Indian Sea Food Industry: The Cold Chain Perspective
<table>
<thead>
<tr>
<th>TITLE</th>
<th>Indian Sea Food Industry: The Cold Chain Perspective</th>
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<tbody>
<tr>
<td>YEAR</td>
<td>December 2015</td>
</tr>
<tr>
<td>AUTHORS</td>
<td>Food &amp; Agribusiness Strategic Advisory &amp; Research (FASAR), YES BANK</td>
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India, contributing 5.7 percent to total global fish production, ranks second in overall fish production and is also the second largest producer of fresh water fish in the world. The Indian Fisheries Industry valued at over USD 15 Bn, has emerged as a significant high value contributor to Indian agriculture as well as a key enabler of diversified agriculture. The industry is a substantial foreign exchange earner, with exports of over USD 5 billion annually, and provides employment to more than 15 million people, directly or indirectly. Production in the last 14 years has more than doubled, i.e. from 4.2 million MT in 1991-92 to 9.6 million MT 2013-14.

Although India has a strong position in global fisheries trade, the sector faces numerous infrastructure challenges, especially across the domestic market value chain. While our ports & harbors require significant modernization and hygienic fish handling facilities coupled with robust food safety compliant mechanism in domestic wholesale or retail markets, the role of efficient and sufficient cold chain infrastructure is critical for the industry to consolidate the strong global position. Challenges in the sector necessitate the need for adopting innovative supply chain solutions from **Boat to Fork**, so as to ensure supply of safe, hygienic & nutritious fish to the consumer, at a reasonable price. With the growth of the modern retail market and increasing consumer awareness about fish as a healthier source of animal protein, the domestic fishery sector is well poised to grow at a faster pace along with the export sector.

The fish industry utilizes only one percent of the total cold storage capacity available in the country today. Further, while three-fourths of fish harvested in India is marketed in fresh form, there is a strong need for the cold chain industry to come up with innovative & cost effective transportation and storage facilities to ensure supply of superior product to the consumer. Innovative & integrated cold chain solutions across the domestic supply chain can act as a critical enabler to guarantee superior quality of fresh, chilled, frozen and processed fishery products across the country. Immense opportunity exist in areas including cold storages, ice making plants, IQF facilities and refrigerated distribution of products. This shall require concerted efforts from the industry to come up with innovative solutions, service providers & equipment suppliers to bring in the best from across the globe through adequate policy support initiatives from the Government.

On the occasion of the **India Cold Chain Show 2015**, we are pleased to release the YES BANK Knowledge Report - **Indian Sea Food Industry - The Cold Chain Perspective**. The report provides an overview of Fisheries Industry in India, present status of cold chain in domestic and export sectors, identifies key infrastructural challenges plaguing the industry and provides specific recommendations to promote integrated cold chain development in Indian Sea Food value chain.

I am confident that this report will serve as an effective reference for all stakeholders of the Indian Sea Food & Cold Chain sectors, including the industry as well as policy makers.

Thank you.

Sincerely,

Rana Kapoor
Managing Director & CEO
Chairman
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Overview of Fisheries Industry in India

Introduction

India has vast potential for fisheries in view of our long coastline spanning about 8,118 kms in addition to inland water resources. India is the second largest producer of fish and also second largest producer of fresh water fish in the world. The sector plays an important role in the overall socio-economic development of India. The sector has gained importance as it contributes significantly to the national food security, livelihood generation, agriculture diversification and enhanced foreign exchange earnings. As a result, starting from a purely traditional activity in the early fifties, fisheries and aquaculture have now transformed into a significant commercial enterprise.

As per the estimates of CSO, the Gross Value Added from fisheries sector at current prices during 2013-14 was INR 96,824 crore which is about 5.2% of the Gross Value Added from Agriculture, forestry and fishing sectors at current prices. India contributes 5.7% of the total global fish production. Fish production has increased from 42 lakh tonnes (25 lakh tonnes for marine and 17 lakh tonnes for inland fisheries) in 1991-92 to 96 lakh tonnes (35 lakh tonnes for marine and 61 lakh tonnes for inland fisheries) in 2013-14 (Provisional).

India exported around 10.5 lakh tonnes of fish and fish products worth value around INR 33 thousand crore in 2014-15. As per the Indian Livestock Census, 2003, 14.5 million people were engaged in various fisheries related activities. About 75% of the fishers are engaged in inland fisheries activities and about 25% in marine fisheries activities.
Categorization of Resources

The fisheries sector is broadly divided into two categories i.e. Inland fisheries and Marine fisheries.

