



ZERO ENERGY COOLING CHAMBER

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INTRODUCTION

- In India **quality deterioration** of horticultural produce takes place immediately after harvest due to lack of on-farm storage
- **Spoilage** of fresh fruits and vegetables is a serious problem
- Cool storage can prolong the life of fresh produce, but refrigeration equipment is **expensive** to buy, run and maintain involving large initial capital investment.
- Considering acute energy crisis and lack of cool storage facility efforts made to develop **low cost/low energy cool chambers**

Zero Energy Cooling Chambers (ZECC)



- An Indian institute has developed technology for zero energy cool chamber an alternative of common refrigerator. (Low cost environment friendly **Pusa Zero Energy Cool Chambers**)
- This is an on-farm storage chamber, for **fresh fruits, vegetables and flowers** extends their **marketability**.
- **Spoilage** of fruits and vegetables can be controlled by reducing the storage temperature.

Zero energy cool chambers stay 10- 15° C cooler than the outside temperature and maintain about 90 percent relative humidity.



Cool Chambers can reduce temperatures by 10-15°C and maintain a high humidity of 95%. This can increase the shelf life and retain quality of horticultural products.

Principle

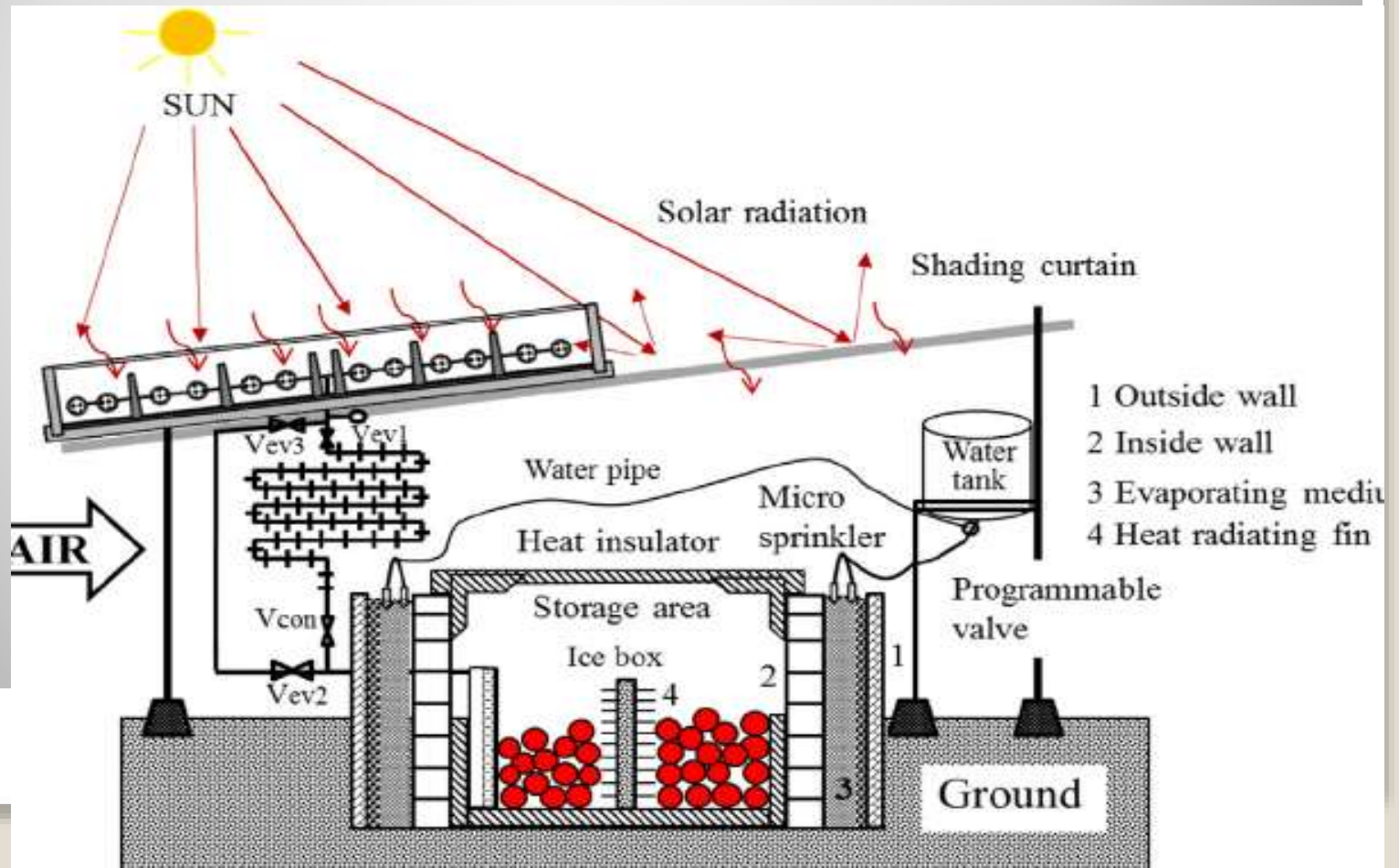
- Based on the principles of **Direct evaporative cooling**.
- Cooling effect obtained by evaporation of water and faster the evaporation, greater is the cooling.
- **Cool temperatures slow respiration** process, allowing fresh produce for longer time and avoid spoilage.



