

Cold Chain Scenario: Sunrise to Sunshine

By Arvind Surange, CMD, ACR Project Consultants

Introduction

Cold chain is an integral part of our lives. In fact, it is a lifeline for the modern human race. It covers the journey of food and pharma products from the point of production to the point of consumption. The article deals with the gamut of cold chain current trends in technology, various refrigeration systems options, renewable energy application, and sustainable features.

Many industrial sectors have shown upward growth in the country in the last few decades but among them, cold chain has made an impressive mark in terms of expansion of its various components, marketing, logistics and exports.

Beginning of Cold Chain Era

The term cold chain and its needs were understood and realized in the 70s in the past century. Till then, bulk cold stores were considered as the only mode of preservation, mainly for potatoes.

It was in the decade of 1980-1990 that the importance of the cold chain was appreciated and the need to develop cold chain facilities for perishable foods was realized by the government and the agro-industrial sectors.

Looking at the vast growth potential, the cold chain sector was recognized as the 'Sunrise Sector' in India. The gamut of cold chain covered a variety of perishable foods and pharma products, vaccines, etc.

About the Author

Arvind Surange, Fellow ASHRAE & CMD of ACR Project Consultants Pvt. Ltd, is the Senior-most Project Consultant in Cold Chain and allied fields in India. Associated with ACR & Cold Chain for the past 60 years, he introduced many technological innovations including the concept of Integrated Cold Chain project design and the first ever concept of 'Green Cold-Chain' on the global level. He is a Past National President of ISHRAE and Co-Chair of NCCD's Non-Conventional and Sustainable Cold Chain committee. He is the recipient of the ASHRAE- UNEP Sustainable Cold Chain Project Award 2023.

The old practice of constructing bulk cold stores for single a commodity was turned into the development of various components in the cold chain. In later years, these include:

- Multi-commodity cold stores for a variety of chilled foods and frozen food cold stores
- Multi-purpose cold stores for chilled and frozen foods combined
- Controlled atmosphere stores (CA Stores)
- Frozen food production complexes.

While this transformation happened, the need was also realized for additional facilities like:

- Packhouses for handling fresh fruits and vegetables produces in large numbers across the various regions of the country.
- Distribution centres designed to handle various types of foods for exports, and supplies to food chains, institutions, hotels, food malls, etc. This development started in the first decade of the current century.
- Ripening units for banana, mango, papaya, etc.
- Farm-level small cold stores for single or group of farmers/FPOs.
- Retail sector growth in cold chain and logistics services has led to the development of the food retail sector, and food malls in metros cities, two tier cities and on highways.
- In order to promote food production processing and storage, the government has been offering incentives for developing well-designed food parks in various regions. However, the number is still small and the component of cold chain is also not sizeable.

