

# Linking Farmers to the Market Through Integrated Cold Chain

Dr. B.K. Sikka, Director

Amity Institute of Horticulture Research & Studies  
Amity University Uttar Pradesh, Expressway, Sector-125, Noida

Horticulture is gaining importance in the global effort to combat hunger and malnutrition, as fruit and vegetables are the most affordable source of vitamins, micronutrients, and health-promoting chemicals. India with more than 68 million tones of fruits and 130 million tones of vegetables is the second largest producer of horticultural crops in the world, next to China. It has witnessed a phenomenal surge in recent years, owing to hi-tech interventions, improved R&D, quality seeds/planting material, post-harvest management, back-end support and favorable government policies.

Horticulture play unique role in developing areas both socially and economically and also help in improving income and nutritional status of rural masses in particular. Further, in a country where a bulk of the population is vegetarian, this can be attained through a large variety of fruits and vegetables. Thus, horticulture is to play a much bigger role than what it has done so far. Hence, the quality of fruits and vegetables available to the population reflects the standard of living of the masses of the country. Apart from this, the horticulture is important in augmenting the income of the farmers and also provides additional employment opportunities. Because of their high productivity and value, they have the potential to provide better economic returns per unit area compared to local crops and are a good source of foreign exchange earnings.

One of the weaknesses of the supply chain in horticultural crops is of a multi-layered marketing channel lacking in infrastructure and number of intermediaries resulting in lower returns to the farmers and higher market price to the consumers. Efficient supply chain requires strengthening all the levels of infrastructure such as the inputs and proper information delivery, credit, irrigation, improved procurement, minimizing post-harvest losses, cold chains and logistics, better and efficient processing and marketing techniques, proper storage and warehouse and also efficient and competitive retailing. The infrastructure to improve efficiency and the linkages of the supply chain is very poor, which is affecting the growth potential of the horticulture sector. Due to inefficiency in the supply chain, the price received by the farmers is only about 25 to 60 per cent of the retail price the consumer pays depending on the nature of the crop.

Another issue in the supply chain is the inefficient post-harvest management. The post harvest losses of fruits and vegetables are estimated to be around 25-40 percent, which contribute to higher market prices for consumer but lower return to growers. Changes in the population, economical conditions, life styles, and eating habits have a profound impact on food marketing. There is an increasing demand for fresh and processed fruits and vegetables at the consumer level. Fruits and vegetables are highly perishable in nature and may be unacceptable for consumption, if not handled properly following harvesting. In India, they pass through a long chain before their use, which leads to a

