COMMON MISTAKES IN COLD CHAIN (INDIA)- VER.3

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Introduction

The refrigeration expert or refrigeration supplier is mistakenly identified as the Cold Chain expert! This has been the common error when identifying expertise to establish a viable and optimal cold chain. One should be aware that refrigeration is only (albeit an important) component of the complete cold chain.

A cold-chain expert is one who applies refrigeration as a technology to facilitate preservation and care of perishables in the closed cold chain loop, one who understands that the viability depends on efficient energy use, optimal choice of the care to be applied, efficient mode of transfer of products from farm to consumer, appropriate & selective choice of equipment and application and one who understands the complete process that is the back bone of the entire cold chain.

The typical cold chain begins at farm gate level (production centre); terrain-farming, sea-farming, manufacturing factory.

The first stage of a cold chain is the 'receiving cold-room'. This loosely mentioned term (at farm gate level) is inclusive of a pre-cooling facility, subsequent compartmented short term storages (pending transport) and ancillary equipment.

The final stage is the consumer and they are linked to the farmer through cold-chain links; thermally controlled transport units, warehouse cold storage, direct access cold storage or a pull based supply system minimizing effects of last leg break of cold chain for just in time consumption.

The real recurring cost of the cold chain is that of controlling the risks and in avoidance of variations. The secondary cost is that of maintaining visibility and traceability all through the cold chain.

LARGE DISCONNECT EXISTS, INDIA-CENTRIC

DISCONNECTED FROM LOCAL RELEVANCE -

- Cold chain in India is currently the domain of business makers, the focus stays largely sale of equipment and machinery.
- The chosen systems are inherited from nations with differing ground realities, disconnected from India's agri-practises.
- The economic learnings on the cold chain from non-Indian foreign sources focused on large volume yields... leading to injudicious choices of equipment & machinery.
- No Flexible designs of cold chain infrastructure to allow full utility given diverse produce cachement and flexible work force. The focus remains on large rigid designs as marketed by companies.

- The operational and handling practises for perishable produce does not factor in the fragmented yield lots that will be handled in Indian cold chain establishments at the farm gate stage.

DISCONNECTED FROM UTILITY-

- Various initiatives taken in participation with foreign organisations and business participants – focussed on academic or on material vestments.
- Seminars by academic luminaries not equivalent to training and awareness programs at grass root level.
- Seminars attended by senior management and leadership level from industry. No pass through to operator level.
- Cold Chain and its linkages function efficiently only when the trained operators exist. No focus (as no integrated cold-chain cadre) in current training curriculum to create such an operator base.

DISCONNECTED FROM INDIA'S RICH & DIVERSE HUMAN BACKDROP-

- The largest disconnect exists in ignoring the awareness and training gap. Untrained application of the cold chain creates greater losses.
- The viability gap and the seminars addressing it focus largely on the power factor. Untrained and inefficient utilisation adds to power wastage.
- Operating errors lead to shrinkage, wastage, damage and all these occur after energy application and thereby translate into gross energy losses.

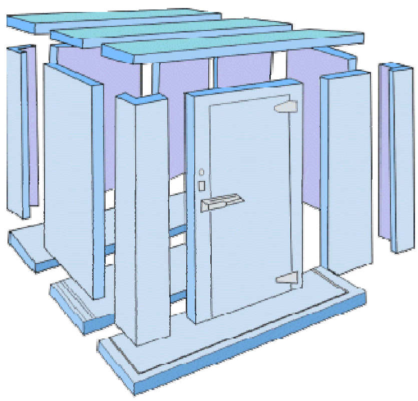
CROSSTREE DIRECTIONS FOR CREATING COLD ROOMS

The cold room or store is an enclosed chamber or box made of insulated walls, ceiling and floor and fitted with an insulated door. It is kept at a preset temperature by refrigeration machinery. Since it an energy intensive application, produce must be undergo selective criterion before subject to energy.

POINTS TO CONSIDER

THE SIZE OF THE CHAMBER

- Type of produce, Form of packaging.
- Cachement area and volume source.
- Location within the chain.
- Stowage factor and air flows.
- Produce biological profile and compatibility.
- Temperature differential and insulations.
- Contingency considerations and safety norms.



THE REFRIGERATION REQUIRED

- Produce type – horticulture or fisheries.
- Support infrastructure.
- Duration/shelf life extension desired.
- Air purging loads.
- Controllers and diagnostic tools.

Cross dock feasibility – if farm of consumer period is short, maintaining a cold profile for longer shelf life is unfruitful.

