

Preserving Quality and Freshness of Horticulture Produce Using Passive Cooling Solutions

Sahaja Samrudha Organic Producer Company aims to reduce point-of-sale rejects of leafy green vegetables to zero by keeping them fresh using a zero-energy cooling solution.



Sahaja Samrudha Organic Producer Company Limited (SSOPCL) encountered Point-of-Sale (PoS) rejections reaching 5% for leafy green vegetables.



Using Subjee-Coolers, a passive cooling solution, SSOPCL reduced the PoS rejects by half.



This zero-energy cooling solution is an effective, sufficient, and efficient solution to retain the freshness of leafy green vegetables for 2-3 days.



Post-harvest losses in India are in the range of 6-15% and have an estimated opportunity cost of Rs 1 lakh crore annually¹.



Post-harvest losses result from deficient post-harvest management practices and inadequate cold-chain infrastructure.



Development of India's cold chain infrastructure provides an opportunity to deploy effective, sufficient, and efficient cooling solutions.

Post-harvest losses in India

Post-harvest losses in India are around 6% for cereals, 8% for pulses, 10% for oilseeds, and 15% for fruits and vegetables, amounting to a value of approximately Rs 1 lakh crore annually, per ICAR-CIPHET Annual Report 2018-19¹. These losses have adverse effects on the income of farmers. Further, every wasted ton of fruit and vegetable decomposes into approximately 1.5 tons of greenhouse gases (GHG)².



15%
Fruits & Vegetables



10%
Oil Seeds



8%
Pulses



6%
Cereals

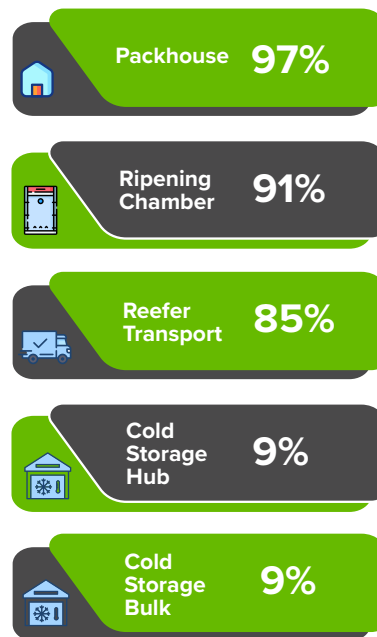
Figure 1: Post Harvest Agriculture Produce Losses in India

¹ICAR-Central Institute of Post-Harvest Engineering & Technology, "Annual Report 2018-19," 2019.

²Kohli, Pawanexh. (2016). Stop Food Loss To Stop Climate Change.

These post-harvest losses can be attributed to inadequate post-harvest practices and a lack of an integrated cold chain infrastructure. The absence of proper cooling and refrigeration technologies and post-harvest facilities is especially evident in rural agricultural communities. These gaps occur at various stages, including the farm gate (harvest point), collection points (aggregation), during transportation, and at wholesale and distribution centres. The 2019 India Cooling Action Plan (ICAP) highlights significant shortcomings in the cold chain infrastructure, with a shortfall of 97% in pack-houses, 91% in ripening chambers, 85% in reefer transport and 9% in cold storage. Developing the necessary infrastructure to address these deficiencies presents an opportunity to incorporate energy-efficient low-GWP technologies into future cold chain systems³. ICAP 2019 suggests that an energy-efficient cold chain could result in 30% energy savings and an 11% reduction in refrigerant demand. This is particularly important for energy-strapped rural areas and contributes significantly to climate change mitigation efforts.

Cold Chain Infrastructure Gaps in India



Source: ICAP



Figure 3: Produce Sorting & Grading at Sahaja Collection Centre

The Problem: SSOPCL faced PoS Rejects for its Leafy Green Vegetables.

Founded in 2010 in Bengaluru, SSOPCL handles the whole supply chain of organic agriculture produce from farms to retailers. They work with a network across Karnataka. Right now, they have 22 Farmer Interest Groups (FIGs) with 10204 farmers who own shares in the company. Together, these farmers have put in INR 54 lakhs as their share capital. About 8-10 of these FIGs consistently supply their produce to SSOPCL.

