

Cold Chain Developments and New Emerging Applications

By Atul Khanna, India Representative, Global Cold Chain Alliance

Introduction

In the agriculture and food processing sector, presence of a robust cooling infrastructure has the potential to save lives and livelihoods, limit food waste levels and bridge the nutrition gap in countries like India.

India was successful in setting up one aspect in the cold chain in terms of long-term temperature-controlled storage of specific commodities like potatoes, spices, pulses, apples but is now advancing the development of other cool logistics components to complement the logistical needs of other highly perishable products. The basic anomalies in the domestic supply chain of perishable produce include an underdeveloped cadre of practitioners and domain knowledge, besides the infrastructure components. Hence, the operational models also have not progressed into inter-modal or multi-modal movements, which need to be rectified.

Besides national horticulture assistance for cold chain development, a broad-based scheme named Pradhan Mantri

About the Author

Atul Khanna is a commerce honors graduate from Delhi University. He has been working towards the development of the Indian cold chain. He is a member of Committee for Supply Chain and Logistics and the co-chair of Committee for Technical Specification, Standards, Test laboratory and Product certification, National Centre for Cold Chain Development, Ministry of Agriculture. He is also a member of the Confederation of the Indian Industry (CII) and a life member of the US India Importer Council (USIIC). He has also acquired a certificate course of 'Emerging Market Program' at Wisconsin, USA.

Kisan SAMPADA (Scheme for Agro-Marine Processing and Development of Agro-Processing Clusters) Yojana, is also being implemented in different states for the following plans:

- Mega Food Parks
- Integrated Cold Chain and Value Addition Infrastructure
- Creation or Expansion of Food Processing and Preservation Capacities
- Infrastructure for Agro-Processing Clusters
- Creation of Backward and Forward Linkages
- Food Safety and Quality Assurance Infrastructure
- Human Resources and Institutions

Performance of the Indian Cold Storage and Cold Transportation Sectors

Today, the cold chain industry in India is rising from a nascent scaffold, making it one of the encouraging fields in the warehousing and logistics industry. Moreover, cold storage facilities in India had only been limited mainly to storing perishable horticulture produce such as fruits and vegetables but now have expanded to numerous other products as well. According to Renub Research new report, the Indian Cold Chain Market is expected to reach USD 53.07 billion by 2027.

Realms of Indian Cold Chain Industry

The Indian Cold Chain Market revolves around the realms of organized and unorganized sectors. More recently,

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the organized industry's growth involves the application of cold chains across Third-Party Logistics (3PLs), Quick Service Restaurants (QSR), retail, and e-commerce. Recently, food service industries supported by changing consumption patterns have also brought the cold chain segments in focus. Thus, with the growth in organized food delivery, e-commerce remains a crucial driver for the cold chain sector in India.

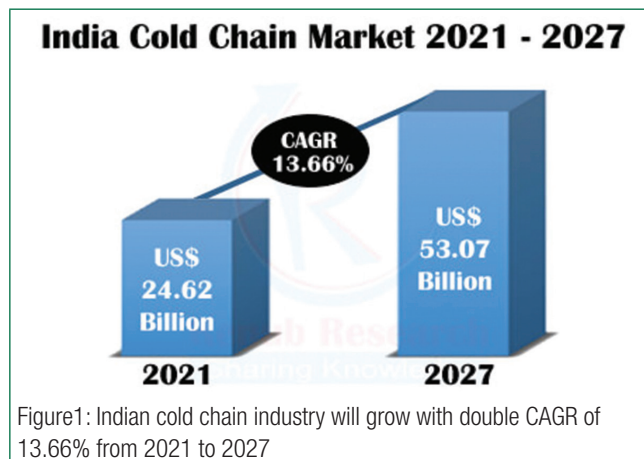


Figure 1: Indian cold chain industry will grow with double CAGR of 13.66% from 2021 to 2027

Nowadays, consumers demand many biopharmaceutical products, fresh perishable food (fruits, vegetables, meat, seafood, and dairy products), processed food, chemicals, flowers, and plants, which are temperature-sensitive commodities and require cold chain infrastructure. The trend is now changing towards setting up multi-purpose cold storage and providing end-to-end services across the value chain.

