A STUDY ON COLD CHAIN STORAGE AND TECHNOLOGY OF PERISHABLE CARGO
With Reference To
TRADERS IN KERALA

A dissertation submitted to the School of Maritime Management, Indian Maritime University in partial fulfilment for the requirements for the award of degree in MBA- International Transportation and Logistics Management

Submitted

By,

SUDEEP P
(Reg. No. 1903305035)

Under the supervision of
Dr. B. SWAMINATHAN
Associate Professor

INDIAN MARITIME UNIVERSITY
(A Central University, Government of India)
SCHOOL OF MARITIME MANAGEMENT
CHENNAI CAMPUS

DECLARATION

I, SUDEEP P **(Reg. No. 1903305035),** student of School of Maritime Management, Indian Maritime University –Chennai Campus, hereby declare that this project report titled **A STUDY ON COLD CHAIN STORAGE AND TECHNOLOGY OF PERISHABLE CARGO With Reference To TRADERS IN KERALA** submitted in partial fulfilment of the requirement for the degree of Master of Business Administration in International Transportation and Logistics Management is my original work carried under the guidance of my project guide. It has not formed the basis for the award of any Degree/Diploma of any University/Institution. The information submitted is true and original to the best of my knowledge.

.

SUDEEP P
(Reg No. 1903305035)

Place: Chennai
Date:

Supervised by

Dr. B. Swaminathan
Associate Professor

ACKNOWLEDGEMENT

It gives me immense pleasure to express my thanks to all those who helped in the successful Completion of this project. First & foremost, I thank the God Almighty for his gracious guidance throughout the project work.

I would like to extend my sincere gratitude to my faculty **Dr. A Mourougane**, Associate professor and Head SMM Indian Maritime University, Chennai Campus for his support during my final project.

I would like to extend my sincere gratitude to my faculty **Dr. B Swaminathan**, Associate professor SMM, Indian Maritime University, Chennai Campus for his guidance and support during my final project.

Most importantly, I would like to express my heartfelt thanks to my beloved parents for their blessing, my friends and classmates for their help and wishes for the successful completion of this project.

EXECUTIVE SUMMARY

India is the second largest producer of meat and fish, largest producer of milk and one of the leading producer of fruits and vegetables. Because of its different agro-climatic zones and resources, the production of various commodities is not only large-scale, but also diverse. Despite these advantages, India is one of the world's major food producers despite the fact that a significant portion of the population suffers from hunger and malnutrition. Due to the fact that Indian farmers generate the highest quantities of the aforementioned agricultural and horticultural products, their economic status is not very bright. In comparison to affluent countries, India's agricultural situation is extremely complicated, as are the factors that have led to it. Poor post-harvest care, very complicated and inefficient supply systems, and lack of storage and processing infrastructure all contribute to large amounts of food loss.

Cold chain sector has an important role in addressing these problems. Addressing the issue of perishability, Cold chain extends the shelf life and thus usability of the commodity in its best form. Based on the purpose, nature and the stage where it is employed, the application of cold temperature is divided into Chilled (0°C to 10°C), Frozen (<-18° C), Mild Chilled (10°C to 20°C) and Normal (>20° C) storage. The majority of horticulture items must be handled in the Chilled and Mild Chilled zones, whilst meat and fish must be handled between the Chilled and Frozen zones.

The whole supply chain of perishable foods produce is fraught with the issue of post-harvest wastages and losses. Around 30-40 % of total production gets waste at various levels of the supply chain. Apart from the loss of revenue to the farmers, it results in increased additional expenses in the supply chain, forcing the final customer to pay excessive charges from his own pocket. The current study provides a precise and accurate assessment of the existing basic and contemporary literature in order to explain the current position as well as the postharvest losses and wastage issues in the supply chain of agricultural products, especially fruits and vegetables and also analyzes the primary elements that cause losses and wastages in the Fruits and Vegetables sector's logistics and supply chain, which are grouped into categories namely Infrastructure, Intermediaries, Harvesting, Transportation, Information, Knowledge of Farmer’s, Storage and Handling.

TABLE OF CONTENTS

LIST OF TABLES, CHARTS & FIGURES

4.12	Transportation time a critical factor for your product	54
4.13	The cost of reefer vehicle is reasonable	55
4.14	Good logistics facilities available in your area to reach cold chain storages	56
4.15	Your product can be transported along with other products	57
4.16	It is difficult to collection the product from farm gate	58
4.17	You know the post-harvest process of handling and storage of your product	59
4.18	Services of cold chain storage are affordable for your product	60
4.19	New and advanced technologies are available at the cold chain storage	61
4.20	Suitable Packing facilities of your product for cold chain	62
4.21	Perishable cargo requires special care while handling	63
4.22	Cold storage centers has proper handling facility	64
4.23	Rough handing major reason for wastage of product	65
4.24	Farmers have knowledge on cold chain	66
4.25	Farmers are awareness of post-harvest cold chain technologies	67
4.26	Cold chain infrastructure affordable to farmers	68

ABBRIVIATION

APEDA	Agricultural Processed Food Export Development Authority
CA	Controlled Atmosphere
CPC	Central Processing Center
ECB	External commercial barrowings
FDI	Foreign Direct Investment
F & V	Fruits and Vegetables
FSSAI	Food Safety and Standards Authority of India
GOI	Government of India
ICT	Information and Communication Technology
IIR	International Institute of Refrigeration
ISAM	Integrated Scheme For Agricultural Marketing
IQF	Individually Quick Frozen
MOFPI	Ministry of Food Processing Industries
NABARD	National Bank for Agriculture and Rural Development
NCCD	National Center for Cold Chain Development
NGO	Non- Governmental Organization
NHB	National Horticulture Board
NMFP	National Mission on Food Processing
PPC	Primary Processing Center
SFAC	Small Farmers Agri Business Consortium
TFCP	Task Force on Cold Chain Projects
TFO	Total Financial Outlay
UK	United Kingdom
WFLO	World Food Logistics Organization

CHAPTER – 1
INTRODUCTION

1.1. BACKGROUND

India, the world's second-largest producer and one of the world's major centers, is also one of the world's largest food wasters. The issue of feeding India's billion-plus people is not so much agriculture and food production as it is getting good food to the right people at the right time. The lack of temperature-controlled transportation and poor quality cold storage facilities for both farmers and food merchants (retailers) are the leading causes of waste. A well-developed, world-class cold chain infrastructure is something India lacks and desperately needs. Without it, India's problems will only become worse. The writers attempt to describe the scope of fruit and vegetable waste in India (at various stages from farm to retail) and its implications for food production and safety in this chapter. The authors also outlined the issues that the Indian cold chain sector faces, as well as a plan for reform. Since that India's economy is built on agriculture, the development of cold chain infrastructure from farm to retail would be critical.

The cold chain is a type of supply chain that refers to a physical mechanism that controls the logistics of certain processed foods. The cold chain employs equipment and facilities to safeguard chilled and frozen foods (Salin et al., 2002). Bishara (2006) gives another definition to the cold chain: "a cold chain is a supply chain of perishable items". A cold chain can also be employed in a variety of different industries, including food, pharmaceuticals, and chemical products. The high demand on temperature, humidity, light, and other specific circumstances is a typical feature of those items. The cold chain and the food cold chain are used interchangeably in this study.

As a result, there are two major distinctions between supply chain and the cold chain: first, the cold chain places a stronger focus on operational conditions than supply chain; second, products in the cold chain have the potential to spoil as they travel from production to consumption (Joshi et al., 2009).

In a world of finite resources, it is critical to produce better and consume wisely in order to live a sustainable existence. Every year, one-third of horticultural products, particularly fruits and vegetables, is wasted in India. Despite the fact that there is enough food for everyone in

today's globe, due to inefficient supply lines and low processing levels, not everyone eats.

1.2 IMPORTANCE OF COLD CHAIN TECHNOLOGY

Many different factors contribute to the protection and efficiency of items delivered globally via the supply chain. Cold chain management is one of the most important components. With a rising number of medications on the market requiring storage in a constantly controlled environment, the need for enhanced cold chain solutions is growing. Packaging, temperature monitoring, and mode of transportation are all critical factors in the supply chain, but especially in the cold chain. When striving to retain sample integrity throughout the cold chain process, proper packaging is critical. Before being transported, shipments must also go through a proper conditioning process to reach the required temperature.

Because protecting temperature-sensitive medications is critical to their operation and effectiveness, cargo that diverges in any way might be judged unusable and dangerous, resulting in a waste of product. “In case of mismanagement of the cold chain we may face a shortage of drugs, so having products that have been rejected because of time out of refrigeration directly affects the continuity of the business and the ability of the company to maintain patients in their treatments.” As a result, it's no surprise that many businesses are willing to make significant investments in the development of an effective and complete logistics system.

