AN ANALYSIS OF COLD CHAIN FOR PERISHABLES IN NAMDHARI FRESH

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Project Report submitted to the

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in partial fulfillment of the requirements for the degree of

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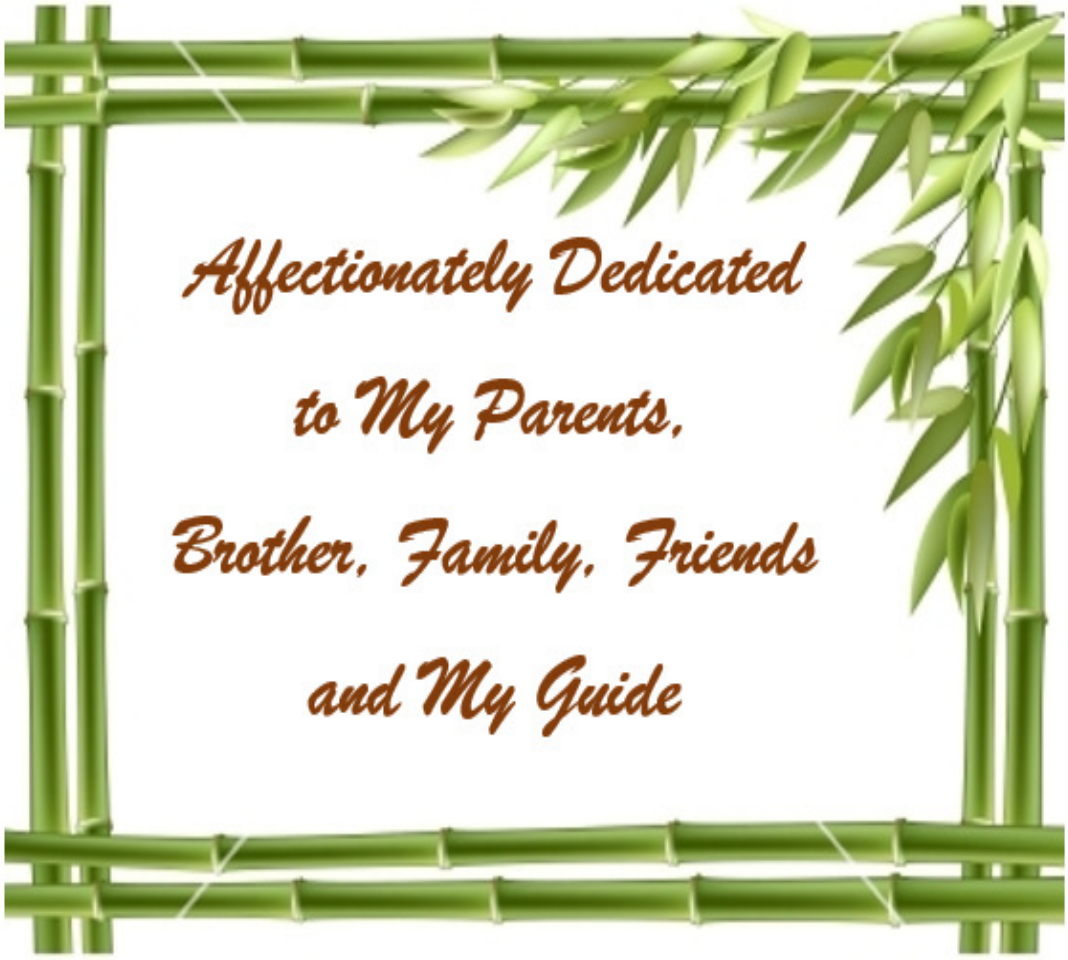
Affectionately Dedicated
to My Parents,
Brother, Family, Friends
and My Guide

DEPARTMENT OF AGRICULTURAL MARKETING, CO-OPERATION AND BUSINESS MANAGEMENT
UNIVERSITY OF AGRICULTURAL SCIENCES,
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CERTIFICATE

This is to certify that the Project Report entitled **"AN ANALYSIS OF COLD CHAIN FOR PERISHABLES IN NAMDHARI FRESH" submitted** by **Ms. NISHTHA, S. PATRAVALI., ID. No. MBAL 5008,** in partial fulfillment of the requirements for the degree of **MASTER OF BUSINESS ADMINISTRATION (AGRIBUSINESS MANAGEMENT)** to the University of Agricultural Sciences, Bengaluru is a bonafied record of research work done by her during the period of her study in this University, under my guidance and supervision and the project work has not previously formed the basis of the award of any degree, diploma, associateship, fellowship or other similar titles.

Bengaluru,
September, 2017

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AN ANALYSIS OF COLD CHAIN FOR PERISHABLES IN NAMDHARI FRESH

NISHTHA, S. PATRAVALI

ABSTRACT

Cold-chain is now recognized as a sunrise sector in India. For safe handling and to convey the perishable products to markets the development of cold-chain infrastructure is not strategically directed, except in the dairy sector. The objectives of the present study was to document the cold chain infrastructure and utilization pattern available, analyze the value chain for perishables and also to identify the constraints in operationalization of cold chain in Namdhari Fresh. The data was collected from the Namdhari Fresh company to know and understand the procurement pattern and cold-chain flow and value chain for perishables. To maintain the quality of perishables, cold chain infrastructure was established by Namdhari. The company has maintained eight cold storages unit to ensure the freshness of vegetables till it reaches the consumers. The company was supplying inputs to the farmers on contract basis and the quality check of the produce was done soon after the farmer unloads their produce in the procurement center. The major constraint in operationalization of cold chain was the water leakage problem with 70 mean score followed by temperature fluctuation with 66 mean score in cold storage rooms. Availability of technicians was least problem with 26 mean score. The company can improve their cold chain infrastructure by adopting new technologies for cold storage and assisted by various government schemes.

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ನಾಮಧಾರಿ ಫ್ರೆಶ್‌ನಲ್ಲಿ ಹಣ್ಣು ಮತ್ತು ತರಕಾರಿಗಳ ಶೀಥಿಲ ಸರಪಳಿಯ ಒಂದು ವಿಶ್ಲೇಷಣೆ

ನಿಷ್ಠಾ ಪತ್ರಾವಳಿ

ಸಾರಾಂಶ

ಭಾರತದಲ್ಲಿ ಶೀಥಿಲ ಸರಪಳಿಯು ವೇಗವಾಗಿ ಬೆಳೆಯುತ್ತಿರುವ ಒಂದು ಮುಖ್ಯ ಕ್ಷೇತ್ರವಾಗಿದೆ. ಹೈನುಗಾರಿಕೆಯನ್ನು ಬಿಟ್ಟು ಇತರೆ ಕ್ಷೇತ್ರಗಳಲ್ಲಿ ಹಾಳಾಗುವ ಪದಾರ್ಥಗಳನ್ನು ಸಾಗಾಣಿಕೆ ಮತ್ತು ಶೇಖರಣೆಯಲ್ಲಿ ಶೀಥಿಲ ಸರಪಳಿಯ ಕೊರತೆ ಎದ್ದು ಕಾಣಿಸುತ್ತಿದೆ. ಪ್ರಸ್ತುತ ಅಧ್ಯಯನದ ಮುಖ್ಯ ಉದ್ದೇಶಗಳೆಂದರೆ ಶೀಥಿಲ ಸರಪಳಿಯಲ್ಲಿ ಲಭ್ಯವಿರುವ ಸೌಕರ್ಯಗಳು ಹಾಗೂ ಅದರ ಉಪಯೋಗಿಸುವ ಮಾದರಿ, ಬೇಗ ಹಾಳಾಗುವ ಆಹಾರ ಪದಾರ್ಥಗಳ ಮೌಲ್ಯವರ್ಧನ ಸರಪಳಿಯ ವಿಶ್ಲೇಷಣೆ ಹಾಗೂ ನಾಮಧಾರಿ ಫ್ರೇಶ್‌ನ ಶೀಥಿಲ ಸರಪಳಿಯ ಉಪಯೋಗಿಸುವಲ್ಲಿ ಇರುವ ತೊಂದರೆಗಳನ್ನು ಅಧ್ಯಯನ ಮಾಡುವುದಾಗಿದೆ. ಅಧ್ಯಯನಕ್ಕೆ ಮಾಹಿತಿಯನ್ನು ನಾಮಧಾರಿ ಫ್ರೆಶ್ ಸಂಸ್ಥೆಯಿಂದ ಪಡೆಯಲಾಯಿತು. ಹಣ್ಣು ಮತ್ತು ತರಕಾರಿಯ ಗುಣಮಟ್ಟವನ್ನು ಕಾಪಾಡಲು ಶೀಥಿಲ ಸರಪಳಿ ವ್ಯವಸ್ಥೆಯನ್ನು ಮಾಡಲಾಗಿದೆ. ಶೀಥಿಲ ಸರಪಳಿಯಲ್ಲಿ 8 ಶೀಥಿಲ ಗೃಹಗಳನ್ನು ವ್ಯವಸ್ಥೆ ಮಾಡಲಾಗಿದೆ. ಒಪ್ಪಂದ ಕೃಷಿಯ ಅನುಗುಣವಾಗಿ ಉತ್ಪಾದಕರಿಗೆ ಎಲ್ಲ ಸಲಕರಣೆಗಳನ್ನು ಒದಗಿಸಲಾಗಿದೆ. ಹಣ್ಣು ಮತ್ತು ತರಕಾರಿಗಳು ಖರೀದಿ ಕೇಂದ್ರಕ್ಕೆ ಬಂದ ತಕ್ಷಣ ಅದರ ಗುಣಮಟ್ಟವನ್ನು ಪರೀಕ್ಷಿಸಲಾಗುತ್ತದೆ. ಶೀಥಿಲ ಸರಪಳಿಯಲ್ಲಿ ನಾಮಧಾರಿ ಫ್ರೆಶ್ ಎದುರಿಸುತ್ತಿರುವ ಅತೀ ಮುಖ್ಯ ತೊಂದರಗಳೆಂದರೆ ಶೀಥಿಲ ಗೃಹಗಳಲ್ಲಿ ನೀರು ಸೋರುವಿಕೆ 70 ಗ್ಯಾರೆಟ್ ಶ್ರೇಯಾಂಕ, ಉಷ್ಣಾಂಶದ ಏರುಪೇರುಗಳು 66 ಗ್ಯಾರೇಟ್ ಶ್ರೇಯಾಂಕ ಆಗಿವೆ. ಶೀಥಿಲ ಸರಪಳಿಯ ನಿರ್ವಹಣೆಗೆ ತಂತ್ರಜ್ಞಾನದ ಕೊರತೆಯು ಇದೆ ಗ್ಯಾರೆಟ್ ಶ್ರೇಯಾಂಕ 26 ಶೀಥಿಲ ಸರಪಳಿ ವಿಸ್ತರಣೆ ಮಾಡುವ ಸಮಯದಲ್ಲಿ ಈಗ ಇರುವ ತೊಂದರೆಗಳನ್ನು ನಿವಾರಿಸಲು ಹೊಸ ತಂತ್ರಜ್ಞಾನವನ್ನು ಅಳವಡಿಸಿಕೊಳ್ಳಲು ಸೂಚಿಸಲಾಗಿದೆ. ಸರ್ಕಾರದಿಂದ ದೊರೆಯುವ ಸೌಲಭ್ಯವನ್ನು ಉಪಯೋಗಿಸಲು ಸೂಚಿಸಲಾಗಿದೆ.

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An Analysis of Value Chain for Perishables in Namdhari's Fresh

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Introduction

Value-chain is now recognized as an important instrument to strengthen the overall agriculture development. A value chain includes all the activities that are undertaken in transforming raw materials into a product that is sold and consumed. These include the direct functions of primary production, collection, processing, wholesaling and retailing, as well as the support functions, such as input supply, financial services, transport, packaging and advertising. The fruits and vegetables consumption in India is mainly in the fresh form. It is essential that they are stored in a system that can maintain their freshness until when consumed without any noticeable physiological disorder, hence value addition is essential for perishables.

Cold-chain is a logistic system that involves various activities and provides a series of facilities for maintaining ideal storage conditions for perishables from the point of origin to the point of consumption in the food supply chain. The chain needs to start at the farm level (e.g. harvest methods, Pre-cooling) and cover up to the consumer level or at least to the retail level. A well-organized cold-chain reduces spoilage, retains the quality of the harvested products and guarantees a cost-efficient delivery to the consumer given adequate attention for customer service.

The Cold-chain logistics infrastructure generally consists of:

- Pre-cooling facilities
- Cold Storages
- Refrigerated Carriers
- Packaging
- Warehousing
- Information Management systems (Traceability and Tracking etc.)

Objective

To analyze the value chain for perishables in Namdhari's Fresh

Methodology

Study Area:

- The present study was conducted in Bengaluru city during the year 2017. In Bengaluru, Namdhari's Fresh company was chosen for the study.

Fig. 1 : Map showing the study area- Bengaluru district

Sampling procedure:

- The data regarding the value chain was collected from the company. The primary data was collected on value chain from the Namdhari's Fresh company to know and understand the procurement pattern and value chain flow for perishables.

Data collection:

- The primary data was collected during the period 2016-2017 through personal interview method.

Analytical tools and technique

- The data was analyzed using descriptive statistics and also value chain mapping.

