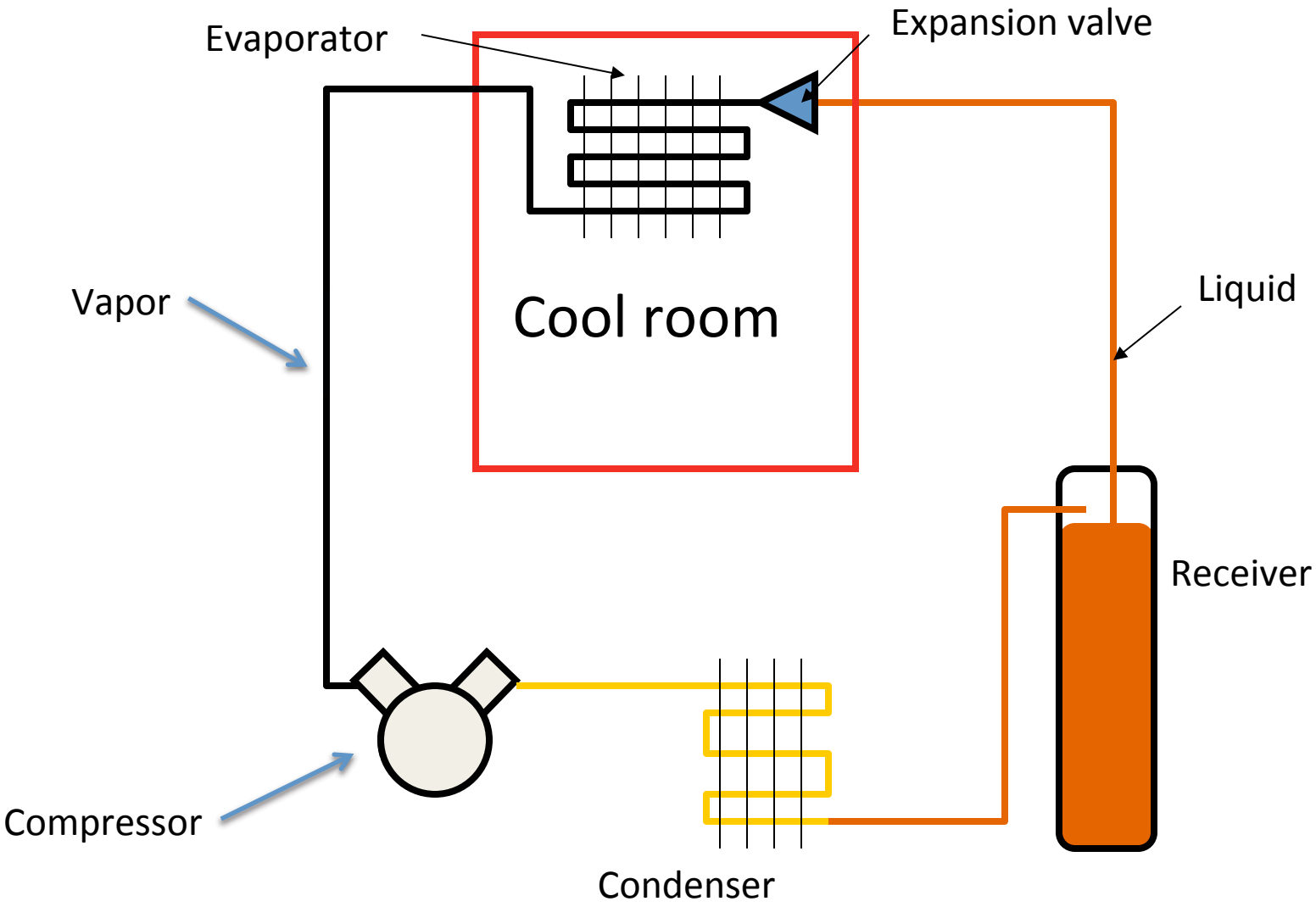


Increases in Shelf Life Via Zero Energy Cool Chamber

CROP	SHELF LIFE (IN DAYS)		ADDED SHELF LIFE (PERCENT)
	ROOM TEMPERATURE	ZERO ENERGY COOL CHAMBER	
Banana	14	20	**43%**
Carrot	5	12	**140%**
Cauliflower	7	12	**71%**
Guava	10	15	**50%**
Lime	11	25	**127%**
Mango	6	9	**50%**
Mint	1	3	**200%**
Peas	5	10	**100%**
Potato	46	97	**111%**

Source: Adapted from Roy. n.d. "On-farm storage technology can save energy and raise farm income." Presentation.