Pharmaceutical products are highly susceptible to temperature and time constraints, making cold chains essential for cold chain applications. In the present situation where safe delivery of vaccines for mass immunization against COVID-19 is an absolute priority, the cold chain is in huge demand across a countrywide footprint. The development is primarily driven by apprehending increased market by organized cold chain operators, changing consumer behavior for quality products and securing supply reliability from the quality point of view.

In addition, traditional dairy products such as *ghee* (clarified butter), curd (yoghurt) and *paneer* (cottage cheese) are primarily catered to by the unorganized sector. However, with the increasing quality consciousness of consumers, the organized sector role is expected to grow in these products in the years to come. Apart from this, the factors acting as catalysts for the cold chain industry include the rising emphasis on reducing food wastage and government initiatives like FDI relaxation.

COVID-19 Impact on Indian Cold Chain Industry

The pandemic has positively impacted the cold chain industry, fueling the market for cold chain industry. The

widening adoption rate of packaged food and beverage products is an encouraging development for the growth of cold chain in India. COVID-19 impacted every industry's supply chain due to restricted trade during the pandemic, resulting in food manufacturers emphasizing food products and their storage to increase their shelf life, which propelled the market for cold chain.

Further, the explosion of pandemic has created a shift toward an organized retail market to prevent further virus outbreaks. Consumers have stockpiled processed food stocks with a long shelf life to perishable foods, and limited trade movements between states have surpassed cold chain storage capacities in certain conditions. Hence, Indian infrastructure underscores the need for the food value chain to move from open-air markets to a cold-chain model to preserve perishable items for a longer duration massively.

Expansion of Cold Chain Industry in Tier I and Tier II Cities of India

The cold chain industrial clusters are concentrated in major metro cities. The cold chain industry has massive potential in Tier I (Delhi, Mumbai, Bangalore, Chennai, Hyderabad, Kolkata, Ahmedabad and Pune) and Tier-II cities (Gurgaon, Noida, Vellore, Coimbatore, Kochi, Thiruvananthapuram, Patna, Rajkot, Goa, Lucknow and Jaipur). Also, an uptick in investment activity amongst the cities is seen. Thus, the industry is more likely to attract significant capital inflow and new capacity creation in the forthcoming years. Our research findings show that Indian cold chain market size was USD 24.62 billion in 2021.



Figure 2: Indian cold chain market will be USD 53.07 bn by 2027 (Source: Renub Research new report, India)

Cold Chain during Last Mile

According to our experts' observations and Andy Connell, a leading consultant in cold chain management, overall discipline in the fruit industry is improving. People used to talk about cold chain management, but it was something they did not do consistently: they put temperature monitors in, but then they would not look at the data to find the weak points and improve upon them. There were temperature fluctuations that did more harm than good due to thermal

shock. But many FDI's projects with international links and funding have worked really hard on cold chain discipline (for instance through the appointment of people whose sole job is to manage the cold chain), but there is visibility only up to the destination port.

Nowadays, the cold chain is much better managed. People know what the temperature was when they loaded it; they know where their produce is. Producers are becoming a lot more invested in the cold chain and they want to see the temperature graphs, which mean the shipper has to pay a lot more attention to the cold chain. Producers are asking for the same transparency and visibility that is demanded from them and they are pushing back against price degradation of their products.

Reefer Demand Growth Trend

The reefer trade slowed in 2019, but now it is growing and has weathered the COVID storm. According to a Maersk study of 2020, reefer demand remained strong, but some commodities fared better than others. Demand drivers and indicative trends of various segments indicate that awareness of nutritious quality food is growing fast, and pattern of various segments is shown in Figure 3.