Results

Table 1: Estimation of wastage of some selected vegetables during sorting and grading

Vegetables/ Fruits	Average	Average		
	Quantity ordered(Kgs)	Quantity supplied(Kgs)	Wastage	Wastage (per cent)
Pearl Tomato	125	110.05	14.95	11.96
Cherry Tomato	138	110.85	27.15	19.67
Brinjal (Black round)	310	263	47	15.16
Bitter gourd	252	211	41	16.26
Okra	1390	1207.5	182.5	13.1
Sweet corn	701	536	165	23.5
Carrot	2700	2471.1	228.9	8.4
Mini cucumber	1555	1372.8	182.2	11.71
Spring Onion	218	110.3	107.7	49.4
Brussel Sprout	97	64.5	32.5	33.5
Zuccini (Green)	365	263	102	27.9
Red Cabbage	343	271	72	20.99
Lettuce (Lolo Green)	134	102	32	23.88
Broccoli	1041	888.5	152.5	14.6

Note: The calculation was for one week as per the indent from the retail outlets.

Table 2: Vegetable mixes ready to use for cooking

Minimally processed product	Ingredients
Steam vegetable	Zucchini, carrot, baby corn, beans, asparagus, broccoli, mushrooms and brussels sprout
Grilled cut vegetable	Onion, broccoli, zucchini, leek, mushroom, parsley, lettuce, brussels sprout, colored capsicum and parsley
Fried rice vegetable	Zucchini, baby corn, carrot, beans, asparagus and sweet corn
Veg noodles mix	Cabbage, red cabbage, carrot, beans, baby corn, Chinese cabbage, spring onion and onion
Sambhar mix	Cauliflower, chillies, drumstick, ridge gourd, garlic, carrot, curry leaf and beans
Pulav mix	Zucchini, baby corn, carrot, beans, asparagus and sweet corn

Discussion

Stage 1: The company supplies inputs such as seeds, seedlings, fertilizer and provides technical support to the farmers. This was done to ensure that the company receives the quality produce from the farmers. The company has the contract farmers who will grow the fruits and vegetables as per the company's requirement.

Stage 2: In this stage, the value addition activities are done by the farmers such as maintaining good agricultural practices, safe harvesting, sorting at the farm level, proper packing for transporting to the company to avoid damages. The company supplies the crates free of cost to enable the farmers for easy packing without any damage.

Stage 3: The quality check of the fruits and vegetables was done as soon as the farmer unloads their produce in the collection centre. The company also takes care of maintaining the freshness and quality of fruits and vegetables at each stage through proper sorting, removal of uneconomic parts and packing. As per the orders for fruits and vegetables from the retail outlets, the company takes the vegetables and fruits from the cold storage and sorts, grades and removes the uneconomic part. The company also prepare minimally processed vegetable mixes.

Stage 4: Lot of care was taken to maintain the freshness of the fruits and vegetables. They are stored in cold storages to maintain their freshness till it reaches the retail outlets.

Stage 5: In retail outlets vegetables and fruits are arranged on racks which was provided with the coolers below. This was done to retain the freshness and maintain shelf life of vegetables and fruits for longer time.

Flow chart

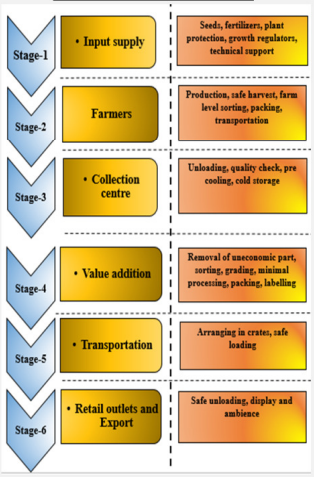

Fig. 2 : Mapping of value chain for fruits and vegetables in Namdhari's Fresh

Fig. 3: Minimally processed vegetable and Namdhari's Fresh retail outlet

Summary

- To maintain the freshness and quality of fruits and vegetables continuous cold chain network and value addition was done by the company.
- The company is very cautious about the quality so that the consumers get the premium quality product. Lot of care was taken to maintain the freshness for the fruits and vegetables.
- The customers can move around the shop and select the fruits and vegetables which are already packed in standard quantities which are already graded and packed in desired quantities.

Advisory Committee

Chairperson: Dr. P. K. Mandanna
Members: Dr. G. N. Nagaraja
Dr. N. R. Gangadharappa
Dr. D. M. Gowda

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEXURES

I INTRODUCTION

India is one of the major producer of fruits and vegetables in the world because of its remarkable diversity and its geographical conditions, the country produces a great variety of the invaluable agriculture and horticultural produce for common use.

The fruits and vegetables consumption in India is mainly in the fresh form. It is essential that they are stored in a system that can maintain their freshness until when consumed without any noticeable physiological disorder. It has been estimated that the post-harvest losses of horticultural produce in India are of the order of 20-30 per cent (Chandra and Kar, 2004).

Over the years the country has a marked increase in production of perishable high nutrition products like fruits, vegetables, meat and poultry products etc., With a milk production of 138 million tonnes annually and fruit and vegetable production of approximately 280.4 MT/annum, India ranks first in milk production and second in fruits and vegetables production in the world. India also has a significant production in meat and meat products (NCCD- National Centre for Cold-chain Development)

Cold-chain is now recognized as a sunrise sector in India. For safe handling and to convey the perishable products to markets the development of cold-chain infrastructure is not strategically directed, except in the dairy sector. As a result, there is demand and supply mismatch for the agriculture and horticulture commodities which frequently contributes for wide spread price fluctuations and inflation in the country.

Due to lack of modern and scientific methods of logistics from farm to market has also contributed for high food losses in case of perishables. To reduce post-harvest loss of fruits and vegetables several schemes were launched by different Ministries of GoI (Government of India). Ministry of Agriculture launched a “Mission for Integrated Development of Horticulture” in 2014, under which cold-chain development is the thrust area, so that all other inputs in way of enhancing horticultural yields can have suitable recourse to reach gainful end-use.

The Indian agricultural sector is witnessing a major shift from traditional farming to horticulture, meat and poultry and dairy products, all of which are perishables. The demand for fresh and processed fruits and vegetables is increasing because of changing food habits of urban population. The changes in the organized retail food sector followed by changes to Foreign Direct Investment laws, are creating opportunities in the domestic food industry, which includes the cold chain sector.

There are six types of cold storages used in India for storing agricultural products namely - Indoor Storage, Outdoor Storage, Refrigerator Storage, Outdoor Sheds, Basement storage room and underground storage room. Underground storage room is a special kind of cold storage at Haripur and Sangliwadi in Maharashtra, which is used for Turmeric Commodity only. This type of cold storages increase the quality and life of the Turmeric.

1.1. Cold Chain:

Cold-chain is a logistic system that involves various activities and provides a series of facilities for maintaining ideal storage conditions for perishables from the point of origin to the point of consumption in the food supply chain. The chain needs to start at the farm level (e.g. harvest methods, Pre-cooling) and cover up to the consumer level or at least to the retail level. A well-organized cold-chain reduces spoilage, retains the quality of the harvested products and guarantees a cost-efficient delivery to the consumer given adequate attention for customer service.

The Cold-chain logistics infrastructure generally consists of:

- Pre-cooling facilities
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- Refrigerated Carriers
- Packaging
- Warehousing
- Information Management systems (Traceability and Tracking etc.)

Based upon the handling requirements for the harvested fresh horticultural produce (fruits & vegetables) and processed products (manufactured food items) a cold-chain flow is suggested. Even though the shelf-life of majority of the fresh horticultural & floriculture produce ranges from just a few days to a few weeks only even in cold-chain, the temporary extension in life, allows the produce to remain in a consumable state for a longer period.

1.2. Existing Infrastructure

The study conducted by NCCD (National Centre for Cold-chain Development) on All India Cold-chain Infrastructure Capacity(AICIC) which was commissioned by Ministry of Agriculture gave the report on the realistic gaps in end-to-end connectivity from farm-to-consumer in which they stated that there are 249 Modern Pack-house (PH) in the country followed by Ripening Chamber (RC) which are 812 in number. There are Cold Storage Hubs (CH) and Cold Storage Bulk (CS) which are 5367 of 5003 tonnes capacity. There are 9000 Reefer Transport (T) and Last Mile Transport (t). The details are shown in Annexure 1.

Cold-chain Infrastructure Gap in India

There are different kinds of cold storage infrastructure available in the country. But considering the production of fruits and vegetables there is shortage of cold chain infrastructure. There are different type of infrastructure such as Pack-house, Reefer Vehicles, Cold Storage(Bulk), Cold Storage(Hub) and Ripening Chamber. The all India requirement of cold storage and the infrastructure created is not sufficient. There is a gap created between the present infrastructure and the needed. The details are shown in the Annexure 2.

State-wise Capacity of Cold Storages in India

As the fruits and vegetables are grown in all parts of the country subsequently the cold storage has also been maintained. The top 5 states for cold storages are Uttar Pradesh, Punjab, Gujarat, Maharashtra and West Bengal. The highest number of cold storages are in Uttar Pradesh with 2176 in number and 1,36,33,039 MT capacity followed by Punjab with 606 cold storages of 20,04,778 MT capacity. Gujarat has 560 cold storages with

20,30,873 MT capacity while Maharashtra has 540 cold storages with 7,06,302 MT capacity. The lowest number of cold storages are in Lakshadweep and Manipur with only one cold storage which are of 15 MT and 2175 MT capacity. These cold storages available in the country are not sufficient to meet the demand of storing fruits and vegetables in the cold rooms. The details are given in Annexure 3.

1.2. Region wise Number and Capacity of Cold Storages in India

Cold storage in India has been largely adopted for long-term storage of potatoes, onions and high value crops like apples, grapes and flowers. 75 per cent of the cold storage capacity is used to store potatoes, while only 23 per cent fall in the multi-product category. Cold storages for meat, fish, dairy items and for other items such as chillies and other spices account for only 1 per cent of total cold storage capacity. These cold storages are also usually smaller in capacity. Much of the multi-purpose cold storage capacity are located in the states of Karnataka, Maharashtra, West Bengal, Tamil Nadu and in the National Capital Region (NCR). The details are furnished in Annexure 4.

1.3. Growth Drivers for Cold-chain

1.3.1 Growth in Organized Retail

Over the last few years, organized retail and food service industries have emerged as new segments of cold chain and cold storage, mainly due to the changing consumption pattern. With the entry of big corporates into retailing, the supply chain including cold chain for food and beverages distribution is getting streamlined. There is an increasing demand not only for capacity addition of cold storage facilities for a set of highly perishable products, but also for a wide variety of vegetables, fruits and grains.

1.3.2 Growth in End user segments (food processing, horticulture)

The Cold storage is critical from the economic point of view and hence the government has its focus on the development of this Cold storages. With the growth in this end user segment, cold chain infrastructure is expected to get a boost and help in reducing the wastage.

1.3.3 Government Initiatives

The government is taking steps for the developing Cold storages, such as schemes for capital investment subsidy from the National Horticulture Board (NHB), the National Horticulture Mission (NHM) and the Ministry of Food Processing Industries (MoFPI) for the agri-investors to set up cold chain or storage infrastructure. Government has as well set up National Centre for Cold Chain Development (NCCD) which would help in establishing building standards through international benchmarking and to promote research and development activity in the cold chain sector.

1.4. Role of Cold-chain

The importance of cold-chain for fruits and vegetables is to achieve following objectives.

1.4.1 Seasonal Production

The demand for fresh fruits and vegetable continuous almost throughout the year, but their supplies are only seasonal. For e.g. Apples grown in Jammu and Kashmir and Himachal Pradesh find markets all over the county. Therefore, cold storages have more importance in storing and supplying the seasonal fruits and vegetables.

1.4.2 Spoilage

A crucial problem faced in the case of fruits and vegetables is that of the huge enormous losses that occur because spoilage. The loss of spoilage on different stages on marketing estimated between 20 per cent to 33 per cent of the total production. So there is need to minimize the spoilage loss through cold storages.

1.4.3 Losses in Transit

Most of the fruits and vegetables are of extremely perishable nature and cannot be kept long under ordinary conditions of storage. Refrigerated trucks and air-cooled wagons will help in minimizing losses is transport.

1.4.4 Stabilizing Market Prices

The role of stabilizing market prices is for distributing both on demand basis and time basis. The farmers get opportunity of producing cash crops to get fair prices at the same time, the consumers get the supply of perishable fruits and vegetables with minimum prices i.e. cold storages will stabilize market prices of fruits and vegetables.

1.4.5 Maintain Quality

Cold-chain will help to maintain the quality of product for some period. It gives a chance to protect the quality of perishable goods for long time whenever it needed to store.

1.4.6 Wastage Reduction

The cold-chain system helps in reducing the wastage of perishable products. Generally, the perishable products wastage is more due its nature of short life and lack of storing facilities. Therefore, the cold-chain have a greater role in reduction of wastage.

1.5 Major Cold-chain infrastructure components

1.5.1 Modern Pack-house

Modern pack house is a infrastructure with facilities such conveyer belt system for sorting, grading, washing, drying, weighing, packaging, precooling and staging. Pack-houses are the first step in organized post-harvest management for perishables and are effectively first mile production units for the modern pack house sector. A modern integrated pack-house unit enables small lot of sourcing and aggregation of horticulture produce, and to built close to farm-gate. For fresh horticultural produce, a modern pack-house initiates the cold-chain wherein the raw harvest is sorted and aggregated. The output, a packaged, pre-cooled load is then directed to distinct last mile markets.