Mechanical refrigeration

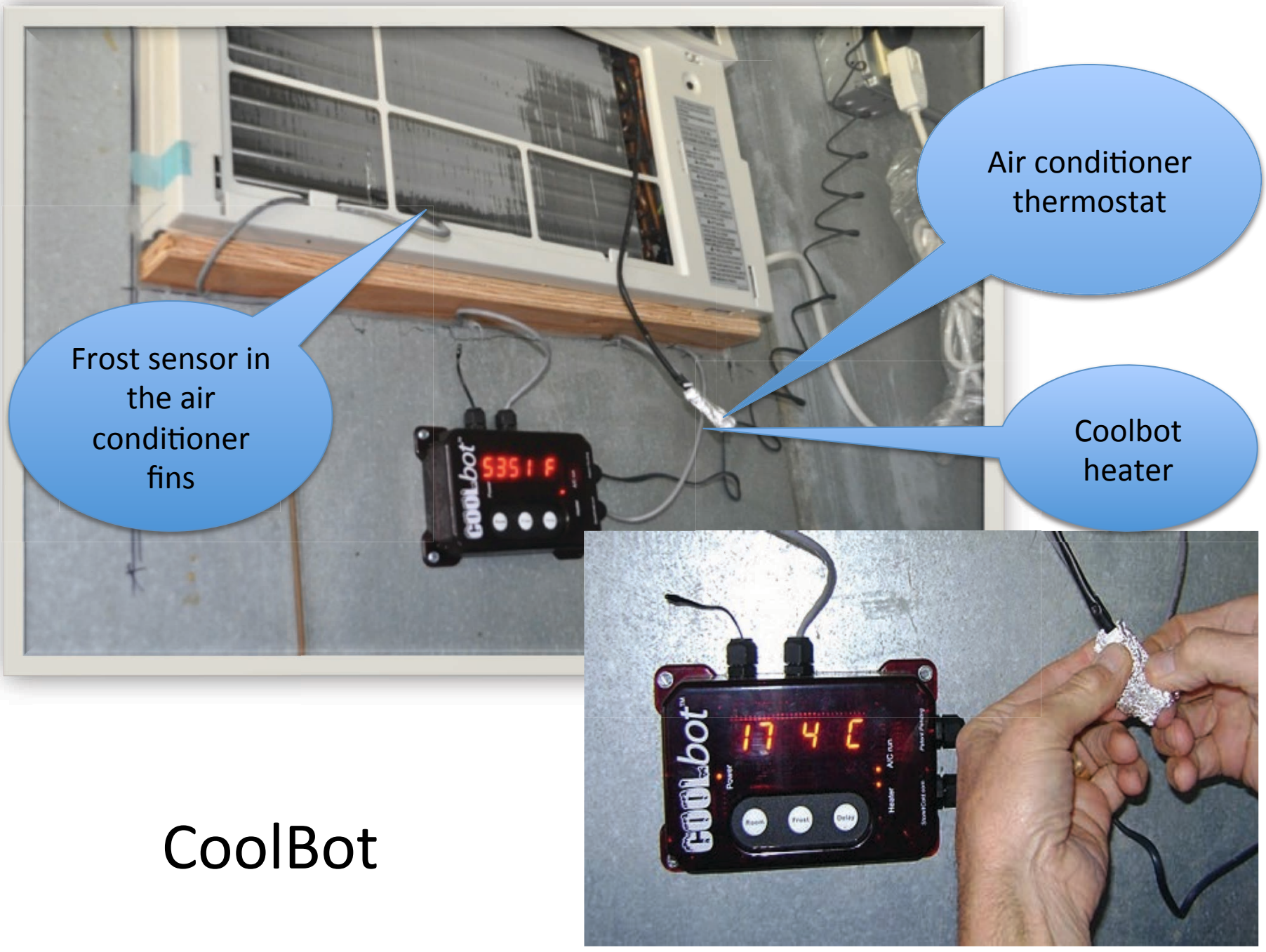


Mechanical refrigeration

- Very efficient (heat pump)
- Commercial units are very expensive

The CoolBot

- Uses a domestic air conditioner
  - Window or ‘Split unit’
- A special controller allows it to achieve low temperatures