REF:BY SUNIEL PAREEK AND
ICAR

EVAPORATIVE COOLING

- Water evaporates into air raising its humidity and same time cooling the bed. Efficiency depends on **humidity** of the surrounding air. Very dry, low humidity air can absorb a lot of moisture so considerable cooling occurs.



CONSTRUCTION

- The zero energy cool chamber can be constructed easily with materials like **brick, sand, bamboo, khashkhas/straw, gunny bag** etc.
- It is most effective during the **dry season**
- The materials primarily used in constructing these chambers i.e. **bricks and sand** fortunately both has great capacity to absorb and/or retain water which evaporates slowly and steadily depending on the atmospheric temperature and humidity resulting in cooling.



Selection of Place

- Site having **natural air flow**.
- It should be made a **shaded place, well ventilated** and **away from direct sunlight**.
- Construct the chamber in an **elevated place** to avoid water logging.
- Easy to build out of **locally available materials**, such as brick, sand, bamboo, straw, and gunny bags





IDEAL ZERO ENERGY COOLING CHAMBER

Amity Science, Technology &
Innovation Foundation

STEPS FOR CONSTRUCTION OF ZECC

- Select an upland having a nearby source of **water supply**
- Make floor with brick 165 cm x 115 cm



Make a floor with bricks.

- Erect a double wall 70 cm high, leaving a cavity 7.5 cm wide between the two walls.

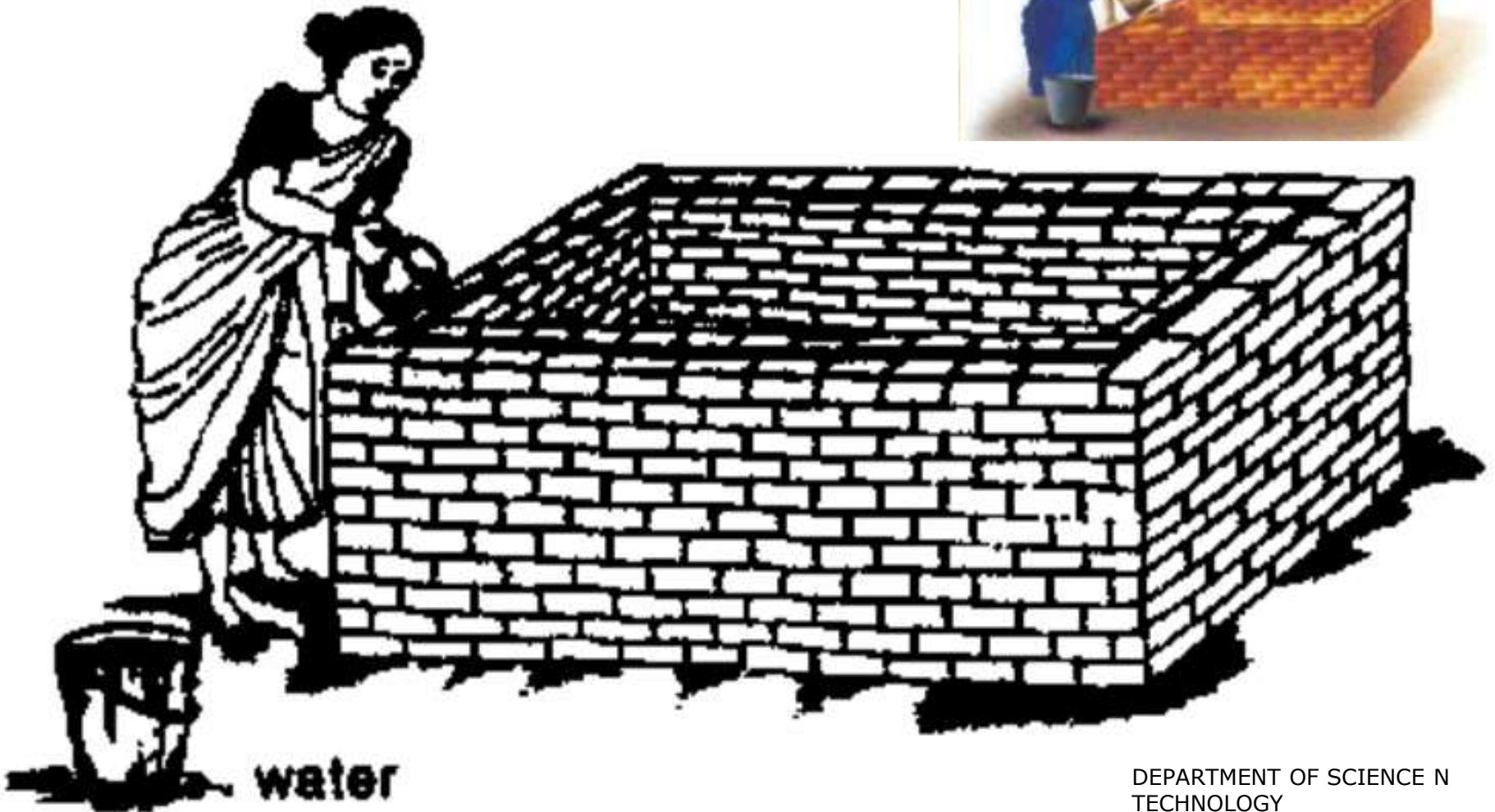
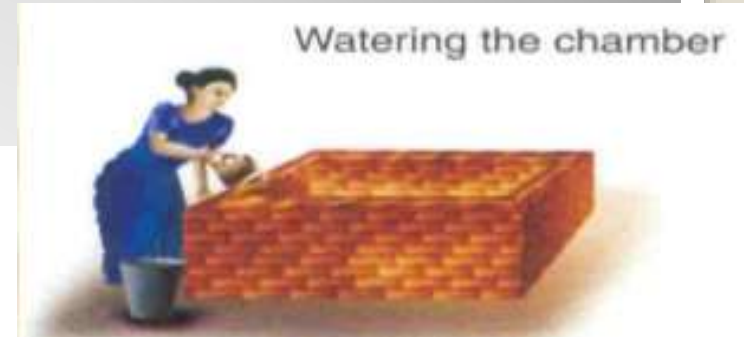