1.5.2 Cold Storage Hubs

It is an environment controlled warehousing space functioning as a distribution hub. It is designed for short-term handling of produce so as to serve as a distribution logistics platform for marketable packaged produce and ready to retail produce. Cold storage (Hubs)

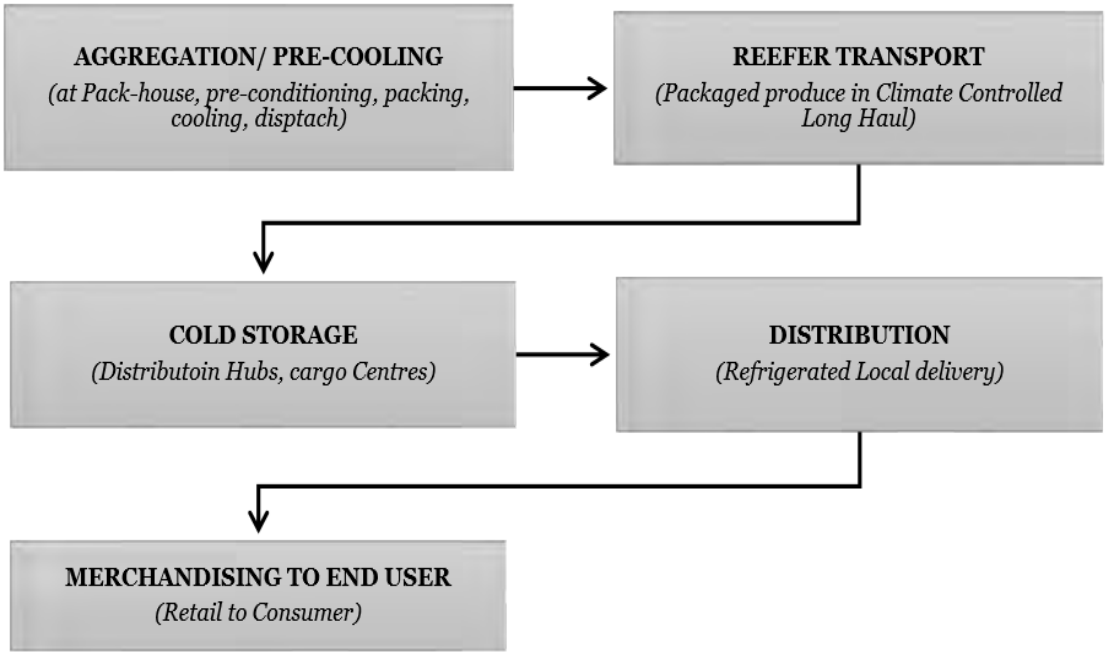

Fig 1: Logistics Flow for Fresh Horticultural & Floriculture Produce

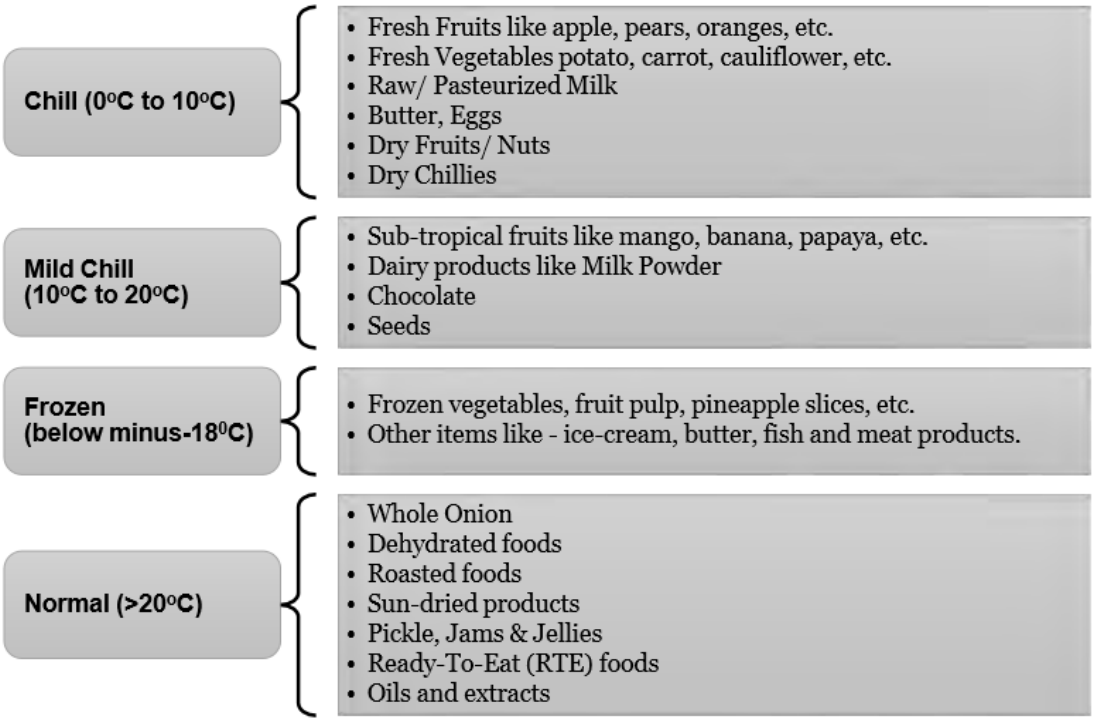

Fig. 2: Cold-chain segmentation based on storage temperature

Source: http://www.nccd.gov.in/PDF/CCSG_Final%20Report_Web.pdf

are key for effective distribution of perishable produce and are essential for maintaining the integrity of the cold-chain. These are normally constructed close to consumption centres, built at the front-end linked to source points with refrigerated transport.

1.5.3 Cold Storage Bulk

It is an environment controlled warehousing space with multiple chambers intended for bulk storage of perishable produce. The space is designed for long duration storage of a specific produce so as to build an inventory buffer which will serve to smoothen the episodic production by stabilising & sustaining the supply lines. These are normally constructed in areas close to producing areas (farm-gate) to facilitate quick access to farmers.

1.5.4 Ripening Chamber

A last mile facility in the cold-chain, designed to function for controlled and hygienic ripening of certain fresh produce. Modern ripening units contain multiple ripening chambers and are used extensively for ripening bananas but are also used to ripen other fruits like mangoes, avocadoes, kiwis, tomatoes, pears, etc. Ripening chambers can be designed for multi-tiered pallet based storing or structures for basic storage. It is important cold-chain component to promote as unsafe ripening practices can cause various health complications to end consumer.

1.5.5 Transport

The material transportation from farm to fork takes place by following different modes:

- Long haul reefer vehicles (T) from farm to consumption centre
- Short haul reefer vehicles (t) from distribution hubs to front-end retail points
- Non-refrigerated trucks (Ts) are used for produce like onion, potato, etc.

The above details of major cold-chain infrastructure components are shown in the form of table in the Annexure 5.

1.6 GOVERNMENT INITIATIVES

The Department of Agriculture and Cooperation is endeavoring to strengthen the supply chain infrastructure including cold chains through various schemes. Some of the most prominent schemes are National Horticulture Mission (NHM), Horticulture Mission for North East and Himalayan States (HMNEH) and National Horticultural Board (NHB).

1.6.1 National Horticulture Mission:

The scheme covers the following areas:

(i) Development of commercial horticulture through production and post-harvest management of horticulture Crops

(ii) Capital investment subsidy scheme for construction/ expansion/ modernization of cold storages/ storages of horticulture produce

(iii) Technology development and transfer for promotion of horticulture

(iv) Market information service for horticulture crops and

(v) Horticulture promotion service

1.6.2 National Centre for Cold Chain Development (NCCD)

The NCCD has been mandated to

(i) Provide an enabling environment for the cold chain sector to gain prominence and invite the much needed private sector involvement.

(ii) To establish standards and protocols related to cold chain testing, verification, certification and accreditation as per international standards.

(iii) To provide technical assistance to Financial Institutions, Government Departments/ agencies, and industry for selection of cold chain component such as refrigeration units, refrigerated transport equipment, display cabinets, milk tanker etc.

(iv) To offer HRD and technical advisory services to personnel engaged in this sector.

1.7 Value Chain

Value-chain is now recognized as an important instrument to strengthen the overall agriculture development. A value chain includes all the activities that are undertaken in transforming raw materials into a product that is sold and consumed. These include the direct functions of primary production, collection, processing, wholesaling and retailing, as well as the support functions, such as input supply, financial services, transport, packaging and advertising. The fruits and vegetables consumption in India is mainly in the fresh form. It is essential that they are stored in a system that can maintain their freshness until when consumed without any noticeable physiological disorder, hence value addition is essential for perishables.

1.8 Need of the study

Although cold storage capacity of over 30 million tonnes has been created in the country, the concept of cold-chain is still not so popular in India. Considering the fact that India is producing about 280 million tonnes of horticulture produce every year, the development of cold-chain networks requires high priority. Owing to the tremendous pressure on improving supply chain and reducing losses during produce handling and movement, the need for creation of a cold chain network is crucial for perishable food commodities.

1.9 Scope of the study

The study will help to understand the cold-chain network of the Namdhari Fresh company from farm till it reaches the consumers. Through the study we can understand what kind of cold-chain facilities are being used for perishables in the private companies to enhance the quality, maintain the freshness of the produce and reduce the post-harvest losses. With this background, the following specific objectives were formulated.

1.10 Specific objectives of the study

1. To document the cold chain infrastructure and utilization pattern available in Namdhari Fresh

2. To analyze the value chain for perishables in Namdhari Fresh and

3. To identify the constraints in operationalization of cold chain.

1.11 Hypotheses of the study

1. Namdhari Fresh's cold chain infrastructure is underutilised

2. Cold chain has added value to perishables

1.12 Limitation of the study

The information for the study is collected from primary and secondary sources. The primary data is collected from the Namdhari Fresh company regarding the cold-chain infrastructure, utilization pattern, constraints in operationalization and the value-chain management.

1.13 Presentation of the study

The study has been organised into seven chapters. Chapter I gives a brief description about the introduction, cold-chain, company profile, specific objectives, hypotheses, need, scope and limitations of the study; Chapter II contains relevant review of literature for the specified objectives of the study; Chapter III outlines the description of the study area, sampling techniques, collection of data and analytical tools used for data analysis; Chapter IV deals with results of the study; Chapter V discussed the results of the study; Chapter VI summarizes the findings and suggestions of the study and Chapter VII listed the references referred for the present study.

II REVIEW OF LITERATURE

A review of past research helps in identifying the conceptual and methodological issues relevant to the study. It provides the researchers a proper direction to carry out their research work and enables them to arrive at meaningful results. Literature reviews are secondary sources, usually precedes a research proposals and results section. This chapter attempts a brief review of the relevant research literature related to the present study. Keeping these facts in view, the available literature relevant to the objectives of the present study was reviewed and presented under the following headings

2.1 The cold chain infrastructure and utilization pattern

2.2 Value chain for perishables

2.3 Consumers preference for perishables

2.4 Constraints in operationalization of cold chain

2.1 The cold chain infrastructure and utilization pattern

Victoria Salin *et al.*, (2003) examined the business relationships in the cold chain used for exporting food to new markets in developing countries. Pricing strategies for cold chain services were closely related to quality and potentially affect the availability of outsourced cold chain services. Opportunistic behavior by buyers could reduce incentives for private investment in cold chain infrastructure, while long term commitment by chain partners would strengthen the potential for private markets to provide cold chain services in newly developing markets.

Moureh *et al.,* (2004) analyzed to improve and optimize air-distribution systems in refrigerated vehicles to decrease the temperature differences throughout palletized cargos. The condition of vehicles is essential to preserve the quality, safety and shelf life of perishable products. They reported on the numerical and experimental characterization of airflow within a semi-trailer enclosure loaded with pallets. The numerical modelling of airflow was performed using the Computational Fluid Dynamics (CFD) code Fluent and a second moment closure, the Reynolds stress model (RSM). Numerical and experimental

results showed the importance of air ducts in decreasing temperature differences throughout the cargo.

Bogataj *et al.,* (2005) in their study "A great challenge for Cold Chain Management (CCM)" defined global cold chain management as "the process of planning, implementing and controlling efficient, effective flow and storage of perishable goods, related services and information from one or more points of origin to the points of production, distribution and consumption to meet customers' requirements on a worldwide scale". It is the process of integrating the existing business activities, including special activities for perishable goods conservation along the value chains.

Anish *et al.*, (2011) studied with reference to agro-industry the Cold chain plays a role of preventing the fruits, vegetables, dairy products and the like from rotting. The same has been an problem for the Indian Government which is accused of wastage about 40 per cent of the total produce of perishables. Indian Government has also given the Cold chain an Infrastructure status in its 2011-12 budget so that it reinforces the importance of the same. The losses occur mostly after harvesting based on the level of infrastructure for handling them in corresponding countries.

Joshi *et al.,* (2011) developed a benchmarking framework that evaluates the cold chain performance of a company, reveals its strengths and weaknesses and finally identifies and prioritizes potential alternatives for continuous improvement.

Myo Min Aung *et al.,*(2012) presented a cold chain monitoring system which focuses on assessment of quality and dynamic pricing information about food in cold chain. The breakdown of a single entity in cold-chain such as temperature control at any stage can impact the final quality of the product. In a cold-chain, the shelf life, quality, and safety of perishable food throughout the supply chain is greatly impacted by environmental factors especially temperature. A prototype application was implemented to retrieve time, temperature, history, the current quality and the dynamic price setting according to changing quality impacted by temperature fluctuations in real-time.

Jiao *et al.*, (2014) stated through their study that to promote the intelligence and automation in the agriculture, it was a trend to apply the Internet of Things (IoT) technology. The environmental monitoring system based on the IoT can meet the fast, accurate and continuous measurement requirements in the precision agriculture. The farm environmental monitoring system based on IoT had to be proposed. Both the hardware and software system for coordinator and routers was designed, integrated with the sensor, embedded system and network communication technology. The results of the experiment showed that the new proposed system had the advantages of good in timeliness and more secure in data transmission, with broad application prospect and industry value.