Major benefits of a well-connected cold chain are:

- Availability: Perishable items, such as fruits, vegetables, meat, poultry, and dairy, require a constant supply of cold. By controlling variables such as temperature, humidity, and atmospheric composition, as well as employing suitable handling practices, the cold chain can extend the shelf life of fresh items by days, weeks, or even months.
- Affordability: Although the country's vegetable and fruit production has expanded over time, pricing remain inconsistent across the country. Through the holistic development of integrated cold-chain systems, it is possible to normalize crop prices throughout the year and across geographies. It is the key to reducing post-harvest losses, assuring continuous supply, and lowering food inflation.
- Accessibility: If the product produced can be distributed to areas where it is not planted, availability can be guaranteed across the country. The cold-chain will greatly assist

farmers in reaching far-flung markets. It gives them the chance to reach a bigger customer base and lets them put their crop to better use. In addition, the consumer will now be able to obtain the products of his choice at a convenient time and location. The components to develop agricultural supply networks are a significant feature of the planned Vision 2022 "for doubling farmer's income." One of the most important strategies for bridging the present gap and strengthening these supply chains is to expand the cold chain network

- Quality: The cold chain protects the quality of perishable foods by decreasing respiration, lowering transpiration, and lowering microbial activity, among other things.
- Social Importance: Having a good backward integration is an important aspect of having a good cold chain. This, in turn, has the ability to create growth possibilities in rural areas, raise living conditions, and reduce migration to cities. It will also significantly increase rural employment, providing huge prospects for both men and women in this field.

1.3 PROBLEM IDENTIFICATION

In a world of finite resources, in order to maintain a sustainable life, it is important to produce better and consume intelligently. In India, one-third of horticultural produce especially vegetables and fruits are wasted in every year. In today's world though there is enough food for everyone but not sure that everyone eats, owing to the inefficient supply chains and poor processing levels. Millions across the country suffer from malnutrition and die because of hunger. Perishable products like fruits, vegetables, meat and poultry products have a significant increase in production. It ranks second in fruits and vegetables, first in dairy production and sixth in chicken and meat production in the world. Unfortunately, the development of cold-chain infrastructure this demand, which resulted in absence of mechanisms, for safe handling and storage, transportation of perishable products to markets.

The environment, food security, quality, and safety are all affected by food losses and their prevention. Food loss also reflects a waste of the labor, water, energy, land and other inputs that used to produce food which has an influence on socio-economic development. Cold Chain industry has a major role to play in addressing food loss issues, both directly by enhancing the food shelf life and indirectly by enhancing the reach of the food to markets and processing

facilities. Cold Stores are buildings or chambers that use proper thermal insulation and an efficient refrigeration system to create regulated storage environment. Its goal is to maintain quality and extend by correctly handling and storing fresh produce at the appropriate temperature and humidity.

In this study, I am discussing about the technology of cold chain that currently available in India for reduce the wastage of perishable food products.

1.4 COMPONENTS OF COLD CHAIN ACROSS VALUE CHAIN

A typical cold chain begins at the farm gate or at the manufacturing facility. Sorting, grading, and pre-cooling are the first steps in the cold chain; after that, the items go through different processing, storage, and infrastructure stages before reaching the ultimate customer. Followings are the various components involved in the integrated cold chain:

- Cooling and Packing fresh food products (immediately after collection)
- Food processing (i.e. ripening, freezing of processed foods),
- Refrigerated transportation (cold transport and temporary warehousing under temperature controlled conditions)
- Cold storage (long or short term warehousing of chilled or frozen foods)
- Retail (freezer or refrigerated storage and displays at wholesale markets, retail markets and foodservice outlets)

Packing and pre-coding:

Pack-houses are facilities where established systems for sorting, grading, washing, drying, weighing, packaging, pre-cooling and staging are present. Pre-cooling refers to reducing the field temperature of fresh horticultural produce soon after harvest and the target temperature depend upon the type of produce Modern pack-houses are the first step in horticulture's systematic post-harvest management, and they serve as the sector's first mile sourcing sites.

5 main method of precooling procure

- ✓ Room cooling
- ✓ Hydro-cooling
- ✓ Vacuum cooling
- ✓ Ice cooling

- ✓ Forced-air cooling

Food Processing:

Cold chain processing plays a significant role in increasing the shelf life, henceforth utility of the product. Produce can be processed via ripening, cooling, or freezing, each of which has its own shelf life effects. Ripening Chambers are specially designed enclosures that replicate the ripening process without affecting the taste or freshness of fruits. A ripening chamber comprises of following components:

- ✓ Air tight room with insulation
- ✓ Temperature control for cooling and heating
- ✓ Air circulation and ventilation system
- ✓ Humidity control system
- ✓ Electric control system
- ✓ Ethylene gas injection system

Using a free flow freezing procedure to generate individually quick frozen (IQF) product bits can speed up the freezing process even more. Quick freezing procedures (IQF by immersion or liquid nitrogen sprays) yield higher-quality food than slow freezing methods (traditional freezer room racking).

Refrigerated Transportation:

- Refrigerated transport is essential for a seamless cold chain, ensuring that materials are delivered to their destinations in good condition. Transportation between farm to processing units and processing units to the retailer is very important to control an unbroken cold chain. Vehicles equipped with active refrigeration designed for environment controlled carriage of goods can be classified as follows:
- Reefer Trucks: The refrigeration trucks, which operate as mobile cold rooms, are powered by integrated diesel engines that are separate from the main truck engine. Smaller trucks with direct drive systems or battery-powered refrigeration units can also be utilized for the same purpose. Newer reefer trucks have GPS-based location tracking systems as well as data-logging temperature and humidity sensors for continuous monitoring.
- Reefer Containers: A refrigerated container, often known as a reefer, is an intermodal container that is refrigerated for the transportation of temperature-sensitive cargo in

intermodal freight transit. While a reefer has its own refrigeration system, it is powered by external power sources such as electrical power points (also known as "reefer points") on land, aboard a container ship, or on a dock. When being moved over the road on a trailer or by rail wagon, diesel generators can be attached to the container and used to power it while on the road. Refrigerated containers can maintain temperatures ranging from -65 to 40 degrees Celsius.

- Reefer Vessels/Ships: Cargo ship that specializes in transporting commodities that must be kept at temperatures below ambient. Layers of insulating material line each cargo carrying compartment. Furthermore, the floor is double-skinned to allow for uniform cooling air circulation. Perforated wooden/plastic gratings are commonly used to provide for uniform cold air percolation. A temperature range of -30 to +12°C can be maintained depending on the type of cargo.

Cold Storage:

A cool store, also known as a cold store, is a large refrigerated room or structure used to keep items in an atmosphere that is cooler than the outdoor temperature. Fruit, vegetables, shellfish, and meat are examples of products that require refrigeration. Cold stores are frequently found near shipping ports where produce is imported and exported. Fresh produce cold stores are created to maintain respiration and prevent discoloration, sprouting, dehydration and decay. The cold stores can be classified as follows:

- Bulk Cold Stores: Bulk cold stores are climate-controlled warehouse spaces used for bulk storage of perishable goods. It is intended for long-term storage of produce in order to create an inventory buffer that will smooth out episodic production by stabilizing and maintaining supply lines. These are typically built near producing areas (farm-gate) to provide easy access to farmers and near shipping ports for a limited number of crops. Typically used for the storage of a particular product that runs mostly on a seasonal basis.
- Multipurpose Cold Stores: For use as a distribution hub, warehousing space with several temperature zones is required. It's built to handle products for a brief period of time and function as a distribution logistics platform for market-ready packaged produce and ready-to-retail products. They are designed for storage of a variety of commodities which operate, round the year.
- Small cold storage with precooling capabilities for fresh fruits and vegetables, primarily for export commodities such as grapes. Maharashtra has the highest concentration of

these units, although the tendency is spreading to neighboring states such as Karnataka, Andhra Pradesh, and Gujarat.

- Frozen food stores for fish, meat, poultry, dairy goods, and processed fruits and vegetables, with or without processing and freezing facilities. These units have aided in the development and expansion of the frozen foods business, both domestically and internationally.
- Controlled Atmosphere (CA) Stores: These are cold stores with technology that can change the gaseous composition of the atmosphere as well as manipulate the temperature. Apples, pears, and cherries are examples of fruits and vegetables.
- Mini units / Walk-in cold stores located at hotels, restaurants, malls, super markets etc.

1.5. KEY PARTICIPANTS AND THEIR ROLES IN COLD CHAIN

Growers associations, farmer's producer organizations and co-operatives, associations of retailers to companies engaged in the manufacture and installation of refrigeration equipment, associations of cold chain owners, chambers of trade, industry and commerce, regulatory and development agencies (NCCD, MOFPI, NHB, WDRA, FSSAI, BIS), PSUs, skill development academic and resource institutions are some of the stakeholders in the cold chain, based on their roles and functions in the chain.