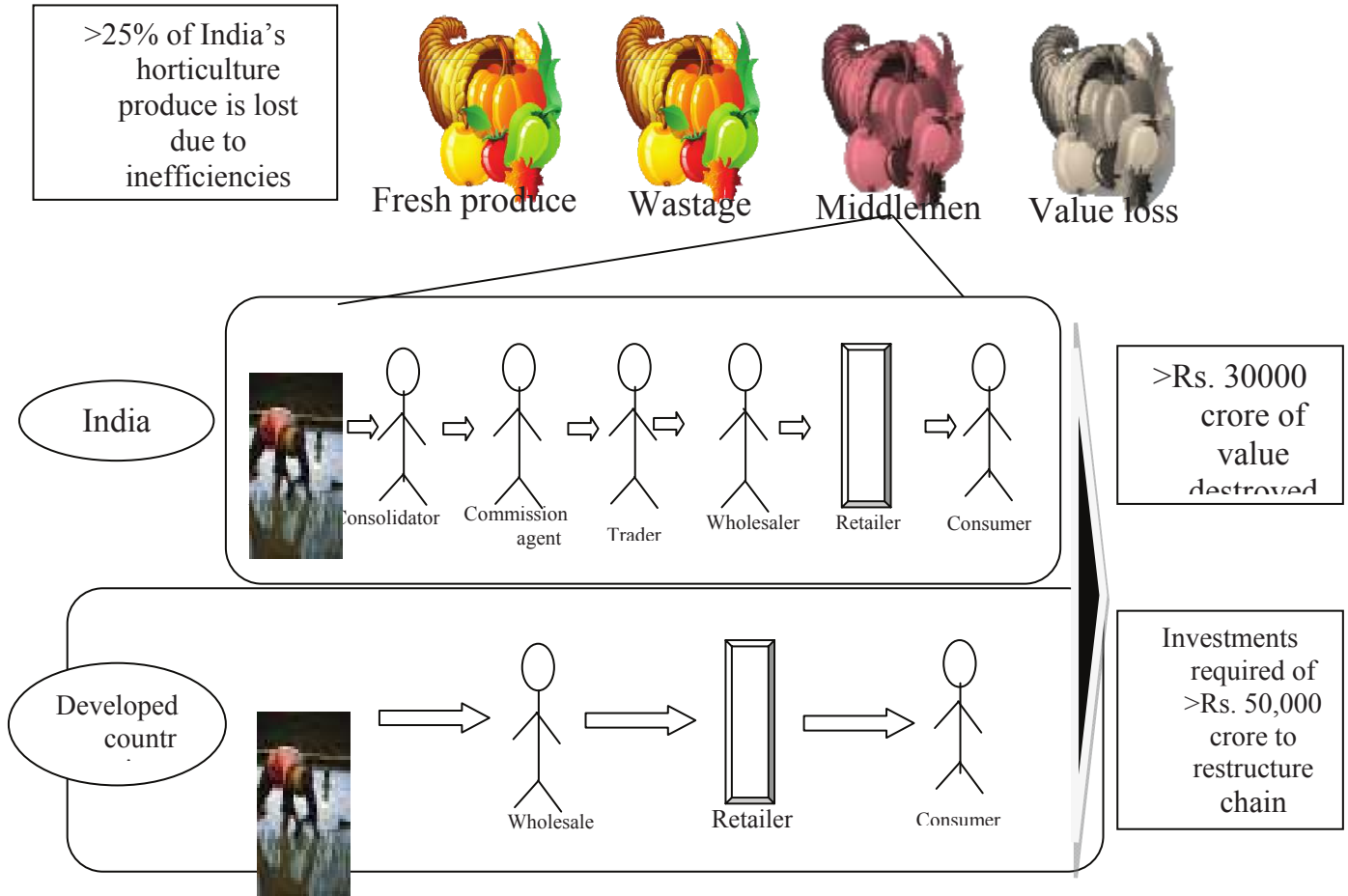
number of undesirable physio-chemical changes in their composition. Fruits and vegetables are also processed into a variety of products (jam, juice, frozen food, canned and fermented products, etc) and require essentially a right stage of picking.

For effective post harvest management of fruits and vegetables and to provide their acceptable quality for value added products for consumption, it is essential to understand their optimum maturity and stage of harvesting, post harvest handling operations, and the physiological changes in their compositions, which take place during the course of ripening, transportation, and marketing. Development of cold chain network will help in reducing the post-harvest losses of fruits and vegetables. Improving the post-harvest management including marketing and distribution means an overall improvement in unit productivity as well as higher returns and export potentials.

In India, the producers' share in consumer rupee is very less in case of perishable produce and the major share goes in the hands of market intermediaries due to inefficient supply chains (**Exhibit1**). Therefore, supply chain management may be a powerful tool in linking farmers to the markets to achieve better returns. Supply chain development not only benefits the private sector but also creates spin-offs that stimulate social, economical and environmental sustainable development in the region (employment generation, added value, decreases of product losses, etc.). Public support (e.g. development of the institutional infrastructure) plays an important role to create an enabling environment for supply chain development. Such support might take the form of a public private partnership in a supply chain to share experiences, risks and bottlenecks. In developing countries and emerging economies, however, supply chain development is often hampered due to lack of governmental support.

## Exhibit 1: Inefficient Agri - Supply Chain in India

### Functional Cost in Chain



With this background, the only suitable option to tide over the problem caused by seasonal marketable surpluses is to undertake expansion of cold storage capacity and integrate it with a sound logistics and transportation system as well as marketing system. As the construction of cold storage is capital intensive, the Government has been giving incentives for the setting up the same. However due to the ceiling on subsidy, the large size cold storage could not come up, thereby making the system unviable. The absence of a policy on integrated cold chain coupled with inadequate subsidy for Reefer Vans, has not helped the cause of setting up integrated cold chain. However with amendment of APMC Acts by the States in recent year, it has allowed and encouraged setting up of big supply and retail chains by few private entrepreneurs who have been setting up integrated cold chain for ensuring quality of perishables in economic scale during it's distribution and retailing round the year across the country. However the same is yet to happen in large scale.