Erecting double wall with cavity



Erect a double wall 70 cm high, leaving a cavity 7.5 cm wide between the two walls.

- Drench the chamber with water and Soak fine river bed sand with water



Drench the chamber with water.

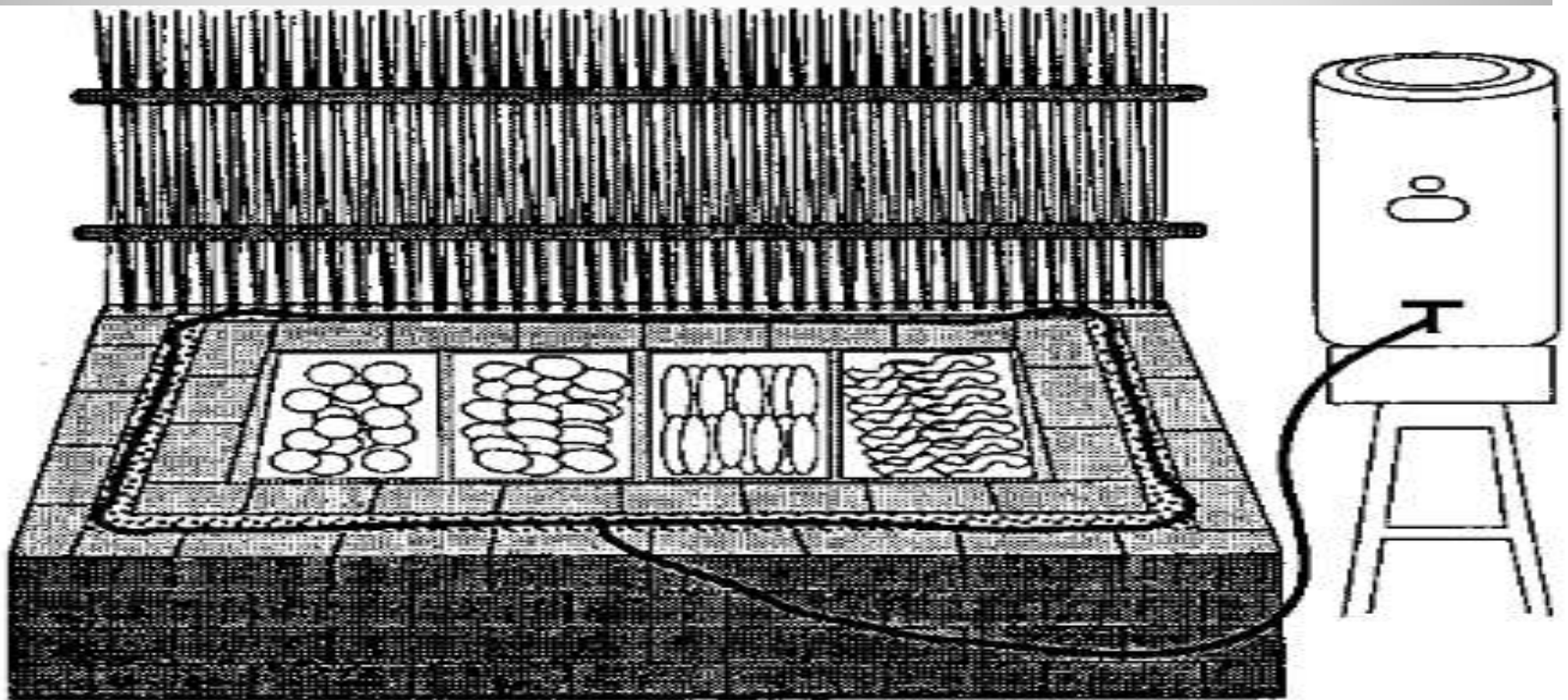
- Fill 7.5 cm cavity between the double wall with this wet sand



- Make a frame of top cover with bamboo, sirki, straw, or dry grass (165 cm x 115 cm) frame.