- Producers/Grower Associations and Consolidators: Farmers in India are small in terms of land holdings, yields, and crop volume, and they are widely dispersed across the country. Typically a farmer handles cultivation, harvesting and preliminary packaging and transportation to the local mandi or consolidator. Some local entrepreneurs/consolidators deliver the collected produce to the traders or processors in predefined quantities and quality, and are responsible for transporting the produce from the field/farmer storage to the trader/processor. The consolidator is responsible for the safe and secure physical transfer of the product. Both of these players are critical in a cold chain since the product is most vulnerable to damage after the first few hours following harvesting.
- Traders & Processors: Small producers with small orchards bring their harvest to the market yard and sell it to traders, who then sell it to processors after executing rudimentary pack house operations. Traders are typically the owners of primary collection centers, which are where the fresh fruit is initially held. They usually do both

trade and packing, as well as storage and, in some circumstances, ripening. Small producers with small orchards bring their harvest to the market yard and sell it to traders, who then sell it to processors after executing rudimentary pack house operations. Traders are typically the owners of primary collection centers, which are where the fresh fruit is initially held. They usually do both trade and packing, as well as storage and, in some circumstances also ripening activities. They buy the food from a number of farmers and then sell it to either a wholesaler or a retailer after conducting the necessary activities. Aside from trading, some traders/pack houses offer their services and charge a set fee for each task completed.

- 3rd party reefer transporter: Currently, vehicles are used for a large portion of transportation. The products are transported from the farm to the trader or mandi in tempo/vans or, in the case of larger consignment trucks, unrefrigerated trucks. Reefer transportation is only used in the organized commerce when two to three stages in the value chain have been completed. To meet the shortage of own reefer transportation, organized retail marts and food processing industries hire third-party reefer transporters.
- Technology Providers: Companies operating in the fields of refrigeration, packaging, IT infrastructure, post-harvest care, monitoring and control technologies for real-time data collecting and reporting make up the cold chain technology providers. They play a vital role in modernizing infrastructure by doing research and development to increase the efficiency of the cold chain by focusing on factors such as energy efficiency, cost reduction, expanding reach, and lowering environmental effect.

- Cold Chain Associations: Various national and state-level cold chain associations are active in advocating for needed policy assistance. They serve as crucial agents for the sector to collaborate and network with one another in order to share expertise, lobby for government support, and liaise with one another.
- Government agencies: Government agencies are in charge of developing policies, building infrastructure, and enacting legislation. Infrastructure development is supported by organizations such as MOFPI, NHB, and APEDA. The National Center for Cold Chain Development (NCCD) is an autonomous body within the Department of Agriculture, Cooperation, and Farmer Welfare that was created to enhance the

perishables cold chain sector in conjunction with industry and other stakeholders. It is important in creating research, developing technological standards and protocols, and developing human resources for the country's cold chain infrastructure.

1.6. SCOPE OF STUDY

In a world of finite resources, in order to lead a sustainable life, it is important to produce better and consume intelligently. In India, one-third of horticultural produce especially fruits and vegetables are wasted every year1. In today's world though there is enough food for everyone but not everyone eats, in spite of being the world's second largest producer of Fruits and Vegetables, the customers are not getting proper quality, at a right time and at a right cost due to losses and wastage in the supply chain of Fruits and Vegetables sector. A huge share of production turns into waste which made India as one of the biggest wasters in the world. Fruit and vegetable supply chains in India are inefficient, resulting in significant losses and wastages, as well as lower income for stakeholders. Aside from the loss of revenue for the farmers, it results in increased additional expenses in the supply chain, forcing the final customer to pay excessive charges out of his own pocket. According to various researchers on post-harvest losses in India, the amount of food wasted in a year in India is comparable to annual food consumption in the United Kingdom.

The present paper is an attempt to provide a snapshot of factors which are contributing to losses and wastage in the supply chain of Fruits and Vegetables sector in India through detailed and extensive review of basic and contemporary literature available, including trends, research avenues and measures to improve the supply chain effectiveness.

The cold chain sector is a critical component in addressing food loss issues, both directly by extending food shelf life and indirectly by extending food reach to markets and processing facilities.

1.7 OBJECTIVES OF THE STUDY

- To find Current technology of cold chain in India
- Factors Leading to mismanagement and wastage in the Supply Chain of Fruits and Vegetables Sector in India
- Suggestions to overcome the mismanagement and wastage in the Supply Chain of Fruits and Vegetables Sector.

1.8 DISSERTATION STRUCTURE

- Chapter One: Gives an overview of the Cold chain Industry, importance of the study and various other details about the project
- Chapter Two: This chapter presents a brief introduction about the Cold chain sector, role of cold chain and challenges.
- Chapter Three: This chapter present Factors Leading to Mismanagement and Wastage in the Supply Chain of Fruits and Vegetables Sectors in India
- Chapter Four: This chapter brings out the analysis of data collected from 30 respondents through online
- Chapter Five: This chapter deals with the conclusion, findings, and recommendations of the study

CHAPTER –2
RESEARCH METHODOLOGY

2.1 PREAMBLE

Research methodology is the path through which researchers need to conduct their research. It shows the path through which these researchers formulate their problem and objective and present their result from the data obtained during the study period. This research design and methodology chapter also shows how the research outcome at the end will be obtained in line with meeting the objective of the study. This chapter hence discusses the research methods that were used during the research process. It includes the research methodology of the study from the research strategy to the result dissemination. For emphasis, this chapter outlines the research strategy, research design, research methodology, the study area, data sources such as primary data sources and secondary data, population consideration and sample size determination such as questionnaires sample size determination and workplace site exposure measurement sample determination, data collection methods like primary data collection methods including workplace site observation data collection and data collection through desk review, data collection through questionnaires, data obtained from experts opinion, workplace site exposure measurement, data collection tools pretest, secondary data collection methods, methods of data analysis used such as quantitative data analysis and qualitative data analysis, data analysis software, the reliability and validity analysis of the quantitative data, reliability of data, reliability analysis, validity, data quality management, inclusion criteria, ethical consideration and dissemination of result and its utilization approaches. In order to satisfy the objectives of the study, a qualitative and quantitative research method is apprehended in general. The study used these mixed strategies because the data were obtained from all aspects of the data source during the study time. Therefore, the purpose of this methodology is to satisfy the research plan and target devised by the researcher.

2.2. BIBLIOGRAPHIC SCOPING

In India the entire supply chain of Fruits and Vegetables is laden with various issues and challenges, to list the possible challenges and suggest a way forward, there is a need to analyze the supply chain of Vegetables and Fruits sector in India. And the purpose of this paper is to discuss the supply chain of vegetables and Fruits sector and explain the problems which are affecting it in India.

The study done by Saurav Negi and Neeraj Anand on issues and challenges in the supply chain of vegetables and fruits sector in India found that Cold Chain Facilities; Fragmented Supply Chain; Linkages and Integration between the partners; Taxation Issue; Infrastructure Facilities; Cost of Packaging Material; Technology and Techniques; Farmer's Knowledge and Awareness; Quality and Safety standards; Processing and Value Addition; Supply Chain inefficiency; Farmers income; Supply chain losses and wastage of fresh produce; Transportation facilities; Demand and market information etc. are the factors which creates serious problems for Vegetables and Fruits sector and are affects the overall growth of the agricultural development of India.

In International Journal of Managing Value and Supply Chains states that F&V sector is perhaps the most profitable venture of all farming activities as it provides ample employment opportunities and scope to raise the income of the farming community. It also has tremendous potential to push the overall agriculture growth. India has been bestowed with wide range of climate and physic-geographical conditions and as such is most suitable for growing various kinds of F&V. This has placed India among the foremost countries in F&V production just behind China. F&V together constitute about 92% of the total horticultural production in India (ASSOCHAM, 2013).

Hsiao, Vorst, Kemp, and Omta (2008) conducted a study and based on the findings of the study, concluded that in order to maintain the quality of food products, logistics plays a major role.

Smith (2006) also identified logistics as the key player in influencing the quality and safety as well as preserving the safety standards of the food products.

Kelepouris, Pramatari and Doukidis (2007); Henderson, (1994); Fearne and Hughes (1999) and Hsiao et al. (2008) also identified many elements like transportation, warehousing, value added services, storage and handling of the stock, third party service providers etc. as the main contributors to the logistics cost. Proximity, network complexity and product specificity were identified as other important factors influencing the cost.

In the year 2016 international trade administration made a study on top markets report cold chain country case study and the finds states that, Even though India is the largest producer of fruit and the second largest producer of vegetables in the world, it represents only 1 percent of world exports, and childhood malnutrition in the country is as high as 45percent. India also the highest milk producer, and 30,000 refrigerated trucks primarily serve the dairy market in the country.

