Plugging Gaps in Indian Cold Chain:

Use of Refrigerated Containers

Application of refrigerated containers for post harvest management, as a link to augment the Cold Chain, is an unexplored territory and is particularly suited for countries in the tropics having high ambient temperatures.

- Chilukuri Maheshwar

About 30% of fruits and vegetables grown in India (40 million tonnes amounting to US$ 13 billion) get wasted annually due to gaps in Cold Chains like poor infrastructure, insufficient cold storage capacity, unavailability of cold storages in close proximity to farms, poor transportation infrastructure etc. This results in instability in prices, farmers not getting remunerative prices, rural impoverishment resulting in farmers' frustrations and suicides.

India wastes more fruits and vegetables than it consumes. Enough attention has been paid at the Pre-Harvest stage for boosting up the levels of production by techniques like crop rotation, soil conservation, pest control, fertilizers, irrigation etc. But, Post Harvest issues have been addressed inadequately. Despite having achieved national food security, the well being of over 200 million Indian farmers and farm workers who have been the backbone of Indian agriculture continues to be a matter of grave concern.

Operating costs for Indian Cold Storage Units are a whopping over $ 60 per cubic metre per year compared to less than $ 30 in the West. Energy Expenses make up about 28% of the total expenses for Indian cold storages compared to 10% in the West. These factors make setting up of cold storages difficult, unviable and uneconomical.

About 30-35% of these losses can be reduced by transporting the freshly harvested fruits and vegetables in refrigerated containers thus closing this gap in the cold chain. We would need about 20,000 refrigerated containers of standard Twenty Foot Equivalent Unit (TEU) size (with about 0.24 million sq. meters of solar PV panels valued at US$ 0.53 billion fixed on their rooftops to be totally independent of the power grid or DG sets using fossil fuels,), to transport this freshly harvested produce, placed strategically at various locations in the farms all across the country. Commercially, the payback period for this mammoth project is quite attractive. Refrigerated Containers score substantially over conventional refrigerated trucks in terms of suitability for this application in Indian terrain.

By the end of 9th Five Year Plan, India had emerged as the second largest producer of fruits and vegetables in the world, with an annual output of 46 million tonnes of fruits and 91 million tonnes of vegetables of a total worth of US$ 250 billion , contributing nearly 10% and 13% respectively to the world's production. By the end of 10th Five Year Plan, production is expected to increase to 56 million tonnes of fruits and 108 million t of vegetables. Out of this, almost about 30% (41 million tonnes worth US$ 85 billion) get wasted due to various reasons and do not reach the end consumers. India wastes more fruits and vegetables than it consumes. Every 1% reduction in wastage of fruits and vegetables would translate to savings of US$ 0.85 billion. Enough attention has been paid at the Pre-Harvest stage for boosting up the levels of production by techniques like crop rotation, soil conservation, pest control, fertilizers, irrigation etc. But, Post Harvest issues have been grossly neglected or addressed inadequately. Every budget makes a feeble attempt to correct the anomaly by provisions, subsidies and budgetary allocations. However, a comprehensive and strategic game plan in the right direction is sadly missing. There are too many weak links and too many chinks in the so called Indian cold chain.

The Problem

The break up of these Losses which occur due to poor Post Harvest Management facilities and practices is as follows:

a) Poor handling 30%
b) Poor storage 30%
c) Poor transportation 30%
d) Presence of large number of middlemen 5%
e) Lack of knowledge about better preservation techniques 5%.

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The Onion Case

There is an enormous wastage of the highly perishable onion crop due to abysmal or virtually non-existent storage facilities. Maharashtra, producing over quarter of the country's onion output loses about 50% of production each year due to poor storage facilities. Rajasthan, the fourth largest producing state does not have a single cold storage unit and farmers are forced to dump their produce at distress prices, leaving them at the mercy of the traders. The retail prices of onions fluctuate between US$ 1.0 during shortage period to US$ 0.1 per kg during glut period, the farmers getting a remunerative price of US$ 0.01 (1 cent) per kg of produce. Often onions are dumped along the highway as the onion prices do not cover even the transport expenses incurred by the farmers who get stuck in a vicious debt trap. Suicides of onion farmers in Maharashtra are no longer shocking news. The onion story gets replicated for tomatoes, cauliflowers, watermelons, etc.

Export of Mangoes

The reasons for failure of Vijaya - APEDA (Agricultural Produce Export Development Agency) experiment in export of mangoes in 1996 have been identified, one of them being poor maintenance of the cool chain causing a delay of 24 hours of the sea-shipment containers on the dock in high ambient temperature before leaving India. It was not any one element which had failed, but the entire chain had collapsed, all the way from tree management to pack-house practice. Clearly, the problem was not technical, but managerial and systemic.