<table>
<thead>
<tr>
<th>Marine</th>
<th>Inland</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Rivers and Canals</td>
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<tr>
<td>Exclusive Economic Zone (EEZ)</td>
<td>Reservoirs</td>
</tr>
<tr>
<td>Continental Shelf (approx)</td>
<td>Ponds and Tanks</td>
</tr>
<tr>
<td></td>
<td>Flood plain lakes and Derelict water bodies</td>
</tr>
<tr>
<td></td>
<td>Brackish waters</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Marine</th>
<th>Inland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastline</td>
<td>8118 km</td>
</tr>
<tr>
<td>Exclusive Economic Zone (EEZ)</td>
<td>2.02 million sq. km</td>
</tr>
<tr>
<td>Continental Shelf (approx)</td>
<td>0.53 million sq. km</td>
</tr>
<tr>
<td></td>
<td>1,95,095 km</td>
</tr>
<tr>
<td></td>
<td>2.92 million ha</td>
</tr>
<tr>
<td></td>
<td>2.43 million ha</td>
</tr>
<tr>
<td>Flood plain lakes and Derelict water bodies</td>
<td>.80 million ha</td>
</tr>
<tr>
<td>Brackish waters</td>
<td>1.16 million ha</td>
</tr>
</tbody>
</table>

Production Trends

India is the second largest producer of fish in the world and also holds second position both in aquaculture and inland capture fisheries. The total provisional fish production for the year 2013-14 was estimated around 96 lakh tonnes growing at a CAGR of around 4% for the last five years and the annual growth rate was around 6%. The marine fishery has been growing at a CAGR of 2%, while the inland fishery has been growing at a CAGR of around ~5% for the last five years.

Exhibit 2- Category wise fish production (lakh MT) in India (2009-14)

Exhibit 3- Share of Marine and Inland fish production in 1990-91 and 2013-14

Source: Handbook on fisheries statistics (2014), YES BANK analysis

Andhra Pradesh tops the chart with a production share of 21% followed by West Bengal (17%) and Gujarat (8%) in total production for the year 2013-14. The chart in Exhibit 4 below depicts the top 10 states in the fish production in the country for the year 2013-14.

**Exhibit 4- Top 10 states in fish production (lakh MT) in India (2013-14)**

[Chart depicting top 10 states in fish production]

Source: Handbook on fisheries statistics (2014), YES BANK analysis

**Freshwater Aquaculture:**

The freshwater culture resources in the country comprise 2.43 mn ha of ponds and tanks. The other resources where fish farming can be undertaken include the flood plain lakes and other natural lakes, reservoirs, irrigation canals and paddy fields. India is basically a carp country with more than 80% of the production being contributed by carps alone. The other significant contributor in recent years is Pangasius species. India is now the third largest producer of Pangasius in the world after Vietnam and Thailand.

The inland fish production for the year 2013-14 (P) was around 61 lakh MT. Andhra Pradesh was the top producer with 15.8 lakh MT followed by West Bengal with 13.9 lakh MT. The graph below in Exhibit 5 depicts the top ten states in the freshwater aquaculture production for the year 2013-14 (P). The share of freshwater aquaculture inland fisheries has increased from 34% in mid 1980’s to 80% in recent time.
Exhibit 5- Top 10 states in freshwater aquaculture (lakh MT) in India (2013-14)

Source: Handbook on fisheries statistics (2014), YES BANK analysis

The graph below in Exhibit 6 shows the production status of major fresh water fishes for the year 2012.

Exhibit 6- Top fish categories in freshwater aquaculture (Production in lakh MT)

Source: Handbook on fisheries statistics (2014), YES BANK analysis
The freshwater aquaculture consists majorly of carp fishes, culture of catfishes, culture of freshwater prawns, culture of pangasius and culture of tilapia. The freshwater prawn farming has got the attention in the recent past with increased consumer demand. The major prawn variety giant river prawn (*Macrobrachium rosenbergii*) is cultivated in monoculture or polyculture along with the major carps.

**Brackish water aquaculture:**

It is practiced in three different ways as described below:

- Fish production after the harvest of rice in the low land areas. It is generally practiced in central Kerala, along the northern coastal waters of Karnataka, Goa and some areas in West Bengal.

- Fish production in ponds throughout the year in larger and deepen fields, it is practiced in Kerala and West Bengal.

- Rice and fish are raised together and is practiced majorly in West Bengal and Goa.

The potential area under brackish water is estimated at 1.19 million hectare. Around 14.8% of the potential area i.e. 0.17 million hectare has been developed for the brackish water aquaculture. West Bengal and Gujarat have the maximum potential area under brackish water aquaculture. Andhra Pradesh has utilized the maximum of the available potential area under brackish water aquaculture i.e. around 57%. The production for the year 2012-13 was around 2.71 lakh MT. The major contributor was Andhra Pradesh with a production of around 1.6 lakh MT followed by West Bengal with a production of around 0.53 lakh MT. Shrimp production comprises 20-25% of the total brackish water aquaculture.

The brackish water sector encompasses the cultivation of giant tiger prawn (*Penaeus monodon*) and exotic white leg shrimp (*Penaeus vannamei*). Tiger shrimp (*P. monodon*) has been the major contributor in the shrimp production, but for the past few years downward trend in production has been observed in giant tiger prawn production due to frequent disease outbreaks. With the introduction of non native white legged shrimp (*P. vannamei*) in the period 2005-09, the brack water aquaculture has got a major thrust. From a production of 90,000 MT in the year 2010, it rose to 2,70,819 MT in 2013-14. It had also increased the export earnings by leaps and bounds. As per the published reports, *P. vannamei* accounted for INR 20,000 crores of exports which is around 66% of the total exports in the year 2013-14. The superior traits of the species such as higher tolerance capacity, lower feed requirements, higher survival rate, fast growth rate and others contributed to the growth in the brackish water aquaculture production.