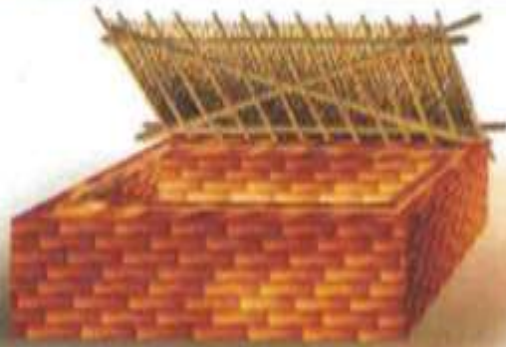
- The cavity between the walls is filled with sand and the bricks and sand are **kept saturated with water**.
- During hot summer months in India , this chamber is reported to maintain an inside temperature between 15 and 18 °C (59 and 65 °F) and a relative humidity of about 95%.





- ZERO ENERGY COOLING CHAMBER



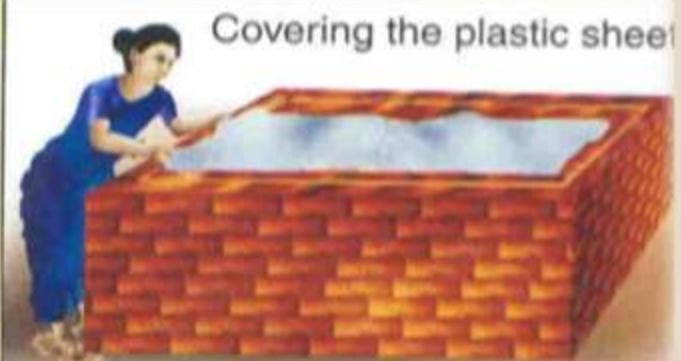


Cool chamber

Storing in plastic crates/baskets



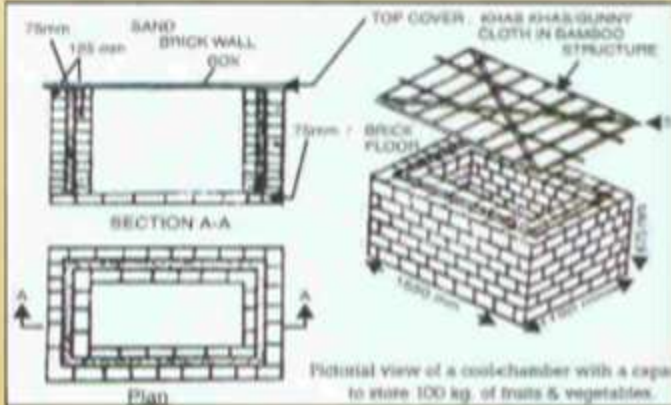
Covering the plastic sheet



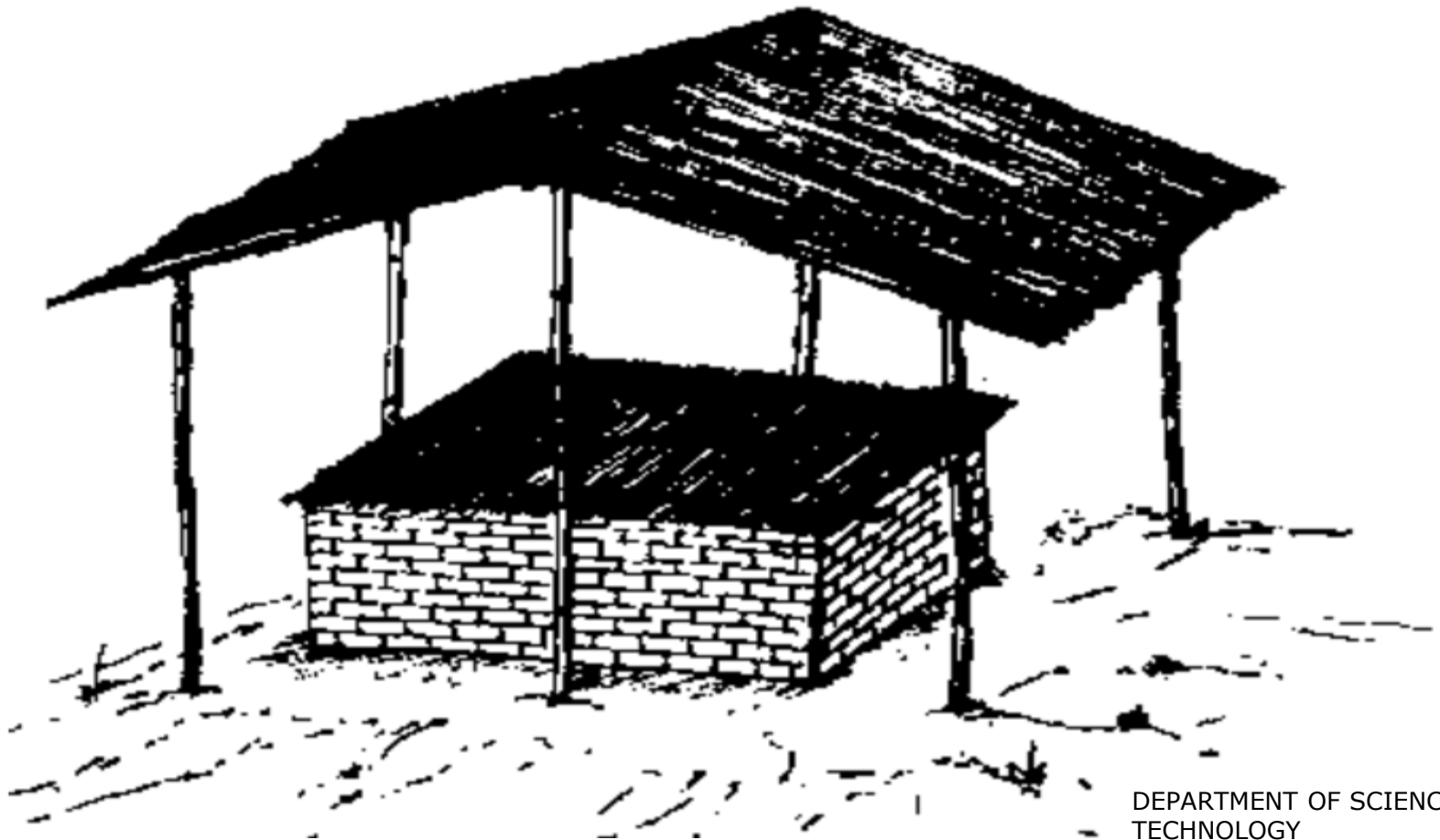
Covering the plastic sheet



Cool Chamber under shed



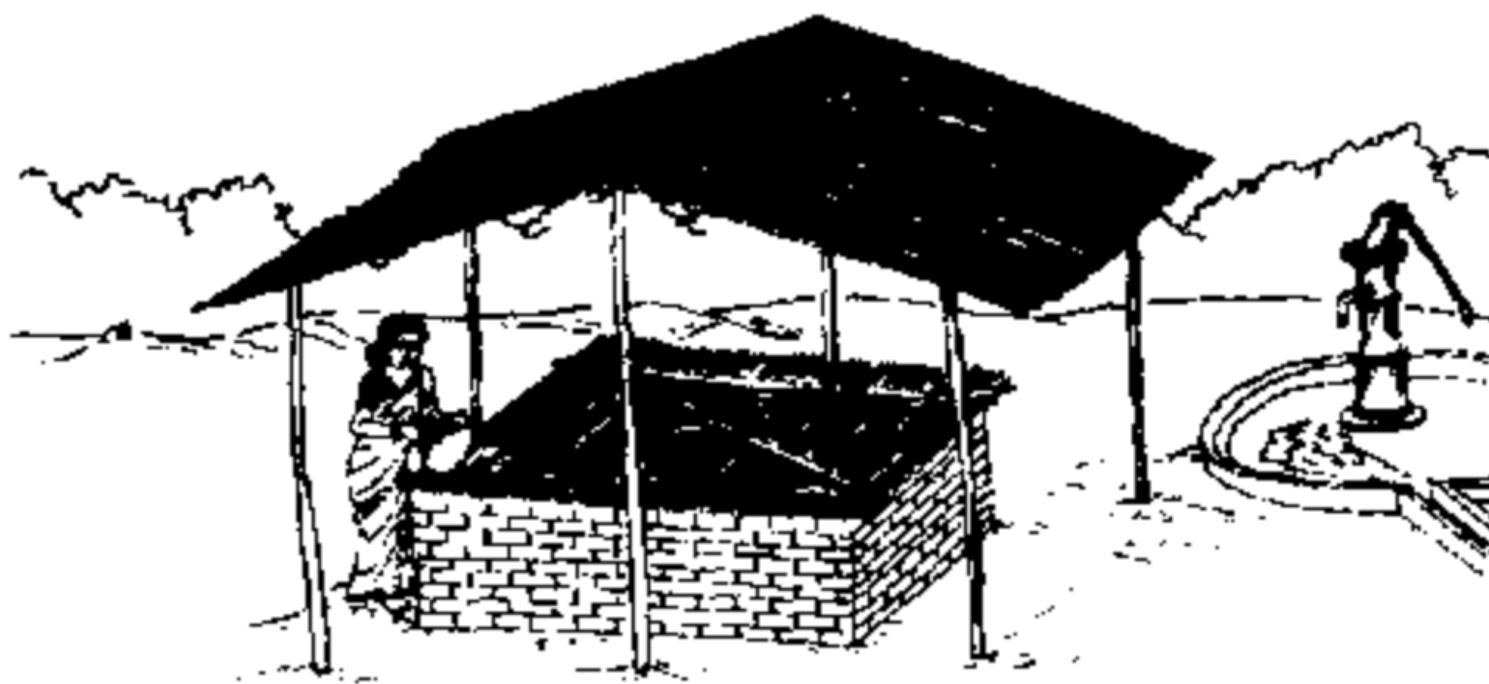
- Build a thatched-roof shed over the chamber to shield the chamber from direct sun and rain.