WHETHER FUNCTION TO ***MAINTAIN*** OR ***LOWER*** FOOD TEMPERATURE

- If cold room is to be used to maintain the food temperature, the design and equipment selection is different.
- If the cold room is to be used to initially lower the food temperature, specialised equipment and design is required to 'pre-cool' before storing.

THE THERMAL PROFILE OF SURROUNDINGS

- Temperature variations of location.
- Solar/UV radiation in region.
- Average cloud cover in region.
- Weather and wind patterns in area.
- The thermal profile of local produce.

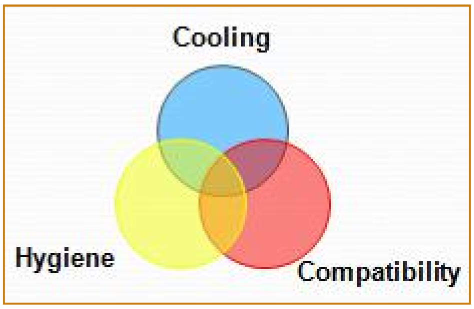
MOST COMMON MISTAKES

Cold spaces are intended for term storage of produce yet to be sold. They are an important aspect in bringing revenue to those who harvest the produce. Cold rooms cannot be simply overgrown refrigerators.

The most erroneous installations are those dealing with living perishable produce – vegetables. Care of post-mortem (fish, meat) food items is relatively simpler.

- KEEP THEM BREATHING-
  - Very little or no consideration is given to the fact that fresh vegetable are living and continue to undergo life processes when stored.
  - They create CO^2 and other gases which require purging. In many long term stores, vegetables die (wilt, rot, decompose) because no air purging system is installed.
- KEEP THEM FRESH-
  - Water is freshness and freshness sells. Moisture loss is one of the main causes of deterioration that reduces the quality & marketability.
  - Refrigeration inherently dries the air. Special techniques must be employed to maintain humidity levels in a store – both vegetables and meats/fish.

- o Most designs tend to add moisture after desiccation has occurred. The primary idea is to replenish moisture before the cool dry air touches the sensitive produce.



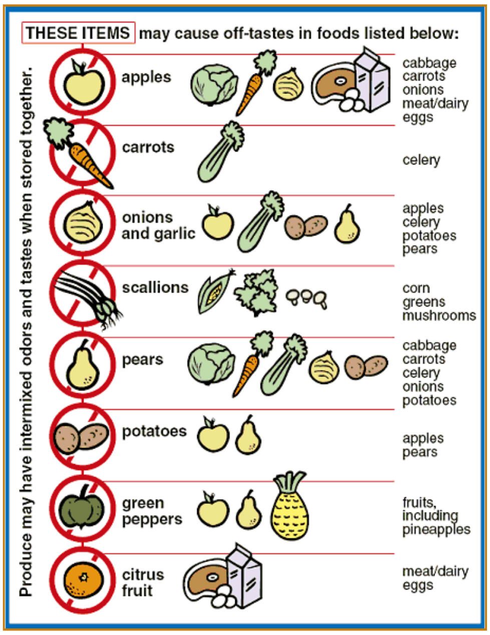
- PRE-COOL TO STORE-
  - o All produce must be pre-cooled to desired storage temperature before moving into cold storage.
  - o A freshly harvested fruit, vegetable, fish or meat has high inherent temperature. Most cold rooms are designed to maintain a particular temperature profile and fresh load can cause entire existing store to rot.

On many occasions it is seen that pre-cooling is ignored, little realising that without this primary process, the entire cold-chain is at risk.

- COMMON IS NOT GOOD-

  Products stored in common spaces must be compatible for shared storing temperatures, moisture levels (RH), volatility (ethylene), odour (tainting), etc.

  - o Everyone knows that you cannot store fish with meat or fish with vegetables because of odour contamination.
  - o Few realise that vegetables are also individual species and cross-contamination is harmful.
  - o Besides smells and gases, the temperature profiles of vegetables also require compartmented rooms.
  - o Rooms must be segregated to suit temperature and oxygen profiles.



- BIG IS NOT BEST-
  - o Most refrigeration experts will install large rooms at farm-gate level, hoping to economise on machinery.
  - o India's harvesters – both farmers and fishing folk – have fragmented holdings and yields are in the range of ~100 kg per acre of holding per day.

- CONTROL THE AIR FLOW-
  - o Cold rooms should be designed such that the cooling medium (air) flows around each packaged produce.
  - o Air that bypasses the produce does little cooling. Design should be to avoid short cycling of air to aid efficiency and keep produce safe.
  - o In any system the air takes the path of least resistance and large gaps must be avoided or allow too much cool air bypasses. For maximum efficiency only that air which comes in contact on the sides of boxes should be permitted to pass. This design is more critical to pre-coolers.