Air conditioner thermostat
Frost sensor in the air conditioner fins
Coolbot heater
coolbot
5351 F
coolbot
17 4 C

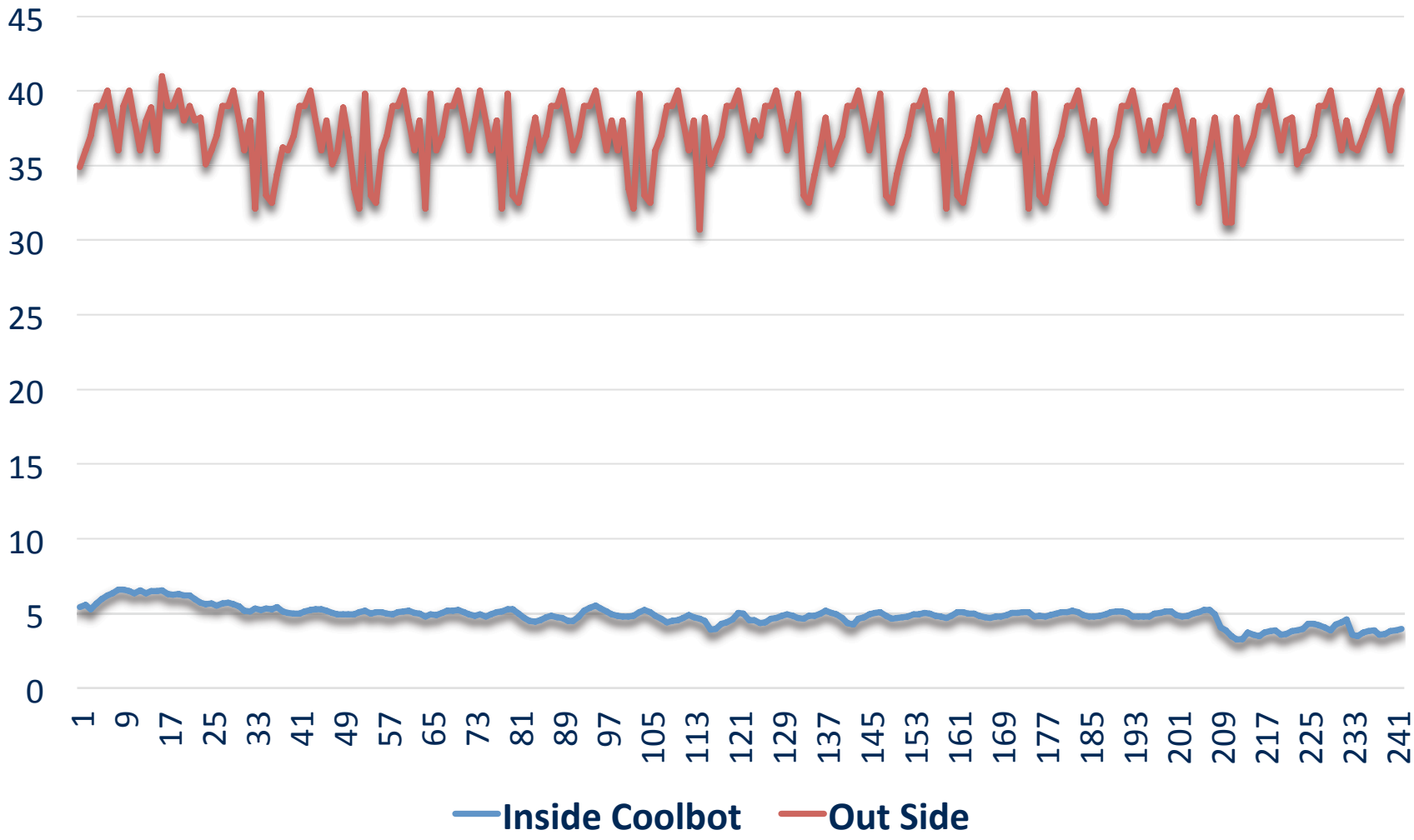
CoolBot