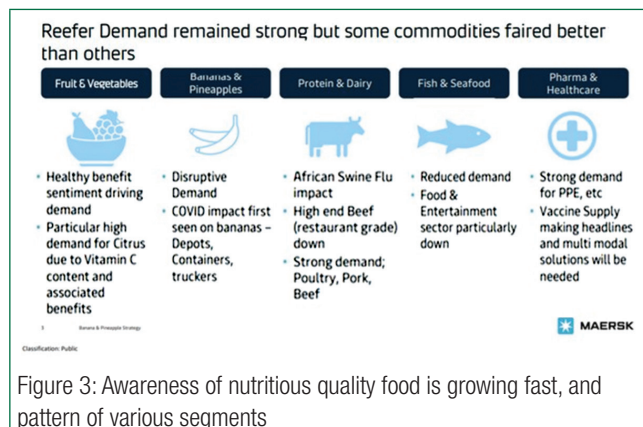


Figure 3: Awareness of nutritious quality food is growing fast, and pattern of various segments

There were also logistical problems in reefer movement, especially getting containers from farms and packhouses to the ports or vice-versa as there was a shortage of drivers. There was a lot of downtime at customs, but support did come from governments who relaxed some restrictions because it became an issue of food security. Logistics to transport food became more collaborative in developing a more digitally advanced industry to cope with future demand.

Opportunities

Primary processed food refers to the conversion of raw agricultural produce, milk, meat and fish into a commodity that is fit for human consumption by adopting minimal or basic processing practices such as sorting, grading of produce, removal of inedible fractions from the produce, refrigeration, etc. To make substantial progress in this field, the objective

of the scheme for Integrated Cold Chain and Value Addition Infrastructure of Ministry of Food Processing Industries is to provide integrated cold chain, preservation and value addition infrastructure facilities without any break from the farm gate to the consumer in order to reduce post-harvest losses of horticulture and non-horticulture agri-produce. This will enable linking groups of producers to processors and the market through a well-equipped supply chain and cold chain, thereby ensuring remunerative prices to farmers and year-round availability of food products to consumers. Financial assistance in the form of grant-in-aid up to a maximum of Rs 10 crore per project is provided for setting up the cold chain infrastructure in the country.

As of 2017, the ministry was assisting 135 integrated cold chain projects. Of this, 97 have already been completed and have commenced commercial operation. Operationalization of 135 cold chain projects envisages the creation of a cold chain capacity of 5.01 lakh MT of cold storage or controlled atmosphere or deep freezer, 116.40 MT/hr of Individual Quick Freeze, 52.65 lakh liter per day of milk processing or storage and 766 reefer vehicles. Out of this, the ministry has so far created a capacity of 3.70 lakh metric tonnes of cold storage, 95.04 metric tonnes per hour of Individual Quick Freezing (IQF), 37.96 lakh liters per day of milk processing or storage and 552 reefer vans. State-wise details of cold chain projects sanctioned by the Ministry of Food Processing Industries during the last three years and current year are given in Table 1.

The government further approved taking up 100 new integrated cold chain projects in 2016-17 for financial assistance. Accordingly, revised operational guidelines for scheme for Integrated Cold Chain and Value Addition Infrastructure were issued on 29.08.2016. Based on the revised operational guidelines an Expression of Interest (EoI) was issued on 31.08.2016, a total of 308 integrated cold chain proposals all over the country were received against the Expression of Interest.

The scope of the scheme was broadened in 2022 under Pradhan Mantri Krishi Sampda Yojna whose guidelines cover non-horticulture produce, dairy, meat, poultry, meat, fish (except shrimp) for farm infrastructure to consumer in order to reduce post-harvest losses and add value. Opportunities are available for the following:

- Farm level infrastructure that includes processing center at the catchment area of the targeted produce
- Processing center (out of the list in Table 2) mandatory for the produce
- Distribution hub with multi-produce, multi-temperature requirement
- Refrigerated vans, trucks, insulated vans, mobile insulated trucks

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- Irradiation facility (including stand-alone, and the fruit and vegetable sector is also eligible).