Logistics effectiveness means the storage and flow efficiency in the process of planning, implementing and controlling fresh products in the supply chain. It also contains the effectiveness of information transformation between the points-of-origin to the points-of-consumption (Lambert, 2008). Therefore, the concept of logistics effectiveness in this paper is the efficiency of the flow and storage of the fresh food logistics.

Fresh food cold chain costs are higher in transit than non-perishable supply chains, according to the argument Joshi et al. (2009), because fresh food must be maintained in the refrigerator to retain quality. Furthermore, various items require various temperatures in shipping and storage. For example, milk must be stored at 4 degrees to 10 degrees, while cheese must be stored at 3 to 5 degrees (Manning et al., 2006).

Boronico et al (1995) review that, the cost and quality of the fresh food cold chain are determined by the distribution system. They also point out that maintaining delivery reliability while keeping costs low is a challenge for the fresh food cold chain. It is critical to manage and enhance the distribution routes for fresh perishable commodities (Liu et al., 1999)

Joshi et al (2009) and Manikas et al (2009) advocate that, the cost of facilities accounts for a significant amount of the entire cost of the fresh food cold chain. Fresh food handling facilities (such as the packing machine) are rare and expensive because fresh food is perishable and washable.

2.3. RESEARCH DESIGN

Research design is the structure of research methods and approaches chosen by a researcher. The design will help researchers to focus in on research methods that are appropriable for the subject matter and set up their studies up for success. Research design has been used in the primary stage of the study to find the possibility of carrying out the research on the topic selected for research study. The researcher undertook the extensive literature survey for this purpose. The exploratory research design was followed by descriptive research in which described the various responses and facts received from respondent. The methodology and theoretical viewpoint are significant in this thesis, to collect information that enhances to find high value outcomes.

The main goal and objective of this research is to know more about the Cold Chain Industry, various techniques to maintain the quality of perishable goods, basic problems that faced by cold chain sector, Factors Leading to mismanagement and wastage in the Supply Chain of Fruits and Vegetables Sector in India.

The theoretical viewpoint and methodology are significant in the thesis, to collect information that enhances to find high value outcomes. The data gathering is significant in a thesis, as the quality of the data can influence the understanding of the theoretical framework. The information collected can be primary or secondary.

Primary data

The data has been collected by using a structured schedule have been prepared and circulated among the respondents. Along with that a personal interview were taken with the respondents for collecting primary data.

Secondary data

The secondary data has been collected through sources such as books, journals, magazines, newspapers report etc. the internet resource were used thoroughly to collect the data.

Data analysis

The data collected through schedule have been tabulated by using the software Statistical Package for Social science version 25. The percentage analysis is been carried out and presented in the report along with the graphical representation of the data for better understanding.

2.4 RESEARCH METHODOLOGY

Research Methodology means, a set of systematic techniques that used in research. This simply means a guide to research, how it is conducted and is a way to systematically solve the research problem. It describe and analyze methods, identifies more light on their limitations and resources, clarify their pre- suppositions and consequences, relating their potentialities to the twilight zone at the frontiers of knowledge. It can be understood as a science that studies how scientific research carried out. In it we studying the various steps that are generally adopted by a researcher in studying his research problem along with the logic behind them. It is very important to the researcher to know not only the research methods/techniques but also the methodology.

2.5. QUALITATIVE STUDY

Qualitative research mainly focuses in understanding a research query as an idealistic or humanistic approach. Quantitative approach is a more reliable method, the reason for that, it is based upon numeric and methods that can be made propagated and objectively by other researchers. Qualitative analysis provide facility to analyze the data that cannot be

quantified. Understanding and insights into the features and attributes of objects (participants) are the focus of this type of data. People's beliefs, experiences, attitudes, behavior, and interactions are studied by using qualitative method. It generates data in non-numerical form. The implementation of qualitative research into intervention studies is a research method that is gaining increased attention across disciplines. Although qualitative research was formerly thought to be philosophically incompatible with experimental research, it is today acknowledged for its capacity to provide a new dimension to interventional investigations that cannot be achieved solely through the measurement of variables. Qualitative analysis can help you to get a deeper understanding of "why" a specific phenomenon occurs. The analysis can be utilized in conjunction with or before quantitative analysis. Unlike with quantitative data analysis, which is restricted by certain classification of rules or numbers, qualitative data analysis can be broad ranged and multi-faced. Researchers found it tedious to evaluate human behavior in numeric terms, they turned to qualitative study. Since then, qualitative research has been used in other variety research fields as well. Qualitative research results are expressed in words. Actually it is used to identify or understand the concepts, thoughts, or experiences. This type of research helps you to gather in-depth insights on topics that are not well understood.

This thesis examines the dynamics of the Cold Chain sector and the various cold shelf conditions or facilities for storing each product.

2.6. ANALYTICAL APPROACH

An analytical approach indicates the use of analysis to break a problem down into the elements necessary to solve it. It is the same as formal analysis. The chance of solving a problem is determined by the technique used to solve it. Difficult social problems necessitate an analytical approach since no other option works. The correct analytic methodology is determined by the question being asked. The approach includes seeking clarification from the person who is asking the question, so as it is very helpful to pick the most appropriate way or approach. Once the problem to be addressed is defined, the appropriate analytic approach for the problem is selected in the context of business requirements. And it consider the second stage of the data science methodology. The analytic approach can be select when a strong understanding of the question is established. This indicates that, identifying what type of patterns will be needed to address the question most effectively. A predictive model could be used to determine the chances of taking a certain action. If the goal is to demonstrate relationships, a descriptive

technique may be necessary. This would be one that looked at groups of comparable activities based on events and performance.

The basis of analysis will be derives from the published export details of the top Cold Chain companies subjected to trend analysis.

2.7. COLD CHAIN IN INDIA AT GLANCE

Over the years India has seen a very increase in production of perishable products like meat, fruits, vegetables and poultry products etc. It ranks first in dairy production, second in fruits and vegetables and 6th in chicken and meat production in the world. Unfortunately, cold- chain infrastructure development has not met this demand, which resulted in absence of mechanisms, for safe handling and storage, transportation of perishable products to markets. As a result, demand supply mismatch has arisen across these agricultural commodities, frequently contributing to widespread price fluctuations and inflation. Due to this shortage of farm-to-market logistics, also contributed to huge food losses in case of perishable foods, further adding to inflationary pressures.

A brief snapshot of the current status of various infrastructures in Indian cold chain is presented below:

PACK HOUSES & RIPENING CHAMBERS:

- Pack-houses and refrigerated transport are important to initiate the vital link of logistics chain from villages to city or distribution hubs (in case of fresh produce).
- According to the NCCD report, India now has around 250 fully equipped functional pack-houses, whereas to fulfill current consumption of urban clusters, India needs about 70,000 pack-houses, each with a pre-cooler and dispatch room for further transport links.
- Backward integration in a cold chain has been completely neglected until recent past when the focus has been shifted from building just cold stores to holistic development of integrated cold chain.
- A small concentration of pack houses in Maharashtra has brought global momentum to India's grape sector. Maharashtra is also a leading state in terms of number of pack houses for Mango and Pomegranate, followed by Andhra Pradesh.
- In Uttarakhand customized pack houses have been created to cater to the need of exporting Litchi.

- Another constraint in this sector is that most of the pack houses in India are primarily focused on fruits, there is very little emphasis on vegetable sector. Only few categories of exotic vegetables are handled properly and not much care is extended to others.
- Most of the pack houses created provide only basic operations of grading sorting and are not equipped with latest technology to carry out further value addition.
- Most of the pack houses are established by government. Lack of active participation from private companies is hindering the growth and innovations.

RIPENING CHAMBERS:

- Generally, ripening can be carried out for fruits like Mangoes, Papayas, Pears, Apricots, Guava, Citrus, Melons, and for reddening of Tomatoes, Green Chilies, but in India ripening chambers are predominantly used only for Mango and Banana.
- Maharashtra and UP are hub of ripening chambers in India. Andhra Pradesh stands 3rd in the country. Most of the ripening chambers are used for ripening of Mangoes in these states.