Profitability of Horticultural Products

Relative profitability of fruits and vegetables was found to be more than 8 and 4.8 times higher respectively than cereals. Although high profits of horticultural crops encourage their cultivation, high yield instability and the high price variability due to poor vertical linkage between production, marketing and processing limit

their widespread cultivation. Instead of speeding up the process of agricultural diversification of high-value commodities, South Asian countries, especially India is lagging behind in reforming institutional arrangements, which can appropriately integrate production and markets by developing roads, creating appropriate infrastructure and encouraging private sector participation for value addition and processing.

Value Addition through Agro Processing

There is a considerable scope for value addition in agro processing. There is not only low value addition in India (7 per cent) compared to China (23 per cent) and developed countries (100 per cent), but also considerable wastage of produce at procurement and storage levels due to the lack of efficient infrastructure for post-harvest management and bottlenecks at market level. Nearly US$ 50 billion worth of fruits and vegetables are lost in the procurement and retail levels constituting 50% of value of the current production in India. There is an urgent need for a model for future agricultural development in line with the ongoing policy of liberalization, privatization and globalisation.

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Impact on Shelf Life

Enough research has been done to elucidate the defects and deterioration in quality occurring in fruits and vegetables due to small temperature differences and their respective impact on the shelf life at various temperatures and loss of quality occurring due to delay in onset of cooling. This is in particular valid for Indian conditions where cold storages are located at considerable distances from the fields.

Inefficiencies in Marketing System

CII - Mckinsey's Food and Agriculture Integrated Development Action (FAIDA) Report on Modernisation of India Food Chain (1997) reported that inefficiency in the marketing system results in wastage and value loss in excess of US$ 10 billion annually. Around 20% of the value of food produced each year gets lost due to inadequate storage and processing capabilities. To avoid these losses and add benefits to the small and marginal farmers, a massive improvement in the existing marketing system and structure had been suggested. Since public investment as a share of GDP has been declining/ stagnating over the years, and is unlikely to solve the problem, enhanced role of private sector was identified as the need of the hour.

Operating Costs

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Export Potential

The poor status of Post Harvest Management in India results in loss of export potential and a dismally low share of India in the export of processed fruits and vegetables (less than 1%) compared to 70% of USA and Brazil, 78% of Philippines and 83% of Malaysia as percentages of total horticultural produce. These low figures are a stark testimony to the lack of infrastructural facilities even in regulated markets in India.

Utilisation of Existing Infrastructure

Presently, there is inefficient and insufficient usage of existing cold storage facilities due to their location, being far way from the farms. The journey from farm to the cold storage is long and arduous by use of open bullock carts or unrefrigerated trucks over unmotorable roads, taking the toll on the products. Refrigerated trucks are in use now, but their usage is limited to long distance transportation of

the products from one city to another due to the obvious voyage economics, rather than from farm to cold storage. Refrigerated trucks suffer from their inherent design deficiencies and are unsuitable for long term and rugged usage. They are simply not robust enough.

Other Considerations

In most of the states, there has been a shift from growing traditional cereal crops to high value horticultural crops, sericulture and animal husbandry. Karnataka having an area of about 1.53 million hectares with production of 11.85 million tonnes under horticultural sector has no organized transportation, cold storage, processing, marketing and export facilities. Without making earnest efforts towards improvement of these elements, aiming to increase production by diversification is totally incorrect.

The Solution

What we require is an integrated cold chain infrastructure covering major production areas, processing units and distribution centers which will call for the following:

ii) Strong fleet of refrigerated transport vehicles to connect the farm level storage facilities, the processing units and the various distribution centres.