Wuxue Jiang *et al.,* (2014) in there study stated that the techniques for improving the efficiency of food cold-chain logistics network, shortening the logistic time of food and reducing the logistics cost of food. the study analyzed the optimization strategy and various cost factors of the supply network of food cold-chain and expanded the logistics network model adapting to the food cold-chain logistics.

Shantanu *et al.*, (2014) studied the performance of channel distribution in cold storage operations and interrelated issues to have a new vision for cold storage operations. An exploratory study was carried out by interviewing, interacting, and sharing of experiences of 64 cold storage operators from various districts of Punjab and Uttar Pradesh. They found that channel distribution plays an important role in maintaining and delivery of perishable products from cold storage to retail markets. The study helped in creating the relevant involvement of channel intermediaries in cold storage operations.

Weiyang *et al.,* (2014) stated that cold chain is considered as the transport and storage chain between the initial production and the final consumer of temperature-controlled perishable goods. It consists of a series of storage and transport links, all of which are designed to keep the products on the correct condition until they reach the consumers. They developed CCLM (Cold Chain Logistics Management) based information technology applications to improve visibility and traceability, thus supporting the design and the control of the whole cold supply chain. The study focused on the risk prediction of CCLM. The study developed indicators, including temperature, humidity, the video interruption time, the temperature interruption time, the weighbridge measurement

difference, the real-time accessibility of electric vehicle tracking, etc. the increased oversight, management, and control of environmental conditions across the entire supply chain can be achieved.

Wei Wang, (2016) elicited that enterprises must change the product logistics and transport conditions for Agricultural and fishery products so that cold chain can be applied to the field of logistics and ensure its quality. And also stated that it is necessary to strengthen the control of agricultural cold chain logistics during transport, logistics and transport to ensure the quality of agricultural products, so that consumers get satisfaction products, and improve the reputation and service levels.

2.2 Value chain for perishables

Stevens (2001) stated that value-chain and traditional trade policy analysis are complementary; each throws light on areas overlooked by the other. Value-chain analysis helps to identify who gains from market imperfections and how the distribution of gains can be altered. Trade policy analysis highlights the extent to which value-chain dynamics are influenced by market rents. The examples of sugar and horticulture were used in the study to illustrate the potential gains from combining the 2 methodologies. It demonstrates that in markets that combine heavy trade protection against some suppliers with preferences for others there exists a relationship of mutual dependency between the elements of the value chain. The implications of this for the distribution of value merit further investigation.

Humphrey (2006) argued that concentration in the retailing of fresh and processed food has led to a substantial reorganization of agribusiness value chains. 'Large buyers have transformed themselves from resellers of products made by others into firms that go out to find suppliers for the products that they want for their customers'. This would also appear to be very much same in the case of wine value chain. It will examine the links between Chilean wine firms and the large supermarket chains in the UK market; these are playing an increasing role in product development, branding and supplier selection.

Sa-Nguanpuag *et al.*, (2007) studied type, price and packaging trends for fresh cut produce in regular and upscale supermarkets. The survey data found that fresh cut

vegetables had a larger market segments than fresh cut fruits. The price of fresh cut produce was higher than whole fresh produce. There was also a great difference between the price at regular and upscale supermarkets with the largest differences found in fresh cut pomelo and ready-to-eat spice set for Thai spicy soup (Tom yam). The price difference was minimal for the produce whose price was relatively expensive, e.g. broccoli and apples. The most used packaging system is the foam tray wrapped with polyvinylchloride film. The study also indicated the suitable packaging for shredded green papaya that would capture market with high margin is in a tray form which could be wrapped, bagged, or heat sealed with a plastic film that had proper barrier properties.

Heiko Bammann (2007) in his study of Participatory value chain analysis in Pacific Islands for improving farmer's income, employment opportunities and food security analyzed the growing recognition for the participatory value chain concepts and their application in Pacific island agriculture. Collaboration between government agencies, non-governmental agencies, and private agribusinesses offers the greatest potential for applying the value chain concept, with the aim of increasing income and employment through improved farming. The public–private partnerships in research and dissemination can improve the technologies available to small-scale producers and processors, while capacity building can help farmers meet new quality and safety requirements. Value chain programs facilitate and support farmers, which allow economies of scale in buying inputs and selling products.

Sikka *et al*., (2008) observed that 30-40 per cent of fruits and vegetables were being wasted due to post-harvest losses due to lack of basic as well as specialized infrastructure such as cold storages, reefer vans, cool chains, ripening chambers, etc. in Punjab. There is also a missing link between production, research system and international consumerism. They found that precision farming technology can bring quick improvement in value chain in different agro-climatic regions. Further, refinement in supply chain, adoption of new technologies and their transfer will bring perceptible improvement.

Nagaraj *et al.,* (2008) indicated in the article on contract farming found that quality inputs such as seeds, fertilizers and plant protection chemicals were provided to the farmers at their farm gate, coupled with the technical advice on production aspects. This not only

reduced the working capital needs of farmers but also substantially reduced their transaction cost per unit of output. This not only reduced the working capital needs of farmers but also substantially reduced their transaction cost per unit of output. Borrowing of crop loans was found 33 per cent higher by non-contract farmers than contract farmers, as the farmer need to buy material inputs. The net returns had been found higher for contract farmers than non-contract farmers. The constraints identified in contract farming during the study included delay in payment and delivery of inputs, delay in lifting the produce, access to seeds, manipulation of grades by the buyers, and high cost of inputs. Factors inducing farmers into contract are: low initial investment, better price for the produce, access to market, technical support on package of practices, access to inputs and easy transportation facilities.

Norton and Fearne (2009) explained the principles behind sustainable value stream mapping or value chain analysis and how the technique can be applied, placing particular emphasis on the importance of relationships and information flows between food retailers and food manufacturers in London. In any industry, waste occurs as both physical by-products and inefficient resource usage. The identification of opportunities for waste reduction requires an analysis of current activities and the waste arising from them. Value stream mapping is a diagnostic technique that originated in lean manufacturing for the purpose of eliminating wasteful activities and reducing production lead time. Case study evidence indicates that order volatility and forecast inaccuracy make it difficult for manufacturers to estimate material requirements and to plan production, thus reducing efficiency and encouraging over-production to ensure availability, factors that increase both physical and operational wastes.

Daniel *et al.*, (2009) carried out a value chain analysis in India to understand processing and marketing-related aspects of Indian gooseberry (*Emblica officinalis*; known locally as 'amla'), tamarind (*Tamarindus indica*), and kokum (*Garcinia indica*). The common production system is agroforestry for 'amla' and scattered trees for tamarind and kokum. Irrespective of the system, profit distribution patterns are similar for all three species. Fresh and processed fruits of these species are dependent on intermediaries for marketing. Therefore, the share of the value addition that reaches the farmers and primary

processors is very small. Therefore, alternative models of production and processing have to be evolved to realize the environmental and economic benefits of underutilized fruit species.

Sharma *et al.,* (2010) studied the structure and extent of value addition in different agro-processing units in Himachal Pradesh. They also examined the financial viability of agro-processing industries in the state. The break-even analysis showed enough leverage for processing units to stay in the business even at the low capacity utilization. The extent of value addition was found to be 53 per cent in the processing sector. The maximum value addition was observed in fruits/vegetables processing (133%), followed by bakery and confectionery units. The financial viability ratios computed from financial accounts revealed high current ratio but lower quick ratio in most of the processing industries, showing that many industries had substantial unsold inventories. However, financial ratios were found to be more favourable in case of small units as compared to large units. It was found that geographical concentration of the processing industries in the state was influenced more by demand rather than supply factors.

Jabir *et al.,* (2010) analyzed the adoption behavior of vegetable growers on various post-harvest practices such as washing, sorting and grading, preserving and cooling, dehydrating/drying, packaging, labelling and storage for value addition, based on primary survey of 556 vegetable growers in eight districts of Uttar Pradesh by administering a structured questionnaire. Various socio-demographic and farm level factors, which were likely to affect the adoption of post-harvest practices in vegetable value chain, had been empirically identified using the Poisson Count Regression Model (PCRM). With the emerging consumer market for vegetables and vegetable products coupled with upcoming organized retailing in fresh agricultural produce, the improvement in post-harvest management, logistics and distribution, starting from the farm gate became important. The findings of this study had critical implications for all the stakeholders involved in vegetable value chain.

Sunita Raju (2014) analyzed the application of the Global Value Chain framework has also Production Networks to agriculture had gained significance particularly considering the importance of promoting agricultural exports from developing countries.

In meeting the challenges of food safety standards increasing in global agricultural trade, demand of global buyers in terms of large-volume supply, speed and reliability of delivery, customization through processing, packaging and product safety emerged as challenges for small producers and strategies for product differentiation. Hence, organizing agribusiness value chains or integrated supply chains is necessary for global competitiveness.

2.3 Constraints in operationalization of cold chain

Montanari (2008) described the process of cold chain is the extension of a good supervision system and specification, so for the construction of cold chain logistics, there is need to consider the problems in all links of the process such as production, transportation, sales, economy and technicality as a whole and coordinate the relationship among all links to ensure the safety of perishable food in the process of cold chain and it is a cryogenic systems engineering with high technology content .

Hongjie Lan *et al.*, (2012) concluded in their study that the construction of food cold chain logistics needs more investment compared with the common logistics system in the average temperature, and it is a huge systems engineering. The need of cold chain logistics grows rapidly, but most consumers are lack of the awareness of the importance of the cold chain and many companies cannot bear the huge investment, it makes the gap of the resources of cold chain logistics large and cannot meet the normal need of cold chain logistics in Beijing.

Amrat lal Basediya *et al.,* (2013) in their study of evaporative cooling system for storage of fruits and vegetables found that horticultural produce are stored at lower temperature because of their highly perishable nature. Hence, preserving these types of foods in their fresh form is demanded with minimum control of temperature and humidity which restricts the chemical, bio-chemical and physiological changes. The high cost involved in developing cold storage or controlled atmosphere storage is a pressing problem in several developing countries. Evaporative cooling is a well-known system to be an efficient and economical means for reducing the temperature and increasing the relative humidity in an enclosure and this effect has been extensively tried for increasing the shelf life of horticultural produce in some tropical and subtropical countries.

Anju Bharti (2014) in her study stated that the biggest challenge lies in connecting the remote villages of the country to the robust supply chains so that all stakeholders get benefited and wastages can be minimized to the possible extent. Investments in cold chain infrastructure, applied research in post-harvest technologies, installation of food processing plants in various sectors and development of food retailing sector is required. Lack of electricity, power supply and other supporting infrastructure are a big deterrent in setting up cold chain facilities. The food supply chain needs the attention of the institutions, the industry and the Government for its enhancement.

Chang Daofang *et al.*, (2015) stated that the cold chain logistics distribution network planning is subjected to cost constraints and establishes a cold chain logistics distribution network model by minimizing the total operation cost. The model was verified through a vegetable firm case in which series of constraint conditions were used to represent the relationship between the various decision variables. The verification results demonstrated the proposed model is capable and effective to solve the distribution problem. Network planning for Shanghai vegetable logistic distribution, through survey data and calculation proves the model is effective.

Surajit Bag (2016) in his study of Modeling Barriers of Green Cold Chain Management in India stated that cold storage facilities are based on conventional energy intensive process with outdated technologies. Improper storage and cold treatment infrastructure reduces the life and deteriorates the quality of perishable products. Supply chain practitioners adopted the green cold chain management practices to overcome numerous challenges associated with developing the cold chain network. The study suggested that cold chain infrastructure and government support are key drivers of green cold chain practices.

III METHODOLOGY

The source and nature of data for the study and the analytical tools employed in the study are presented in this chapter. The details of methodology are presented in the following sub headings.

3.1 Selection and description of the study area

3.2 Sampling procedure

3.3 Nature and source of the data

3.4 Analytical tools and techniques

3.1 Selection and description of the study area

3.1.1 Selection of the study area

The present study was conducted in Bengaluru city of Karnataka state. In Bengaluru, Namdhari Fresh company was chosen for the study.

3.1.2 Description of the study area

Bengaluru is located between $23^0$58'N Latitude and $77^0$34'E Longitude, is the capital state of Karnataka. It has a population of about 8.42 million and a metropolitan population of about 8.52 million. Located in southern India on the Deccan Plateau, at a height of over 900 m (3,000 ft) above sea level, Bengaluru is known for its pleasant climate throughout the year. Its elevation is the highest among the major cities of India. Bengaluru serves as the cultural, administrative, industrial and the commercial center of Karnataka. It is the information technology (IT) and biotechnology (BT) hub of India, with industrial estates and numerous financial and educational institutions of immense potential for retail food outlets.

Bengaluru urban district came into being in 1986, with the partition of the erstwhile Bengaluru district into Bengaluru Urban and Rural districts. Bengaluru Urban district is surrounded by the Bengaluru Rural district on the west, east and north and Ramanagar

district on south. It has four taluks namely; Bengaluru North, Bengaluru East, Bengaluru South and Anekal. The Bengaluru Urban district has 17 hoblies, 668 villages and 9 municipal corporations.

Bengaluru is known as Garden City of India and has two nationally recognized botanical gardens- Lal Bagh and Cubbon Park, which attract a lot of visitors through the year. The city was the recipient of the Indira Priya darshini Vruksha Mitra Award in the late 1980s, in recognition of its extensive green cover.

In Karnataka fruits and vegetables are cultivated in almost all districts. Both Bengaluru Urban and Bengaluru Rural districts contribute around 14 per cent area and 12.7 per cent production of fruits cultivation. Similarly, these districts together account for 5.7 per cent area and 7.5 per cent production of vegetables.