**Marine fish production:**

The marine fish production for the year 2013-14 (P) was 34.43 lakh MT. Maharashtra is the largest producer with a share of around 20% followed by Chennai with a production of around 5 lakh MT and Karnataka with a production of around 4.67 lakh MT. The combined share of all the three states is around 49% of the total production. Marine fish production is practiced along the Indian Ocean east and west coast of India. The east coast of India includes Andhra Pradesh, Odisha, Chennai, West Bengal, Andaman & Nicobar and Pondicherry and the west coast includes Gujarat, Karnataka, Kerala, Maharashtra, Lakshadweep, and Daman & Diu. As per the production statistics of 2012, the contribution of the west coast had the higher share in the marine production (65%) than the east coast (35%). The graph below in Exhibit 7 depicts the state wise marine production (lakh MT) for the year 2013-14 (P).
Exhibit 7- State wise marine fish production (lakh MT) in India (2013-14 P)

Source: Handbook on fisheries statistics (2014), YES BANK analysis

The major fish species reared in the marine fish cultivation are depicted in the Exhibit 8 below:

Exhibit 8- Major marine fish species produced in India in lakh MT (2012)

Source: Handbook on fisheries statistics (2014), YES BANK analysis

Indian oil sardine is the major marine fish produced in the country. The production for the year 2012 was around ~ 4.04 lakh MT with a share of around ~ 12%. The top ten species have a combined share of around ~ 52%.
Overview of Domestic Fish Marketing Value Chain

Fishery is a state subject under the constitution of India but very few states have dedicated bodies for the development and marketing of fish produced in the state. Domestic market has the bulk share in context to the marketing of the fish produced in the country i.e. 85% of the produce which is highly unorganized and scattered. About, 70% of the fish harvested is marketed fresh and rest is consumed in the form of smoked, dried, processed fish meal and others. However, the harvested fish is not evenly distributed to interior areas due to lack of transportation and non-availability of proper storage facilities. Therefore, there is a need for balanced system of distribution to make fish available in the interior areas at reasonable rates. The annual per capita consumption of fish in India is 2.85 Kg. The existing per capita availability of fish is 6.5 kg and is expected to reach 9.0 kg by 2030.

The domestic fish marketing is primarily dominated by the private players with the involvement of different stakeholders across the hierarchy thereby reducing the fishermen’s profit margin. Bulkiness, perishable nature, poor handling, heterogeneity, high transportation and storage costs are the major constraints faced by this sector. The different stakeholders involved in the value chain include:

Exhibit 9- Key Players in Domestic Fish Marketing in India

<table>
<thead>
<tr>
<th>Role</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auctioneer</td>
<td>They are the first point of contact for the fishermen. In freshwater marketing, auctioneer source through a commission agent who charges 5-10% of the total sales value.</td>
</tr>
<tr>
<td>Wholesaler</td>
<td>They buy in bulk and sell further in the chain. Value addition is done in terms of sorting, grading, cleaning, icing and packaging. The profit margin depends upon the demand in the markets and supply of the species.</td>
</tr>
<tr>
<td>Retailer</td>
<td>They directly sell to the consumers and are engaged in the maximum value addition in terms of grading, cleaning, icing, packing and dressing of the fishes. The profit margin extends upto 20%. Sometime, a group of retailers directly purchase from the auctioneer.</td>
</tr>
<tr>
<td>Vendor</td>
<td>They are involved in door to door selling and value addition in terms of sorting, grading, cleaning and icing is done. Lack of storage facility is a critical issue.</td>
</tr>
</tbody>
</table>
For example, in Gujarat, fish passes through several intermediaries from the landing centre or fish pond to the consumer. The intermediaries are involved in providing services of head loading, processing, preservation, packing and transporting and these activities result in cost addition at every stage of marketing. The key intermediaries in fish marketing are: commission agent, wholesaler, vendor and retailer. The fisherman brings his catch to commission agents or factory agents appointed by the processors. Some value addition is carried out by the commission agent in terms of sorting, grading, cleaning, icing and packing fish before sale. The fish is manually graded and sorted. The processors further grade, clean, process and pack fish for exports. Retailers mainly buy fish from the commission agents. In Gujarat, the following models exist with respect to fisheries value chain.

**For Domestic Market**

Fish for consumption in domestic market is not processed and is stored in ice flakes for transportation. The domestic industry is not organized and vendors procure unprocessed fish from commission agents after primary sorting and grading to sell to consumers in local markets. For domestic consumption, fish reaches the consumer within 1-2 days. Various stakeholders do not store the fish due to the high perishability and sells it to the next level as soon as possible.

