



Development of Cold Supply Chain for a Controlled Atmosphere Cold Store for Storage of Apple

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Abstract:

Supply chain strategies are critical backbone to business organizations today. The implementation of supply chain management can reduce costs, facilitate information sharing, enable enterprise to maintain high degree of market sensitivity and can respond effectively to market uncertainty. The study is carried out to develop a cold supply chain for a Cold Storage installation company. The study uses supply chain based approach for development replacing mere storage based development approach. The first step will be Study of the existing supply chain and to list the possible challenges. Holistic development has been considered to link and integrate the current supply chain for improvement in it. The study will include corresponding mitigation strategies to overcome the identified issues and challenges. In order to collect the information needed to complete the project, the researcher will collect the data from the company, government agencies and miscellaneous sources available. This information will enable the researcher to visualize the current scenario and look for opportunities to improve the cold chain.

Keyword: Cold supply chain, Controlled atmosphere cold storage, Distribution network, Reefer transport, Supply chain management

1. INTRODUCTION

The agriculture sector in India plays a major economic role. This sector employs many direct workers, has a wide network of suppliers, and is directly responsible for a significant share of the Gross Domestic Product. India over the years witnessed a marked increase in production of perishable high nutrition products like fruits, vegetables, meat and poultry products etc. but development of cold-chain infrastructure was not strategically directed, for safe handling and to convey these perishable products to markets, except in the dairy sector. A resultant demand supply mismatch emerged across the Apple supply chain, frequently contributing to wide spread price fluctuations and inflation. The inadequacy of scientific farm-to-market logistics, also contributed to high losses, further adding to inflationary pressures. These inflationary trends are evaluated to be mainly due to ineffective post-harvest logistics on domestic front, which was unable to cope with increased demand and the associated increase in production. Cold-chain is an industrial technology, and as an application has extended itself from a merely preservative role into a larger life enhancing solution for the fresh food sector only recently. Cold-chains have become the prime link between a long existing production base (the farms) and consumption centers.

2. LITERATURE REVIEW

The term "supply chain management" entered the public domain when Keith Oliver, a consultant at Booz Allen Hamilton (now Strategy&), used it in an interview for the Financial Times in 1982. The term was slow to take hold. It gained currency in the mid-1990s, when a flurry of articles and books came out on the subject. One of the first to formally define supply chains as encompassing all activities associated with the flow and transformation of goods from raw materials

through to the end user, as well as the associated information flows.

2.1 Concept of Supply Chain Management

Supply chain management was thus defined as the integration of these activities through improved supply chain relationships to achieve a competitive advantage. In the late 1990s it rose to prominence as a management buzzword, and operations managers began to use it in their titles with increasing regularity

2.1.1 Ganeshan and Harrison Terry (1995) has defined SCM as a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers.

2.1.2 Lee Hau L. & Corey Billington (1995) stated that SCM consists of the integration activities taking place among a network of facilities that procure raw material, transform them into intermediate goods and then final products, & deliver products to customers through a distribution system.

2.1.3 Christopher (1998) defined the supply chain as the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer.

2.2 The Supply Chain and the Cold Chain

The supply chain has more than one definition. Kovacs (2008) states that supply chain are a "product- based approach" of industrial ecology. It includes the companies that providing the products, raw materials, technology and service. Furthermore, companies which help to make the operation of the production chain smooth can also be considered as part of the supply

chain. Maxwell et al. (2006) argue that the both supply chain and cold chain management could be defined under the "umbrella" of the sustainable production and consumption. Given above, the supply chain means that sustainable operation and coordination of the companies are involved in the process of providing the products. As a special kind of supply chain, the cold chain refers to a physical process that dominates the supply chain logistics of certain processed food. Equipment and facilities are used in the cold chain to protect the chilled and frozen food (Salin et al., 2002). Bishara (2006) gives another definition to the cold chain: "a cold chain is a supply chain of perishable items". Furthermore, a cold chain can be used in many other areas, such as food, pharmaceutical and chemical products. The common thing of those products is the high requirement on the temperature, humidity, light or other particular conditions. In this paper, the cold chain and the food cold chain refer to the same thing. Therefore, the two main differences between supply chain and the cold chain are: first, compared with supply chain, the cold chain demands a lot on the operating conditions; second, from the production spots to the consuming place, products in the cold chain have the possibility to spoil (Joshi et al., 2009). Meanwhile, the relationship between supply chain and cold chain is that, cold chain can be viewed as facilities and conditions demanded in a supply chain (Salin et al., 2002); and sustainability is important for both of them (Maxwell et al., 2006).