CoolBot room construction

CoolBot room construction


COOLBOT
28

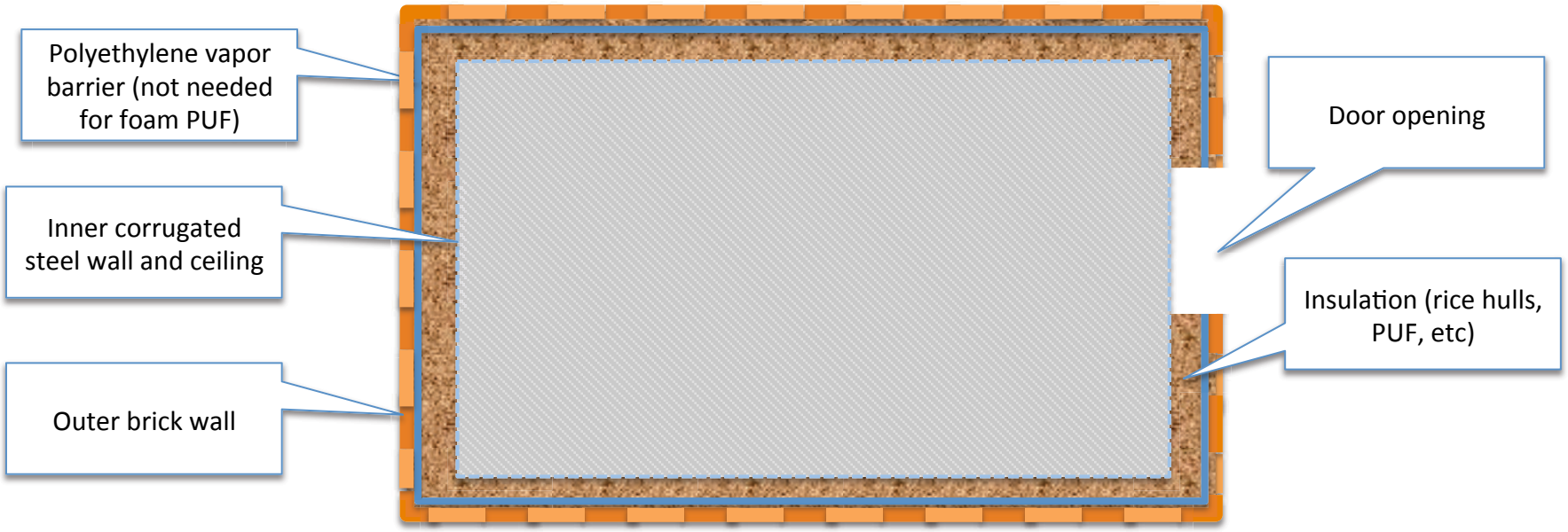
Very effective



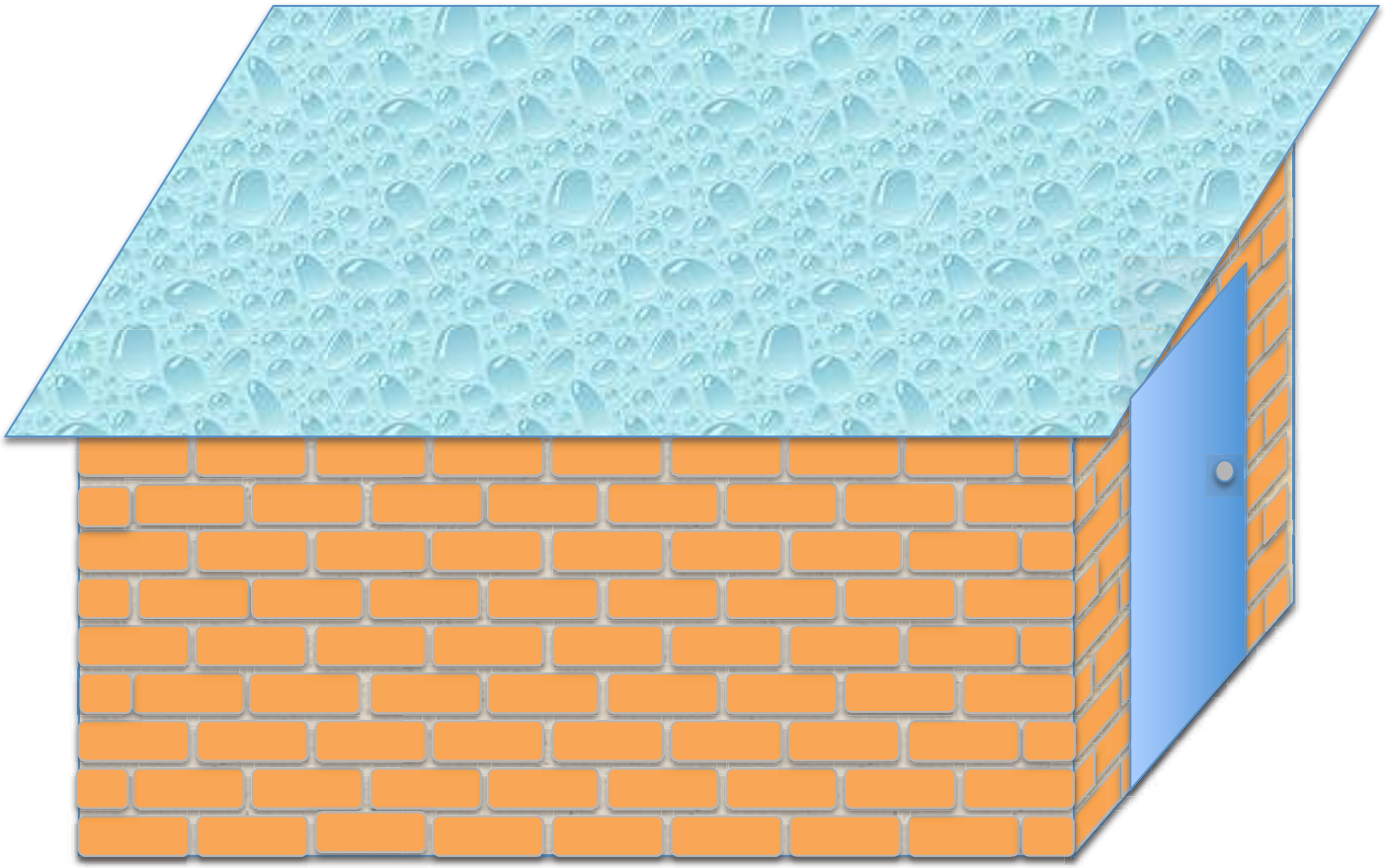
Problems