Plan well, understand the utility and do not depend solely on refrigeration equipment sellers to make the best sense of your infrastructure.

OTHER MATTERS

These items apply diversely to different utilities, types and designs of cold rooms.

Moisture vapour barrier – placed on the **outside** of all surfaces including the underfloor with all joints lapped and sealed. Any damage **must** be repaired

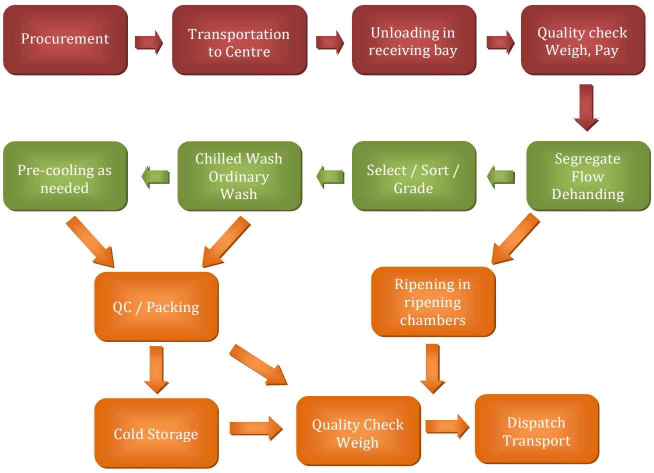
Underfloor heating is commonly used to prevent freezing of the foundations; usually this is by means of low voltage electricity or a recirculating fluid in pipe work. This **must** be maintained if major damage is to be prevented

Low volt heating around the door seal above & below floor level, typically at 2 - 5° C, prevent ice forming which would otherwise interfere with door opening.

An **emergency exit** from within the chamber to allow a safe escape route for persons trapped inside.

Internal lighting – consider low temperature grade fluorescent lights.

Design the layout keeping in mind produce flow, segregations and HACCP compliance.



Typical Flow of Produce in a PackHouse

Careful stock rotation and safe stacking are vital within the cold store. ***first in, first out*** is the best practice for food product storage.

Walls and General **internal finish**: All internal walls to be smooth faced in production areas to allow for thorough cleaning. Where budget permits, glazed tiling on the walls to a level of some 4 feet is preferred. Selected areas should be ceramic tiled (for example behind sinks or where machinery will cause considerable product splashing).

Energy Saving designs: keep natural inclination of sun in mind when designing placement of plant and machinery. Air purge systems will tend to waste cool internal air – these should be planned for and energy recovery options applied.

Water Treatment: Only treated (hygienic and sanitized) water to be used for washing of produce. Keep in mind that contaminated water adds external pathogens that create major risk to long term storage of produce.

In regard to the refrigerating machinery, if the cold store is to cool the incoming food, what is the maximum temperature, weight and type of food being entered in a given period, e.g. an eight-hour period? Additional refrigeration capacity may be required to cater for the extra load.

Crosstree is a group of industry professionals involved in bringing Cold Chain technology, based out of Gurgaon, Haryana. Crosstree comprises experts who apply refrigeration as a technology to preserve perishables, while creating the rest of the cold chain process, viz, efficient mode of transport from farm to consumer, selection of equipment for multi tasking / multiplexing (or building the refrigeration system for smaller storage installations), the system to handle single or every type of commodity that may be used, power management in remote areas to sustain the system, creation of backup systems using zero electric power (during transport) to sustain perishables) right up to the point of delivery.

Crosstree are complete application professionals adept at management / operational training of the entire perishables handling sequence,

- from handling lags at the farm gate level (from soil/sea/manufacturing centres)
- design, selection and erection of precooling centres.
- design, selection, supply of base end cooling centres with compartmentalised and categorised cooling rates built for the sole purpose of preserving, not using standard equipment, but tailor made for the product (quite often with saving with capital costs and power consumption)
- system design and commissioning of thermocontrolled transport, warehouse cold storage, direct access storage / pull (Kanban) type supply chain

ALL focussed toward minimising breaks in the chain for Just-in-Time (JIT) consumption by end user.

SECTOR EXPERT

Name: Captain Pawanexh Kohli

Experience:

Pawanexh Kohli has seasoned in cold chain management, with over 27 years of global professional experience. Of these, 15 years of hands on post-harvest expertise and international exposure in Dole Food Co. [USA], the world's largest in fresh produce.

