Volume 3, Issue 9
September I 2025

Agri Roots
e- Magazine

www.agrirootsmagazine.in

ISSN: 2583-9071

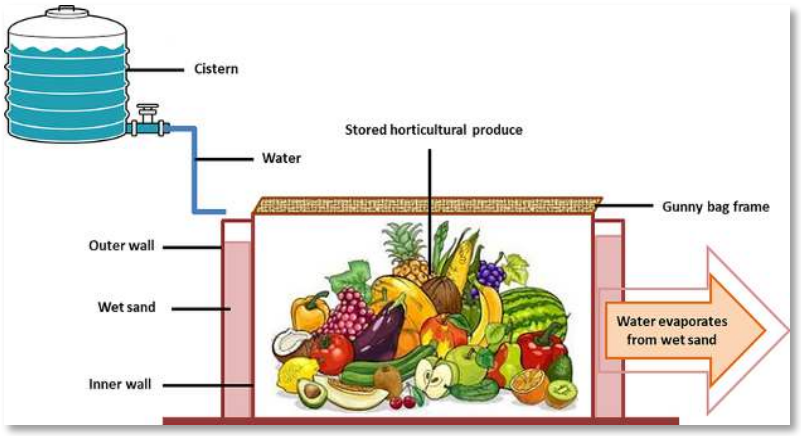
Zero Energy Cool Chamber: Affordable Storage for Small-Scale Farmers

ARTICLE ID: 0242

Shashi Kala

Department of FS&PHT, Bihar Agricultural University, Sabour, Bhagalpur-813210

Horticultural produce is inherently perishable and begins to deteriorate immediately after harvest. In India, a tropical country, post-harvest losses of fruits and vegetables are particularly significant. The lack of adequate storage and processing infrastructure results in a considerable proportion of produce being spoiled after harvesting. Given that most Indian farmers have small landholdings, they are compelled to sell their produce promptly, as refrigeration often required for effective storage is prohibitively expensive. To address this challenge, a low-cost refrigeration chamber was developed by IARI Pusa, New Delhi (Roy and Khurdiya, 1983). In many developing countries, more than 40 percent of losses occur at various points along the post-harvest supply chain, reducing the per capita availability of fruit to approximately 80 grams per day about half the amount recommended for a balanced diet. The Zero Energy Cool Chamber (ZECC) does not require electricity and can be installed on farms. Operating on the principle of evaporative cooling, the ZECC reduces spoilage by lowering temperature and raising relative humidity. Although the technology was introduced some time ago, efforts to promote this affordable on-farm storage solution have gained momentum only recently. It lowers the temperature and raises humidity within the chamber, which can help extend the shelf life of fruits and vegetables without the need for electricity.



Construction of ZECC

Zero energy cool chambers can be readily assembled with locally available resources. For a 100 kg capacity chamber, approximately 400 bricks are necessary, along with sand, bamboo, khas-khas or other grasses for the top cover, a thatched shed, a water tank, pipes, tubes, poly sheet for water supply, and 5–6 perforated plastic crates to store horticultural products. Labour is

also required for construction. The following steps outline the recommended procedure for building the chamber:

- Begin by identifying an elevated area or floor that has access to water supply.
- The ZECC floor should have dimensions of 165 cm x 115 cm and be constructed with bricks.
- Construct a double brick wall with a height of 67.5 cm, leaving a 7.5 cm gap between the two walls for river sand filling.
- Uniformly textured riverbed sand, soaked with water, can be used to fill the cavity between the double walls.
- Cover the top of the structure with bamboo straw or other locally sourced materials to protect the chamber from direct sunlight or rainfall.