**Exhibit 10- Value Chain for Fisheries in Gujarat (Domestic)**

![Value Chain for Fisheries in Gujarat (Domestic)](image)

*Source: YES BANK Analysis. The value chain study was done for Gujarat.*

**Exhibit 11- Value Chain for Fisheries in Gujarat (Exports)**

![Value Chain for Fisheries in Gujarat (Exports)](image)

*Source: YES BANK analysis (The value chain study was done for exports taking place from Gujarat)*
Marine and freshwater cooperative societies also exist but the operating costs are very high because of the poor management and marketing skills.

**Processing and Storage Infrastructure**

The Table 1 below depicts the number and capacity of the infrastructure created with respect to processing and storage facilities in India.

**Table 1: Processing and Storage Infrastructure in India**

<table>
<thead>
<tr>
<th>Processing Facilities</th>
<th>Storage Facilities</th>
<th>Handling Facilities</th>
<th>Ice Plant</th>
<th>Pre-processing facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>No (in ‘000 MT)</td>
<td>No (in ‘000 MT)</td>
<td>No (in ‘000 MT)</td>
<td>No (in ‘000 MT)</td>
<td>No (in ‘000 MT)</td>
</tr>
<tr>
<td>465</td>
<td>20.2</td>
<td>597</td>
<td>224</td>
<td>148</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>78</td>
</tr>
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<td></td>
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<td></td>
<td></td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>620</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.7</td>
</tr>
</tbody>
</table>

*Source: MPEDA*

**Wholesale markets** - The fish handling capacity in the Indian wholesale markets ranges from 1 MT to 100 MT. The infrastructure is dismal in majority of the Indian wholesale markets with limited cold chain facility, access to quality drinking water, parking facilities. Most of the wholesale markets are obsolete with minimal supervision and low keeping quality. The left over fishes are stored in unhygienic plastic containers.

**Retail markets** - They are the miniature version of the wholesale markets with majority of them along the roadside. The retail markets lack the cold storage facility, shelters, and fish dressing platforms. They are highly organized with limited keeping quality.

**Retail outlets** - They are owned both by the private and government bodies. They are located strategically in towns and cities. They are equipped with the modern facilities. They procure directly from the fishermen or the cooperative societies and cater the need of the consumers at a reasonable rate. The objective of retail outlets is to minimize the involvement of middlemen so as to create win-win situation both for the consumers and the farmers. Tamil Nadu Fisheries Development Corporation (TNFDC) with name “Neidhal” and MatsyaFED with the name “Fresh fish point” are running successfully in the state of Tamil Nadu and Kerala respectively.
Cold Chain infrastructure in Indian Fisheries Export

**India’s Exports of Marine Products**

During the financial year 2014-15, exports of marine products reached an all-time high of USD 5511 million. Marine product exports crossed all previous records in quantity, rupee value and USD terms.

Frozen shrimp continued to be the major export item in the export basket in terms of quantity and value, accounting for a share of 34% in quantity and 67% of the total USD earnings. USA is the largest market (1,12,702 MT) for frozen shrimp exports in quantity terms followed by European Union (81,952 MT), South East Asia (69,068 MT) and Japan (30,434 MT). The contribution of cultured shrimp to the total shrimp export is 76% in terms of value. Fish, is the second largest export item, accounting for a share of about 29% in quantity and 11% in USD earnings. Fr. Cuttlefish recorded a growth of 21% in quantity, 32% in value. Dried fish have shown a positive growth in terms of quantity by 4% and in rupee term by 1%, Live items exports have increased by 8%, 7% and 2% in quantity, rupee value and USD realization respectively compared to the previous year. Chilled items have shown 59% increase in quantity.

**Major Export Markets from India**

US emerged as the largest buyer of Indian marine products with a share of 26% in terms of US $ value realization in 2014-15. South East Asia captured the second position with a market share of 25% followed by European Union (20%), Japan (9%), and Middle East (6%). The country wise export share in volume and value terms has been depicted in Exhibits 12 & 13 respectively below:

**Exhibit 12- Country Wise Export Share (%), volume terms (2014-15)**

Source: MPEDA
Exhibit 13 - Country Wise Export Share (%), value terms (2014-15)

![Pie chart showing export share by country](image)

Source: MPEDA

Present Status of Cold Chain in Sea Food Exports from India

The fisheries sector has been one of the major contributors of foreign exchange earnings through export. Over the past few years, safety has become very topical subject eliciting a great deal of public concern particularly in the developed countries, where food safety offences are now dealt at Government level. Once caught, marine food products are highly perishable. Marine foods for export typically need to be quickly frozen after initial processing and kept frozen until purchased by the consumer. New initiatives have been adopted for developing the sector to increase yields and ensure a sustained livelihood for fishermen. There has also been an amplified effort to increase exports to other countries through improvements in infrastructure facilities like cold storage that better address post-harvest management. To cope up with the increasing demand for safe food and to satisfy the needs of health / quality conscious consumers of the global seafood market, MPEDA Quality Control Section has identified the following thrust areas for development / improvement and implements programmes which can be addressed via efficient cold chain solutions across the value chain:

- Monitoring of seafood quality in landing and pre-processing centers.
- Integrated development programme for upgrading seafood quality by providing infrastructural facilities like pre-processing centers and setting up of mini lab towards quality assurance.
- Evolving standards for compliance for export of fish and fishery products to various developed countries based on standards / norms / regulations prescribed by such countries from time to time.
- Fishing Harbors Upgradation/improvement.
The region wise processing facility of marine products is given in Table 2 below with maximum number of processing facilities present in Veraval region followed by Kochi.