Capt. Pawanexh Kohli had an initial 25 years work experience in cross-continental specialised transportation of various products and cargos. Since 1993, for 14 years, he was appointed the Chief Executive as captain of refrigerated ships; he was also entrusted for 4 years one of the world's largest with capacity of 15,000 MT, cycle time of one to four weeks. His exposure was with state-of-art facilities where cold chain was implemented for transportation of produce from tropical zones (Africa, South and Central America, Philippines) to temperate and cooler climes (North and South Europe, North America, Japan).

In 2007, he was exposed to India's non-existent cold chain on taking assignment with Acme Cold Chain Solutions as Operations Head for a Pan India venture. Capt. Kohli brought about various design and process changes to make the in-house cold chain apparatus more cost effective, practical and at par with quality initiatives. He subsequently was asked to head (Assoc. Vice President) three of the four business verticals and was integral to technology and product development initiatives.

As independent consultant, he provides mature, in-depth business direction to Clients.

Selected Highlights

2009 — **Asian Development Bank – ILF&S.**: Specialist Advisor (Cold Chain, Logistics & Infrastructure)– Agri Infrastructure Development Investment Programme of Asian Development Bank.

Develop 4 value chains (comprising 55 facilities each), including facility design, linkages to railheads and airports. Identify PPP participants and new technologies.

2009 — **Laxman Logisitcs Pvt Ltd.**: Technical Advisor Logistics Solution.

Innovate; develop customized transport mechanism basis specialized requirement of company client – utilizing a low carbon footprint temperature maintenance system.

2008-09 — **Intnl Fresh Farm Produce India Ltd.**: Cold Chain Advisor & Project Technical Consultant – complete integrated Cold-Chain, packhouse and Distribution centre.

Verify technical feasibility, Identification and selection equipment for selected produce range, Facility Layout and design basis required product and work flow, Provide thermal management and energy saving inputs during design phase.

2008-09 — **Calypso Foods Ltd.**: Cold Chain Advisor & Project Technical Consultant – PPP venture with state govt. for complete backward and forward linkage from farmers to the consumers through a Post Harvest management and Auction house.

Evaluate DPR for design feasibility for selected basket of fruits and vegetables, Categorise infrastructure requirements, Create and compile parameters for post harvest care of identified produce, Create quality check processes to conduct operational audits.

2008 **Thermal Transport Unit**: Market study on refrigerated transportation in India and develop an innovative design for Acme Cold Chain Solutions.

Directed first ever market research on refrigerated movement in India, Developed portable reusable transport units for perishables utilizing Passive cooling media and created operating guides and protocols for transport of various cargos.

2007-08 **Thermally enabled Vending Cart**: Develop a thermally managed mobile vending platform for use by India's street hawkers. Thermal control by innovative use of thermal storage – for Acme Telepower Pvt Ltd.

Categorised requirements of planned utility, developed design in interaction with street hawkers, NID and other design houses. Interacted with CSIR and CMERI on design enhancements. Coordinated with state govts, MoHUPA and departments for subsequent successful launch of product.

2007-08 **Village Collection Centres & City Consolidation Centres**: design layout and plan for farm gate collection and front end distribution centres for Acme Cold Chain Solutions.

Member steering committee and Headed project development. Created SOPs and evaluated locations and roll out.

2006-2004
1998-1994 **Refurbishment/Upgradation/repairs**: plan for, detail & Directed the complete projects in compliance with international regulations in Curacao, Korea, Germany, Italy – DFFI.

Overhaul and refurbishment of insulation and refrigeration systems of assets values of upto USD 45 million. Enhance/upgrade cold storage spaces inclusive of environmental and safety systems. Verify and calibrate monitoring and control systems in abidance to USDA and other international norms.

1996-2001-05 **Author documents**: evaluate IMO and international regulations and create operational guidelines and documents for compliance on ocean transports – DFFI.

Authored cargo securing manual for refrigerated transports, environmental protection management manual from ballast waters, guidelines for prevention of air pollution from refrigerated ships include handling of ozone depleting refrigerants, Safety management manuals as per ISM guidelines, Security and risk mitigation as per ISPS norms.

1998-1999 **Controlled Atmosphere Installations**: retrofit of control atmosphere plants with flexible design to serve permanent spaces and mobile containers.

Directed complete installations and implemented safety guidelines & equipment, including nitrogen analysers, Pressure Vacum valves, purging systems. Trained and created check lists/guidelines/SOPs for operating staff. Obtained clearances from European and American authorities' basis stringent international norms.

Post Harvest Cooling – (Living Produce)

Proper postharvest cooling will:

- Suppress respiratory activity and enzymatic degradation (softening).
- Slow or inhibit water loss (wilting).
- Slow or inhibit the growth of decay-producing microorganisms (molds and bacteria).
- Reduce the production of ethylene or minimize the commodity's reaction to ethylene.