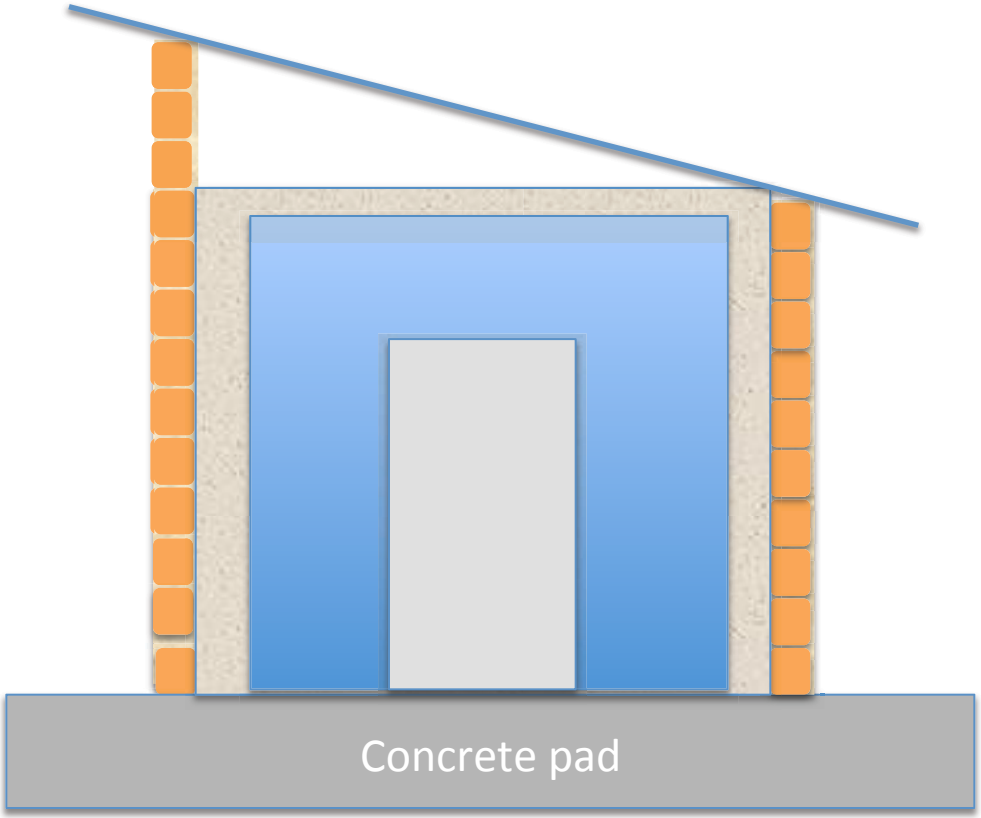
- Expense ($7,000 to $9,000)
  - Use different construction techniques
- Electricity supply – availability, reliability
  - Use solar and batteries