3 Company Background

ABC is a Private limited. It is classified as Non-government Company and is registered at Registrar of Companies. The objective of company is to carry on business of preservation of fruits and vegetables, food processing, efficient storage and transportation, construct and install CA cold storage facility with objective to increase the shelf life of fruits and vegetables so that the farmers can get the best prices for their produce.

4 Controlled Atmosphere Cold Storage

Controlled Atmosphere (CA) storage uses oxygen and carbon dioxide Concentrations of about 1% to 5% for each gas in most

applications. Normal room air has an O₂ concentration of about 21% and CO₂ levels near 0.03%. Low O₂ and high CO₂ levels slow the ripening process, stop the development of some storage disorders such as scald in apples, and slow the growth of decay organisms. All of these effects increase storage life of fresh produce compared with conventional refrigerated stores. These facilities are recommended for long term storage of fruits and vegetables like Apples, Pears, kiwi, cabbage etc. for up to 10 months. In Indian context, use of Controlled Atmosphere technology has increased steadily, contributing significantly to extending the post-harvest life and maintaining the quality of apples during the past few years. This trend is expected to continue as technology advances are made in this field. CA storages are generally multiple chambers with each chamber of capacity of 50-250 MT. However, it is expected that economically viable designs of small CA storages of single chamber and storage capacity of 50 MT or so may come up in near future. In CA stores produce is stored in large bins which are stackable up to 11 high (total 1 chamber height up to 10 m) or in PVC crates which can be stacked in Mild steel pallet frames up to 4 levels high (chamber height up to 8 m). Storage in CFB box may also be resorted to for short duration storage of fruits like strawberry. The refrigeration system is designed to maintain temperature of -1°C with humidity of 90%- 95% RH. Recommended levels of O₂ and/ or CO₂ are automatically regulated, measured and corrected during the storage period. Manual regulation supported by high precision analyser has been in use in some countries but are getting phased out. In spite of cost implication Automatic regulation levels of O₂ and/ or CO₂ is recommended to minimise possibility of storage disorders in high value produce stored in CA storages. Several types of CA storage technology are available which include Ultra Low Oxygen Cold Store (ULO) for storage atmosphere below 2%, Low Ethylene CA storage, Rapid CA cold store for rapid establishment of optimal levels of O₂ and CO₂ levels and Programmed/ Sequential CA storage. Such facilities are recommended to be store under the desired storage and CA conditions within 5 to 7 days of harvest.

Table.1. Investment comparison for cold storage

| Particulars | Investment | | | |
|-----------------------------|-------------------|------|-----------------------|------|
| | Normal Atmosphere | | Controlled Atmosphere | |
| | Rupees(lacs) | % | Rupees(lacs) | % |
| Land | 38.51 | 3.7 | 42.90 | 2.6 |
| Construction | 585.99 | 56.3 | 864.70 | 52.4 |
| Equipment | 379.90 | 36.5 | 683.18 | 41.4 |
| Truck | 5.20 | 0.5 | 9.90 | 0.6 |
| Miscellaneous | 31.22 | 3 | 49.51 | 3 |
| A. Fixed investment | 1040.83 | 100 | 1650.19 | 100 |
| Labour | 4.59 | 35.8 | 6.25 | 37.6 |
| Electricity | 6.17 | 48.1 | 7.40 | 44.5 |
| Fuel | 0.40 | 3.1 | 0.27 | 1.6 |
| Water | 0.23 | 1.8 | 0.28 | 1.7 |
| Maintenance | 0.49 | 3.8 | 0.91 | 5.5 |
| Insurance | 0.72 | 5.6 | 1.36 | 8.2 |
| Communication | 0.23 | 1.8 | 0.15 | 0.9 |
| B. Working Capital | 12.83 | 100 | 16.63 | 100 |
| Total Investment cost (A+B) | 1053.66 | | 1666.82 | |