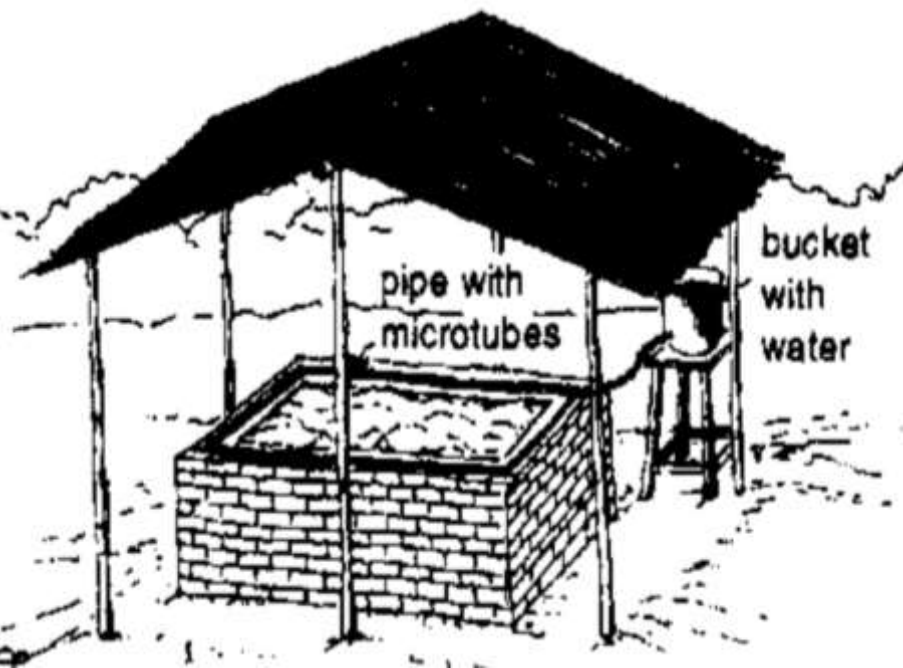


REQUIREMENTS

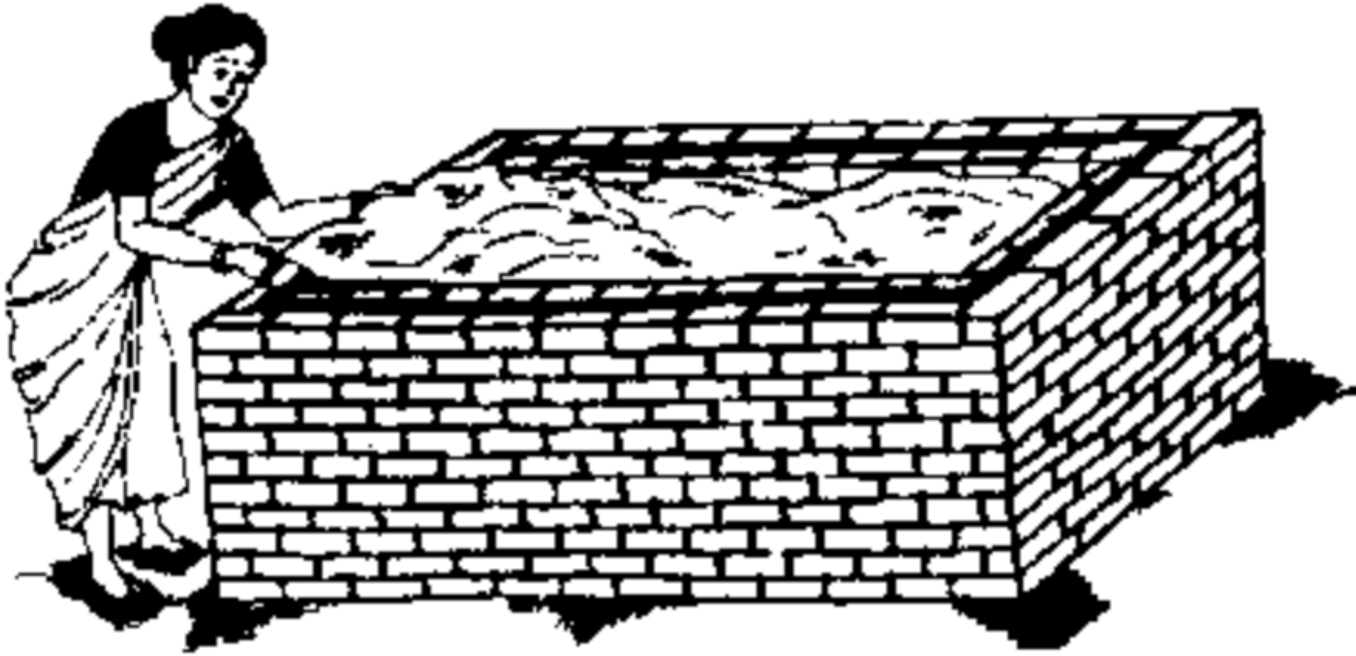
- **Make shed** over the chamber in order to protect it from direct sun or rain.
- Keep the sand, bricks and top cover of the chamber **wet with water**.
- **Water twice daily** in order to achieve desired temperature and relative humidity or fix a drip system with plastic pipes and micro tubes connected to an overhead water source.
- Store the fruits and vegetables in this chamber by keeping in **perforated plastic crates**
- **Cover** these crates with a **thin polyethylene sheet**
- The cool chamber should be reinstalled **once in 3 years** with new bricks utilizing the old bricks for other purposes.
- Do not use bamboo, wood, or fiberboard boxes because these will be damaged by moisture.