Double wall structure, brick outside, iron sheet (corrugated?) inside. 8’ x 8’ x 12’
Plan view. Insulation thickness 4 – 12 inches depending on material



Double wall structure, brick outside, iron sheet (corrugated?) inside. 8’ x 8’ x 12’
Metal roof above ceiling insulation





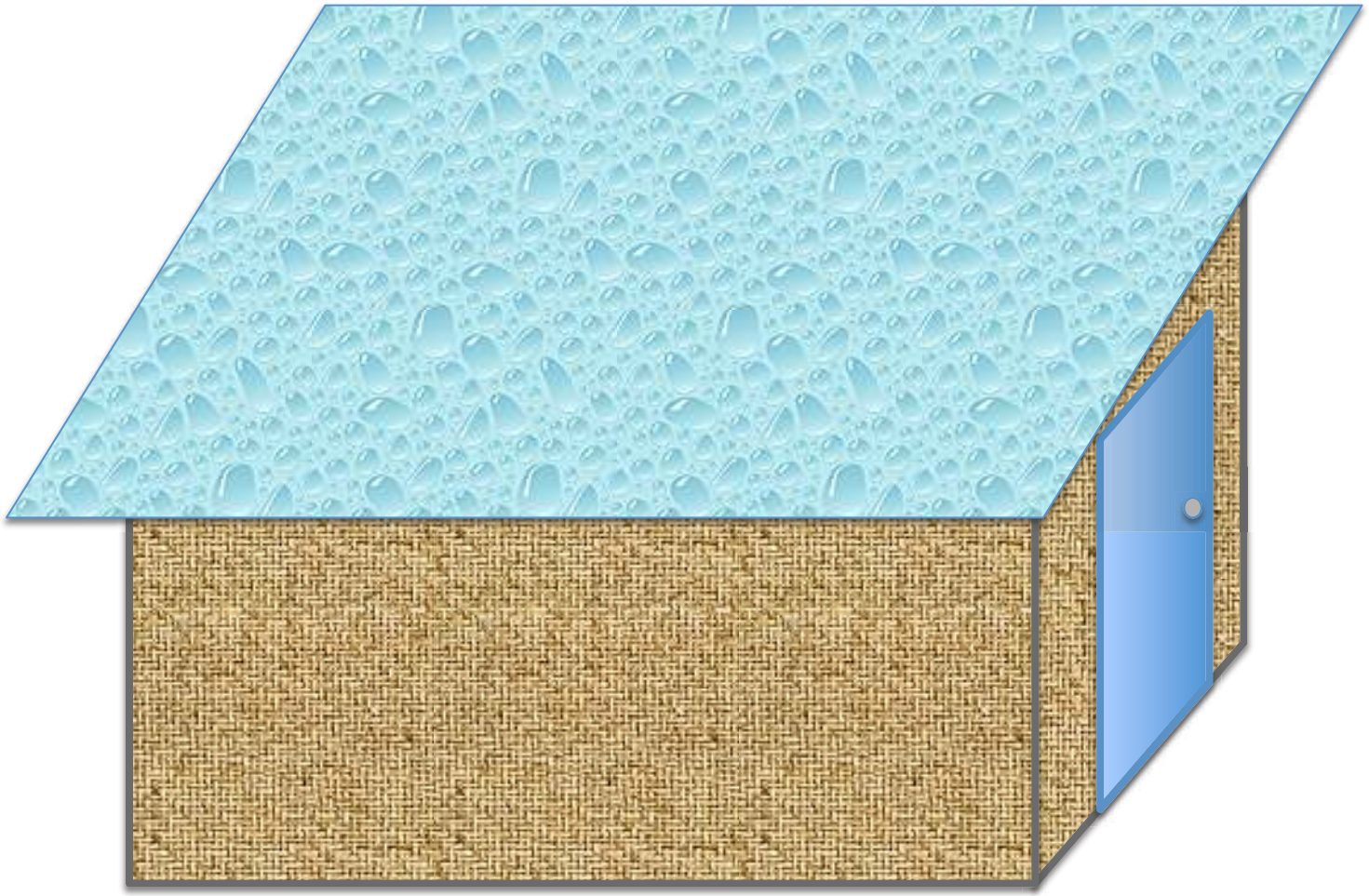
Double wall structure, brick outside, iron sheet (corrugated?) inside. 8’ x 8’ x 12’