SSOPCL purchases Grade A produce at its Collection Centre (CC), situated in Mayasandra, Bengaluru, offering prices that are 20% higher compared to HOPCOMS. From CC, the produce is collected and transported to Sahaja Distribution Centre (DC) in Bengaluru on the same day. Furthermore, SSOPCL operates a retail outlet under its ownership and supplies produce to an additional 600 retail outlets across India, serving both B2B customers and the general public. SSOPCL was facing problems with the retailers rejecting their leafy green vegetables due to quality issues, particularly lack of freshness, in spite of being sold within 24-48 hours of harvesting. SSOPCL needed a solution to retain the freshness of leafy green vegetables from the time of harvest to the sale in retail stores, typically 24-48 hours.

³India Cooling Action Plan 2019

The Solution: A Passive Cooling Solution for Short-Term Storage

The Subjee-Cooler, a passive cooling solution from RuKart, uses evaporative cooling to reduce the temperature of the produce and retain a high humidity level within the storage space. Evaporative cooling phenomena function by pulling warm air through water-saturated pads. As the warm air traverses these pads, the water within them absorbs the heat, undergoes evaporation, and subsequently releases cooler air into the surrounding area. This results in a notable reduction in respiration rates, mitigates water loss and minimizes spoilage across a range of vegetables by retaining freshness for 2-3 days. A 100 kg capacity Subjee-Cooler uses 15 litres of water on a daily basis



Figure 4: Subjee-Cooler Deployed in SSOPCL, Bengaluru

Results

Five Subjee-Coolers were installed in March 2023 at the Sahaja DC. The performance of the Subjee-Cooler and the savings achieved have been analyzed for a period of six months. Prior to installing the Subjee-Cooler, the sales reject of leafy green vegetables was up to 5%. However, after installing the Subjee-Coolers, SSOPCL could retain the freshness of leafy green vegetables, which resulted in reduced rejection at the point of sale. The monetary losses for leafy green vegetables over the monitoring period have come down from Rs 51000 to Rs 7000/-. Figure 5 depicts the sales quantity of leafy green vegetables and the percentage of sales rejected at the point of sale from April to October for the years 2022 and 2023. The point of sales reject percentage came down by half, and in the warm months of April and May by more than half. In addition to the economic benefits, the reduction has yielded environmental benefits. Horticulture produce decomposes and releases methane, a greenhouse gas that is 80 times more potent than carbon dioxide. By reducing the amount of produce that is wasted, the Subjee-Coolers can help to mitigate climate change. For the period April-October, the food loss avoided due to sales rejection has resulted in an estimated GHG savings of 414 kg CO₂-eq.

