Postharvest handling of horticulture produce in the developing world

Vijay Yadav Tokala

Member, Board of Directors
The Postharvest Education Foundation, La Pine, Oregon 97739, USA
The Postharvest Education Foundation

What we do...

- Train young professionals through postharvest e-learning programs.
- Free postharvest training materials and long-term mentoring.
- Trained more than 175 postharvest specialists from 34 different countries.
- Provide access to postharvest tools and basic equipment.
- Postharvest workshops – train the trainers.
- Advice and guidance for establishing local Postharvest Training and Service Centers (PTSC).
2nd All Africa Postharvest Congress and Exhibition

- Six different themes covering all the aspects of postharvest loss reduction.
  - Essential roles of public sectors and the importance of their partnerships with private organizations.
  - Financial models for the success of the projects.
  - Scientific technologies and different approaches for capacity building.
  - Role of youth and women in achieving UN-SDGs
Presentation on postharvest capacity building for the developing world

PEF e-learning graduates at African Union Commission Seal

African Union Commission, Addis Ababa, Ethiopia
2nd All Africa Postharvest Congress and Exhibition

*Key take-away points*

- Increase **public-private partnerships** and **sustainable agri-development projects**.
- The **new technologies suiting the small-scale farmers** will have wide adoption - Storage and Agro-processing technologies.
- Encouraging **group approach** would increase the chances of successful implementation of any technology.
- **Capacity-building programs**.
Postharvest losses – Global scenario

- Postharvest food losses - negative impacts on the world economy, environment and sociological factors.
- Money and natural resources invested go waste.
- More than 815 million – 1 in 9 on the planet is chronically hungry and malnourished.

- Two-thirds of total food losses are postharvest losses, occur at beginning of the food chain even before reaching consumers.
- Reducing postharvest losses – sustainable way to ensure global food and nutritional security.
Postharvest losses – India

- **India** – 2nd largest producer of horticulture crops.
- Postharvest losses estimated **INR 926 billion (US$ 14.33 billion)** (ACCI, 2016)
- The loss is estimated to be **3 times of national budget** allotted for Agriculture sector.
- About **16 % of fruit and vegetables** (US$ 6 billion) lost between 2012 to 2014 (CIPHET).
- **Global Hunger Index 2018** – Rank 103 among 120 countries (von Grebmer et al., 2018).
- Reducing the losses can **generate significant economy and reduce food insecurity**.
Causes of Postharvest losses
Causes of Postharvest losses

Farmer level:
- Improper harvest & handling
- Poor grading and packing

Infrastructure:
- Availability of technology
- Improper storage/ cold chain

Market:
- Market delays
- Improper transport

Environmental conditions
Pests/ Diseases

❑ The losses are across the postharvest value chain and hence measures to reduce the postharvest losses should also start from farm till it is consumed.
Reducing postharvest losses

At farm

- Harvesting at right **maturity indices**.
- Using **proper tools** (clean and sharp knives, picking bags).
- Gentle handling.
- Using **shade** to protect the harvested produce.
- **Pre-cooling** the produce before storage.
Reducing postharvest losses

- Harvesting at right maturity indices
- Picking bags
- Gentle handling and grading
- Proper packing
- Shadennet cover
Reducing postharvest losses

Infrastructure

- Reefer vans (refrigerated transport)
- Cold storage.
- Agro-processing – Solar driers, Juicers etc.
Reducing postharvest losses

- Reefer vans
- Solar drier
- Cool rooms
- Agro-processing (Sun-dried vegetables)
Cold Chain for Horticulture Produce

- Cold chain is essential at different steps of supply – Precooling, packing, processing, transport, storage, distribution as well as marketing.

- $Q_{10}$ temperature coefficient – Degradation enzyme activity doubles with 10 °C.

- Unlike meat fruit and vegetables have a specific safe storage temperature range.

- Mango $\sim<9-12^\circ$C; Sweet Orange $\sim <2-5^\circ$C
Cold Chain for Horticulture Produce

- Cold chain only extends **holding life**, but produce ultimately deteriorates.
- The extended holding life should be efficiently used to **improve shelf life or marketing chances**.
- Further extension of holding time – **needs expensive technologies** to offset perishability – not economically feasible in small-scale agriculture.
- Proper cold chain management at every possible step of supply chain is **easy and comparatively economical option**.
Cold Chain Management begins on the Farm

Pre-cooling

- To reduce field-heat (respiration and moisture loss) before transferring into storage.
- Essential in products with high respiration rates – leafy greens, peas, berries.
- Types – Hydrocooling, Vacuum cooling, Forced Air cooling, Hydro air cooling, Contact icing
Pre-cooling – Status in India

- Most neglected practice and rarely practised.
- **Reasons** – lack of awareness, use of poor quality packages/containers and sometimes water scarcity.
- **Scope**: Create awareness about the importance and different ways to precool.
Cold Chain Management

Transport

- Temperature management is critical factor for long distance transport.
- Load stacking – different patterns to ensure maximum air circulation.
- Losses are mainly by physical and mechanical injuries or uncontrolled temperature and humidity.
- Road – short distance.
- Rail or air – long distance.
Transportation – Status in India

- Still in **precarious stage** – horticulture produce.
- ~9000 reefer vehicles out of 62,000 requirement (~85 % gap) (NCCD, 2015).