  In addition to protecting quality, postharvest cooling enhances marketing flexibility by making it possible to market fruits, vegetables, and flowers at more optimum times.

Field heat removal method choices depend on several factors, including:

- Temperature of commodity when harvested.
- Nature of the commodity(ies); type of product (e.g., leafy greens, flowers, fruit) respiration rate(s), cooling requirements, lowest safe temperature, tolerance of exposure to water. (Typically, with the exception of onions, garlic, zucchini, summer squash, hard squash, most fresh fruit and basil, all other crops can be washed by either spraying with water or dunking to remove soil and/or reduce "field heat").
- Product packaging requirements; Box, bin, or bag; because packaging materials and design configurations affect method and rate of cooling.
- Product flow capacity; Volume of commodities which must be handled per unit of time will determine the appropriateness of cooling methods and systems.
- Mix of commodities; Compatibility depends on their nature with regard to sensitivity to odors and volatiles, such as ethylene.

Common Cooling Systems

- Room cooling: Produce is placed in an insulated room equipped with refrigeration units. This method can be used with most commodities, but is slow compared with other options. A room used only to store previously cooled produce requires a relatively small refrigeration unit.

  However, if it is used to cool produce, a larger unit is needed. Containers should be stacked so that cold air can move around them, and constructed so that it can move through them.
- Forced-air cooling: Fans are used in conjunction with a cooling room to pull cool air through packages of produce. Although the cooling rate depends on the air temperature and the rate of air flow, this method is usually 75–90 percent faster than room cooling.

  Fans should be equipped with a thermostat that automatically shuts them off as soon as the desired product temperature is reached. To avoid over-cooling and dehydration of produce, do not operate forced-air fans after the produce has been cooled to its optimum temperature.
- Hydro-cooling: Dumping produce into cold water, or running cold water over produce, is an efficient way to remove heat, and can serve as a

means of cleaning at the same time. In addition, hydro-cooling reduces water loss and wilting. Use of a disinfectant in the water is recommended to reduce the spread of diseases.

Hydro-cooling is not appropriate for berries, potatoes to be stored, sweet potatoes, bulb onions, garlic, or other commodities that cannot tolerate wetting.

Water removes heat about five times faster than air, but is less energy-efficient. Well water is a good option, as it usually comes out of the ground with temperatures in the 10-15º C range. If hydro-cooling water is recirculated, it should be chlorinated to minimize disease problems.

- **Icing**: Icing is particularly effective on dense products and palletized packages that are difficult to cool with forced air. In top icing, crushed ice is added to the container over the top of the produce by hand or machine. In case of liquid icing, a slurry of water and ice is injected into packaged produce through vents or handholds.

  Icing methods work well with high-respiration commodities such as sweet corn and broccoli. One Kg of ice will cool about three Kgs of produce from 30º C to 4º C.

- **Vacuum cooling**: Produce is enclosed in a chamber in which a vacuum is created. As the vacuum pressure increases, water within the plant evaporates and removes heat from the tissues. This system works best for leafy crops, such as lettuce, which have a high surface-to-volume ratio. To reduce water loss, water is sometimes sprayed on the produce prior to placing it in the chamber.

  This process is called hydrovac cooling. This is the most cost-effective and rapid method of cooling. The primary drawback to this is the cost of the vacuum chamber system.

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ANNEXURE-II

Pre Cooling Choices – (Living Produce)

Method	Commodities	Comments
Hydrocooling	Most leafy vegetables, fruits and fruit-type vegetables, sweet corn, snap beans	Very fast cooling; uniform cooling in bulk if properly used, but may vary extensively in packed shipping containers; daily cleaning and sanitation measures essential; product must tolerate wetting; need water-tolerant shipping containers
Forced-air cooling	Most fruits, berries, fruit-type vegetables, tubers, and vegetables not susceptible to chilling injury	Much faster than room cooling; cooling rates very uniform if properly used. Container venting and stacking requirements are critical to effective cooling. Economical and efficient.
Package-icing	Most vegetables	Fast cooling; limited to commodities that can tolerate water-ice contact; water-tolerant shipping containers are essential. Economical and efficient.
Vacuum cooling	Leafy vegetables, iceberg lettuce	Commodities must have a favourable surface-to-mass ratio for effective cooling. Causes about 1% weight loss for each 6°C cooled. Adding water during cooling prevents this weight loss, but equipment is more expensive, and water-tolerant shipping containers are needed.
Room cooling	All commodities	Too slow for many perishable commodities. Cooling rates vary extensively within loads, pallets, and containers.