The benefits which will accrue are as follows:

- a) Reduction in post harvest losses
  - b) Improvement in Quality and consumer well-being
  - c) Better Income to Farmers
  - d) Impact on Government Subsidies
  - e) Employment Generation
  - f) Impact on Rural Society
1. Infrastrucure development – roads, water, power etc.
  2. Technology induction in rural areas
  3. Better agricultural practices
  4. Improved access to information
  5. Skill & Entrepreneurship development
  6. Enhanced access to credit.
  7. Improved quality of life

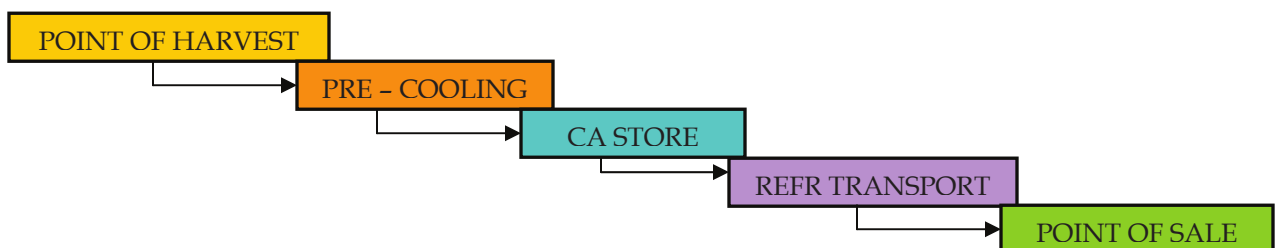
### *The Cold Chain*

Cold chain refers to a complete subset of the total supply chain involving the production, storage and distribution of the perishable products that require temperature control in order to keep the products' characteristics, active ingredients, freshness and nutritive values retained for longer durations.

It is basically a logistics system, which provides and maintains a series of facilities for ensuring ideal storage conditions for the perishables from the point of origin to the point of sale. A well-developed and efficiently organized cold chain reduces wastage, spoilage and helps keep the perishables intact, thereby helping to maintain the quality of the harvested food products in a cost effective manner.

### ***The term cold chain refers to two distinct components:***

'COLD' refers to the need to control temperature in preventing the growth of microorganisms in food while maintaining its wholesomeness as it is processed, shipped, delivered and stored at the stores where as, the term 'CHAIN' focuses on monitoring the 'chain of custody' in which each segment of the processing, storage, transport and delivery functions is linked to the step before and after with proper documentation and records.



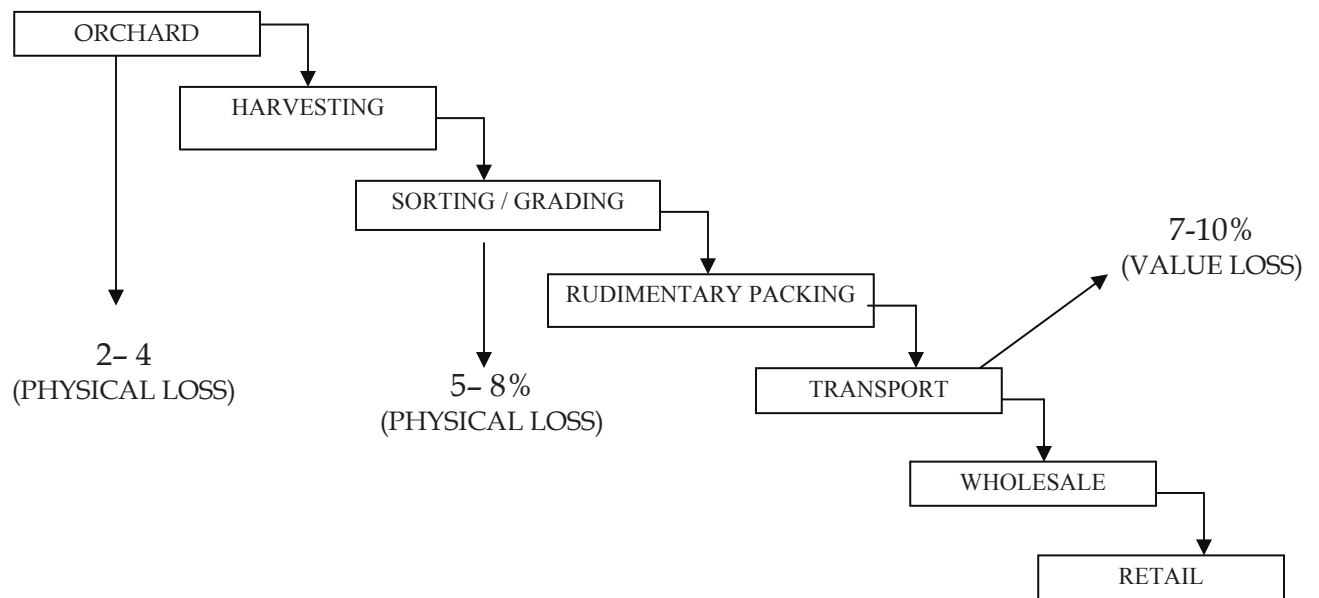
Cold Chain network in India till a few years back has been practically non-existent (even today more or less for fruits and vegetables) with stand alone cold storage facilities passing of cold chain network. Some development has taken place in the last decade being driven primarily by proteins – meat, fish and dairy products but is still largely inadequate.

