

Low-cost storage structure for perishable horticultural produce – Pressing priority for small and marginal farmers

Though, India suffices enough in total fruit and vegetable production, bitter fact is that the farmers are unable to sell about 40% of the total fruits and vegetables (equivalent to ₹63,000 crore) produced. As more than 80% of the Indian farmers are small and marginal, the post-harvest losses have first-order effects on them. These post-harvest losses are mainly due to unavailability of proper storage facilities that compel small holder farmers in India to sell their produce at low prices soon after the harvest. These losses can be minimized to a significant extent through large-scale promotion and installation of crop and region-specific model low-cost storage structures such as, Zero Energy Cool Chamber, Low-cost onion and ginger structure, Pusa-Farm Sun-Fridge, etc. developed by different institutes.

INDIA is the second largest producer of fruits and vegetables in the world with a record production of 103.02 million tons of fruit and 197.23 million tons of vegetables during 2020-21. Storage of fresh horticultural produce after harvest is one of the most pressing problems of a tropical country like India. Due to their high moisture content, fruits and vegetables have a very short life and are liable to spoil. Moreover, they are living entities and carry out transpiration, respiration, and ripening even after harvest. Due to the short shelf life of these crops, it is estimated that about 30 to 35% of India's total fruits and vegetable production is lost during harvest, storage, grading, transport, packaging, and distribution in a year which reduces the growers share. Moreover, the majority of the growers belong to marginal to sub-marginal category. Thus, it has been frequently seen that huge post-harvest losses of their produce forced them to shift to other cultivation. In this context, a mini-review on low-cost storage structure for marginal growers is felt urgent and in the following section few well-performed storage structures are presented in detail.

Zeer/ Pot in pot/ Doubled wall pot

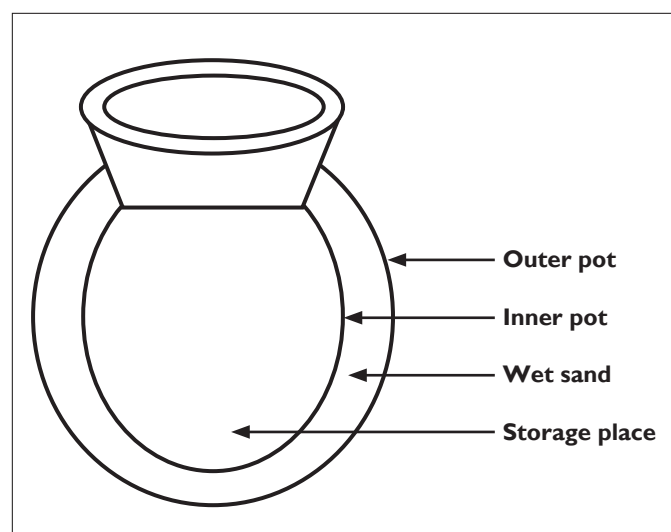
Zeer, an Arabic word meant for large pots, are simple designs of evaporative coolers that can be used in the home. The basic design consists of a storage pot placed inside a bigger pot that holds water. The inner pot stores food that is kept cool. One adaptation on the basic pot design is the Janata cooler which is developed by the Food and Nutrition Board of India. It consists of one earthenware pot set inside another, with a layer of wet sand in between. As the moisture evaporates it cools the inner pot, keeping up to 12 kg of fruit and vegetables fresher for longer. A comparative study on shelf-life of different horticultural crops showed that produce can be stored for longer within Zeer than normal storage.

Table 1. Case study on shelf-life improvement using Zeer

Produce	Shelf-life of produce without using the Zeer	Shelf-life of produce using the Zeer
Tomato	2 days	20 days
Guava	2 days	20 days
Rocket	1 day	5 days
Okra	4 days	17 days
Carrot	4 days	20 days

Zero Energy Cool Chamber (ZECC)

This structure was initially developed by Roy and Khurdiya in 1985 at IARI, New Delhi by using locally



Model schematic diagram of ideal double walled Zeer pot



(A-C) Pusa ZECC adapted by KVK, Sundargarh-1 (Odisha); (D) Model structure of Pusa ZECC installed at ICAR-IARI, New Delhi



Bottom and side ventilated double row onion storage installed at ICAR-DOGR, Pune

available materials like bricks, river sand, paddy straw and sacks or cloth which can be built in any parts of the country at very low cost. The structure was made based on the principle of an evaporative cooling system. It has been recommended to construct this structure near the water source. The floor and both outer and inner cavity walls are made from a single layer of bricks and a gap of 75 mm should be given in between the two walls. The cavity is then filled with sand and saturated with water after final construction. The whole structure must be protected from sunlight by making a paddy-straw thatched roof to provide shade. After final construction, water is thoroughly sprinkled twice a day on both the walls and cavity sand to maintain enough moisture and temperature of the chamber.