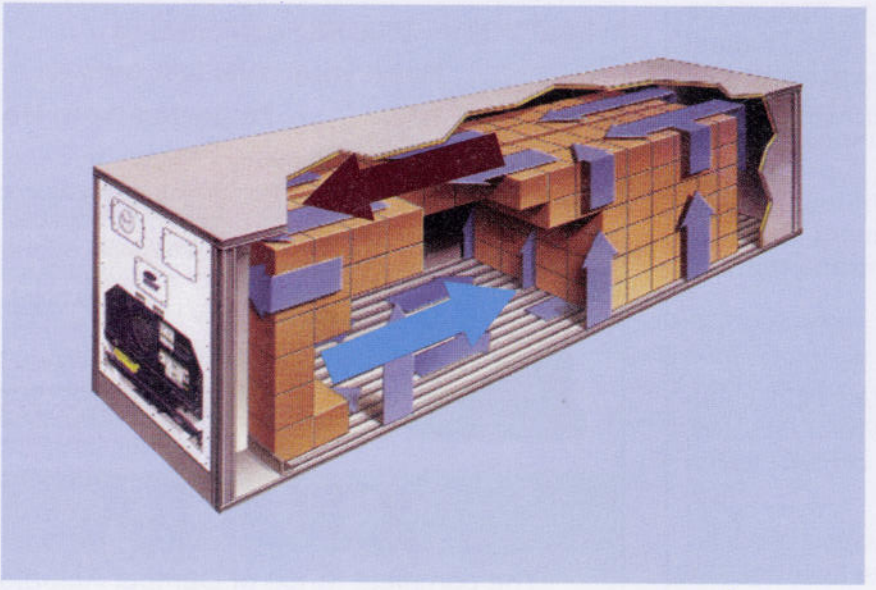
iii) At retail outlets, display cabinets for marketing of frozen food products are to be provided.

iv) Need to augment cold storage facilities and container handling facilities at major ports as also an air cargo complex for targeting the global market.

A grower who can meet the challenges of preserving the quality from field to dinner table will be able to expand his marketing opportunities and will be able to compete better in the market place. If a product does not hold up in the distribution chain, often the grower is blamed for poor handling practices. Refrigeration of the product at the grower's end is highly recommended as the grower has no control over its handling and storage after it is sold and leaves his hands. It buys the growers that extra shelf life time that the wholesaler and retailer might reduce with poor handling procedures.

Losses due to poor storage and transportation

can be minimised by use of Refrigerated Containers which can be used to supplement the existing conventional cold storages. Reefer Containers can also be used for storage and transportation of Potatoes, Onions and Flowers.



Refrigeration as a technique for preservation of food stuffs has been in existence for more than 100 years. This is currently being applied in Post Harvest Management in the form of stationary cold storages. Similarly, the idea of Containerization as a cargo carrying method dates back to 1960s. However, application of Refrigerated Containers for Post Harvest Management as a link to augment the Cold Chain is an unexplored territory and is particularly suited for countries in tropics with high ambient temperatures. International Institute of Container Lessors (IICL) in their 2005 IICL Annual Leased Container Fleet Survey, reported that the total number of Refrigerated Containers currently in use as on 1 January, 2005 were equivalent to 291620 Twenty Foot Equivalent Units (TEUs). In 2005, the IICL members had planned to purchase 33,636 TEUs of Reefer Containers. If non-IICL members are also included, these figures could be much larger. All these containers are deployed for transporting perishable products across oceans. These figures testify to the established reliability of Refrigerated Containers.

Advantages of Refrigerated Containers over Conventional Cold Storages

- Mobility
- Modular Structure
- Standard Sizes/Dimensions
- Ease Of Handling
- Robust Design And Construction
- Ease Of Operation And Serviceability
- Suitability For On-Site Application
- Low Power Consumption Wide Temperature Range

Specifications Of A Standard 20 Feet Refrigerated Container

- External Dimensions: 20x8x8.5 Ft.
- Internal Dimensions: 18x7.5x7 Ft.
- Internal Volume: 1000 Cu. Ft.
- Payload Capacity: 21350 Kgs
- Gross Weight: 24000 Kgs
- Temperature : -25 To +35°C
- Power Consumption: 3 Kwh

Modifications

The refrigerated containers used presently for marine applications are designed to transport parcels of homogeneous cargo across oceans from one part of the world to another. For applications over land in Indian terrain, to suit Indian environmental and climatic conditions, with the presently available power and road infrastructure in India, the following modifications may be needed.

a) The air inlet to the air cooled Condensor needs to be provided with a removable and easily cleanable filter.

b) To enable faster cooling of the products, it may be required to supplement the existing evaporator fan capacity by fitting an additional blower.

c) The entrance doors to interior of the container need to be modified to fold in four parts instead of two doors. They are to be opening inwards rather then outwards as per the present design.

d) They should be provided with an inner set of doors

creating a buffer (handling space) of about 6 feet length.

e) Inside the container, stainless steel racks should be provided all along the length on the sides with moving space at the centre to facilitate storage of harvested fruits and vegetables.

f) An air curtain should be provided in the buffer space to provide a positive pressure inside and exclude dust and other atmospheric elements from outside.

g) The air curtain should be able to be started automatically and be running whenever the outer container doors are open using a microswitch.

h) The container insides should be provided with suitable lighting using power efficient PL or fluorescent lamps with minimal heat generation inside the container. Same to be controlled along with air curtain using the micro switch.