4.1 Present scenario of apple supply chain: Traditional Model is a complex chain for the supply flow of Apple, which

is predominantly followed currently in traditional chain. Players involved in this model are agents (commission agents),

auctioneers, wholesalers, traditional retailer of all type, roadside shops, pavement shops and cart vendors apart from farmers and customers. Agents, auctioneers, and wholesalers are traders in apple supply chain. Farmers are the cultivators of produce and source of apple produce. Farmers in India are small by land holding, yield volume of crop and are highly fragmented across geographical areas. In this traditional supply chain model, farmers sell their products to the customers through various intermediate partners who eat the entire price share in the market.

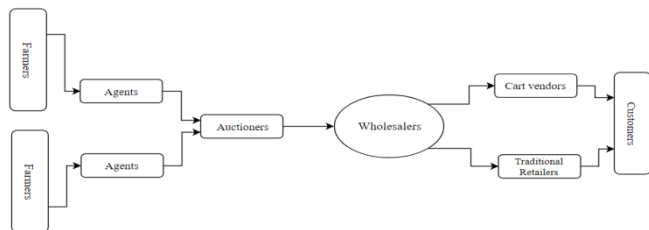


Figure.1. Existing supply chain of apple

When considering distribution between any other pair of stages, such as supplier to manufacturer or even a service company serving its customers through a distribution network, many of the same options still apply. Managers must make two key decisions when designing a distribution network:

1. Will product be delivered to the customer location or picked up from a preordained site?
2. Will product flow through an intermediary (or intermediate location)?

Based on the firm's industry and the answers to these two questions, the following network has been developed

Through effective and efficient market linkage, perishable produce from horticulture is able to maximize upon its potential, by not only realizing optimal value to the growers, but also by providing cause to farm more quantities, produce better yields and use more resourceful technologies. The supply chain networks that ensue also make sure more of the food is delivered to consumers, less is lost in its delivery, and allows for more stable economic trends.

4.2 Proposed Cold Chain

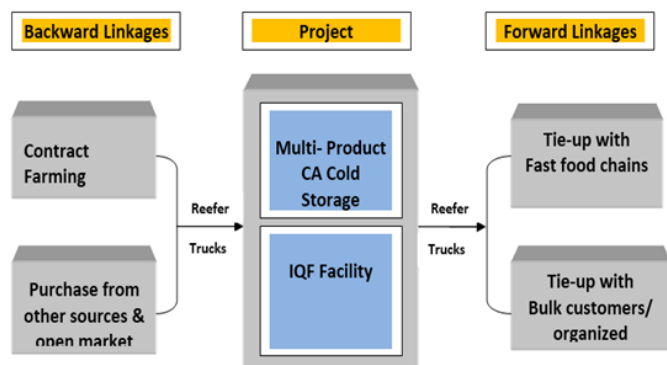


Figure. 2. Proposed Cold Chain

4.3 Future impacts on farmers

- Integrated Cold Atmosphere Storage for fruits and vegetables will lead to reduction in wastage which will help farmers to get better value for their crop.
- Increase in income of farmers by better price realization through contract farming and also elimination of agents. Help attract farmers into production of high value crops and attract more farmers to boost their confidence, resulting into more income for farmers.
- Efforts will also be made directly with farmers to not only

increase production of cash crops but also help reduce cost of production for farmers thus resulting into more income for them. Full time employment to 20 personnel and part time/ indirect employment to hundreds of farmers, local construction workers, equipment suppliers, transport workers, retailers etc.

- Additional income will be generated for both Central and state governments in the form of excise duties, sales tax, income tax etc.
- Last but not the least, the success of this project will attract more investment into this sector which will not only help farmers but also government in boosting its efforts to build preservation infrastructure facilities in India.