Water twice daily.



Watering with drip system



amber with new bricks after 3 years. (The bricks' pores become blocked over time and this reduces the chamber's effectiveness.)



27/04/2009

Advantages

- Better **marketability**.
- Retain **nutritive value**.
- **Environment friendly** storage system with **no pollution**.
- Can be constructed by an **unskilled person** .
- **No mechanical or electrical energy** is needed.
- Allows small farmers to store produce for a few days and thus **avoid costly rush** selling and distress sale.
- **Ideal** for household storage.
- **Reduces losses** and thus pays for itself in a short time.
- Useful for **temporary storage** of curd, milk, and cooked food.
- Can also be used for **mushroom** cultivation, storage of **biofertilisers**.

Disadvantages

- Requires a **significant capital investment**.
- Operation relies on a **reliable source of water** throughout the year.

Precautions

- Site in a place where breezes blows.
- Build on an **elevated site** to avoid water logging.
- Use **clean, unbroken bricks** with good porosity.
- Always keep the bricks, top cover and sand **saturated with water**.
- Prevent water drops coming in contact with stored material.
- Keep the chamber **clean** and disinfect the chamber periodically with permitted insecticide/ fungicide/ chemical, to protect from fungus, insect/ pests, reptiles etc.
- Construct under a thatch to avoid direct exposure to sun light.

Shelf life of fruits and vegetables in zero- energy cool chamber

Produce	Time of storage	Outside(days)	Cool chamber(days)
Leafy vegetables	Summer	< 1	3
	Winter	3	8-10
Other vegetables	Summer	1-2	5-6
	Winter	4-5	10-12
Potato	Spring/Summer	40	97
Mango	Summer	4	8
Orange	Winter	8-10	50-60

Cost Structure:

100 Kg Capacity Chamber

S1. No.	Item	Amount
1.	Bricks (400 nos.)	Rs.1,000.00
2.	Sand	Rs.100.00
3.	Bamboo, Khaskhas, etc. for top cover	Rs.300.00
4.	Thatched shed	Rs.500.00
5.	Water tank, pipes, tubes poly sheet etc.	Rs.600.00
6.	Plastic crates (6 nos.)	Rs.1200.00
7.	Labour	Rs.300.00
	Total :	Rs.4,000.00

Total Budget Outlay : Total 1020 Nos. of Structure @ Rs.4,000/- comes to Rs.40,80,000/- which will be given in 50% subsidy to farmers it comes to 20,40,000/- /-

Prof. Susanta K. Roy Professor Emeritus

Areas of Application

- **Short term storage** of fresh vegetables, fruits and flowers
- Growing of **white button mushroom**
- **Ripening** of tomato and banana
- **Plant propagation**
- **Storage** of processed fruit products

Storage life of fruits and vegetables:

Crop	Month	Cool Chamber		Room Temperature	
		Days	Weight loss %	Days	Weight loss %
Mango	June-July	9	5.04	6	14.90
Banana	Oct-Nov	20	2.50	14	4.80
Sapota	Nov-Dec	14	9.46	10	20.87
Lime	Jan-Feb	25	6.00	11	25.00
Kinow	Dec-Feb	60	15.30	14	16.10
Potato	Mar-May	90	7.67	46	19.08
Tomato	April-May	15	4.42	7	18.62
Amaranth	May-June	3	10.98	1	49.80
Methi	Feb-March	10	10.80	3	18.00
Parwal	May-June	5	3.89	2	32.36
Okra	May-July	6	5.00	1	14.00
Carrot	Feb-March	12	9.00	5	29.00





WATERING OF BRICKS



CONSTRUCTION OF FLOOR



DOUBLE BRICK WALL



CAVITY FILLED WITH SAND



WATERING OF COOL CHAMBER



CLOSEUP VIEW



CONSRUCTION OF COVER



PUSA ZECC READY FOR USE

SCOPE OF COOL CHAMBER

- Proposed cool chamber can be installed in different places of handling
- At present fruits and vegetables are handled in open shed the freshness is prone to considerable deterioration.
- It is suggested that a battery of commercial size cool chambers can be installed in wholesale markets.
- Units can be installed in two rows with a corridor in between.
- Fruits and vegetables stored temporarily in the cool chamber units before the transaction can **retain freshness and quality**.

SOMETHING MORE..

National Horticulture Board is giving 100% grant in aid for the benefit of the farmer

Technology Vision 2020 has identified it as a low cost storage technology for 2020.