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i) Container floor T bars should be gently sloped down towards the door to facilitate drainage of any accumulated water.

j) Efficient water drains should be provided in the form of suitable U seal tubes.

k) Compressor and other components of the Refrigeration unit should be able to run with the existing single phase power supply available. Alternately, the chassis of the truck on which the container is permanently mounted should be able to accommodate a DG set capable of generating the required power.

l) The present solar power technology gives only a small quantity of power per unit area of solar photovoltaic cells. As technology develops and is made available, the entire unit should be able to run as a stand alone unit running entirely on solar photovoltaic cells mounted on the top of the container, without depending upon any external source of power supply.

m) The controller of the container should be modified and configured to record the timings and duration of opening and closing of the container doors along with other parameters like temperatures, alarms etc.

Economics

Total Annual Losses in Fruits, Vegetables, Meat, Fish & Milk products: 38.77 million MT of Value: US$ 13 bn (25% of total production)

- Payload per Reefer Container: 21 MT
- No. Of Containers Required to transport the total produce: 8 million
- No. Of Containers required if each Container makes one trip a day: 21000
- Cost of a 20 ft. Container with Solar PV panel: $ 15,000+$ 10,200=$ 25,200
- Cost of 21000 Containers: $ 0.529 bn
- With Freight, Duties & Taxes (100%): $ 1.06 bn
- Reduction in Post Harvest Losses achieved per year: $ 4.5 bn (35% of Total Losses).
- Payback Period: 0.25 years or 3 months
- ROI can be higher if Customs Duties & Taxes can be exempted.

Why Solar Power?

- Cost Of 1 Kwh Using DG Set At Current Bunker Prices: 15 Ct
- Cost Of Running Reefer Container Per Hour @3kwh: 45 Ct
- Cost Of Running Reefer Container Per Day (12 Hrs.): $5.40
- Cost Of Running Reefer Container Per Year (365 Days): $1971
- Cost Of Running Reefer Container Using Solar Power: Nil
- Payback Period Of Solar Power Vs. Dg Set: 10,200/1971= 5.17 Years
- Payback Period With Freight, Duties & Taxes (100%): 10.34 Years
- Other long term environmental and social gains.

Additional Considerations

- **Suitable Elevated Land** to place the Containers to

avoid flooding

- **Alternatively** the Containers may be mounted on the Truck Chassis.
- **Power supply requirement:** 3 PHASE 440 VOLTS. Can work on 220 Volts power supply also. Alternatively, Power supply can be provided from rooftop mounted Solar PV panels or a dedicated DG Set mounted on Truck Chassis
- **Motorable Roads** access to the farms for free movement of Containers.
- **Location of Containers:** Within close proximity at the periphery of the Farms.
- For higher productive areas, where more than one Container is required Horizontal & Vertical Stacking can be done.
- **Creating Awareness** in Rural farming Community on a national scale regarding the benefits and usage of Refrigerated Containers.

Social Angle

India has a major chunk of its population (200 million) depending on agriculture and related activities for their livelihood. Any Reduction achieved in Post Harvest Losses would directly contribute to their health and prosperity, measured by the actual reduction in rural impoverishment, and farmers' suicide rate. It would also directly contribute to the better health of the entire population due to preservation of natural nutritional value of the food products. A life saved is a life gained.

Benefits

- **To Customers:** Better Quality produce guaranteeing additional returns.
- **To Farmers:** Better returns for their efforts in the form of additional revenue due to extended life of the product, reduction in loss of moisture content, fewer incidences of pilferage, reduced spoilage and wastage.
- **To End Consumers:** Availability of fresh and better nutritional product, more choice of foodstuffs, better health standards.
- **To Government:** More revenue in the form of taxes for goods sold, greater export potential especially in view of stricter standards recently imposed, encouragement to intellectual and technological awareness among citizens.

Post Harvest Management - A Panacea!

This is just an overview of the entire issue - simply a tip of the iceberg. It is important to adopt correct handling practices throughout a product's post harvest life i.e., from the field to the consumer. Agriculture is a very competitive and risky business; it emphasizes the importance of control at various stages of the product movement viz. Grading, Packaging, Pre-cooling, Storage and Transportation so that correct product quality is maintained. It is not to be treated as an individual activity. It is a community activity involving growers, shippers, importers, carriers, government authorities, equipment suppliers and others. Only commitment, communication and free flow of information from all concerned parties make it a successful enterprise. ■

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