Most of the cold stores are single chambered, single product facilities which mainly stock up potato and potato seed potato for about 6 months a year and are lying idle during the rest of the year. The technology in use has also been largely based on Evaporative Cooling principle with the use of diffusers and bunker coil and even the change has been ammonia air-cooling units which again is a 7-80 year old technology. The last few years have seen replacement of ammonia with Freon. However, the technology in use along with the design of single chamber, in most of these cold stores is dated resulting in high energy wastages and escalation in cost of storage. The government has been supporting the construction of these large single chambered cold storages through various schemes including those through National Horticulture Board.

With the rapid growth of organized Food Retailing, there are requirements for infrastructures like:

- Efficient end to end logistics
- Controlled Atmosphere / Cold Storage
- Cold Storage at retail points
- Perishable inventory handling capabilities
- Customization of food service / retail chains
- Ability to handle large volumes across different types of products

## Wastages in the Chain



### Cold Chain Infrastructure Requirement

The requirements for cold chain extend right across the product value chain and can be very complicated depending upon the nature of the produce and the ultimate customer preference. Two such routes are given below:

1. Harvest-Primary Market Transport-Secondary Market Transport-Processor-Consumer
2. Harvest-Pre-cooling-Packaging- Reefer Transport-Perishable Center Handover-Dock Unloading-Dispatch-Tarmac-Aircraft

The development of the cold chain network must take into account the needs of the produce right from the farmer to the ultimate consumer. This would reduce not only wastages of produce but also lead to a greater income in the hands of the farmer.

#### A. Development of Cold Chain in Rural Areas:

Development of Cold Chain in rural areas presents the biggest challenge due to lack of existing infrastructure, poor financial strength of the farmers in taking part on an individual basis (high cost of services) and security issues. This can, however, be circumvented through the adoption of an Integrated Cluster Approach involving aggregation of villages in the form of clusters can be done in an effective manner

wherein infrastructural facilities (such as that required for pre-cooling and pack houses in case of fruits and vegetables

### **B. Development of Cold Chain in Urban Areas:**

The development of cold chain infrastructure in the urban areas presents a larger challenge given that most of the fruits and vegetables flows to the primary markets from where it changes multiple hands before reaching the ultimate consumer. The nature of fruits and vegetables determines the storage condition as well as the length of storage. Given the lack of facilities along the transportation route and frequent hold ups at check posts and city borders, traders and farmers often face problems due to produce getting wasted and deteriorated in quality. The need of the hour, hence, is that of an effective cold chain network at these places in order to enable the transporter/owner to store the produce in a congenial atmosphere.

#### **Centres for Perishable Cargo (CPC)**

Major problems faced by the Indian exporters of perishable products relate to the poor and inefficient handling of the perishable commodities at the cargo centres resulting in poor quality of products reaching the international markets. It hampers the export performance and also damages the image of Indian goods in the international market. During summers, when temperature cross 35 degrees Celsius, the handling is inefficient and palletisation procedure is slow resulting in spoilage of perishable commodities. The documentation procedure is also cumbersome and time consuming. This necessitates more efficient and well-equipped cargo centres for perishable commodities

#### **Farm Road Infrastructure**

The Indian road network is the largest in the world aggregating 3.32 million kilometers, consists of 65,569 km of National Highways, 1,28,000 km of State Highways, 4,70,000km of Major District Roads and 26,50,000 km of other District and Rural Roads. National Highways account for only 2 per cent of the total length of roads, but carry about 40 per cent of the total traffic across the length and breadth of the country. Though the main road network is important for movement of agricultural produce, the more crucial part of bringing the produce from the field to the transport point is more often ignored. Even the programmes of rural road connectivity mostly concentrates linking the villages, which is no doubt, important. From the farmer point of view, the farm roads that facilitate transportation of farm produce from fields to the collection centre/mandi are very vital. Providing farm roads will help in transportation of the farm produce without loss of time thus protecting the quality of the produce, which is very crucial factor in perishables.