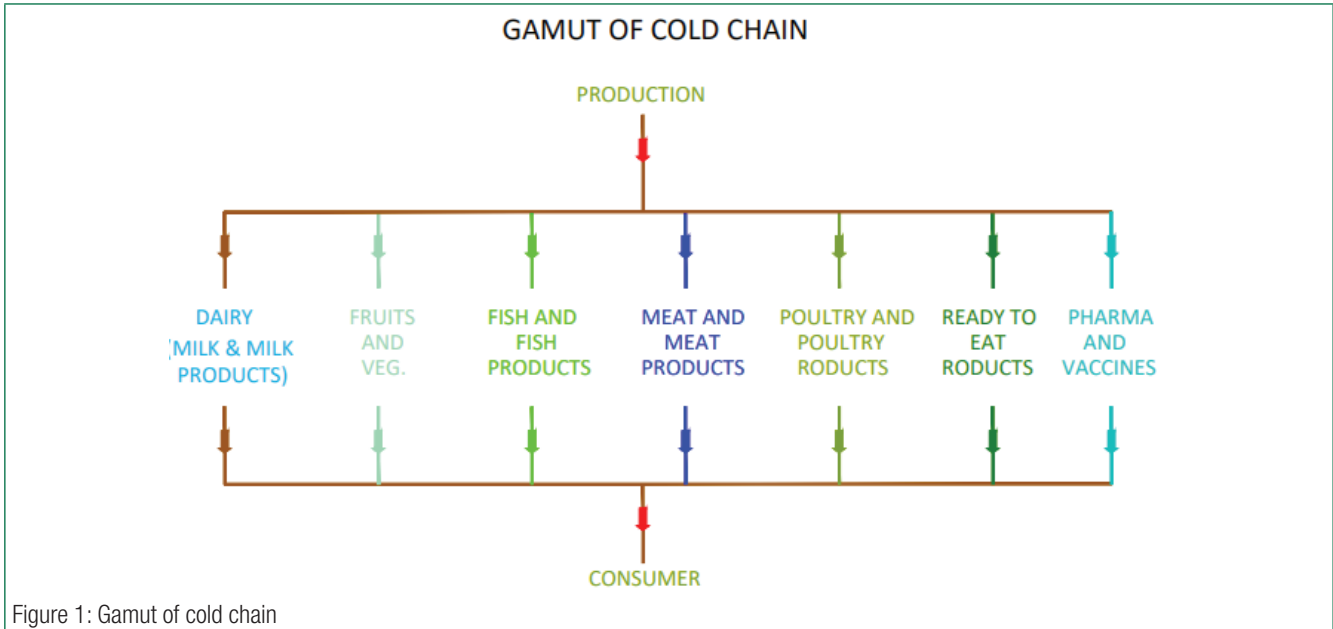


Figure 1: Gamut of cold chain

Pharma Sector

The recent COVID era has clearly emphasized the need for a sound and efficient pharma cold chain covering the production, storage and distribution of medicines and vaccines up to the remotest corners of the country.

Modernization of Old Cold Stores

Out of some 8,200 cold stores in the country, nearly 5,000 units are used for potato storage and are based on old and outdated technology. Upgradation of these units by taking the benefit of NHB’s scheme of modernization of thermal insulation and modernization of refrigeration needs to be actively promoted and could turn into a good business opportunity.

Prospect for Further Growth

Large number of packhouses designed to handle fresh fruits and vegetables are needed in various regions. Simple packhouses have been set up to handle sorting, cleaning, washing, drying, grading, and packing of fresh fruits and vegetables produce mainly for domestic consumption.

Integrated packhouses with mechanised lines for the above-mentioned functions with additional facilities for pre-cooling and staging cold stores are needed in big numbers. These are mainly designed for exports and institutional supplies.

Packhouses for exports need to have add-on facilities as per APEDA norms and have to be certified by APEDA. Many states in India have currently, taken up pack house projects for F and V produces.

Onion Cold Stores

Whereas multi-product cold stores have come up in

various regions, there is a need for large number of onion cold stores in view of the sizeable production and consumption of onions in the country. It must be mentioned that onions need proper pre-treatment before the cold storage and the stores have to be designed for lower temperatures (0°C to 1°C) and lower R-H (65-70%) with higher air circulation rates.

Palletized Stores

In the light of increasing number of international and national food chains, growing exports and import logistics, there is a growing need for palletised stores. As a result, different designs of racking systems with a variety of material handling equipment (MHEs) are being employed in the field.

Frozen Food Complexes

There has been a fairly rapid growth in the production and distribution of frozen food in various sections like dairy and milk products, processed fruits and vegetables, and ready-to-eat foods besides the poultry, meat, and fisheries sector.

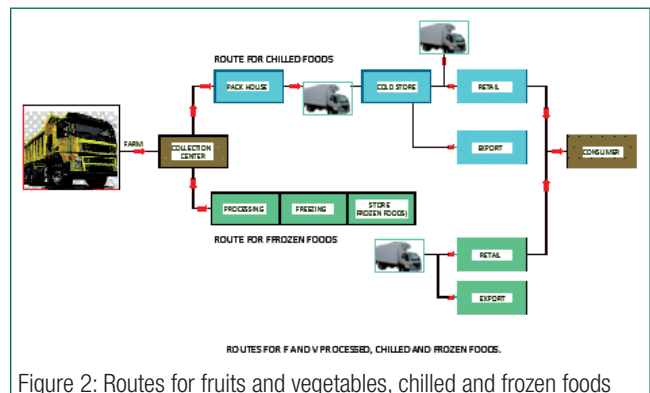


Figure 2: Routes for fruits and vegetables, chilled and frozen foods

Cold Chain Developments and New Emerging Applications

The term *Frozen is fresher than fresh* was also coined in the seminars and webinars in recent times. The frozen food industry involves proper pre-processing, processing, and packing of the products before freezing and storage. This has also helped the growth of the processing industry and the logistics services. It is expected that this industry will see fairly rapid growth.