**Table 2: Region wise processing facility capacities (as on July 2014)**

<table>
<thead>
<tr>
<th>Centre</th>
<th>No</th>
<th>Capacity (MT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional Office Kochi</td>
<td>99</td>
<td>3006</td>
</tr>
<tr>
<td>Sub Regional Office Quilon</td>
<td>14</td>
<td>417</td>
</tr>
<tr>
<td>Sub Regional Office Mangalore</td>
<td>36</td>
<td>2155</td>
</tr>
<tr>
<td>Regional Office Mumbai</td>
<td>48</td>
<td>3450</td>
</tr>
<tr>
<td>Sub Regional Office Goa</td>
<td>14</td>
<td>900</td>
</tr>
<tr>
<td>Regional Office Veraval</td>
<td>103</td>
<td>5509</td>
</tr>
<tr>
<td>Regional Office Kolkata</td>
<td>32</td>
<td>915</td>
</tr>
<tr>
<td>Sub Regional Office BBSR</td>
<td>21</td>
<td>664</td>
</tr>
<tr>
<td>Regional Office Vizag</td>
<td>56</td>
<td>2273</td>
</tr>
<tr>
<td>Regional Office Chennai</td>
<td>9</td>
<td>163</td>
</tr>
<tr>
<td>Sub Regional Office Tuticorin</td>
<td>33</td>
<td>804</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>465</td>
<td>20255</td>
</tr>
</tbody>
</table>

Source: MPEDA

The region wise storage capacities as per MPEDA are tabulated in Table 3 below. The maximum cold storages have been concentrated in Kochi on account of huge supplies from Andhra Pradesh and export of high value added products.

**Table 3: Region wise storage capacities in MT (as on July 2014)**

<table>
<thead>
<tr>
<th>Centre</th>
<th>Cold Storage</th>
<th>Chilled Storage</th>
<th>Dry Fish Storage</th>
<th>Other Storages</th>
<th>Total</th>
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<tr>
<td></td>
<td>No</td>
<td>Capacity</td>
<td>No</td>
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<td>No</td>
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<tr>
<td>Kochi</td>
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<td>Quilon</td>
<td>24</td>
<td>6318</td>
<td>0</td>
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<td>0</td>
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<td>Mangalore</td>
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<td>6299</td>
<td>0</td>
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<td>Mumbai</td>
<td>47</td>
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<td>1</td>
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<td>11476</td>
<td>5</td>
<td>1270</td>
<td>4</td>
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<td><strong>Total</strong></td>
<td>479</td>
<td>193464</td>
<td>29</td>
<td>11376</td>
<td>57</td>
</tr>
</tbody>
</table>

Source: MPEDA
The cold chain components for export value chain are Flake Ice/Block Ice (Farm to Factory Gate)>> Block Processing/Blast Freezing/IQF (Processing and Freezing)>> Freezer Cold Storages (Storage) >>Cold Chain Containers (Logistics and Export). A brief description of these components is provided below:

**Block Ice/Tube Ice/Flake Ice/Slurry Ice** – Block Ice plants are the most widely available source of ice for the fishing industry in the country. These ice plants are densely established in the coastal regions mainly for satiating the need of the fisheries sector. Tube Ice is the new development in the fishing industry as many of the sea food factories have already resorted to it for getting regular ice production in the plants. Flake Ice machine is widely used in IQF sea food plants and is useful where immediate chilling is required. Slurry Ice machine can be fixed onboard fishing vessels ensuring rapid cooling of fish till it reaches the shore.

**IQF Processing** - India till the year 1986 was exporting fish products by using conventional type of freezing wherein the products were generally packed in blocks of 2 kgs by block freezing. The disadvantages of block freezing are that the product loses its identity and the consumer is forced to buy the product in bulk. In cases where reprocessing is involved the quality of end product is affected. Hence these factors necessitated the introduction of Individually Quick Frozen Products. Shrimp products are the major item among the marine products exported from India. Since the preference in importing countries is towards IQF products and also there is value addition if the products are IQF. The major varieties of IQF products which are exported include shrimp, cuttle fish, lobsters and fishes.