Low-cost thatched roof bamboo garlic storage structure

This model storage structure developed at Krishi Vigyan Kendra, Anta, Baran, Rajasthan made from the bamboo sticks with cemented floor measures 15' (w) × 30' (l) × 12' (h) in size with the storage capacity of 10 tons of garlic. The cost of the storage structure is nearly ₹1.0 lakh. The storage of whole garlic plants up to 3 feet height was found most suitable for decreasing the rotting (3.40%) and weight losses of bulb (4.04%) in low-cost garlic storage structures due to the proper ventilation enabling the circulation of fresh air.

Low-cost ventilated onion storage structure

ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune has developed several types of low-cost, farmers-friendly storage structures to store the onion bulbs with minimum input and to reduce the market glut during the off-season (<https://dogr.icar.gov.in/>). Among these, low volume (5-10 tons storage capacity) low-cost onion storage structure, and high volume (25-30 tons storage capacity) bottom and side ventilated double row onion storage structure is the most cost-effective and highly recommended to the farmers for storing their onion

bulbs. Both of these structures reduce storage losses by 20-50% depending upon the period of storage.

Improved Ginger storage structure

This two-chambered structure of size 2 m × 2 m × 1.4 m (height) was developed by ICAR- Research Complex for NEH Region, Barapani (Meghalaya). The walls of the structure were made of bamboo mat, clay, and cow dung. The thickness of the wall is 20 cm; it is double-walled with its frame made of bamboo and GI wire. The clay and cow dung paste were poured in the gap of the wall in 4-5 stages at regular intervals with a one-day interval up to the complete height (1.4 m) of the walls. This filling was kept for drying continuously for 20-25 days. The outer surfaces of the walls were plastered with clay and cow dung paste. After drying the structure is ready for storage of ginger. Durability of the structure is more than 4 years and single unit costs only rupees five thousand (₹5000). Using this structure farmers can store their ginger up to 5 months in desired quality.

Pusa-Farm Sun Fridge (Pusa-FSF)

It is a grid-less, battery-less, fully solar-powered cold storage structure developed by ICAR-IARI, New Delhi to store the perishable fruits and vegetables on-farm itself. This on-farm cold store has a storage capacity of 2 tons which cools the store using the principle of both evaporative cooling and thermal storage (a 'solar refrigeration' during the day and a 'water batter' during the night). The size of the structure is 3 × 3 × 3 m that uses 14 solar panels in a series of parallel circuits to power the structure. A low-cost styrofoam panels insulation with mesh-fabric walls was used as a basic material for its construction. It starts to cool automatically in the morning with the sunshine and shuts off in the evening with sunset. However, it does not work under cloudy sky and it starts functioning again when the sky gets cleared. Pusa-FSF can maintain the temperature between 5-10°C during the daytime and <14°C during the night when the daily maximum temperature reaches approximately 45°C.



Pusa Farm Sun-fridge

The Cool-Bot

Cool-bot is a device conceptualized by Mr. Ron Khosla, which turns a conventional room air conditioner into a produce cooler. The air conditioner's thermostat is heated so that the unit keeps running until the room temperature reaches the Cool-bot set point. To prevent icing of the fins, the Cool-bot measures the fin temperature and stops the compressor (through the thermostat heater) when ice builds up. The ice on the fins continues to cool the room air until it melts and the compressor turns on again. At less than US\$300, the Cool-Bot is an inexpensive controller that enables a standard air conditioner unit to cool rooms down to 0-15°C, without ice accumulating on the evaporator coils. When applied in a well-insulated room constructed from locally-available materials, this relatively inexpensive cooling system makes cold storage a viable option for smallholder farmers. With the cold storage facilities farmers can store their produce for prolonged periods thus extending the marketing period to enable them negotiate better prices for their produce, access new markets and increase their income. On the other hand, consumers benefit from a regular supply of high-quality fruits and vegetables. Under this, different products like mango, brinjal, cucumber and okra were

showed highest degrees of visual sensory score at 10 days of storage in cool-bot.

SUMMARY

Several simple practices are useful for cooling and enhancing storage system efficiency wherever they are used, and especially in developing countries, where energy savings may be critical. Countries like India where the majority of the fruit and vegetable growers belong marginal and sub-marginal category, promotion of alike cool storage technologies mentioned above which are low-cost, low-energy consuming, environment friendly and made up of locally available materials should be taken care of at government level to reduce post-harvest losses of the majority of horticultural produce, thereby helping the farmers to earn more profit.

For further interaction, please write to:

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Movable screens in rose production

- Use movable screen, an important tool for rose cultivation.
- It can help growers manipulate environment conditions — lowers temperature, changes humidity and influences production numbers.
- The movable screens can be used year-round and in a variety of climates — from the Netherlands to India.