## **Market Information Infrastructure**

The system of market information has continued to be far from satisfactory. While the traders and processors use their own informal sources, farmers depend both on formal and informal sources. Though, both market news and market intelligence are equally important but farmers are more interested in market news.

### **Challenges:**

The concept of cold chain i.e. handling the produce at low temperature during the entire postharvest processes right from the harvesting till commodity reaches the consumer is by and large missing in India. Harvesting is done under hot and many a times humid conditions, no pre-cooling is practiced, transportation to wholesale markets is again done at extreme hot conditions and rains, and thereafter produce is put into cold storages by wholesalers, again taken out for transportation to retail market, sold by retailers at high temperatures, purchased by consumer and put into the refrigerators till consumed. So the Hot–Cold, Hot – Cold cycle experienced by the fruits increases the postharvest losses both in terms of quantity as well as quality.

Development of protocols for the complete postharvest handling, transportation and marketing of apple in India need to be worked upon. Postharvest processes include the integrated functions of harvesting, cleaning, grading, cooling, storing, packaging, transporting and marketing. The technology of postharvest handling especially cool chain bridges the gap between the producer and the consumer - a gap often of time and distance.

Besides, avoiding mechanical injuries to the fruits and vegetables during harvesting and field handling, temperature, humidity and atmospheric conditions are the most crucial factors that determine safe storability of these perishables for a long time. The cool chain is the only way by which the reduction in post harvest losses can be achieved. At present the gap lies both in technology and its accessibility. Therefore the standardization of technology as well as the establishment of required infrastructure at the growing sites itself and assured marketing would certainly change the scenario altogether. Reduction of post harvest losses of perishables is an indirect contribution to the increase in production and availability of the commodity. There is a need to shift from the traditional system of harvesting, post harvest handling and marketing of fruits and vegetables to specific modules of post harvest handling and marketing for specific crops.

The present method of harvesting, does not meet out the standards and often a major proportion of physical damage and injuries are caused during harvesting and field handling. In some the parts of the state grading is not practiced at all and where so ever it is done it is done manually based on the size only. The present day requirements are some what different. The use of mechanical (size and colour) graders shall be used in



the project. The best lots shall be exported and the second and third grades shall be marketed within the country. The small fruits shall be sent for processing industries (private and cooperatives). Pre-cooling is not at all followed in this part of the country for apple. Pre-cooling shall be done by cold (humid) air followed by transportation in refrigerated trucks to the cold storage sites. The marketing shall then be done by the private players for export as well at domestic levels. The assured marketing and modern infrastructural facilities that is still beyond the imagination and reach of normal growers and farmer of the state shall be made available at the doorsteps of the producers.

The difference between cold storage and cold chain has to get reflected right from the stage of policy formulation to its implementation, more so because till now the policy and efforts have been towards promotion and creation of cold storage as opposed to development of cold chain – thus the need for integrated cold chain – as the absence of any one component in the chain – negates any advantages gained in the previous stage.

This integrated nature of the cold chain, thus, poses, mainly challenges in its development – starting at the production level – in terms the nature of the produce lending itself to longer duration of storage- the integrated nature of the cold chain to right practices being adopted at the point of harvest to eliminate/minimize risks of injury to the produce to post harvest operations – starting again from rapid removal of field heat from freshly harvested produce to movement and storage under controlled temperatures (per the produce requirement) at all levels – intermediate as well as final-before it passes on to the consumer – allowing it to maintain its freshness as well as intrinsic qualities.

Thus, development of appropriate cold infrastructure along the entire chain with emphasis on technology – to minimize energy requirements yet marinating the quality and freshness of the produce - and on human resources as they play a vital role in the handling and operations of the infrastructure required to be developed.