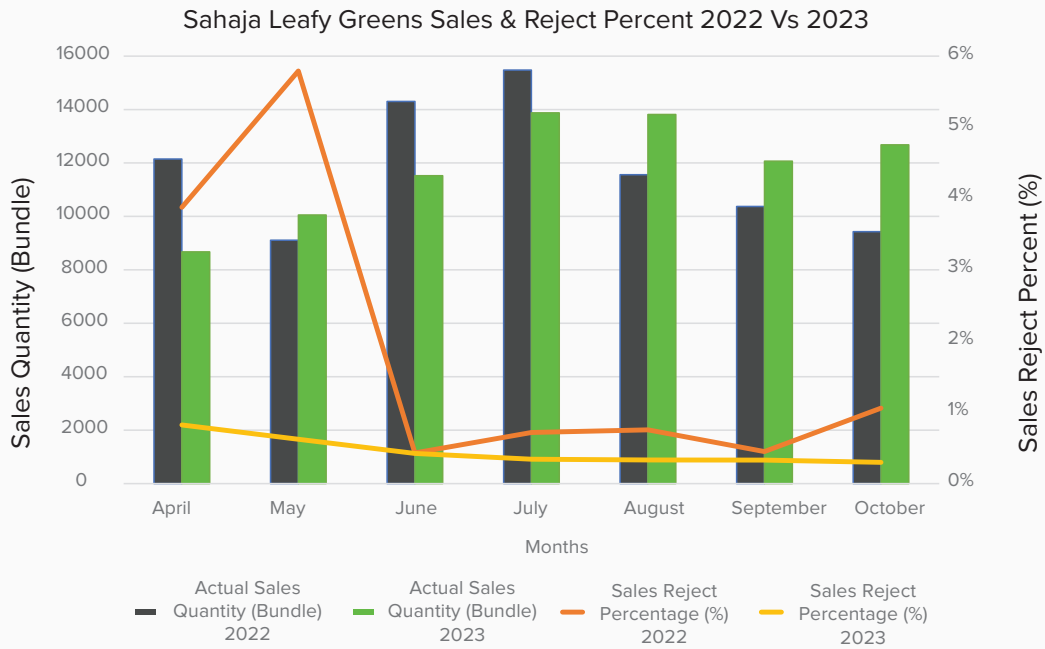


Figure 5: Sales Quantity and Sale Reject Percentage for Leafy Green Vegetables

The Subjee-Cooler was able to maintain a high humidity level inside, with readings ranging from 90% to 100%, while the ambient humidity was lower, between 60% and 80%. The temperature inside the Subjee Cooler was 5-6 degrees Celsius lower than the outside ambient temperature. Further, the Sahaja team confirmed that the produce kept in the Subjee Cooler for 2-3 days remained fresh and marketable.

In Figure 6, a comparison is presented between the ambient and the inside temperature over a span of four months, from June to September 2023. The graph indicates that the temperature inside Subjee-Cooler consistently remains 5-6 degrees lower than the ambient temperature.

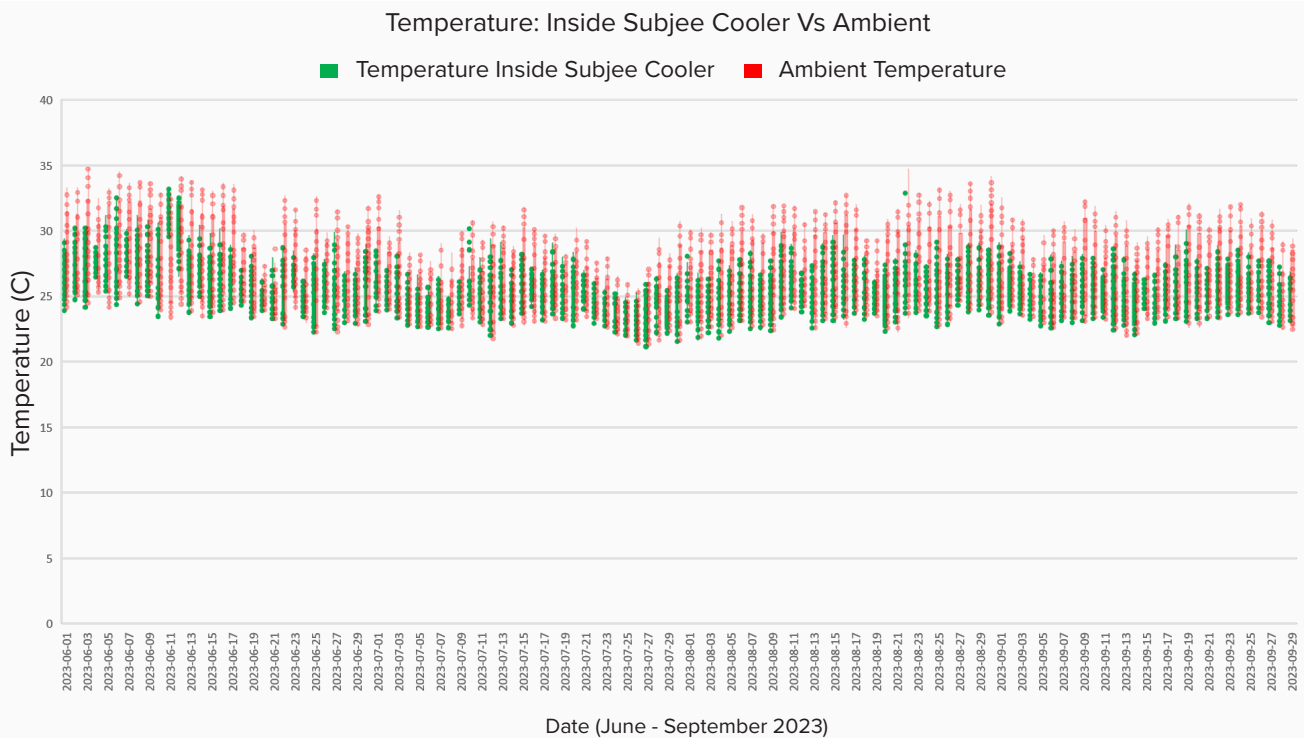


Figure 6: Ambient Vs Subjee Cooler Temperature (June to September 2023)

Figure 7 illustrates a comparison between the ambient humidity and the humidity inside the Subjee Cooler from June to September 2023. The graph demonstrates that the humidity within the Subjee Cooler consistently maintains a range of 90-100%, while the ambient humidity remains around 60-80%.