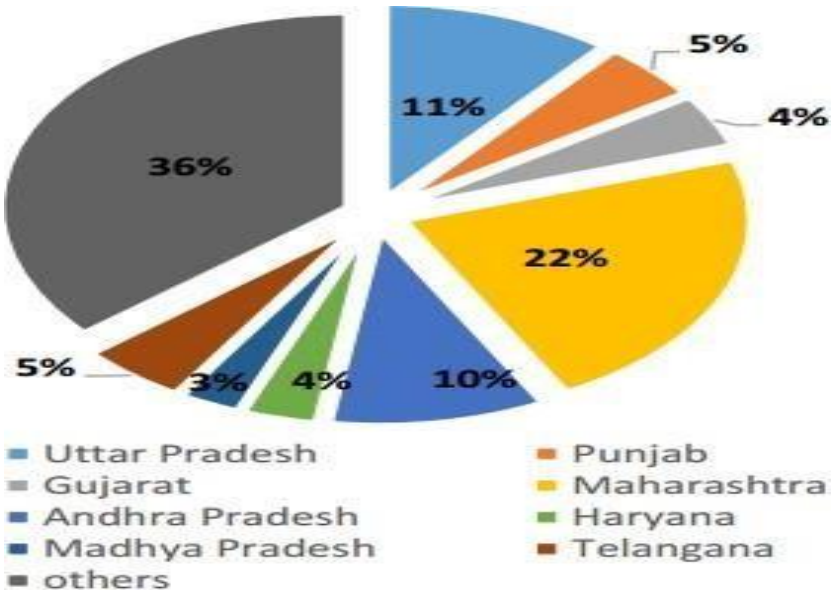


Fig 2.1: State-Wise Distribution of Ripening Chambers created under various government schemes

Source: NCCD All India Cold-chain Infrastructure Capaci**ty**

2.8. COLD STORAGES

The Task Force on Cold-chain Projects (TFCP-2014) reported that 31.82 million metric tons of cold stores have been created in the country, out of these, a total of 10.58 million tons in cold storage size were created in the last decade, through Central Government Assistance.

Majority of the warehouses in India are under private ownership. A lot of cold storages are owned by partnerships in states like Gujarat, Haryana, and Uttar Pradesh, whilst storages in AP are primarily controlled by private limited corporations. Proprietorship is very common in places like Karnataka.

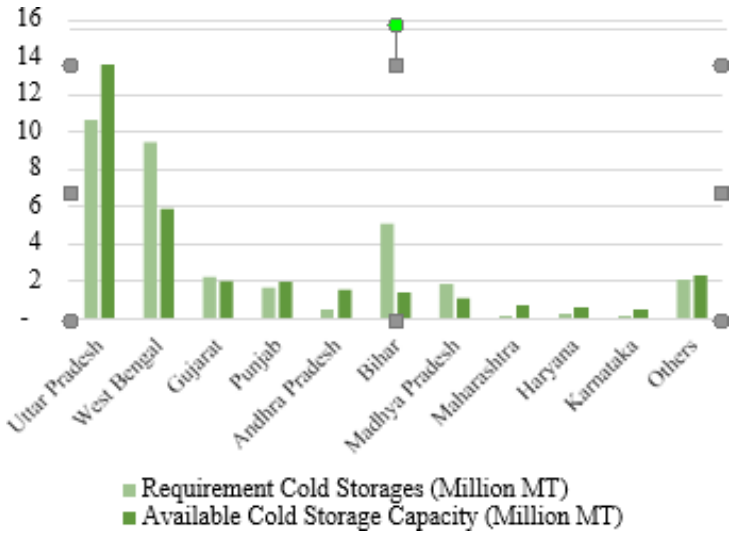


Fig 2.2

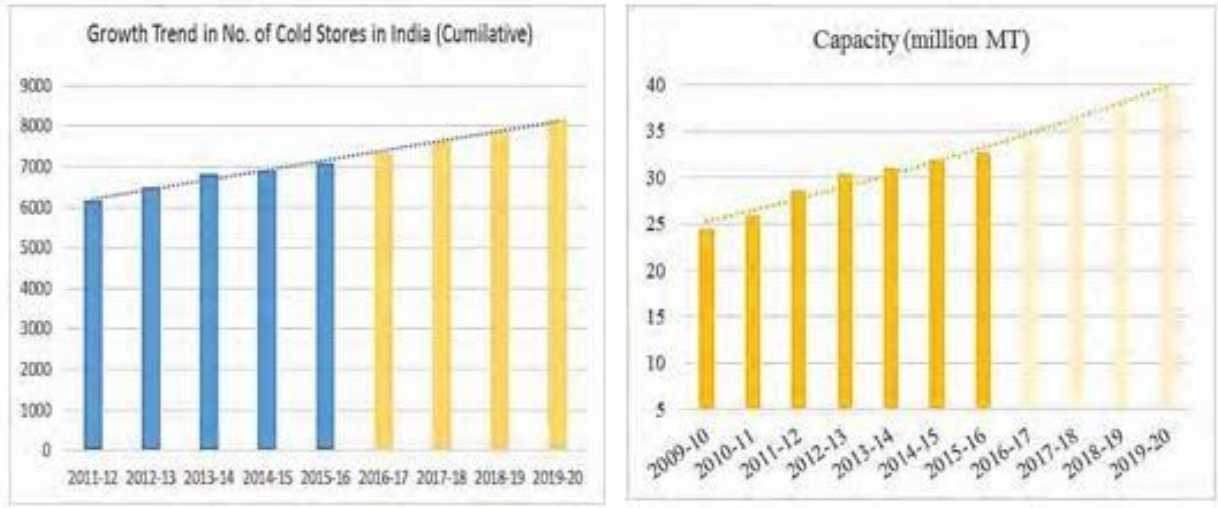


Fig 2.3

2.9. REEFER TRANSPORT

- In cold chain, it is very essential to maintain the link and ensure that the chain is not broken. One crucial aspect to ensure this is to have a seamless refrigerated transportation network.
- Currently, this sector is ignored in the industry as very few players are equipped to provide the temperature controlled logistics service. This sector is highly fragmented and dominated by the private players.
- Indian market comprises of around 250 major and minor reefer transport service providers with ~ 9000 controlled temperature vans having a capacity of 4.2 million tons.
- The states like UP, West Bengal and Punjab are leading in terms of number of cold stores, but they are considerably lagging behind in transportation network.
- NCCD in collaboration with Mahindra Logistics has come up with a unique service proposition of Reefer Vehicle Call-in Center. It is 24/7 call-in facility for registered transport drivers to help them with on-road concerns regarding extortion, transit bottlenecks or any other issues.

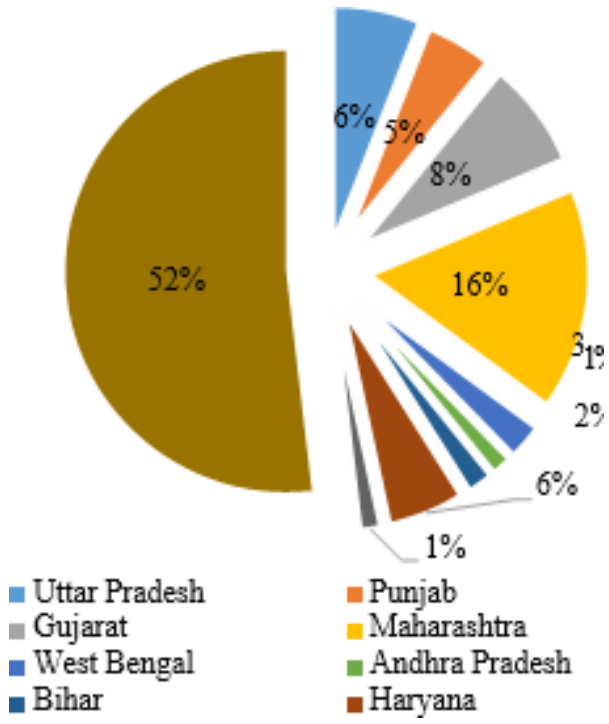


Fig 2.4

2.9. CHALLENGES IN INDIAN COLD CHAIN INFRASTRUCTURE

- **Operational Challenges:**

- High lifecycle cost: High real estate prices with an increase of more than 280% in last decade adds up significantly to the total cost, an acre of land requires for constructing a cold storage with 1 million cubic feet of space. Other factors contributing to the rise in project and operational costs are interstate barriers, intercity and state taxes, and bad roads etc. In USA, the similar scale of installation cost less than half of the investment required in India.
- Quality cold warehouse infrastructure: Nearly 75% of the cold storage infrastructure developed in the past is suitable only to store a particular commodity, rendering them of useless for multi temperature and multi commodity storage.
- Standards and protocols in construction and operation of facility: The Technical standards that using in India are mostly not suitable for Indian conditions, and also it results in poor performance of a standard refrigerated system.
- Uneven distribution of cold storage: Another major challenge of Indian cold chain infrastructure is Storage facility throughout the supply chain. Most of the cold storage facilities are located at the point of production, creating a lack of efficient supply chain to the downstream operations/ markets.
- Low awareness: Cold chain industry consists of multiple players, of which are 85% of unorganized players who are unable to invest much in the technology required to build high quality cold storages along with reefer trucks. 36% of the total players are small players with capacity less than 1000MT and their lower margins further limit their ability to maintain quality standards and invest in growth.