3.1.3 Description of the study unit

Namdhari Fresh

Namdhari's Fresh (NF) started in 2000 at Bengaluru - 'The Garden City of India', with a view to export fresh vegetables and provide a premium quality produce to domestic customers. The company has various productions centers across the country where it produces more than 40 different vegetables and fruits. The suitable climate, availability of sufficient infrastructure, technical manpower and the applications of advanced technology in Production, Processing, Grading, Packing, storage, Transportation, Communication and with dedicated skilled laborers enables the company to produce and sell the best quality vegetables and fruits for Fresh Market to meet the International Standards. The company strictly follows European standards of Good Agriculture Practices (GAP) for production of fruits and vegetables. The company handles more than thousand tons of fresh vegetables and fruits at domestic and International market. The produces are mainly exported to Europe, Australia and the Middle East. It’s the India's first company to receive the EUREP-GAP (European Retailers Certified Vegetable Growing and Exporting Firm) certificate, which is an assurance for our high-quality standards.

Retailing

The backward integration has enabled the company to produce and supply quality produce to the end customers. The company are pioneers in providing international ambience and quality in fresh vegetables and fruits retailing. Majority of the vegetables and fruits are grown by them and under contract farming, ensuring optimum freshness and quality of the produce. Presently, there are 24 retail outlets operating in the Bengaluru.

Wholesale

Apart from the export and retailing, the company has also supplying fresh vegetables and fruits to Insitutional customers like star Hotels and retail chains. They are catering to India's oldest and largest five star Hotel group across the country. The produce are also send to other retailers through the channel partners.

Quality Assurance

The quality control systems are such that the products are checked and rechecked right from the field, grading and packing and during shipment, which makes it possible to meet the high-quality standards of Europe and other developed nations. The company also performs shelf life test of the produce under different temperature conditions, the results will be used to improve the shelf life of the produce. The packing section is being geared up to a hygienic handling so that the consumers receive a clean, hygienic product.

3.2 Sampling procedure

The data regarding the cold-chain was collected from the company executives. The primary data was collected from the Namdhari Fresh company to know and understand the procurement pattern and cold-chain flow for perishables. The fruits and vegetables that were procured in Namdhari Fresh were considered for study and are shown in the table 3.1.

Table 3.1: The List of Fruits and Vegetables produced and procured by Namdhari Fresh

Cole Crops	Exotic Vegetables	Salad	Gourds
Cauliflower	Asparagus	Cucumber	Bottle gourd
Brussels Sprout	Baby corn	Cherry	Bitter gourd
Red Cabbage	Sweet corn	Tomato	Ivy gourd
Chinese	Zucchini	Novelty	Sponge gourd
Cabbage	Leeks	Tomato	Ridge gourd
Cabbage Green	Colored	Lettuce	Pumpkin
Broccoli	Capsicum	Iceberg	
		Lettuce	
		Lola rosa	
		Lettuce Lobi	
		Carrots	
		Radish	
Indian Vegetables	**Herbs**	**Leafy Vegetables**	**Fruits**
Green Peas	Sage	Palak	Watermelons
French Beans	Rosemary	Amaranthus	Melons
Haricot Beans	Thyme	Chinese Kale	Physalis
Okra	Oregano	Mustard Leaf	Passion Fruit
Brinjal (striped)	Lemon	Methi	Strawberries
Brinjal (big)	Grass Basil	Spring onion	Grapes
Hot	Celery	Dill	Fig
Pepper(Chillies)	Curry Leaf	Coriander	Pomegranate
	Marjoram	Pokchoy	Papaya
	Mint	Spinach	Mango
	Parsley	Kale	Chickoo(Sapota)
	Wheat		Kiwi
	Grass		Avocado

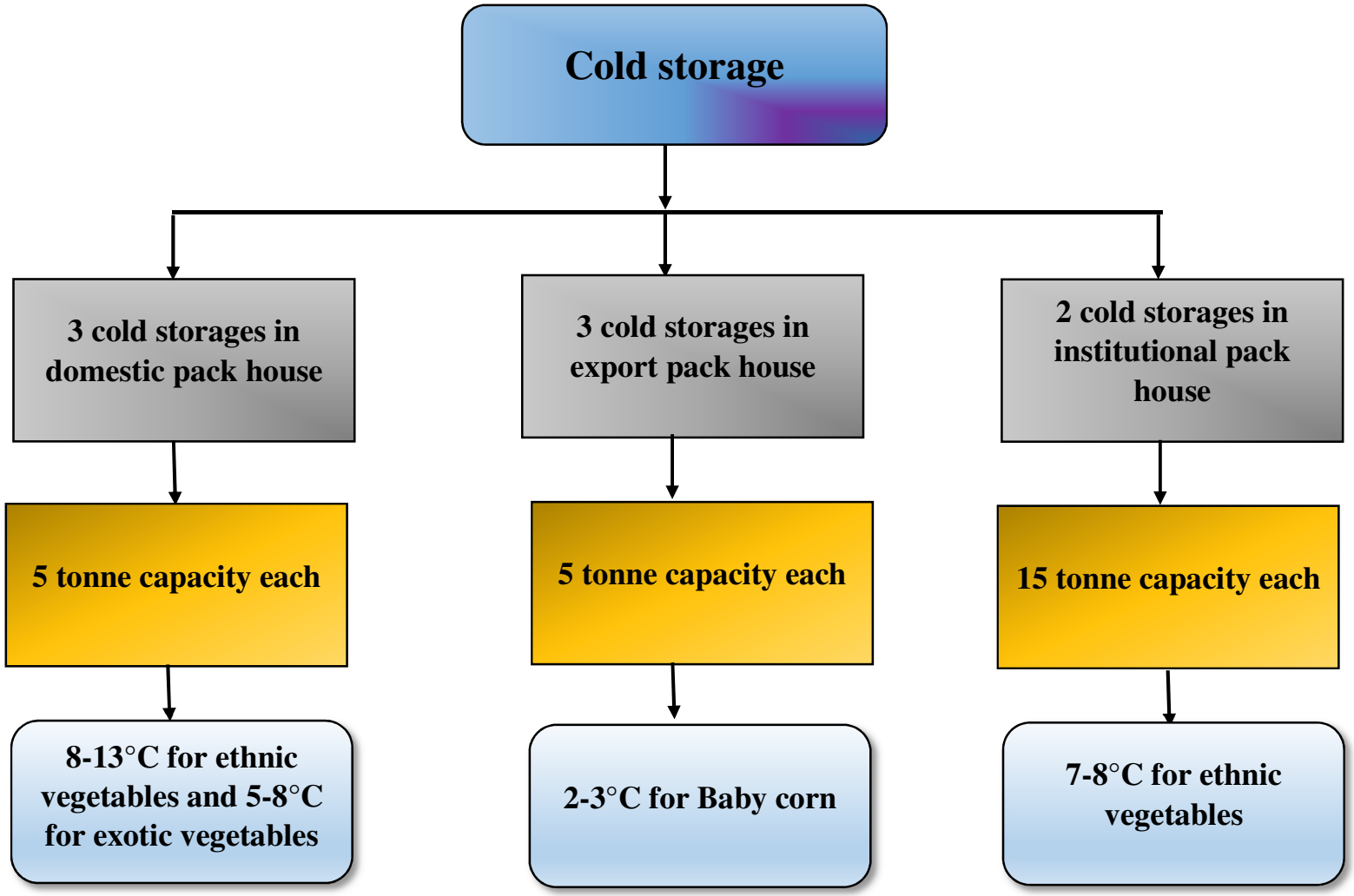

Fig. 3: Cold chain distribution in Namdhari Fresh

3.3 Nature and source of data

In order to test the hypothesis of the study, data was collected from both primary and secondary sources.

3.3.1 Primary data

The information on the supply of fruits and vegetables to Namdhari, value addition and the cold-chain flow were elicited from company. Executives of the company were interviewed to get the information related to procurement of fruits and vegetables, value addition, cold-chain at collection centre and supply of fruits and vegetables to hubs and thereafter to retail outlets.

3.3.2 Period of reference

The reference year for the study was 2016-17 and the collection of data was carried out during the months of March and April 2017.

3.4 Analytical tools and techniques

Keeping in view the specific objectives of the study, the data collected were subjected to the following statistical analysis.

3.4.1 Descriptive statistics

3.4.2 Henry Garrett ranking technique

3.4.1 Descriptive statistics

The following Descriptive statistics was used to analyze and interpret the data.

3.4.1.1 Average

A single value (as a mean, median, or mode) that summarizes the general significance of a set of unequal values.

3.4.1.2 Percentage Analysis

Percentage Analysis is applied to create a contingency table from the frequency distribution and represent the collected data for better understanding.

3.4.1.3 Ratio Analysis

Ratio Analysis is an attempt to express the relationship between two or more accounts or variables in a simpler, more comprehensive way.

3.4.2 Henry Garrett ranking technique

The technique was used to evaluate the influencing factors for the purchase of packaged drinking water and constraints faced in marketing. In this method, consumers were asked to rank the factors influencing their buying behaviour for packaged drinking water and retailers were asked to rank the constraints they are facing in marketing of packaged drinking water. The orders of merit given by the respondents were converted into ranks by using the following formula.

$$\text{Percent position} = \frac{100\,(R_{ij} - 0.5)}{N_j}$$

Where

R_{ij} = Rank given for the i^{th} variable by j^{th} respondents

N_j = Number of variable ranked by j^{th} respondents

The per cent position of each rank thus obtained was converted into scores by referring to the table given by Henry Garrett. Then for each factor the scores of individual respondents were added together and divided by the total number of respondents for whom the scores were added. These mean scores of all factors were arranged in the order of their ranks and inferences were drawn.

IV RESULTS

This study provides valuable insights on cold chain infrastructure, value chain, value addition and constraints in operationalization of cold chain with respect to Namdhari Fresh company. In consonance with the objectives of the study, necessary information was collected from the company. The collected data was analyzed. The results of the study are presented under the following headings:

4.1 Documentation cold chain infrastructure and utilization pattern available in Namdhari Fresh

4.2 Analysis of the value chain for perishables in Namdhari Fresh and

4.3 Constraints in operationalization of cold chain.

4.1 The Cold chain infrastructure and utilization pattern available in Namdhari Fresh

To ensure the freshness of the vegetables till it reaches the consumer, the company has continuous cold chain network. Soon after the farmer brings his produce to the collection center the vegetables are sent for quality check. After the quality check if the produce was suitable for marketing then it stored in cold storage room. As per the order requirement by the retail outlets, the produce was taken out from the cold storage room and was transferred to the grading hall, which was also air conditioned and packed under cool climate. The packed vegetables are stored in the cold rooms before being transported to the retail outlets and for export.

The company has three pack houses for the sorting, grading and packing of vegetables. First pack house was meant packing of all the vegetables required for retail outlets. Second pack house was mainly and exclusively for packing of baby corn which was meant for export purpose. The third pack house was the institutional pack house where they supply the fruits and vegetables to the institutions, hotels, companies, organizations, canteens, hospitals as per the requirement by them. In the in institutional pack house the produce was only cleaned, sorted, graded and packed in crates. There was a pre-cooling area in the institutional pack house.

There are total 8 cold storages in the Namdhari Fresh company. Three cold storages are meant for baby corn export purpose. Another two are for the storage of domestic produce required for retail outlets and the sixth cold storage room was for the packed fruits and vegetables which are going to be transported to the retail outlets and for export. There are two cold storage rooms in institutional pack house where they store the fruits and vegetables. The institutional pack house cold storage rooms are of 15 tonne capacity. Other cold storage rooms are of 5 tonne capacity. The fruits and vegetables which are stored in cold storage are listed in the Table no 4.1.

Table 4.1: Details of leafy vegetables, vegetables and fruits stored in cold storage by Namdhari Fresh

Sl. No	Vegetables	Sl. No	Leafy vegetables
1.	Cucumber	25.	Basil
2.	Mini cucumber	26.	Dill
3.	Colored capsicum	27.	Mint
4.	Green capsicum	28.	Methi
5.	Brinjal	29.	Lemon grass
6.	Baby corn	30.	Wheat grass
7.	Sweet corn	31.	Coriander
8.	Ridge gourd	32.	Palak
9.	Snake gourd	33.	Amaranthus
10.	French beans	34.	Lettuce
11.	Bottle gourd	35.	Oregano
12.	Bitter gourd	36.	Thyme
13.	Carrots	37.	Rosemary
14.	Haricot beans	38.	Marjoram
15.	Brussel sprout	39.	Sage
16.	Chillies	40.	Pokchoy
17.	Okra	41.	Parsley
18.	Tomato	42.	Leeks
19.	Broccoli	43.	Celery
20.	Zucchini		
21.	Red cabbage		**Fruits**
22.	Cabbage	44.	Strawberry
23.	Chinese cabbage	45.	Avocado
24.	Lettuce	46.	Amla

The peak season for storage of fruits and vegetables in cold storage depends upon their harvesting season. The exotic vegetables are stored at 5-8° C whereas ethnic vegetables are stored at 8-13° C. Baby corns are stored at 2-3° C. In Institutional pack house the vegetables are stored at 6-7° C. The temperature maintained in pre-coolers of institutional pack was 7-8° C where the vegetables are kept for 5 minutes to remove the field heat. The shelf life of the vegetables stored in cold storage was shown in Table 4.2

Table 4.2: Shelf-life of the vegetables stored in cold storage of Namdhari Fresh

Sl. No	Vegetables	Shelf life (days)
1.	Wheat grass, dill, lettuce, broccoli, herbs- sage, marjoram, oregano, rosemary, thyme	3
2.	Basil, mint, methi, coriander, palak, amaranthus, snake gourd, lettuce, celery,	4
3.	Lemon grass, bird eye chilli, mini cucumber, ridge gourd, pokchoy, zucchini, Chinese cabbage	5
4.	Okra, bitter gourd, cucumber, amla, parsley, haricot beans, avocado	6
5.	Thin chilli, scotch bonnet, naga chilli, baby corn, sweet corn, French beans, brussel sprout	7
6.	Tomato, green capsicum	8
7.	Colored capsicum	9
8.	Bottle gourd	10
9.	Red cabbage, Freshno chilli, carrot	12

There are refeer vehicles owned by the company for distribution of fruits and vegetables which maintains the quality and freshness till it reaches the designated place. There are 2 refrigerated trucks of 4 tonne capacity for the domestic usage. There are 4 refeer vehicles for the institutional pack house where 3 vehicles are of 4-7 tonne capacity

and another one vehicle was of 3-5 tonne capacity. The company has third party logistics for the export purpose wherein the logistics company takes care of the produce that has to be exported.