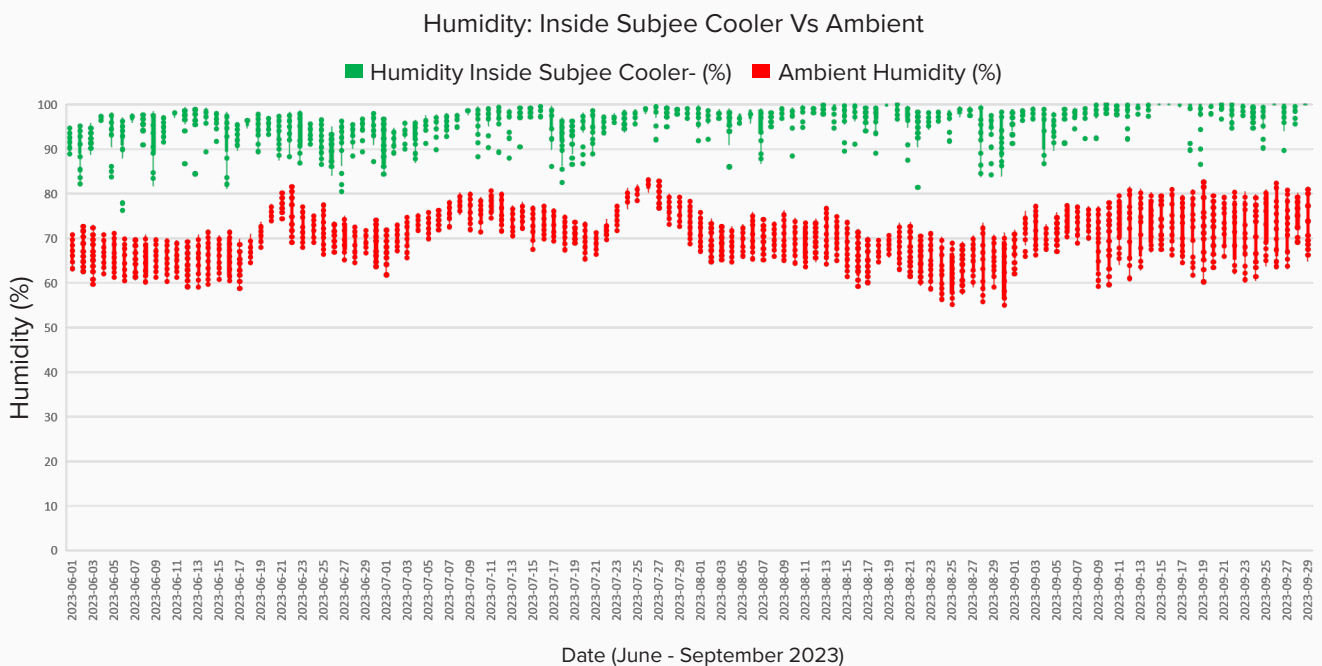


Figure7: Ambient Vs Subjee Cooler Humidity (June to September 2023)

Lessons Learned, Recommendations, and Best Practices

Overall, the Subjee-Cooler is an effective, sufficient and efficient cooling solution for short-term storage (2-3 days) of horticulture produce. The implemented solution was put into operation in Bengaluru, Karnataka, where the average temperature typically ranges between 25-37 degrees Celsius throughout the year. It can be effective in other regions too, particularly those characterized by hot and dry climates or seasons. The Subjee-Cooler operates with just 15 liters of water a day and requires no electricity, making it an affordable, environmentally friendly cooling solution for short-term storage of horticulture produce.

“ Testimonial from Mr. Somesh B, CEO of Sahaja Samrudha Organic Producer Company:

The deployed solution has proven to be a game-changer for our business. The freshness of leafy green vegetables stored in Subjee-Cooler has been exceptional and instrumental in our ability to consider business expansion confidently. The ease of operating and maintaining this solution is remarkable; it only requires 15 litres of water daily and comes with zero maintenance costs. Affordability was a key factor for us, and this solution has met our expectations with minimal OPEX and a reasonable CAPEX of Rs 50,000 for 100 KG capacity storage. We are highly satisfied with the overall performance and cost-effectiveness of this solution



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