**Reasons** –
- Mostly used to transport meat/fish.
- Lack of proper roads.
- Rail and Air transport – expensive.
Transportation – Status in India

- **Support:** Government of India (GoI) through MIDH scheme provide 35% subsidy (credit-linked back-ended) on Refrigerated vehicles (up to INR 30 Lakh (~US$ 42,000) – 9 to 15 MT capacity).

- **Scope:**
  - Huge scope for public-private partnerships to provide reefer vans/trucks/trains with proper specifications and ‘pay-to-cool’.
  - Reefer vans with different capacities and ability to change specifications easily.
Cold Chain Management

Cold Storage Options (at farm level, traders, markets)

- Keeping produce in low temperatures to improve ‘holding life’.
- In developing countries – it is considered as first step of building a cold chain.
- Different methods – based upon cooling requirement and expected length of storage.
  - Evaporative cooling – ZECC, Fan and pad system (desert cooler), Charcoal evaporative cooler
  - Mechanical – Ammonia/ Freon refrigerators, CoolBot equipped cold rooms
  - Solar powered – Ecozen solutions, Ecofrost, ColdHubs
Zero Energy Cooling Chamber (ZECC)

Solar-powered ‘ColdHubs’ unit (Nigeria)

Charcoal cooler (Kenya)
Cold storage – Status in India

- GoI in coordination with organisations such as MIDH, ICAR, APEDA, and allied ministries and departments provided financial support since 1999.
- 135 million cubic metres capacity – largest temperature controlled space.
- **Support:**
  - **✓ MIDH** – Credit linked back-ended **35-50% subsidy** (5000-10000 MT = INR 8000-10000 (US$120-140)/MT).
  - **✓** Assistance will be available to individuals, Farmer groups/ Public-private partnership, SHGs, Farmers Producer Organization (FPOs), Companies, Corporations, Agricultural Produce Market Committees (APMC).
Cold storage – Status in India

- **Limitations:**
  - ✓ **Electricity** supply.
  - ✓ Lack of awareness on right cooling procedures – mixed loads, too cold temperatures, produce-specific requirements.

- **Scope:**
  - ✓ Third-party logistic services construct multi-chambered cold storage and offer pay-to-cool.
  - ✓ More scope with small-capacity storage units that can store fruits separately from vegetables.
Cold storage/Ripening room

Multi-storied Cold storage

Mixed loads in cold rooms (Bakery foods, Dried chillies, Tamarind)
Cold Chain Management

Cooling at Retail

- **Last link** of cold-chain and **often neglected**.
- Limited to carbonated beverages, ice creams or expensive products.
- Range of temperature-control measures at retail – **fundamental methods** like spraying water to refrigerated displays.
- Mostly refrigeration done **for high value**, but not by understanding requirements of specific produce.
Retails display at ambient (using water and jute bags for cooling)

Refrigerated retail display in racks
Cooling at Retail – Status in India

- Mostly displayed at **ambient conditions**.
- **Moist jute bags** / **water sprays** are most common method at retail.
- Recent increase in **retail sale of fruit and vegetables in supermarkets** – refrigerated displays.

**Scope:**

- Training retailers/staff about appropriate temperature choice, packing as well as food safety issues.
Clean Cold Chain

- Present day – mostly **mechanical refrigeration systems**.
- Stationary system – **Electricity**.
- Mobile system – **Diesel or other fuels**.
- “Today’s solution shouldn’t be tomorrow’s problem”
- Cooling – emits **GHGs = shipping and aviation combined**.
Clean Cold Chain

- **Alternate technologies:**
  - Solar-powered storage facilities – CoolHubs, Ecozen
  - Off-grid fridges with **Phase change materials (PCMs)** – Birmingham scientists and China Railway Rolling Stock Cooperation Limited (CRRC).
  - **Liquid Air technology** – Dearman engines, UK.
Phase Change Materials (PCM)

Solar-powered ‘ColdHubs’ unit (Nigeria)

Dearman engine model [Image source: Univ of Birmingham]
Conclusions

- Cold chain management enhances **farmer income** as well as **ensures food security**.
- Concept of cold chain is more than just cold storage but **starts from farm and continues until the produce is consumed**.
- Success of cold chain management is depends on **how the extended holding time is efficiently used** to improve shelf life, maintain quality or marketing options.
- As more investments are made in this sector, there is a need for wide adoption of sustainable technologies and **clean cold chain development**.