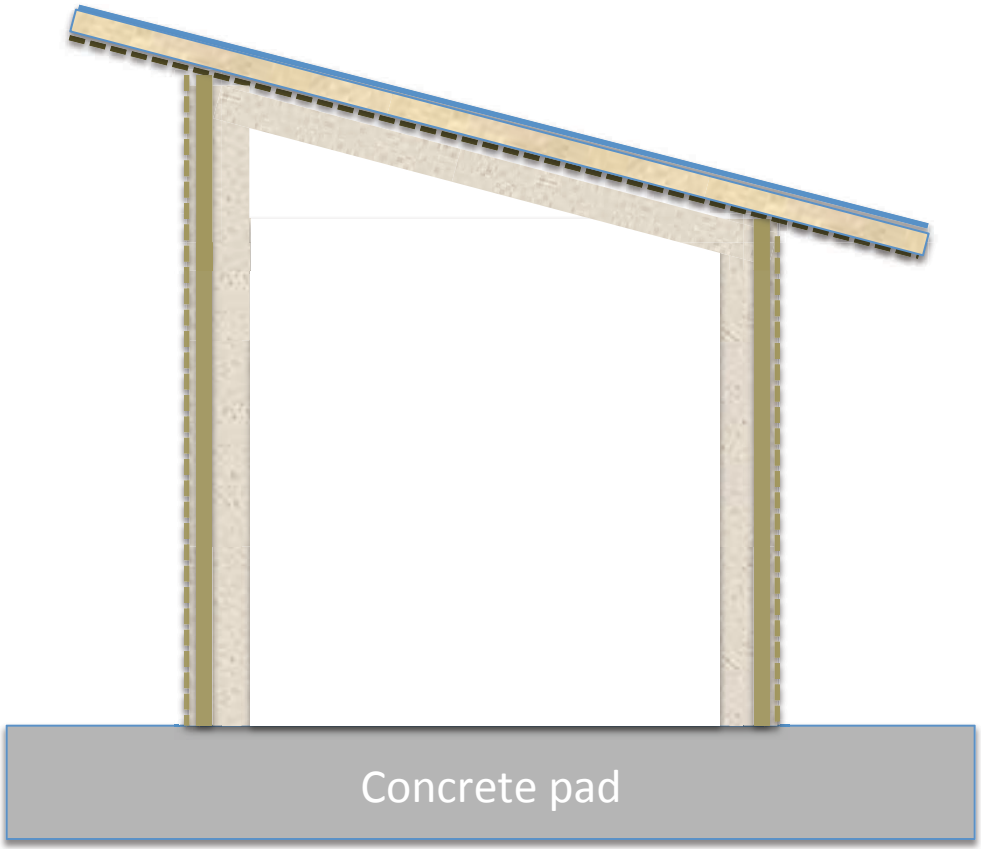
Side elevation. Insulation thickness 4 – 12” depending on material. Note vapor barrier around insulation (not needed for PUF)

Single wall structure, woven bamboo (?), sprayed PUF insulation

8’ x 8’ x 12’ Insulation thickness 4 – 6 inches. Plan view

Single wall structure, woven bamboo (?), sprayed PUF insulation
8’ x 8’ x 12’ Insulation thickness 4 – 6 inches. Inside shown, could be outside?





Single wall structure, woven bamboo (?), sprayed PUF insulation
8’ x 8’ x 12’ Insulation thickness 4 – 6 inches. Side elevation

Solar power for cooling

- Getting cheaper
  - Was >$5,000
  - Now <$3,000