The retail outlets are also provided with the chillers so that the vegetables and fruits are maintained with optimum freshness. The chillers provided to the retail outlets are of 100kg capacity.

4.2 The Value chain for perishables in Namdhari Fresh

The value chain of Namdhari Fresh was shown in the Fig 4 indicates the value addition activities done at various stages.

Stage 1: The company was supplying input like seeds, seedlings, fertilizers, pesticides and technical support for growing to the contracted farmers on credit basis.

Stage 2: At this stage, various value addition activities such as safe harvesting, sorting, filling in crates and safe loading are the major value addition activities undertaking at farm level. Thus, company encourages Good Agricultural Practices.

The price of fruits and vegetables procured from farmers was based upon the price of HOPCOMS. The company procures the produce from the farmers based on the daily prices of HOPCOMS. But as the company itself supplies inputs to farmers, they procure after deducting certain costs. If the price of fruits and vegetables is ranged between Rs 40 and above in HOPCOMS then they procure such produce from the farmers after deducting Rs 4/ Kg. If the price varies between Rs 20-30 then they deduct Rs 2/ kg and if it is below Rs 10 then they deduct Rs 1 from the HOPCOMS price and procure it from farmers.

The average pricing and marketing cost incurred by the farmers furnished in Table 4.3.

Table 4.3: Details of average price received and marketing cost incurred by farmers for selling produce at Namdhari Fresh

Sl. No	**Particulars**	**Okra**	**Sweet corn**	**Carrot**	**Mini cucumber**	**Broccoli**	**Strawberry**
1.	Avg. Qty sold/day (Qtl.)	5.00	2.60	6.50	6.00	3.20	1.40
2.	Price received (Rs. /Qtl.)	4800	3000	6000	3600	17,400	3200
3.	Total value (Rs)	24,000	7800	39,000	21,600	55,680	4480
4.	Price received (Rs. / Kg)	48.00	30.00	60.00	36.00	174.00	32.00
5.	Cost of marketing						
a.	Cost of cleaning and sorting (Rs. /Qtl)	18	25	16	18	16	17
b.	Cost of loading and unloading (Rs. /Qtl.)	20	27	17	20	19	20
c.	Cost of transportation (Rs. /Qtl.)	30	35	35	28	37	30
	Total/ Cost of marketing (Rs. /Qtl.)	68	87	68	66	72	67
	Cost of marketing (Rs. / Kg)	0.68	0.87	0.68	0.66	0.72	0.67

Stage 3: After the harvested produce was brought to the collection center by company transportation, the produce was subjected to quality check. After the quality check the produce was stored in cold storage. The Produce was taken from the cold storage rooms for packing as per the indent (orders) given by retail outlets. During the process sorting, grading and removal of uneconomic part was done. Some of the selected vegetables and fruits wastage was calculated in Table 4.4

Table 4.4: Estimation of wastage of some selected fruits and vegetables

Sl. No	Vegetables/ Fruits	Average		Average	
		Quantity supplied (Kgs)	Quantity sold (Kgs)	Wastage (Kgs)	Wastage (per cent)
1	Pearl Tomato	125	110.05	14.95	11.96
2	Cherry Tomato	138	110.85	27.15	19.67
3	Brinjal (Black round)	310	263	47	15.16
4	Bitter gourd	252	211	41	16.26
5	Okra	1390	1207.5	182.5	13.1
6	Sweet corn	701	536	165	23.5
7	Carrot	2700	2471.1	228.9	8.4
8	Mini cucumber	1555	1372.8	182.2	11.71
9	Spring Onion	218	110.3	107.7	49.4
10	Brussel Sprout	97	64.5	32.5	33.5
11	Zuccini (Green)	365	263	102	27.9
12	Red Cabbage	343	271	72	20.99
13	Lettuce (Lolo Green)	134	102	32	23.88
14	Broccoli	1041	888.5	152.5	14.6
15	Oregano	18	11.4	6.6	36.6
16	Chilli (Freshno Red)	163	144	19	11.65
17	Pokchoy	293	260	33	11.26
18	Wheat Grass	33	16.075	16.925	51.28
19	Italian Basil	36.3	21	15.3	42.14
20	Lemon Basil	35.5	21.65	13.85	39.01
21	Asparagus	45.5	32.2	13.3	29.2
22	Strawberry	816	739.25	76.75	9.4
23	Avocado	418	387	31	7.41
24	Palak	197	161.3	35.7	18.12

Note: The calculation was of one week as per the indent from the retail outlets.

Later, packing, labelling and arranging in crates was done. The cost of packaging and other overheads costs for packaging by the company shown in Table 4.5.

Table 4.5: Cost of packaging and overheads for fruits and vegetables per pack in Namdhari Fresh

Sl. No	Particulars	Poly Bag	Punnets
1.	Labour charge	0.25	0.25
2.	Packaging material	1.00	1.5
3.	Electricity and overhead costs	1.00	1.00
4.	Transportation	0.25	0.25
	Total	2.5	3

Other value added i.e, minimally processed products are also undertaken at this stage. The company produces the various types of sprouts of cowpea, green gram, horse gram, ragi, methi and chana. They even prepare minimally processed vegetables shown in Table 4.6

Table 4.6: Vegetable mixes ready to use for cooking

Sl. No	Minimally processed product	Ingredients
1.	Steam vegetable	Zucchini, carrot, baby corn, beans, asparagus, broccoli, mushrooms, brussels sprout
2.	Grilled cut vegetable	Onion, broccoli, zucchini, leek, mushroom, parsley, lettuce, brussels sprout, colored capsicum, parsley
3.	Fried rice vegetable	Zucchini, baby corn, carrot, beans, asparagus, sweet corn,
4.	Veg noodles mix	Cabbage, red cabbage, carrot, beans, baby corn, Chinese cabbage, spring onion, onion
5.	Sambhar mix	Cauliflower, chillies, drumstick, ridge gourd, garlic, carrot, curry leaf, beans
6.	Pulav mix	Zucchini, baby corn, carrot, beans, asparagus, sweet corn

Stage 4: The packed vegetables brought from the collection centres are loaded safely into the vehicles and transported to the outlets located in the Bengaluru city on the same day. Safal market at the white field acts as a hub for the fruits procurement for retail outlets.

Stage 5: At retail outlets of the Namdhari Fresh, the fruits and vegetables are attractively arranged in different racks. The racks are provided with coolers which helps in maintaining the freshness of fruits and vegetables. The customers can easily move around the shop and select the fruits and vegetables as they are already sorted and packed in standard quantities. The outlets are maintained in a clean and hygienic manner.

Different kind of packing was done for fruits and vegetables and was shown in Table 4.7.

Table 4.7: Packing pattern of fruits and vegetables in Namdhari Fresh

Sl. No	Type of packing	Vegetables
1.	Net packing	Tomato, onion, potato
2.	Plastic packet/ Ploy bag	Chilli, Brinjal, Beans, Bitter gourd, grapes, okra, cucumber, French beans, sweet corn, brussel sprout, carrot, zucchini, basil, lemon grass, marjoram, mint, oregano, parsley, rosemary, sage, thyme
3.	Plastic wrap (Bunch)	Palak, methi, coriander, asparagus, spring onion, leek, amaranthus, basali, dill, mustard leaves
4.	Punnet	Cherry tomato, baby corn, okra, Haricot beans, sprouts, thai kit
5.	No packing	Bottle gourd, cabbage, capsicum, cauliflower, radish, ridge gourd, broccoli, red cabbage, lettuce

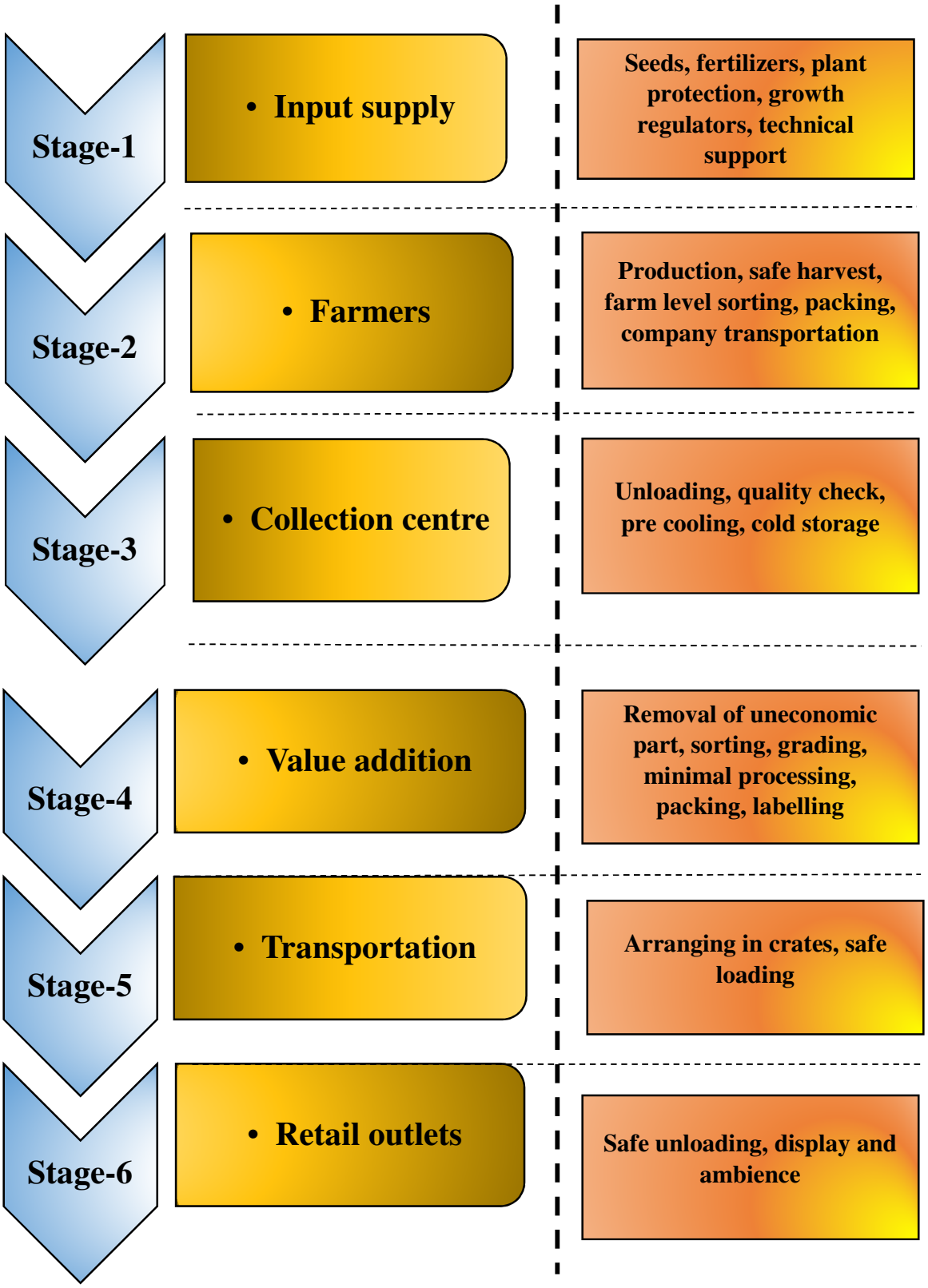

Fig 4: Mapping of value chain for fruits and vegetables in Namdhari Fresh

4.3 Details of the constraints in operationalization of cold chain in Namdhari Fresh

The details of constraints in operationalization of cold chain in Namdhari Fresh is furnished in the table 4.8

Table 4.8: List of constraints involved in operationalization of cold chain

Sl. No	Factors	Mean	Rank
1.	Electricity problem	59.16	IV
2.	Costly	48.13	V
3.	Water leakage	70.066	I
4.	Temperature fluctuation	66.266	II
5.	Maintenance problem	61.766	III
6.	Discoloration of fruits and vegetables	33.366	VII
7.	Upgrading of cold chain	34.233	VI
8.	Availability of technicians	26	VIII

The major constraint in operationalization of cold chain was the water leakage problem followed by temperature fluctuation in cold storage rooms. The other constraints are maintenance problem, electricity problem and costly. The negligible constraints are upgrading of cold chain, discoloration of perishables and availability of technicians.