Members of a women's group in Nduruma, [Tanzania](#) stand over their zero-energy cool chamber, or ZECC. ZECCs can extend the life of fresh produce by a few days up to two weeks. Credit: Rachel Cernansky.

Low cost environment friendly **commercial size cool chamber**

- A low cost environment friendly commercial size cool chamber (6-8 ton capacity) has been developed utilizing the same principle of evaporative cooling.
- It is also a double brick-wall structure, the cavity is filled with sand and walls of the chamber are soaked in water from an overhead tank.
- The floor is made of wooden planks and the bottom of the chamber is provided with air ducts.
- Air is drawn with the help of an exhaust fan - can run for a specific time with timer.
- Like ZECC this chamber can also reduce temperature and maintain high humidity.
- Commercial cool chamber has been found to be useful for storage of citrus, banana, potato, tomato etc. and onion during the rainy season by stopping water supply.
- In apple growing areas of Jammu and Kashmir, Himachal Pradesh and Uttarakhand these chambers would be useful for storing apples after harvest until they are required for sale.
- This chamber can also be used as a pre-cooling chamber, for mushroom growing storage of bio-fertilizers.



Outside



Inside

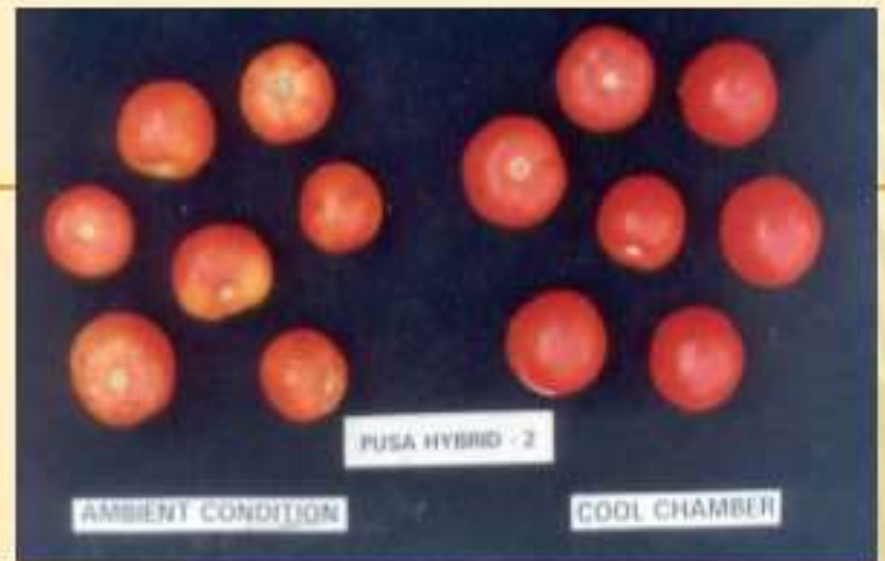
TABLE

Storage of vegetables in cool chamber

Crop	Cool chamber Shelf life (days)	Room temperature Shelf life (days)
Amaranth	3	<1
Okra	6	1
Parwal	5	2
Carrot	12	5
Potato	97	46
Mint	3	1
Turnip	10	5
Peas	10	5
Cauliflower	12	7



Kinnows stored at Cool Chamber (60-80 days)



Enhance lycopene development (20 days)



Spinach stored in cool chamber (3 days)

Storage study of banana : At the end of 12 days



ROOM TEMPERATURE



COOL CHAMBER



COOL STORE

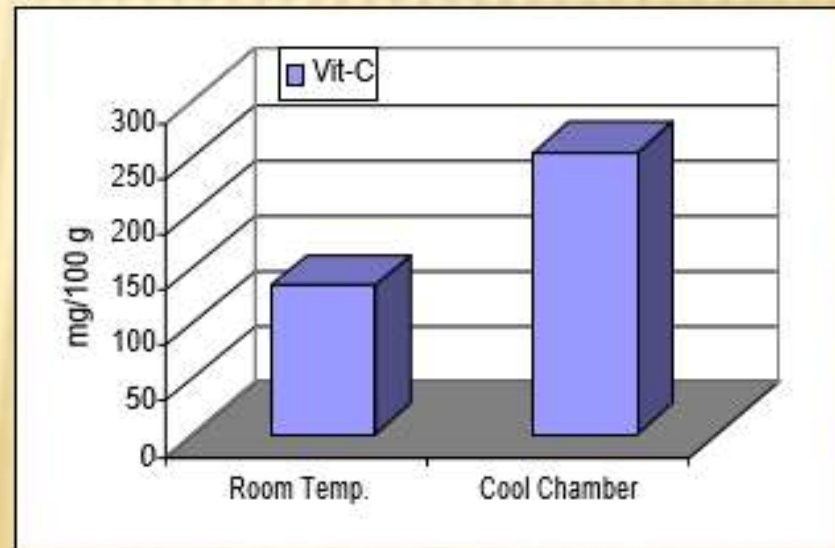
Various uses and benefits of Cool Chamber



Mushroom Growing and storage



Rhizobium Culture



Thank you