Thus the challenges can be:

1. Production related
2. Infrastructure related
3. Human Resource related

### **Production Related**

Production related challenges again can be further sub divided into

- R&D challenges for the development of the varieties lending itself to longer duration storage and market acceptability
- Management practices

## **Management Practices**

### **Pre –Harvest & Harvest Management Practices**

Crop management practices similarly have a critical role as this impact not only the productivity but also the quality of produce. Timely adherence to the crop calendar, use of integrated pest management, use of micronutrients, improved moisture conservation and fertilizer application not only increase the productivity but also reduce the chances of quality deterioration in terms of both physical and visual characteristics of most of the fruits and vegetables. Cultural practices affect the postharvest quality of a crop. Timely cultivation, moderate use of nitrogen fertilizer, avoidance of drought, and control of fungal infection all increase storage potential. Crops are prone to pests and diseases in the field. Thus, farmers should be aware of crop protection measures. Timing of harvest is another critical point which good management practice takes care of as harvesting should ideally be done in the early morning hours or later in the evening to minimize field heat.

### **Post Harvest Management Practices**

Post harvest management is another crucial management practices as improper practices result in high wastages which can be easily avoided. After harvesting, fruit should not be exposed to sun, rain, or wind.. Fruit and Vegetables should never be allowed to come in contact with soil after harvest as it can lead to contamination which may have impact during storage. Collection points should also be shaded. Researchers have reported up to 10 °C difference in temperature between shaded and exposed fruit. Rudimentary grading at this point can also improve overall fruit quality. Farmers should discard diseased, damaged, or over-ripe fruit. While certain fruits like mangoes etc need to be desapped, care should be taken in case of vegetables regarding washing etc as it can lead to chilling related injuries, if subsequently subjected to cold storage. Similar is the case with ripening and transportation. Presently, most of the fruits and vegetables do not follow scientific ripening and transportation practices. The transportation even over long distances happens in normal, open trucks leading to high temperature exposure thereby leading to reduce shelf life. Additionally, the tightly packed vehicles without use of proper packing materials like crates, wooden boxes etc (widely prevalent in case of vegetables) result in bruising injury and spoilage during transportation. In case of bananas, chemical coating of fruit, treatment of fruit with gibberellic acid, and treatment of fruit with radiation all extend storage life.

### **Technologies Involved:**

- Modern harvesting methods
- Mechanical sorting, size and colour grading
- Pre-cooling
- Refrigerated transportation

- Controlled Atmospheric storage
- Assured purchasing and contract marketing

### **Infrastructure Related Challenges**

Infrastructure poses the biggest challenge within the cold chain. At the post harvest stage, appropriate post harvest management infrastructure is practically non-existent, more so at the farm proximate level.

Along with the lack of infrastructure, the technology in use and more so from a cold chain perspective, does not lend itself to meeting crop/product specific requirements. Till about a couple of years back, technological advancement like humidity control, phase change materials, controlled/modified atmosphere chambers, pressure ventilators were unheard of in the perishable domain.

The other drawback has been the creation of large single chambered storage facilities (primarily for potatoes) with improper insulation materials being used. Multi chambered facilities are being put only over the last couple of years. This result in high operational costs of these units and also the mixing (at times) of multiple products that more or less impinge on the intrinsic qualities of the various produce.

Even today, the use of advancements in technology has not really found their way into the Indian perishable value chain. This is further aggravated by the fact that there has not been any institutional mechanism created within the country which can evaluate emerging technologies in the cold chain and its suitability and adaptability to Indian conditions. Thus, the adoption of technology advancement has primarily been either through a hit and trial mechanism or based on feedback from earlier users and not based on sound scientific evaluations available in the public domain. . Some of these get reflected in

- Temperature abuse in transit —. Temperature recording devices, which are seldom used and more so during transit result in product temperatures varying significantly during transit.
- Absence of proper temperature recording and other related devices – at the cold stores and the container
- Improper storage and handling practices — most of the perishables, are handled in the open at the time of receipt and dispatch even at the cold stores. The doors of the cold stores are kept open during the entire operations resulting in temperature abuse but also high energy costs
- Improper distribution practices

## **Human Resource Challenges**

In the agricultural sector there is substantial scope for creating new jobs through diversification of cropping patterns into cash crops— especially vegetables and horticultural crops. Together, these could generate upwards of 20 to 30 million new on-farm employment opportunities during the next decade. Assessing the huge potential for agriculture sector in general and amendments in APMC Act, large industrial houses have worked out plans for contract farming and branded exports resulting in increased demand for "pre-coolers, bulk cold storages, transport refrigeration and perishable cargo complexes

Lack of trained manpower in the operations and maintenance of cold chain at all stages starting right from harvesting operations to storage and handling, transportation and final product sale is a major challenge that needs to be addressed.