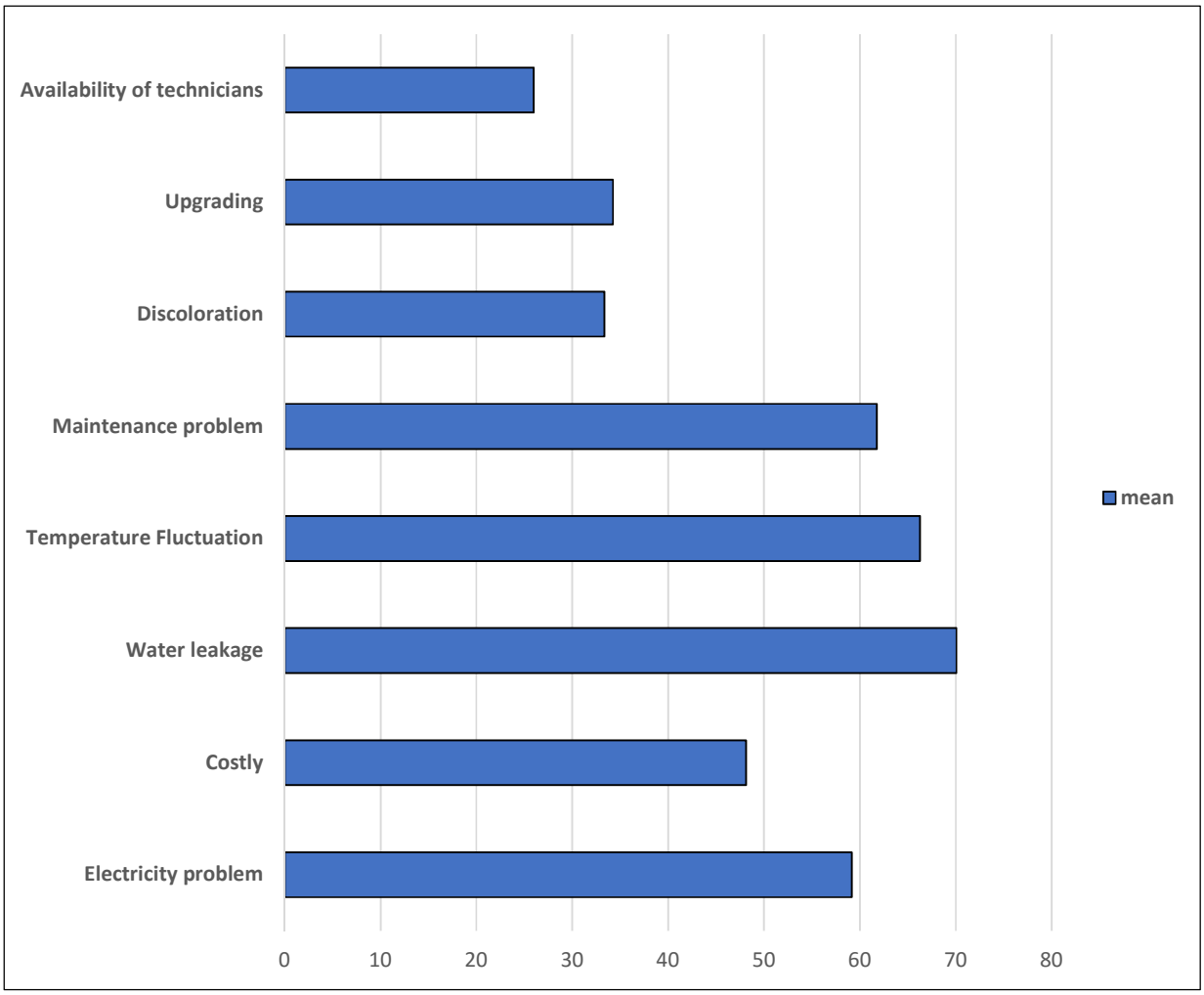

Fig. 5: Constraints in operationalization of cold chain

V DISCUSSION

The results of the study presented in the previous chapter are discussed in this chapter under the following headings.

5.1 Cold chain infrastructure and utilization pattern

5.2 Value chain for perishables

5.3 Constraints in operationalization of cold chain

5.1 Cold chain infrastructure and utilization pattern

To maintain the freshness and quality of fruits and vegetables continuous cold chain network was maintained by the company. To give the customers best quality produce the company has quality check lab to ensure the produce was of good quality. The grading and packing hall are air conditioned and provided with ventilators to maintain freshness of the produce.

To have easy working operations the company has divided their pack houses into three sections. For supplying the produce to the retail outlets there was domestic pack house and for export purpose there was another pack house. In the domestic pack house three cold chain are maintained in which two cold storages are meant for storing the produce and the third cold storage was meant for storing the produce after packing for final transportation to the retail outlets and for export. In the export pack house only baby corn was sorted, graded and packed as the major export from the company was of baby corn. Because of that reason the company has maintained three cold storage rooms only for baby corn. The cold chain was used to the optimum level.

In the institutional pack house, huge quantity of fruits and vegetables are sorted and graded. The institutional pack house supply the fruits and vegetables to the institutions, hotels, companies, organizations, canteens, hospitals as per there requirements. They pack the produce in crates as the quantity required was larger than compared to the retail outlets. The major customer for the institutional pack house was the Toyota company. The institutional pack house stores all the ethic vegetables in the cold storage. The institutional

pack house uses first cold storage to the optimum but they don't utilize much the second cold storage as the first cold storage itself was enough to store the produce. They store the fruits in the second cold storage which requires time to mature. There the excess fruits and vegetables were stored.

The exotic vegetables such as asparagus, baby corn, sweet corn, zucchini, leeks, colored capsicum, cauliflower, brussels sprout, red cabbage, chinese cabbage, cabbage, green broccoli were stored at 5-8° C. Whereas, ethnic vegetables are stored at 8-13° C. The ethnic vegetables such as green peas, french beans, haricot beans, okra, brinjal, chillies, bottle gourd, bitter gourd, ivy gourd, sponge gourd, ridge gourd, pumpkin.

Based on the shelf life of the perishables they were stored in the cold storage. The leafy vegetables and herbs have the shelf life of 3-4 days whereas some ethic vegetables have shelf life from 5-7 days. The maximum shelf life of the perishable stored in the cold storage was red cabbage, freshno chilli and carrot having shelf life of 12 days.

The company has their own as well as the third-party logistics reefer vehicles for transport of perishables to the destination points. The reefer vehicles is an integral refrigeration unit with in temperature controlled ambience. It ensures the produce reaches the consumer in fresh produced condition. The company has different capacities reefer vehicles for transportation. The company has Uniworld logistics for export purpose. The outsourced logistics reduces cargo delays and costs associated with non-compliance to customs regulations.

There are 24 retail outlets of Namdhari in Bengaluru. All the retail outlets were provided with the chillers to store the produce and were of 100kg capacity. The fruits and vegetables were arranged in racks systematically.

5.2 Value chain for perishables

The value chain map reveals the value addition activities, supporting activities and supporting actors involved at each level of the value chain management for the fruits and vegetables in Namdhari Fresh.

Stage 1: This stage was relatively meant for input supply given by the company to the farmers. The company supplies inputs such as seeds, seedlings, fertilizers and technical support to the farmers. This was done to ensure that the company receives the quality produce from the farmers. The company has the contract farmers who will grow the fruits and vegetables as per the demand by the company. The contract farmers are in and around the Bidadi. Villages such as I.D.Halli, Channapatna, Harohalli and Hegadagari. The company itself has 400 acres farm for the cultivation of fruits and vegetables. Apart from the contract farming and own cultivation the company also procures vegetables from other places such as from Punjab and Ooty they procure exotics, Haricot Beans from Madya Pradesh.

Stage 2: This stage was operated mainly at the farm level. In this stage, the value addition activities are done by the farmers such as maintaining good agricultural practices, safe harvesting, sorting at the farm level, proper packing for transporting to the company to avoid the damages. The company supplies the crates free of cost to enable the farmers for easy packing without any damage. The company itself provides transportation to farmers to bring their produce to the collection center.

Stage 3: The quality check of the fruits and vegetables was done as soon as the farmer unloads their produce in the collection centre. The quality control was based on certain quality specifications. The company is very cautious about the quality. The company also takes care of maintaining the freshness and quality of fruits and vegetables at each stage through proper sorting, removal of uneconomic parts and packing. As per the orders for fruits and vegetables from the retail outlets, the company takes the vegetables and fruits from the cold storage room and sorts, grades and removes the uneconomic part. The removal of uneconomic part and the unhealthy produce from the lot causes some wastage. The wastage differs from vegetable to vegetable. The wastage was more in case of sweet corn and baby corn while minimum wastage was in case of carrots and cucumber. The wastage in case of leafy vegetables and herbs was also more as they are more perishable in nature. The wastage in case of broccoli, Brussel sprout, cabbage, lettuce was also more as the uneconomic part has to be removed.

Different kinds of packing patterns are used for the fruits and vegetables. The company also produces minimally processed vegetables packed in punnets. The minimally processed vegetable products are of different mixes. They also produce sprouts which are considered as very good for health.

Stage 4: Care was taken to maintain the freshness for the fruits and vegetables. They are stored in cold storages to maintain their freshness till it reaches the retail outlets. The packed vegetables are carefully loaded in the vehicles to transport them to the retail outlets. As the fruits are not procured in the Bidadi collection centre the fruits are procured in the Safal market at the white field from there fruits are supplied to the retail outlets. The vegetables are transported in reefer vehicles for export.

Stage 5: The last stage relates to the retailing. At retail outlets vegetables and fruits are arranged on racks which was provided with the coolers below. This was done to retain the freshness and maintain shelf life of vegetables and fruits for longer time. The customers can move around the shop and select the fruits and vegetables which are already packed in standard quantities.

5.3 Constraints in operationalization of cold chain

Interviewing the executives and employees of domestic and institutional pack house some of the major constraints in operationalization of cold chain were found. The constraints are listed below which are faced by the company.

1. Water leakage through the humidifiers in the cold storage rooms when there was no power supply.
2. Electricity problem because of the power cut
3. The cold storage room temperature was fluctuated because of power cut it takes time to adjust to the required temperature
4. Maintenance problem- frequent opening and closing the doors of the cold storage rooms fluctuates the temperature and thus the steady temperature was not maintained

5. Petrol fuel generator was used as power back up which was very costly
6. Upgrading the cold chain was problem
7. Availability of company workshop technicians for the cold storage problem
8. Discoloration of the perishables due to low temperature and electricity problem

VI SUMMARY AND SUGGESTIONS

India is the second largest producer of fruits (12 %) and vegetables (13 %). The diverse agro climatic conditions have supported India to grow various fruits and vegetables. Among the major fruits and vegetables producing states in India, Karnataka is the 7th largest producer (14.6 %). Karnataka has 10 agro climatic zones suitable for growing varieties of fruits and vegetables throughout the year. Kolar occupies first position in production of horticulture crops contributing about 37 per cent of area (64.2 thousand hectares) and about 28 per cent of production (7.3 lakh tonnes) followed by Bengaluru rural and Bengaluru urban districts. Thus, places in and around Bengaluru is the hub for vegetables.

Cold-chain is now recognized as a sunrise sector in India. For safe handling and to convey the perishable products to markets the development of cold-chain infrastructure is not strategically directed, except in the dairy sector. As a result, there is demand and supply mismatch for the agriculture and horticulture commodities which frequently contributes for wide spread price fluctuations and inflation in the country.

The Indian agricultural sector is witnessing a major shift from traditional farming to horticulture, meat and poultry and dairy products, all of which are perishables. The demand for fresh and processed fruits and vegetables is increasing because of changing food habits of urban population. The changes in the organized retail food sector followed by changes to Foreign Direct Investment laws, are creating opportunities in the domestic food industry, which includes the cold chain sector.

6.1 Specific objectives of the study

1. To document the cold chain infrastructure and utilization pattern available in Namdhari Fresh
2. To analyze the value chain for perishables in Namdhari Fresh and
3. To identify the constraints in operationalization of cold chain.

6.2 Methodology

The data regarding the cold-chain was collected from the company executives. The primary data was collected from the Namdhari Fresh company to know and understand the procurement pattern and cold-chain flow for perishables.

The information on the supply of fruits and vegetables to Namdhari, value addition and the cold-chain flow were elicited from company. Executives of the company were interviewed to get the information related to procurement of fruits and vegetables, value addition, cold-chain at collection centre and supply of fruits and vegetables to hubs and thereafter to retail outlets.

The study was conducted in Namdhari Fresh. The company was started with a view to export fresh vegetables and provide a premium quality produce to domestic customers. The company has various productions centers across the country where it produces more than 40 different vegetables and fruits. The suitable climate, availability of sufficient infrastructure, technical manpower and the applications of advanced technology in production, processing, grading, packing, storage, transportation, communication and with dedicated skilled labours enables the company to produce and sell the best quality vegetables and fruits for Fresh Market to meet the International Standards. The company strictly follows European standards of Good Agriculture Practices (GAP) for production of fruits and vegetables. The company handles more than thousand tons of fresh vegetables and fruits at domestic and International market.

6.3 Findings of the study

1. To ensure the freshness of the vegetables till it reaches the consumer, the company has continuous cold chain network. Soon after the farmer brings his produce to the collection center the vegetables are sent for quality check. After the quality check if the produce was suitable for marketing then it stored in cold storage room. As per the order requirement by the retail outlets, the produce was taken out from the cold storage room and was transferred to the grading hall, which was also air conditioned and packed under cool climate. The packed vegetables are stored in the cold rooms before being transported to the retail outlets and for export.

2. There are total 8 cold storages in the Namdhari Fresh company. Three cold storages are meant for baby corn export purpose. Another two are for the storage of domestic produce required for retail outlets and the sixth cold storage room was for the packed fruits and vegetables which are going to be transported to the retail outlets and for export. There are two cold storage rooms in institutional pack house where they store the fruits and vegetables. The institutional pack house cold storage rooms are of 15 tonne capacity. Other cold storage rooms are of 5 tonne capacity.