**Cold Storages** - Once fish is frozen, it must be stored at a constant temperature of −23 degree celsius or below in order to maintain a long shelf life and ensure quality. A large portion of fresh fish is water. Because the water in fish contains many dissolved substances, it does not uniformly freeze at the freezing point of pure water. Instead, the free water in fish freezes over a wide range of temperature, beginning at approximately −2 degree celsius. The amount of remaining free water decreases until the product reaches a temperature of approximately −40 degree celsius. Fish held below that temperature and packaged so as not to allow water loss through sublimation can be stored for an indefinite period. Unfortunately, there are relatively few commercial freezers capable of storing fish at −40 degree celsius because of the tremendous variation in energy costs. Fish are therefore normally stored at −18 to −29 degree celsius resulting in a variable shelf life ranging from a few weeks to almost one year. A production cold store is usually a part of the fish processing plant for storing frozen finished products. Bulk cold stores normally give the same service as production cold stores, but are often located at some distance from the actual processing industries and are normally much larger than the production stores which cater to the needs of other processing plants also for storing frozen sea foods on custom hiring basis. Capacity of cold stores normally ranges between 1,000 MT and 10,000 MT. However, the size of the cold store depends on a number of factors like amount of traffic, average storage period, number of articles, as well as the number of clients.
Cold Chain challenges in Domestic Marine Marketing

The domestic fish marketing scenario in India is constrained by infrastructural issues creating a blockade for seamless trade. It is generally observed that post-harvest infrastructure is grossly inadequate in fisheries sector. As spoilage of fish begins right from the time it is caught, proper storage, preservation and quick disposal are crucial. Some of the key challenges across the supply chain include:

• Lack of exclusive fish markets except in urban centres limits the movement of fish. Numerous players in the marketing channels consume time and decrease marketing efficiency. The result is the poor quality fish available to the end consumers at the higher price. Inadequate cold storage and transportation facilities at retail level compound this problem. A wholesaler of fish can afford to have a cold storage wagon to supply fish at retail markets. The retail suppliers are small traders; cycle/rickshaw or head-load vendors who use ice for storage and cannot afford capital intensive storage facilities. The quality of water used in ice preparation can also cause degradation of quality of fish. Further, the inability to respond to changing safety and quality standards is a major concern in developing countries.

• Presently, fish markets, both wholesale and retail in the country are in a pathetic condition. Besides, a larger volume of fish is sold through unorganized channels via street markets, often on footpaths. This unhygienic environment and the fact that fish is seldom kept in ice, results in fast deterioration of the quality of the fish. Mostly whole fish is sold in the market and there is negligible processing/value addition. Further, while marketing, transportation or storage of fish, the standard norms of hygiene and sanitation are least considered, leading to a product that is contaminated and unsafe from food safety point of view.

• Various studies have indicated to the high levels of wastage in the Indian fishery due to spoilage especially during the monsoon season, when up to 30 percent of the catch could be lost. Therefore, strengthening of post-harvest infrastructure such as cold storage facilities, ice plants, freezing/processing units, roads and transportation, modern and hygienic wholesale and retail market outlets etc., as well as effective marketing system in identified areas are the key requirements for the development of this sector. This would ensure higher profit margins to the fish producers accelerating the growth of the sector. This will also promote quality assurance and better food safety standards for fish food for domestic consumers and also for the export market.

• There is lack of awareness and appreciatiion for cold chain systems especially in the more remote and rural areas where artisanal fishermen operate. For example, in Gujarat, fisheries sector is currently facing challenges of poor quality of produce. During recent years, low value fishes have dominated the landings, whereas the contribution of prime varieties of fish has declined. Few of the smaller processing units operating in Veraval have closed due to lack of raw material and/or their inability to cope with the quality. The inability of the local processing houses to comply with the regulations has resulted in the rejection of marine/fishery products in the overseas market. There is an urgent requirement on expanding and strengthening domestic marketing of fish by supporting fresh fish preservation, transportation and marketing through hygienic and organized retail outlets. Large processing units are expanding and modernizing their processing units which would entail investments in cold chain infrastructure starting from harvesting of fish to exports. The potential exists in providing cost effective cold chain solutions starting from ice manufacturing/handling, refer vans/insulated vehicles and cold storages to improve the quality of fish.
Case Study on Best Cold Chain Management Practices: Pesca Fresh

Pescafresh is India’s first fresh seafood brand conceived in 2004; offering fresh & hygienic seafood cut & cleaned as per the consumers’ requirement packaged in world class packaging. Pescafresh is currently servicing over 1,00,000+ households through their home delivery centers and retail chain across four cities. Strong relations with India’s leading retail brands, including Aditya Birla Retail Limited’s MORE, Godrej’s Nature’s Basket, Future Group’s Foodhall & Big Bazaar, Tata Trent’s Gourmet West, TESCO’s Star Bazaar & Le Marche has allowed them to enter into front end retail through SIS arrangements in Mumbai, Bengaluru, Hyderabad & Delhi.