Refrigeration Systems

Refrigeration works as the heart of the cold chain operation. Its role starts from pre-cooling, process cooling, chilling and freezing, storage, and covers reefer transport from process hall and cold dock cooling, etc. and reefer transport.

The present-day design engineer and owner have good options for selecting proper refrigeration equipment and systems based on the selected refrigerant. The refrigerant options include natural refrigerants like ammonia, carbon dioxide (CO₂), and hydrocarbons, which have zero or near zero global warming potential (GWP).

The other option is for hydrofluorocarbons (HFCs) (Phase down starting from 2028) hydrofluoroolefins (HFOs), mid-term and long-term substitutes with medium and low GWP. Important factors in the selection of refrigerant are:

- Eco-friendly character
- Energy efficiency
- Cost and availability
- Safety features
- Charge limits if any.

Refrigeration System Options

There are different types of refrigeration systems that can be chosen based on the type of application, size, location, energy supply, water supply, etc.

Apart from the standard systems in use in the current times, the latest options include:

- **Low charge ammonia DX systems** with an air-cooled condenser with inlet air adiabatic cooling, electronic expansion valves and required level of automation. These systems are also designed with rooftop models.
- **Li-Br absorption systems**, which can be used for application up to 0°C.
- Recently introduced adsorption systems for smaller capacity cold rooms working on the heat energy from agro wastes, biogas, etc are very innovative ones. These systems work with ammonia as refrigerant. It is heartening to note that this system has recently received the UNIDO-PFAN award for clean technology at Vienna.

Renewable Energy Application

As the drive for sustainable plants goes on and the country moves forward with decarbonization, more and

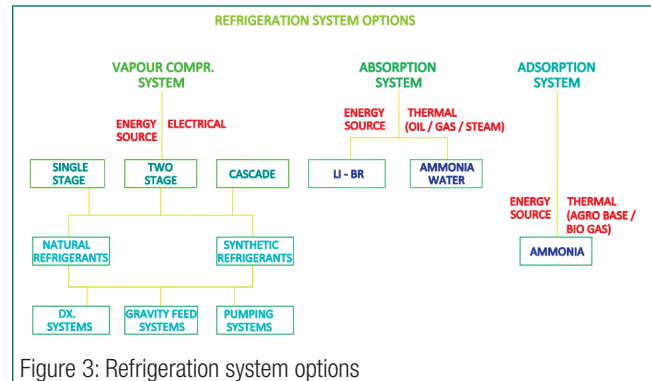


Figure 3: Refrigeration system options

more plants are opting for rooftop solar PV installation. This is a very welcome development and is a step towards net-zero energy projects in the near future. Thus, the cold chain as a sunrise sector is now geared up to use the sunshine as the most convenient energy source.

Sunrise to sunshine: A rooftop PV cell installation on a cold store

Please see the title image. It must be noted that solar PV system is the most convenient form of renewable energy where net metering facility is available and the users enjoy the reduction of 30% to 40% in their energy bills.

Reefer Transport

This is an important link for the operation of the cold chain. A variety of vehicles in different forms, sizes, and temperature ranges are available. They offer services for long-distance deliveries to last-mile deliveries to different locations. E-vehicles are also available with refrigeration systems designed with Eutectic plates for thermal energy storage, which provides required refrigeration effects during transport.

Controls and Automation

This has been a major area of development in the last few decades. The technologies of IoT, Blockchain have already been introduced in the field.

Conclusion

Current scenario in the cold chain sector indicates a very positive environment for a healthy growth in the whole food and pharma sectors. Innovative technologies with focus on energy savings and sustainable design features will transform the cold chain in to a value chain for the stakeholders from producers to consumers. Fortunately, there is a positive support from the government in terms of financial incentives and technology support from institution like ISHRAE, ASHRAE, IAR, GCCA, NCCD and others.

Let us join the mission to make the nation a global food basket.