3. The vegetables are stored in cold storages with different temperatures based on their shelf life. The exotic vegetables are stored at 5-8° C whereas ethnic vegetables are stored at 8-13° C. Baby corns are stored at 2-3° C. In Institutional pack house the vegetables are stored at 6-7° C. The temperature maintained in pre-coolers of institutional pack was 7-8° C where the vegetables are kept for 5 minutes to remove the field heat.

4. There are refeer vehicles owned by the company for distribution of fruits and vegetables which maintains the quality and freshness till it reaches the designated place. There are 2 refrigerated trucks of 4 tonne capacity for the domestic usage. There are 4 refeer vehicles for the institutional pack house where 3 vehicles are of 4-7 tonne capacity and another one vehicle was of 3-5 tonne capacity. The company has third party logistics for the export purpose wherein the logistics company takes care of the produce that has to be exported.

5. The retail outlets are also provided with the chillers so that the vegetables and fruits are maintained with optimum freshness. The chillers provided to the retail outlets are of 100kg capacity.

6. The company has maintained value chain for the fruits and vegetables. The company was supplying input like seeds, seedlings, fertilizers, pesticides and technical support for growing to the contracted farmers on credit basis. The farmers do various value addition activities such as safe harvesting, sorting, filling in crates and safe loading. Thus, company encourages Good Agricultural Practices. The quality check of the produce is done after the farmer unloads his produce in the procurement center.

7. The company even produces various value-added products such as minimally processed vegetable mixes, sprouts, bakery and confectionaries.

8. The major constraint in operationalization of cold chain was the water leakage problem followed by temperature fluctuation in cold storage rooms. The other constraints are maintenance problem, electricity problem and costly. The negligible constraints are upgrading of cold chain, discoloration of perishables and availability of technicians.

6.4 Policy Implications

The company can improve their cold chain infrastructure by adopting new technologies for cold storage and can be assisted by various government schemes. The Department of Agriculture and Cooperation is endeavoring to strengthen the supply chain infrastructure including cold chains through various schemes. Some of the most prominent schemes are National Horticulture Mission (NHM), Horticulture Mission for North East and Himalayan States (HMNEH) and National Horticultural Board (NHB). The company can even get assistance by The Agricultural and Processed Food Products Export Development Authority (APEDA) and Associated Chambers of Commerce and Industry of India (ASSOCHAM)

VII REFERENCES

AMRAT LAL BASEDIYA, SAMUEL D. V. K., AND VIMALA BEERA, 2013, Evaporative cooling system for storage of fruits and vegetables. *Journal of Food Science and Technology,* **50**(3): 429-442.

ANISH MATAPURKAR, AND ARNAV SINHA, 2011, Cold chain: Finally warming up to India?. *Infrastructure Today.*

ANJU BHARTI, 2014, Examining market challenges pertaining to cold chain in the frozen food industry in Indian retail sector. *Journal of Management Sciences and Technology,* **2**(1): 33-40.

BOGATAJ, M., BOGATAJ, L., AND VODOPIVEC, R., 2005, Stability of perishable goods in cold logistic chains. *International Journal Production Economics*, **93–94**(1): 345–356.

CHANDRA, P., AND KAR, A., 2004, Post-harvest processing for developed India. International *Seminar on Emerging Technology in Agricultural and Food Engineering,* IIT, Kanpur, p.14-17.

CHANG DAOFANG, ZHU JINFENG, AND LIN DANPING, 2015, Cold Chain Logistics Distribution Network Planning Subjected to Cost Constraints. *International Journal of Advanced Science and Technology*, **75**(1): 1-10.

DANIEL, J.N., JAENICKE, H., GANRY, J., ZELEDON HOESCHLE, I. AND KAHANE, R., 2009, Value Chain Analysis in relation to processing and marketing of three underutilized fruits in India. *Acta Horticulture*, **806** (2): 505-512.

HEIKO BAMMANN, 2007, Participatory value chain analysis for improved farmer income, employment opportunities and food security. *Pacific Economic*, **22** (3): 113-125.

HONGJIE LAN, AND YONGBIN TIAN, 2012, Analysis of the demand status and forecast of food cold chain in Beijing, *Journal of Industrial Engineering and Management*. **6**(1):346-355.

HUMPHERY, 2006, Policy implications of trends in agribusiness value chain. *The European Journal of Development Research*, **18**(1): 572-92.

JABIR ALI, AND TRIBHUVAN NATH, 2010, Factor Affecting Adoption of Post-harvest Techniques in Vegetable Value Chain. *Agricultural Economics Research*, **23**(1): 554-568.

JIAO, J., H.M. MA., Y. QIAO, Y.L., W. KONG, AND Z.C. WU., 2014, Design of farm environmental monitoring system based on the internet of things. *Advances in Food Sciences and Technology,* **6**(3): 368-373.

JOSHI, R., BANWET, D., AND SHANKAR, R.A., 2011, Delphi-AHP-TOPSIS based benchmarking framework for performance improvement of a cold chain. *Expert Systems with Applications* **38**(1): 170-182.

MONTANARI, R., 2008, Cold chain tracking: a managerial perspective. *Trends in Food Science & Technology* **19**(1): 425-431.

MOUREHA, J., AND FLIC, D., 2004, Airflow pattern and temperature distribution in a typical refrigerated truck configuration loaded with pallets. *International Journal of Refrigeration*, **27**(1): 464-474.

MYO MIN AUNG, YOON SEOK CHANG, AND WOO RAM KIM, 2012, Quality Monitoring and Dynamic Pricing in Cold Chain Management. *World Academy of Science, Engineering and Technology*, 62(1): 435-439.

NAGARAJ, N., CHANDRAKANTH, M, G., CHENGAPPA, P, G., ROOPA, H, S., AND PRAMOD, CHANDAKAVATE, M., Contract Farming and its Implications for Input-supply, Linkages between Markets and Farmers in Karnataka. *Agricultural Economics Research,* **21**(1): 307-316.

NGUANPUAG K. A., KANLAYANARAT, S., AND TANPRASERT, K., 2007, Trends of Fresh Cut Produce in Thai Retail Markets for Identification of Packaging for Shredded Green Papaya. *Acta Horticulture*, **746**(6): 481-486.

NORTON, A., AND FEARNE, A., 2009, Sustainable value stream mapping in the food industry in the food industry. Handbook-ofwaste-management-and-co-product-recovery-in-food-processing, **2**(24): 3-22.

SHANTANU SAHA, K., MUKHERJEE, B., AND CHANDRA, 2014, Channel Distribution Performance in Cold Chain Management: A Comparative Scenario Between Two States of India. *Indian Journal of Marketing,* **45**(1): 19-35.

SHARMA, K. D., PATHANIA, M. S., AND HARBANS LAL, 2010, Value Chain Analysis and Financial Viability of Agro-Processing Industries in Himachal Pradesh. *Agricultural Economics Research Review,* **23**(1): 515-522.

SIKKA, B.K., ASHUTOSH SINGH, AND AGNIHOTRI, A.K., 2008, Export competitiveness of Indian horti-business industry: a model for capacity building under precision farming. Proceedings of the 9th International Conference on Precision Agriculture, Denver, Colorado, USA, 20-23rd July 2008.

STEVENS, C., 2001, Value chains and trade policy: the case of agriculture*. IDS Bulletin*, **32**(3): 46-59.

SUNITA RAJU., 2014, Global Value Chains and Indian Food Sector: A Preliminary Analysis of Issues and Options. *Indian Institute of Foreign Trade,* July 14-23rd.

SURAJIT BAG, 2016, Modeling Barriers of Green Cold Chain Management in India. *Journal of Supply Chain Management Systems,* **5**(1): 37-45.

VICTORIA SALIN, RODOLFO, M., AND NAYGA, J, R., 2003, A cold chain network for food exports to developing countries. *International Journal of Physical Distribution & Logistics Management*, **33**(10): 918 – 933.

WEI WANG, 2016, Cold Chain Logistics Development and Analysis of Necessity. *Journal of Service Science and Management*, **9**(3): 238-242.

WEIYANG X.U., ZHENJI ZHANG, DAQING GONG, AND XIAOLAN GUAN., 2014, Neural Network Model for the Risk Prediction in Cold Chain Logistics. *International Journal of Multimedia and Ubiquitous Engineering,* **9**(8): 111-124.

WUXUE JIANG, ZHIXIONG, H.U., YAN LIANG, AND YUQIANG CHEN, 2014, Modeling and Optimization of Food Cold-chain Intelligent Logistics Distribution Network. *Advance Journal of Food Science and Technology*, **7**(8): 573-578.

Websites

http://www.nccd.gov.in/AboutUs.html

http://www.nccd.gov.in/PDF/CCSG_Final%20Report_Web.pdf

http://www.nccd.gov.in/PDF/ColdStoragedistribution.pdf

http://www.nccd.gov.in/AboutUs.html

http://agriexchange.apeda.gov.in/

ANNEXURES

Annexure 1: Existing Cold-chain infrastructure in India

The table represents the component-wise present status of cold-chain infrastructure in India created under different schemes of various departments.

Sl. No	Infrastructure Component	Numbers	Average Capacity size	Remarks
1.	Modern Pack-house (PH)	249		Study of secondary data and estimates
2.	Cold Storage Hubs (CH)	5367	5003tons	Baseline Survey (DAC)
3.	Cold Storage Bulk (CS)			Baseline Survey (DAC)
4.	Ripening Chamber (RC)	812		Study of secondary data and estimates
5.	Reefer Transport (T)	9000	6 to 15 tons	Market estimate
6.	Last mile Transport (t)		<4 tons	Market estimate
7.	Retail/ Front-end (FE)	1.968 million outlets		Market estimate

Source: http://www.nccd.gov.in/PDF/CCSG_Final%20Report_Web.pdf

Annexure 2: Cold-chain infrastructure gap in India

Sl. No	Type of Infrastructure	Infrastructure Requirement (A)	Infrastructure Created (B)	All India Gap (A-B)
1.	Pack-house	70,080 nos.	249 nos.	69,831 nos.
2.	Reefer Vehicles	61,826 nos.	9000 nos.	52,826 nos.
3.	Cold Storage(Bulk)	341,64,411 MT	3,18,23,700 MT.	32,76,962 MT
4.	Cold Storage(Hub)	9,36,251 MT		
5.	Ripening Chamber	9,131 nos.	812 nos.	8319 nos.

Source: http://www.nccd.gov.in/PDF/CCSG_Final%20Report_Web.pdf

Annexure 3: State-wise capacity of cold Ssorages in India

Sl. No.	State/UTs	Number of Cold stores	Capacity in MT
1	Andaman & Nicobar (UT)	2	210
2	Andhra Pradesh	404	15,77,828
3	Arunachal Pradesh	2	5000
4	Assam	34	1,19,652
5	Bihar	303	14,06,395
6	Chandigarh (UT)	6	12,216
7	Chhattisgarh	89	4,27,766
8	Delhi	97	1,29,857
9	Goa	29	7705
10	Gujarat	560	20,30,873
11	Haryana	295	5,88,649
12	Himachal Pradesh	32	38,557
13	Jammu & Kashmir	28	64,769
14	Jharkhand	55	2,17,280
15	Karnataka	189	5,26,752
16	Kerala	197	78,355
17	Lakshadweep (UT)	1	15
18	Madhya Pradesh	260	10,97,168
19	Maharashtra	540	7,06,302
20	Manipur	1	2175
21	Meghalaya	4	8200
22	Mizoram	3	3931
23	Nagaland	2	6150
24	Odisha	111	3,26,639
25	Puducherry (UT)	3	85
26	Punjab	606	20,04,778
27	Rajasthan	154	4,80,032
28	Sikkim	2	2000
29	Tamil Nadu	163	2,95,671
30	Tripura	13	39,181
31	Uttar Pradesh	2176	1,36,33,039
32	Uttarakhand	28	84,545
33	West Bengal	502	59,01,925
	Total	6891	3,18,23,700

Source: http://www.nccd.gov.in/PDF/ColdStoragedistribution.pdf

Annexure 4: Commodity wise number of cold storages

Sl. No	Commodity	Capacity (Million MT)	Per centage to the total	No. of Cold Storages
1.	Potato	18.43	75.4	2862
2.	Multi-Purpose	5.64	23.1	1584
3.	Fruits & Vegetables	0.10	0.4	160
4.	Meat & Fish	0.19	0.8	497
5.	Milk/Milk Products	0.07	0.3	191
6.	Others	0.03	0.1	87
	Total	24.46		5381

Source: http://agriexchange.apeda.gov.in/

Annexure 5: Major Cold-chain infrastructure components

Sl. No	Infrastructure Component	Desirable Set-up Location	Current Usage
1.	Modern Pack-house (PH)	At farm gate for fresh produce preconditioning	For exporters, mostly
2.	Long Haul Transport (T)	From pack-house to Mandi/ wholesale buyer	Across the country
3.	Cold Storage Hubs (CH)	Close to consumption/ distribution centre	Across the country
4.	Cold Storage Bulk (CS)	At farm gate/food processing premises	At farm gate/ food processing premises
5.	Ripening Chamber (RC)	Close to consumption/ distribution centre	Near to Consumption centre
6.	Last mile Transport (t)	Within distribution city	Major cities
7.	Retail/ Front-end (FE)	Last mile merchandising	Front end
8.	Food Processing Unit (PU)	Factory dispatch of food product as source point	Cluster parks, production zones

Source: http://www.nccd.gov.in/AboutUs.html