- **Availability and supply of electricity through-out the country:** India currently faces about 9% of peak power deficit, which enforces the use of fuel based operations leading to a marked increase in operating costs. The majority of electricity deficiency and unavailability could be found in the major agrarian states of the country, having a significant percentage of cold storages.
- **Laxity in refer transportation and development of rail and air mode to cold transport:** There is a marginal lag of proportionality between storage to the reefer capacity, leading to 85% shortage of refers in India. Additional consideration should be given to air and rail reefer modes. Rail reefer transport, despite wide coverage of

railway network, is still at the nascent stage and calls for a need for drawing better strategy.

Major challenges to reefer transportation are:

- Dearth of adequate in-house facilities for holding consignments.
- Lack of proper handling facilities at intermediate stations.
- Multi temperature and chamber support system for air and rail refers.
- Cost optimization for transit.
- Skilled workforce to understand the product standards.
- Backup support for detaining of refers increasing perishability chances. There is no financial coverage for the losses caused as a result of vehicle malfunctioning.
- Lack of specific guidelines that set the standard or protocols which need to be maintained for refrigerated transports.

CHAPTER 3

FACTORS LEADING TO MISMANAGEMENT AND WASTAGE IN THE SUPPLY CHAIN OF FRUITS AND VEGETABLE SECTORS IN INDIA

3.1. FACTORS LEADING TO MISMANAGEMENT

The study identifies the major factors leading to mismanagement and wastages in the logistics and supply chain management of Fruits and Vegetables sector classified into categories namely Poor Infrastructure, Knowledge of Farmer's, Storage, Handling, Intermediaries, Transportation and Information.

3.1.1 POOR INFRASTRUCTURE:

Infrastructure plays a very important role and it is the backbone of the supply chain of any industry. In perishable fresh produce supply chain, it includes cold chain, transportation infrastructure, road connectivity and network, port infrastructure, marketing facilities, processing facilities etc. The Infrastructure for perishable food supply chain is very weak in India and that is one of the important reasons for losses and wastage of food. Singh, et al. (2009) found in his research, that inadequate infrastructural support to government regulated supply chain leading to very high losses as high as 40 percent of vegetables and fruits. The post-harvest losses at various stages in the supply chain are Gaps in cold chain such as poor infrastructure, insufficient cold storage capacity, unavailability of cold storages in close proximity to farms, poor transportation infrastructure, etc. Food losses and wastages reduce the returns of fruits and vegetables, and are mostly caused by a lack of infrastructure. Viswanadham (2007) states in his study that, the reason for the waste is the absence of suitable infrastructure for processing, cold storage and transportation in developing countries ranged from 20% to 50% due to poor infrastructure and lack of marketing facilities.

Supply chain of perishable food needs appropriate temperature for maintaining and sustaining the quality and also to increase the shelf life of the produce but there have been staggering losses in the food sector due to the very weak and inadequate cold chain infrastructure (Rathore et al., 2010) and improper marketing methods and facilities (Gauraha & Thakur, 2008; Singh et al., 2008) of the country resulting in losses and wastages in the perishable food supply chain. According to Kader (2005), inadequate storage facilities are a source of product being exposed to direct sunlight that may accelerates metabolism leading to

higher levels of damage and decrease the shelf life of the produce. Due to high charges around 95 % of the cold storages are in private hands, an average Indian farmer is not able to avail the facilities of cold storage. In India the cold chain has emerged as one of the weaker links in the supply chain of fruits and vegetables resulting to losses.

Maheshwar & Chanakwa (2006) mentioned about 30 % of the fruits and vegetables grown in India which is 40 million tones amounting to $13 billion get wasted annually because of gaps in cold chain such as poor infrastructure, unavailability of cold storage in close proximity to farms, insufficient cold storage capacity, poor transportation infrastructure etc. Here a lack of ownership within the chain. All of the players are focused with their personal revenue maximization with limited attention towards the chain's overall profit. Post-harvest waste is the result of a lack of a holistic understanding of a supply chain. The reason of losses is also depends on the road connectivity and network. Most of the northern and eastern region is covered with hilly terrain areas in India and these are the major sources of fruits and vegetables. In such areas the road connectivity and network infrastructure are very poor which takes a long time to take the fresh fruits and vegetables product to the market and it effect in the quality and condition of the produce which results in wastage. A lack of proper infrastructural facilities results in greater wastage of the fresh produce on its way to market.

3.1.2. TRANSPORTATION:

In this section we discusses the transportation related causes of the losses and wastage in the logistics and supply chain of perishable fresh food produce. It found that, losses in transportation are one of the highest and important operational causes of wastage in Perishable food supply chain followed by inventory management.

Rehman et al. (2007) mentioned that the losses mainly occurred during the transportation of the fresh produce to the market. Poor and inappropriate transportation facilities contribute more to this problem. In an attempt to examine the scope and size of post-harvest losses in Uttar Pradesh, Singh et al. (2008) identified transportation and distribution of agricultural goods as a contributing factor. The author discovered that transport loss accounts for around a quarter of the total loss. In transportation, time is a vital component in delivering fresh produce on time and in good condition. There are various losses due to the ignorance of time factor at farm level also.

In the retail industry, wastage is caused by a faulty transportation infrastructure and delayed

delivery of fresh product. It arrives on store shelves too late and with a short remaining shelf life, resulting in wastage in the perishable food supply chain at the retailer level, as well as a penalty. The bulkiness of the fresh fruit makes shipping difficult.

Adoption of enhanced transportation methods, which increases the demand for specialized transportation vehicles such as reefer trucks for perishable commodities, which may retain fresh produce quality and extend shelf life while also lowering transit losses.

3.1.3. LARGE NUMBER OF INTERMEDIARIES:

The supply chain of perishable fresh produce is inefficient by large number of intermediaries and fragmented chain. In India, the traditional supply chain for perishable fresh food is extensive and fragmented, with suppliers taking a large cut of the price paid by buyers. The intermediaries in the supply chain of fresh produce are Farmers, Agents, Pre harvest Contractors, Wholesaler, Commission Agents at whole sale level, Auctioneers, Retailers and the customers. A horticultural product travelled through six-seven different distribution channels from the farm gate to the consumer. A large number of intermediaries contributes to waste and raises the cost of consumption per unit. Market middlemen are responsible for a number of losses. The losses in fresh vegetables were discovered to be dependent on the number of participants in the marketing channel and the length of the channel at the wholesale level.

Because the bulk of Indian farmers are tiny and marginal, with small landholdings, the horticulture supply chain is fragmented. Because of their small landholdings, these farmers' product is very low, which causes transportation issues, leading to a greater reliance on middlemen to market their goods. The intermediaries are often unconcerned about the farmer's losses and are unwilling to invest in better cold storage and other facilities. As a result, the quality and quantity of the produce suffers, resulting in a 40% value loss in the fruit and vegetable supply chain. Companies are developing a variety of methods for obtaining fresh vegetables directly from the farm. Contract farming is another innovative concept that eliminates the layer of intermediaries and decreases the farmers' reliance on them.

3.1.4. INFORMATION OF MARKET DEMAND:

Flow of Information has a very important role in the supply chain to run the smooth flow of functions. In case of fresh produce supply chain due to short shelf life and perishable nature it becomes even more important. In this section classifies the important causes of loss due to poor information regarding demand in supply chain. Viswanadham, 2007 states that, Lack of information regarding demand is considered as a major reason of waste of perishable goods. Buyukbay et al. (2011) also mentioned that, lack of demand information as one of the major reason for waste. Kader (2005) also States Lack of information as one of the important socioeconomic factor causing post-harvest losses. Fresh food is frequently left unsold in retail establishments after its expiration date has past, which is the most common cause of waste at the retail level. This happens when there is no knowledge about demand and retailers place orders that are higher than the actual demand. Farmers must plan and take care of planting and harvesting activities based on timely market demand information, as absence of adequate planning and management methods is one of the reasons for losses in the fresh produce supply chain.

The next section covers the farmer's knowledge and experience as the cause of post-harvest losses in fresh produce supply chain.

3.1.5. FARMERS KNOWLEDGE AND EXPERIENCE:

Farmers' knowledge of technology and market information is critical in the perishable fresh food supply chain because they are the primary source and supplier of all fresh produce, and their education, experience, and knowledge of technology, market information, and new equipment are all factors that contribute to losses in the perishable fresh food supply chain. The majority of the farmers are small landowners and share croppers who have minimal awareness of technology, market demand, and financial incentives.

In his study, Babalola et al. (2010) discovered that the majority of the farmers were illiterate, which could be a contributing factor to significant losses in tomato production because they are unable to comprehend and apply the majority of post-harvest technologies available. One of the reasons for post-harvest losses, according to Ozcan (2007), is a lack of staff training and experience. In the research on Economic analysis of post-harvest losses in vegetable in Uttarakhand, Sharma & Singh (2011) discovered that losses at the grower level are caused by a lack of farmer awareness about post-harvest management. They also have a limited

understanding of the optimal maturity of fresh fruit and the best time to harvest it, resulting in losses.