Cold Chain Interventions

Pescafresh reaches its customers through organized retail partnerships as well as directly through Home Delivery. Home Delivery is executed from various satellite units with order fulfillment by delivery bike across Mumbai. The Distribution Centre is designed to perform the following functions:

- Receive Seafood in bulk from landing centers, shipped by the most cost effective means.
- Maintain stock at 1-4 degrees Celsius with the help of ice and stored in assorted insulated boxes under HACCP compliant conditions.
- Serve as a check point for inward movement of product (weight validation, quality testing and entry into the Inventory Management System).
- **Home Delivery** - the product is then wrapped in food-grade plastic packing and placed in a leak-proof, insulated thermocol box pioneered by Pescafresh into which the appropriate quantity of ice is added to keep the temperature of the fish at 1-4 degrees Celsius.
- **Inter-state fish distribution:** Fish is packed in thermocol box with adequate layers of ice, which is then transferred via Indian Railways.

- **Inter-city fish distribution:** Fish is packed in plastic trays with multiple layers of ice which helps to maintain product temperature throughout.

### Marketing Channels

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Channel</th>
<th>Temperature</th>
<th>Packaging</th>
<th>Delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Home Delivery</td>
<td>Product chilled to core temperature 1 to 4 degree celsius by keeping it in contact with ice throughout</td>
<td>Wrapped in a polythene paper and arranged on the ice bed in Insulated box</td>
<td>Delivery boy collects the box</td>
</tr>
<tr>
<td>2</td>
<td>Hypermarket</td>
<td>Product chilled to core temperature 1 to 4 degree celsius by keeping it in chiller</td>
<td>Wrapped in a 2D &amp; 4D tray with cling film</td>
<td>Delivery experts load the insulated boxes in the vehicle</td>
</tr>
<tr>
<td>3</td>
<td>Gourmet Stores</td>
<td>Product chilled to core temperature 1 to 4 degree celsius by keeping it in chiller</td>
<td>Wrapped in a 2D &amp; 4D tray with cling film</td>
<td>Delivery boy collects the box</td>
</tr>
<tr>
<td>4</td>
<td>Supermarket</td>
<td>Product chilled to core temperature 1 to 4 degree celsius by keeping it in chiller</td>
<td>Wrapped in a 2D &amp; 4D tray with cling film</td>
<td>Delivery boy collects the box</td>
</tr>
</tbody>
</table>

### Case study on Best International Fisheries Marketing Practices in the area of Cold Chain Development: Sydney Fish Market (SFM)

Sydney Fish Market (SFM) is the largest market of its kind in the Southern Hemisphere and the third largest seafood market in terms of variety in the world. A working fish market, SFM sources product both nationally and internationally and trades over 14,500 tonnes of seafood annually - with up to one hundred sustainable seafood species traded every day and approximately 500 species traded annually. SFM employs approximately 65 staff to organize the weekday wholesale auction, promote Sydney Fish Market as the centre of seafood excellence and operate the Sydney Seafood School.

The quality assurance (QA) procedures involve checking the temperature of product as it arrives at the market cool room to ensure it is less than 5°C – the legal temperature threshold for food safety. Each consignment is inspected and graded, with any notes on the quality of the catch provided to the auctioneer and passed on to buyers before bidding. With seafood coming from throughout New South Wales (NSW), interstate and overseas, the timelines and temperatures can prove the critical difference between a marketable product and one rejected as unsalable. Sydney Fish Market has developed Seafood Handling Guidelines as part of its internal guidance to suppliers and resellers to encourage the adoption of best practice. It includes a revised recommendation to hold product at 4°C or lower. Treatment at the point of harvest is crucial in providing product for sale in the best possible condition. Ice slurries onboard are the best way to remove heat from fish and to bring the internal temperature down to 0°C. slurries of freshwater and freshwater ice can leach colour from the flesh and eyes. Using a mix of fresh and salt water in the slurry can prevent this, although the ratios
change, depending on the species. Once cooled, fish should be removed from the slurry and packed into flake ice; larger ice is more prone to damaging the flesh.

Once packed into crates, the fish are kept in cool storage between 0ºC and 2ºC while awaiting transport. The co-op uses Charter freightlines refrigerated trucks to transport product to SFM. Deliveries are made overnight for sale at the following morning’s auction. Fish for regional markets are packed in polystyrene boxes and delivered by regional couriers.

**Case Study on Slurry Ice Making Machine Onboard MFV Rajani at Versova Jetty, Mumbai: MPEDA**

Slurry ice is a phase changing refrigerant made up of millions of ice "micro-crystals" (typically 0.1 to 1 mm in diameter) formed and suspended within a solution of water and a freezing point depressant. Slurry Ice has greater heat absorption compared with single phase refrigerants (Brine) because the melting enthalpy (latent heat) of the ice is also used. The spherical crystals have good flow properties, making them easy to distribute through conventional pumps and piping and over product in direct contact chilling applications, allowing them to flow into crevices and provide greater surface contact and faster cooling than other traditional forms of ice (flake, block, shell, etc.). Slurry ice is also used in direct contact cooling of products in food processing applications in water resistant shipping containers. It provides the following advantages:

- Product is cooled faster - the smooth round shape of the small crystals ensures maximum surface area contact with the product and as a result, faster heat transfer.
- Better product protection - the smooth, round crystals do not damage product, unlike other forms of sharp, jagged ice (flake, block, shell, etc.).
- Even cooling - unlike other irregular shaped ice which mostly conducts heat through the air, the round shape of the slurry crystals enables them to flow freely around the entire product, filling all air pockets to uniformly maintain direct contact and the desired low temperature.