Eligible facilities are given in Table 2. While implementing the project, sometimes consultants or entrepreneurs are unaware of non-eligible components and as such the cost goes very high due to their inclusion. Therefore, such components list is given in Table 3 for clarity.

Table 1: State-wise details of Cold Chain Projects sanctioned by Ministry of Food Processing Industries during the last three years and current year

State	2013-14	2014-15	2015-16	(As on 24.03.2017)	Projects sanctioned
	Nos.	Nos.	Nos.	Nos.	Nos.
Andhra Pradesh	0	0	1	0	1
Assam	1	0	0	0	1
Bihar	0	0	1	0	1
Chhattisgarh	0	0	0	0	0
Gujarat	4	0	1	0	5
Haryana	1	0	4	0	5
Himachal Pradesh	5	0	0	1	6
Jammu & Kashmir	3	0	1	0	4
Karnataka	2	0	0	0	2
Kerala	0	0	0	0	0
Madhya Pradesh	2	0	1	0	3
Maharashtra	15	0	2	2	19
Manipur	0	0	0	0	0
Mizoram	0	0	0	0	0
Odisha	1	0	0	0	1
Punjab	4	0	3	0	7
Rajasthan	2	0	1	0	3
Tamil Nadu	0	0	1	0	1
Telangana	1	0	0	0	1
Uttar Pradesh	3	0	3	0	6
Uttarakhand	7	0	5	1	13
West Bengal	0	0	2	0	2
Total No. of Projects Approved	51	0	26	4	81

Source: Lok Sabha Unstarred Question 4327 For 28th March, 2017 reply)

Table 2: Processing center list

(a)	Mechanized sorting & grading line / packing line / staging cold rooms
(b)	Cold storage units (s) [Associated with value addition]
(c)	Controlled Atmosphere (CA) storage [Associated with value addition]
(d)	Frozen Storage / Deep freezers [Associated with value addition]
(e)	IQF line, Tunnel / Spiral / Blast / Plate Freezer, Vacuum Freeze Drying
(f)	Milk Chilling / Bulk Milk Cooling / Automatic Milk Collection Unit / Milk Processing Unit (including packing) for which temperature control is necessary during some part of the processing. Note: Maximum 10 milk chilling or Bulk Milk Cooling or Automatic Milk Collection Unit can be assisted per project.
(g)	Poultry / Meat / Marine / Fishery Processing Unit
(h)	Packaging line for chilled / frozen / temperature-controlled product
(i)	Food Irradiation unit
(j)	Refrigerated / insulated transport
(k)	Pre-Cooling Unit(s) / Mobile pre-coolers
(l)	Retail refrigerated carts, temperature controlled solar powered retail carts Note: maximum 5 such carts can be considered per project

Table 3: List of non-eligible components

(a)	Compound wall
(b)	Approach road / internal roads
(c)	Cost of Land and site development
(d)	Administrative office building
(e)	Canteen
(f)	Labour rest room and quarters for workers
(g)	Security / guard room of enclosure
(h)	Non-technical civil works not related to the components of the scheme
(i)	Margin money, working capital and contingencies
(j)	Fuel, consumables, spares and stores
(k)	Transport vehicles other than controlled temperature vehicles

(l)	Pre-operative expenses
(m)	Service charges, carriage & freight charges or other such charges / fees
(n)	Expenditure on painting of machinery
(o)	AC ducting, furniture, computers and allied office items.
(p)	Closed Circuit TV Camera and security aystem related equipment.
(q)	Consultancy fee, taxes etc. on plant and machinery.
(r)	Stationery items
(s)	Plant & machinery not directly related to components of the scheme
(t)	Fly catchers, hand washers, laundry
(u)	Reconditioned / refurbished / second hand / old plant & machinery
(v)	Consumables (such as Plastic crates, bins, pallets etc.) Note: <i>The list is only indicative and the Project Approval Committee constituetd by the Ministry will be the final authority to decide on inliability or otherwise</i>

The good thing is that there is a provision for deduction or recall of the grant-in-aid ranging from 0.5 to 5% for non-implementation or delay in implementation to encourage healthy competition for serious investors.