3.1.6 IMPROPER AND POOR HARVESTING:

Fresh food harvested at the incorrect time or before maturity might result in wastage in the perishable fresh produce supply chain. Poor harvesting has been identified by many researchers as one of the causes of post-harvest losses. According to Rehman et al. (2007), losses occurred primarily during crop plucking. The key factor responsible for post-harvest losses in tomato crops was determined to be harvesting at the wrong stage and inappropriate harvest care, as well as post-harvest difficulties. Sharma and Singh (2011) discovered that harvesting at an inopportune stage promotes uneven ripening and low quality, which is one of the leading causes of post-harvest losses. Early and late harvest losses in tomato and fresh bean output were found to be 5-12.97 percent and 18.44 percent, respectively, by Buyukbay et al. (2011) in Turkey's Tokat province. According to Ozcan (2007) Early or late harvest, unsuitable harvest method for specific product, and use of incorrect tools and equipment's by farmers in harvesting their farm fresh products are further factors for marketing losses.

3.1.7. STORAGE AND HANDLING:

For the reason that, perishable fresh fruit has such a short shelf life, careful storage and handling are required after harvest. Proper storage helps to preserve the quality of fresh food and protects it from deterioration due to rough handling, germs, fungus, mildew, insects, and other factors. Farmers placed their food into huge cane baskets or onto vehicles without taking appropriate action, exposing it to the sun and resulting in losses. According to Jain (2007) the biggest cause of post-harvest losses is physical handling of crops. The operational source of waste in the supply chain is multiple inefficiencies in storage and inefficient handling processes. Improper handling and storage cause about 25% of fruit and vegetable products spoiled. Fresh produce is not properly cared for by farmers. They improperly handle, grade, and pack these produce, exposing fresh fruit to severe temperatures, air modification or contamination, and parasite/disease attack. Pests and illnesses in the field, fruit pressing and crushing at the market, and fruit injury from pressing at the retail level are all major causes of loss due to incorrect handling and storage. One of the reasons for fresh produce selling losses is a lack of suitable storage conditions.

Fresh product supply chain losses are also caused by poor packing. Farmers lose money because they employ wooden crates and unsuitable packaging methods. The losses are due to the fact that produce is packaged in bulk without being sorted or graded. Tobacco suffers economic losses as a result of such factors. The author also noticed that improper handling of fresh vegetables promotes bruising, which leads to splitting and skin breaks. Rough handling of the produce causes damage during off-loading, resulting in a high percentage of fruit and vegetable losses. When moving goods from the farm gate to the market, baskets are stacked on top of each other in an inefficient manner. Because of the bulkiness of the fresh food, transporting is a challenging undertaking. The majority of farmers clean, dry, and store their crops incorrectly.

3.2. GOVERNMENT SCHEMES AND SUPPORT FOR COLD CHAIN INFRASTRUCTURE

Agency	Component	Incentive
MOFPI	It is for storage infrastructure which includes pack house, pre-cooling unit, ripening chamber and transport infrastructure	Grant in aid of 50% of the project cost for difficult areas and 35% of the project cost for general areas.
	Value addition and processing infrastructure including frozen storage associated and integral to the processing	Financial assistance grant-in- aid of 75% for difficult areas, subject to a maximum of Rs.10 crore and 50% the total cost of plant and machinery and technical civil works in General areas

	Mega Food Park Scheme: to facilitate the establishment of a strong food processing industry backed by an efficient supply chain, which includes Collection Centers, Primary Processing Centers (PPC), Central Processing Center (CPC) and Cold Chain infrastructure.	A onetime capital assistance of 50% of the project cost (excluding land cost) subject to a maximum of Rs. 50 crore in general areas and 75% of the project cost (excluding land cost)subject to a ceiling of Rs. 50 crore in difficult and hilly areas
National Horticulture Board (NHB)	Capital Investment subsidy for construction/ expansion/ modernization of cold storage for Horticulture Products	Setting up of cold storage (of capacity above 5000 MT and up to 10000 MT) and their modernization are eligible for assistance of 40% of capital cost of project limited Rs.30.00 lakhs per project in general area and 50% limited to Rs.37.50 lakhs per project in case of NE, Hilly and areas.
Small Farmer Agri-Business Consortium (SFAC)	Integrated Scheme for Agricultural Marketing (ISAM)	Setting up of cold storage as a part of an integrated value chain project are eligible for subsidy provided the cold storage component is not more than 75% of TFO (Total Financial

		Outlay). The scale of assistance as subsidy to projects is at 25% of capital cost and maximum ceiling to Rs.2.25 crores in general area and 33.33% and maximum ceiling up to Rs.4 crores in case of NE, Hilly & Scheduled areas.
National Mission on Food Processing (NMFP)	The State Governments have been allowed to sanction cold chain projects for non- horticulture sector under the NMFP for Dairy, Meat, Poultry, Fish, etc.	Financial assistance is provided up to Rs.5.00 Crore per project in form of grant-in- aid and interest subsidy at 6%, subject to maximum Rs.2.00 Crore.
	Primary Processing Center/Collection Centers (PPC/CC) for both horticulture and non-horticultural produces: Reefer Vehicles for carrying horticultural/food products.	Financial assistance is provided at 50% eligible project cost limited to a maximum of Rs.2.50 Crore. Back ended grant in aid of Rs.50 Lakh
NABARD	For setting up of warehouse for agricultural produce	Low interestloan through food processing and infrastructure fund.
Agricultural and Processed Food Products Export Development Authority (APEDA):	For setting up infrastructure including specialized pack-houses, reefer transport, and cold stores as perishable cargo centers for promoting exports.	Financial assistance of 25% of project cost to private companies aimed at exports.

Table 3.1: Support to Cold Chain sector from various government agencies

Recently MOFPI has announced a consolidated help scheme called SAMPADA (Scheme for Agro-Marine Processing and Development of Agro Processing Clusters), the existing programs of Integrated Cold Chains and Value Addition Infrastructure will be implemented according to this new scheme.

3.3. FOREIGN DIRECT INVESTMENT:

Foreign Direct Investment (FDI) is allowed under automatic route in cold storage. External Commercial Borrowing (ECB) can be raised for creation of cold storages, cold room including farm level pre-cooling for preservation or storage of agriculture/horticulture produce. To provide the growth of cold chain infrastructure in the sector, following additional support factors are considered.

- Reduced excise duty on refrigerated containers, from 12.5% to 6%.
- Reduction of customs duty from 10% to basic 5%, on imports for cold storage, cold chamber and cold chains including pre-cooling unit, pack house, sorting and grading lines and ripening chambers.
- Service tax exemption on the operations like pre-conditioning, pre-cooling, packaging, and transportation of milk. Service tax exemption on construction, erection, commissioning or installation of post-harvest storage infrastructure/cold storages

Other tax incentives:

- Profits from industrial activities related to cold chain are eligible for deductions under Section 80-IB of the Income Tax Act. For the first 5 years, the deductions are at 100% and then at 25 % for next 5 years.
- Under Section 35-AD of the Income-tax Act 1961, deduction @ 150% is permitted for expenditure incurred on capital investment in setting up a cold chain facility.
- Concessional rate of customs duty @ 5% on imported equipment for cold chain facility under the project import benefits.
- Under Section 35-AD of the Income-tax Act 1961, deduction for expenditure incurred on investment is allowed, if this investment is wholly and exclusively for the purpose of any specified business which are explained below . This deduction, however, is only available for investments made in the previous year and prior to the start of operations.
    - Businesses allowed 150% deduction (provided the tax payer has

commenced business on or after01.04.2012).

- Setting up and operating a cold chain facility.
- Setting up and operating warehousing facility for storage of agricultural produce.

- Refrigeration machinery and parts used for installation of cold storage, cold room or refrigerated vehicle, exempt from Excise Duty.
- Cold Chain services of preconditioning, pre-cooling, ripening, waxing, retail packing, labeling of fruits and vegetables exempted from service tax.

Current status of various schemes:

Agency	No. of Project(s)	Total Subsidy Sanctioned (In lakhs)
MIDH	1249	93346.26
NHB	2496	112327.8
MOFPI	135	60349.58
APEDA	81	35569.26
NCDC	23	657.1
Compiled as on April 2017		

Table 3.2 Current status of various schemes

3.3. VISION 2022 AND COLD CHAIN:

The government has time and repeatedly emphasized the value of farmers in our economy. The vision statement of niti ayog indicates clearly the one of the major purpose of the present government is to double the farmer's income by 2022. For a farming household, cultivation and sale of crops are the primary source of income. Another basic ancillary sources are wages earned by farm or casual labor and rearing livestock. In order to fulfill this objective, the action plan outlines a strong program for agricultural transformation. It covers a number of methods aimed at increasing agricultural productivity, obtaining remunerative pricing for farmers, and increasing farmland production. Better price realization for farmers can be ensured through competitive markets, value chains and improved linkages between field and fork. Large number of recommendations have been submitted covering all the aspects and are grouped

Into –

- ✓ Increasing incomes by improving productivity

- ✓ Water and Agri-Input policies
- ✓ Integrated Farming Systems
- ✓ Better market price realization
- ✓ Special Policy Measures.