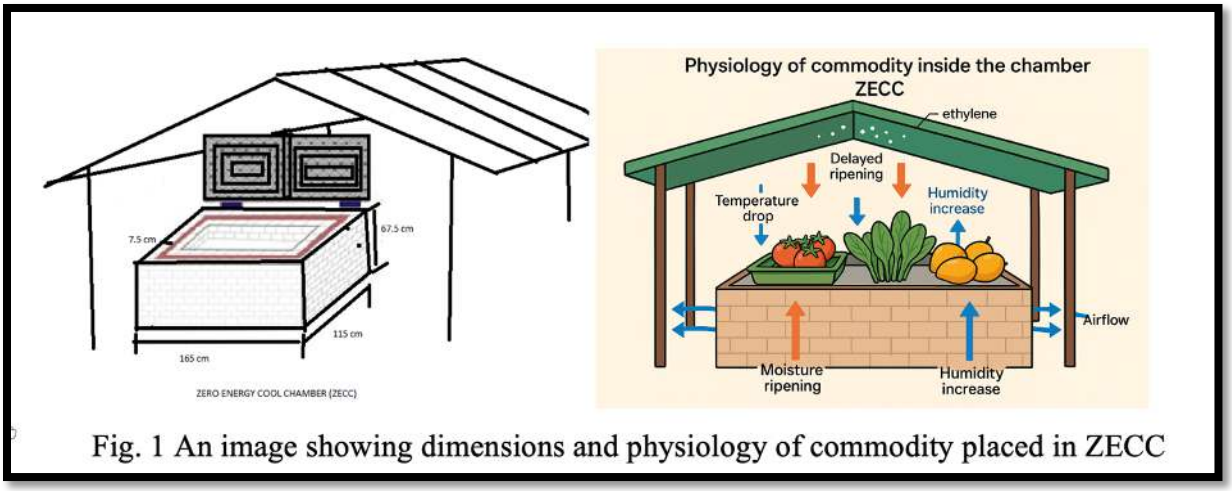


Fig. 1 An image showing dimensions and physiology of commodity placed in ZECC

Guidelines for Optimising Chamber Performance

- Keep the sand, bricks, and top cover of the chamber moist by watering twice daily once in the morning and once in the evening or by installing a drip irrigation system to help achieve the desired temperature and humidity.
- Cover crates with polyethylene sheets.
- The cool chamber should be rebuilt every three years using new bricks.

Both temperature and relative humidity are critical factors in storing fruits and vegetables. While temperature predominantly influences the rate at which fresh produce deteriorates, maintaining appropriate humidity levels during storage is also essential. The ZECC can be easily constructed by farmers using locally sourced materials such as grasses, leaves, bamboo, sand, and bricks. This system preserves vegetable freshness for 7–12 days, enabling farmers to access wholesale markets and thus avoid loss-making local sales through intermediaries.

The National Horticulture Board offers grants for constructing this type of chamber. It is suitable for storing a variety of crops such as citrus fruits, bananas, potatoes, tomatoes, and onions (with no water supplied during the rainy season). In apple-growing regions, these chambers are also used postharvest until apples are sold. Studies indicate that the shelf life of horticultural products increases significantly when stored in ZECC compared to room temperature. For example, storage durations observed include:

cauliflower (12 days), peas (10 days), turnip (10 days), potato (97 days), carrot (12 days), pointed gourd (5 days), okra (6 days), and amaranth (3 days). For fruits: kinnow (60 days), guava (15 days), grapefruit (70 days), lime (25 days), mango (9 days), sapota (14 days), banana (20 days), and aonla (18 days). It works best in hot and dry climates where evaporative cooling is most efficient. Root and bulb crops like onions and garlic are not ideal for ZECC due to their preference for dry conditions.

Recommended ZECC Storage Conditions for Common Fruits and Vegetables

Produce (Fruits and Vegetables)	Temp (°C)	R H (%)
Tomato, Brinjal, Chili, Okra, Leafy greens, Potato	12–15	85–95
Onion and Garlic	ZECC not ideal for storage	
Mango, Papaya, Banana, Guava, Lime	10–15	85–90

Conclusion

This zero energy cooling chamber (ZECC) is a low-cost structure that can lower temperatures by 10–15°C and maintain relative humidity up to 95%. It has been shown to extend the shelf life and preserve the quality of stored produce. Therefore, removing field heat and applying cooling soon after harvest can increase the storage life of horticultural products. ZECCs may be considered an alternative to high-cost refrigeration chambers for small-scale farmers and contribute positively to environmental sustainability. Proper installation and usage can provide practical storage solutions for marginal farmers.

References

1. Roy, S.K. & Khurdiya, D.S. (1983). Storage of fruits and vegetables in zero energy cool chamber. *Indian Food Packer* 37, 26–31.