## **Suggested Framework for Human Resources Development**

The various initiatives required to be undertaken to contain the skill gaps are

- Creation of a institutional framework for developing skilled manpower
- Creation of incentives for development of skills along the chain

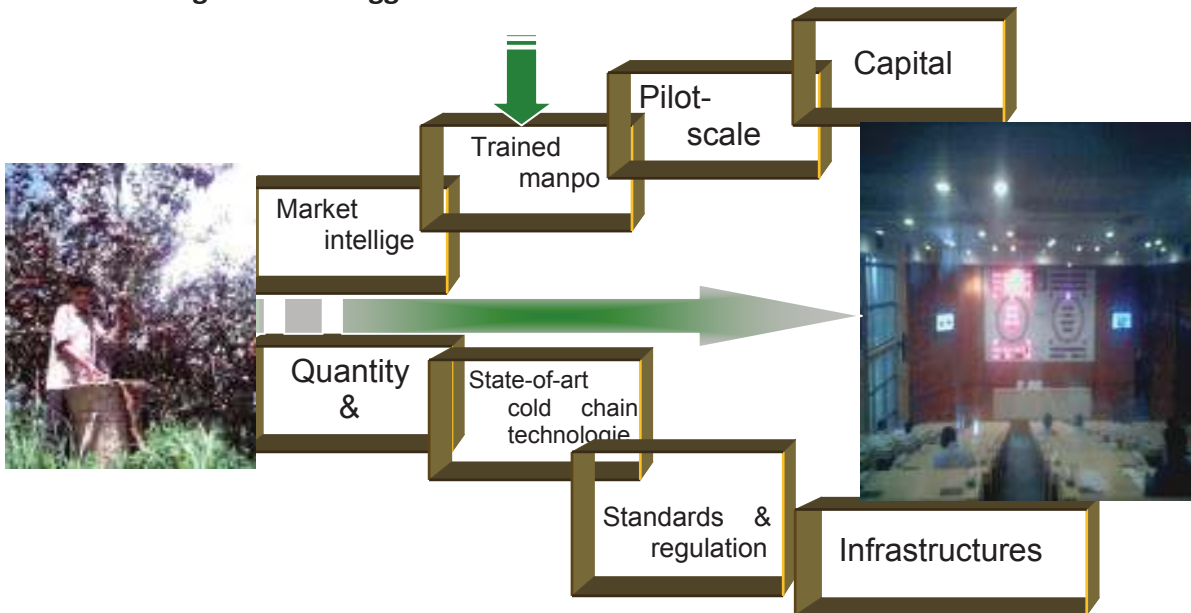
Acceleration of the drivers of consolidation, integration and organization in the industry

## **Suggested Mechanism**

Given the magnitude and complexity involved in the Human Resource Development for the efficacy of the integrated cold chain, a multi-disciplinary, multi agency integrated delivery point for all cold chain logistics information, research, training and systems solutions is suggested to provide for:

- Cold chain logistics training and education to improve skills and knowledge.
- Cold chain logistics accreditation:
- Innovative solutions suited to cold chain issues in India through applied R&D
- Developing standards and certification programs for the cold chain industry
- Assisting industry in development of feasible projects
- Developing specific and generic information packages, seminar programs, workshops and networks

**Exhibit: Farm Gate to Marketplace – Value Addition through Cold Chain Management: A Suggestive Model**



**Way Forward**

Despite the reform in regulatory frame work, India is yet to witness large-scale investment by private sector in the cold chain. This is despite the government extending financial support for setting up cold chain and construction of Reefer vans through various Plan Schemes of National Horticulture Mission and that of Ministry of Food Processing. The government support to this sector has been viewed as limited and in piece-meal, given the high capital requirements for setting up. Given the high cost of energy, the operational cost becomes uneconomical without passing on the burden to ultimate consumers. Large scale investment is essential for transforming the inefficiencies of the food chain. To be able to capitalise on the huge potential of the sector, especially that of mass based high volume foods, will require large scale integration.