5. CONCLUSIONS

The present study undertakes a thorough review of basic and contemporary literature available and identified the issues which are affecting the supply chain of apple. Literature collected for study includes research papers from peer-reviewed journals, and data from the industry. Holistic development is of utmost importance in integrating the supply chain, to improve the existing domestic supply of apple, to include the complete basket of perishable foods in cold-chain, to mitigate food losses and to improve direct market connectivity for producers. Cold-chain primarily functions as a chain of activities to prepare and facilitate market reach of apple, with minimal damage. Cold storages form one part in this chain in collaboration with modern pack-houses and refrigerated vehicles.

- Presently apples are transported at ambient temperature from the producing regions to consumption markets through this study a future strategy may be developed for cold supply chain for apple, by the planning and policy for a self-sustainable development of cold-chain.
- The cold storage is a stepping stone to markets; its establishment will not only enhance the life of apple fruit but also the life of stakeholders by eliminating the intermediate agents. Lack of reefer transport hampers the application of cold-chain and is a missing link.
- Since most small and medium sized farmers need cash soon after harvest, they evacuate their produce to the nearest Mandi immediately to try and reduce product risk, obviating the need for cold storing.
- Cold-chain will create the greatest socio-economic impact when used as a logistics medium that will help farmers to directly connect with distant and emerging markets.

6. REFERENCES

- [1]. All India Cold-chain Infrastructure Capacity (Assessment of Status & Gap), By National Centre for Cold-chain Development (NCCD), 2015.
- [2]. Saurav Negi and Neeraj Anand, "issues and challenges in the supply chain of fruits & vegetables sector in india: a review", International Journal of Managing Value and Supply Chains (IJMVSC) Vol. 6, No. 2, June 2015
- [3]. M. Cagla Ormeci Kart, Vecdi Demircan, "Analysis of investment cost of apple cold storage facilities", Custos e @gronegocio online - v. 11, n. 1 - Jan/Mar - 2015. ISSN 1808-2882.

[4].Guidelines & minimum System Standards for Implementation in Cold-chain, Delhi, NCCD 2014.

[5].Aziz Muysinaliyev, SherzodAktamov, “Supply chain management concepts: literature review”, IOSR Journal of Business and Management (IOSR-JBM) e-ISSN: 2278-487X, p-ISSN: 2319-7668. Volume 15, Issue 6 (Jan. 2014), PP 60-66

[6].Vipul Chandra Tolani and HuzefaHussain, “Strategic Change in Model of Fruit and Vegetables Supply Chain”, Global Journal of Management and Business Studies. ISSN 2248-9878 Volume 3, Number 9 (2013), pp. 965-970

[7].Sichao Lu, Xifu Wang, “Toward an Intelligent Solution for Perishable Food Cold Chain Management”, IEEE 2016.

[8].TianbaoXie, MengZha, “Research on Cold Chain Logistics Joint Distribution Model Based on Cloud Logistics”, IEEE 2016.

[9].Pei Zhang*, HanpingHou, Jianliang Yang, Dawei Zhang, “Study on Appreciation Strategy of Meat Cold Chain in China”, IEEE 2016.

[10].Xuebing Wang, “Keep the Products Fresh: A QFD Approach to Improve the Logistics Service Quality of Cold Chain” IEEE 2016.

[11].Christian C. Emenike, Nardus P. Van Eyk, and Alwyn J. Hoffman, “Improving Cold Chain Logistics through RFID temperature sensing and Predictive Modelling”, IEEE 19th International Conference on Intelligent Transportation Systems (ITSC) 2016.

[12].All India Cold-chain Infrastructure Capacity (Assessment of Status & Gap), By National Centre for Cold-chain Development (NCCD), 2015.

[13].Chang Daofang, Zhu Jinfeng, and Lin Danping, “Cold Chain Logistics Distribution Network Planning Subjected to Cost Constraints”, International Journal of Advanced Science and Technology, Vol.75 (2015), pp.1-10.