Recent Innovations

Rethinking Cold Chain Nodes and Modes to Market

As water molecules come closer during freezing causing cell membrane rupture in tissues, another recent innovation to make cold chain operations more efficient and sustainable is the ‘ice feeling’ technology. It is controlled by high voltage with micro vibration applied creating a condition where water molecules will stay apart without freezing even in sub-zero temperatures. This can maintain freshness by adding special electrostatic energy safely and stably to the ice storage chamber. The unit can be moved from truck to rail without disrupting the cooling process. It is battery operated so that it can be used remotely and is charged by a generator.

Such initiation has been done through a project subsidized by Japan with a focus on the storage of perishables and transportation around the country while contributing to the reduction of carbon dioxide.

Technology

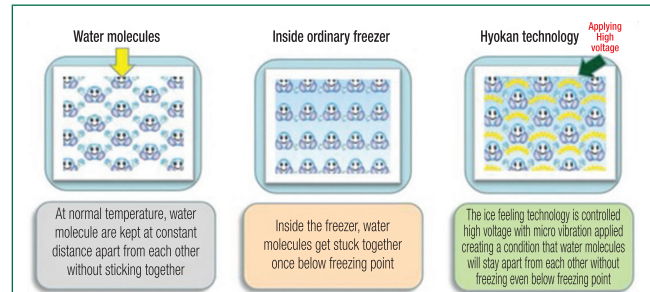


Figure 4: Ice Feeling technology

Focus

- Storage of perishables
- Transportation by rail linking whole Japan (except Okinawa)
- Contribution to CO₂ reduction





Figure 5: Applications of Ice Feeling Technology (Source: Cool Logistics Global)

Digitalization for Connectivity, Transparency and Efficiency

Companies need to work together to challenge business models and drive the entire supply chain towards a new era of connectivity, transparency and efficiency. If these work their own, all invest substantial amounts of money and in the end their customers will not reap the benefits. If they do it together, some of the costs and research can be shared to ensure giving customers a workable solution. While digitalization is only one part of transforming the industry, it may be difficult for some to invest in it, but only mass adoption will make it accessible to everyone.

A common problem is that if a company is shipping a smart container between two continents, several carriers may be used along the journey. Hence, the customer can only have uninterrupted service if the carriers have implemented a compatible communication solution on board. It will be a win-win solution in sharing a unified digital ecosystem. Customers want to be in control of what is being monitored, and they want reactivity, traceability and the inclusion of an encrypted private communication channel. A series of pilot projects is underway to this end.

Internet of Things and Blockchain Technology

To embrace the full potential of Internet of Things (IoT) companies had to look at the whole supply chain journey from an end-client perspective; meaning the best practices

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along each link in the supply chain, both inside and outside of the container, will ensure as much shelf life is passed on as possible. It is not about replacing people with digital technology or competing with other carriers, but it is about meeting future demand as the population reaches 10 billion by 2050. Digital Container Shipping Association (DCSA) was formed in 2019 as a neutral non-profit association trying to drive standardization, digitalization, and interoperability in the container shipping industry. Thus, it is not so much about how to make the data available in real time, but about building trust that is needed for customers to start using the technology as a standard. Some companies are providing solutions throughout the agriculture supply chain with the power of Blockchain technology to help provide many benefits for farmers and suppliers including efficiency and traceability. A World Bank-sponsored Development Aid Initiative allows farmers in Haiti to maintain ownership of their produce until the sale at destination, and hopefully improving their returns while providing support through the process. There is a great opportunity to look at how to mitigate the issues and losses associated with trust that the right thing has happened. Often the term digitalization is understood to involve complex technology; however, it could be as simple as just having an up-to-date phone and streamlining the information in an application platform. The company chose to use an R3 platform to help ensure that the client's private data was adequately secured.

Conclusion

The government schemes play a vital role in encouraging development across the board and government needs to keep on working in similar direction with focus on planned development of the targeted infrastructure touching the various areas of cold chain industry.

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