Even though the advantages of slurry ice are widely known, the fishermen were reluctant in experimenting the new technology and MPEDA intervened a subsidy scheme for the same with 50% subsidy on a pilot scale. A pilot level installation of slurry ice making machine was done on board MFV Rajani at Versova Jetty Mumbai. Ice flow slurry ice making machine manufactured by Icelings, Mumbai was used for the purpose. After the installation, a trial fishing voyage was also conducted to assess the performance of the machine under field conditions and to ensure the stability of the vessel. It was observed that the machine needs around 2.15 hrs to cool the seawater from 30 degree celsius to -2 degree celsius. Slurry ice production takes up a pace once it reaches -2 degree celsius and flow can be controlled after the same if required. The diesel consumption of the slurry ice making machine is approximately is 3.5 ltrs/hr and 250 kg - 330 kg of slurry ice is produced per hour.
After the installation of Slurry Ice Making Machine, a multiday fishing trip consisting of 13 days was also conducted to assess the quality of the ice and the iced products. The overall quality of the fish was very good and had retained the natural colour. The core temperature ranged from -0.8 to -1.4 degree celsius and external temperature ranged from +1 to +1.3 degree celsius. The product was firm and the eyes were having a good lustre.
Way Forward

Cold chain is one of the most critical requirements to guarantee the quality of the fresh, chilled, frozen or processed fishery products. The perishable nature of fish compels its quick disposal in each point of transaction. Several technological innovations and changes have taken place in the marketing pattern of fish both in fresh or processed form of disposal, preservation, storage, transportation, wholesale and retail marketing systems across the globe and the wastages in the marketing process have been considerably reduced due to the innovative technological changes. India needs to urgently frame its policy for promotion of fish in the domestic market and development of necessary infrastructure in the sector.

1. Adequate Policy Support:

   The establishment of modern domestic markets plays a very crucial role in the development of fisheries sector in the country. Apart from ensuring nutritional and food security, it also helps in minimizing post-harvest losses, increasing revenue, enhancing employment opportunities and offers high standards of hygiene and sanitation leading to food safety. In this context, institutions like National Fisheries Development Board (NFDB), Marine Products Exports Development Authority (MPEDA), National Cooperative Development Corporation (NCDC) and National Federation of Fishermen's Cooperatives Ltd. (FISHCOPFED) play an important role for the development of domestic fish marketing system in terms of modernization of wholesale markets and promotion of cold chains, ice plants, cold storages, retail outlets, etc.

   This efforts need to be supplemented by giving increased impetus to the sector, especially by promotion of domestic cold chain and marketing infrastructure on similar lines to the Integrated Cold Chain scheme of the central government. Both the state and the central government need to equally support the development of domestic fish retail network with adequate policy framework to provide fresh and hygienic fish to the consumers.

2. Innovations in Supply Chain:

   The cold chain concept in the country, calls for provisions of integrated facilities to retain the quality of refrigerated or frozen fish from the time of harvesting till it reaches the consumers. This calls for development of cold chain system in the country and requires immediate participation of the industry and replication global success stories across the fish supply chain:

   - Adequate supply of ice at landing centres for holding fresh fish before processing.
   - Containers for holding fresh fish in ice, cold storage at landing centers;
   - Wholesale markets with ample supply of ice
   - Intermediate points on the transit route;
   - Insulated/refrigerated vans for transport of fish and fish products
   - Processing, marketing and distribution centers; and
   - Facilities at retail markets.
3. **Infrastructure development through PPP mode:** While the PPP concept has picked up in many other sectors mentioned above, it is yet to take roots in the fisheries sector. Establishment of high investment projects fishing harbors/Fish Landing Centres (FLCs)/wholesale markets and cold chain are some of the areas where PPP mode can be explored and NFDB/MPEDA could facilitate the process.
YES BANK, India’s fifth largest private sector Bank with a pan India presence across all 29 states and 7 Union Territoriest of India, headquartered in the Lower Parel Innovation District (LPID) of Mumbai, is the outcome of the professional & entrepreneurial commitment of its Founder Rana Kapoor and its top management team, to establish a high quality, customer centric, service driven, private Indian Bank catering to the future businesses of India.

YES BANK has adopted international best practices, the highest standards of service quality and operational excellence, and offers comprehensive banking and financial solutions to all its valued customers. Today, YES BANK has a widespread branch network of over 700 branches across 375 cities, with 1300+ ATMs across India.

YES BANK has a knowledge driven approach in banking, and offers a superior customer experience for its retail, corporate and emerging corporate banking clients. YES BANK is steadily evolving as the Professionals’ Bank of India with the long term mission of “Building the Finest Quality Large Bank of the World in India” by 2020.