The Cold Chain Sector must be prioritized in terms of infrastructure development and market connections. It is an essential component of the agribusiness sector and serves as a connecting link between producers and consumers. Cold-chain has prodigious socio-economic impact as it empowers the farmers to directly connect with multiple markets, across geographies. Because there is no measure to address perishability without Cold Chain facilitation, the average farmer is forced to sell his produce soon after harvest. Farmers will be encouraged to sell their product at distant marketplaces if the cold chain is efficient and economical, allowing them to earn higher earnings. In addition, the cold chain will ensure that the produce is of higher quality and will command a higher price.

Currently it is estimated that only 70% of the crop produced by the farmer reaches the end consumer. The loss of perishables can be considerably reduced if cold chain elements such as pack houses, reefer vehicles, and storages are included in policy support. As a result, the farmer will have more crop to sell, which will increase his or her revenue. If cold chain elements like pack houses, reefer vehicles, and storages are incorporated in policy support, perishables loss can be significantly minimized. As a result, the farmer will have a larger crop to sell, increasing his or her income.

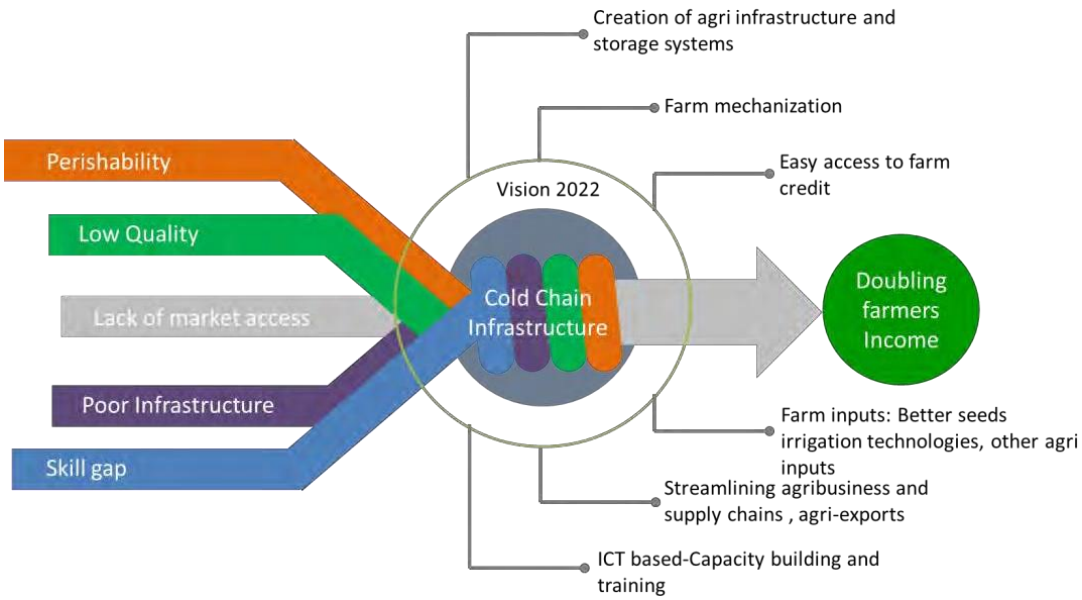


Fig 3.3

CHAPTER 4

ANALYSIS OF THE DATA

4.1. CROSS TABLE SHOWING AGE OF THE RESPONDENTS AND GENDER OF CORESPONDENTS

		GENDER OF CORESPONDENTS Male	Total
AGE OF THE RESPONDENTS	25 to 34 years	8(26.66%)	8(26.66%)
	35 to 44 years	13(43.33%)	13(43.33%)
	45 to 54 years	6(20%)	6(20%)
	More than equal to 55 years	3(10%)	3(10%)
Total		30	30

Interpretation: out of 30 respondents 8 are male which is 26.66% are of the age of 25 to 34 years, 13(43.33%) male are of 35 to 44 years of age, 6(20%) male are of 45 to 54 years of age, 3 (10%) male are of more than equal to 55 years. This states that more of the male are of between the ages of 25 to 44 years.

4.2. CROSS TABLE SHOWING EDUCATION QUALIFICATION OF RESPONDENTS AND EXPERIENCE OF RESPONDENTS

		EXPERIENCE OF RESPONDENTS				Total
		Less than equal to 5 years	6 to 15 years	16 to 25 years	26 to 35 years	
EDUCATION QUALIFICATION OF RESPONDENTS	Under Graduation	0	12(57.14%)	6(28.57%)	3(14.28%)	21(70%
	Graduation	3(42.86%)	4(57.14%)	0	0	7(23.3%
	Post-Graduation	2(100%)	0	0	0	2(6.66%
	Others	0	0	0	0	
TOTAL		5(16.67%)	16(53.33%)	6(20%)	3(10%)	30

Interpretation: out of 30 respondents 21 are under graduate, 7 are graduate and 2 are post graduate. Out of 21 graduates 12 have experience of 6 to 15 years, 6 have 16 to 25 years and 3 have 26 to 35 years of experience. Out of 7 graduate 3 respondents have experience of less than 5 years, 4 have 6 to 15 years of experience and 2 post graduates have 6 to 15 years of experience.

4.3. CROSS TABLE SHOWING PRODUCT DELT BY THE CORESPONDENTS AND TYPE OF BUSINESS OF RESPONDENTS

TYPE OF BUSINESS OF RESPONDENTS				Total
		Domestic	Both	
PRODUCT DELT BY THE CORESPONDENTS	Fruits	6(26%)	0	6(20%)
	Vegetables	4(17.40%)	0	4(13.33%)
	Sea food and Meat	13(56.52%)	7(100%)	20(66.6%)
	All the above	0	0	0
Total		23	7	30

Interpretation: out of 30. 20(66.67%) of respondents deals with sea food and meat, 6(20%) of respondents deal with fruits and 4(13.33%) deals with vegetables.

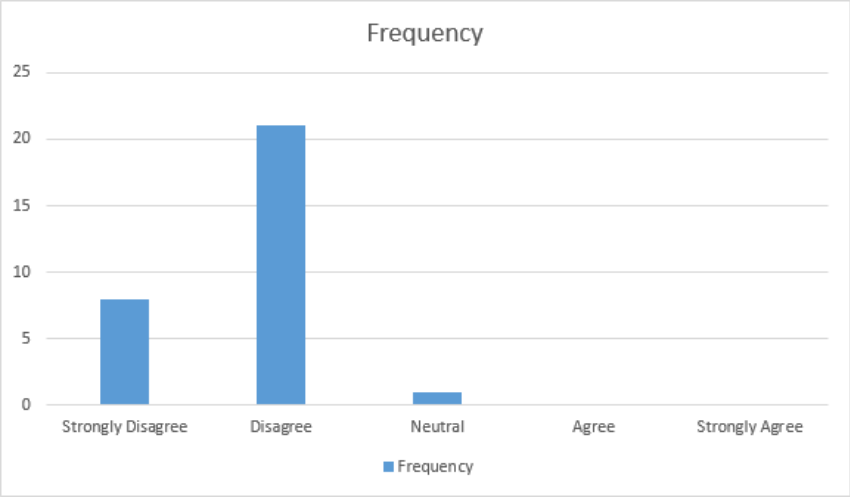
4.4 CROSS TABLE SHOWING ANNUAL TURNOVER IN TONES AND TYPE OF BUSINESS OF RESPONDENTS

		TYPE OF BUSINESS OF RESPONDENTS		Total
		Domestic	Both	
ANNUAL TURNOVER IN TONES	Less than equal to 30 tonnes	14	5	19
	31 to 50 tonnes	6	3	9
	more than equal to 51 tonnes	1	1	2
Total		21	9	30

Interpretation : out of 30 respondents 19 of them have less than equal to 30 tonnes of annual turnover and out of that 19 respondents 14 have domestic business and 6 of them have both domestic and international business.9 of the respondents have annual turnover of 31 to 50 tonnes out of which 6 have domestic and 3 have both domestic and international business and 2 respondents have turnover more than equal to 51 tonnes in which 1 have domestic and 1 have both domestic and international business.

4.5 AVAILABILITY OF COLD CHAIN INFRASTRUCTURE IN THE CLOSE PROXIMITY TO THE FARM

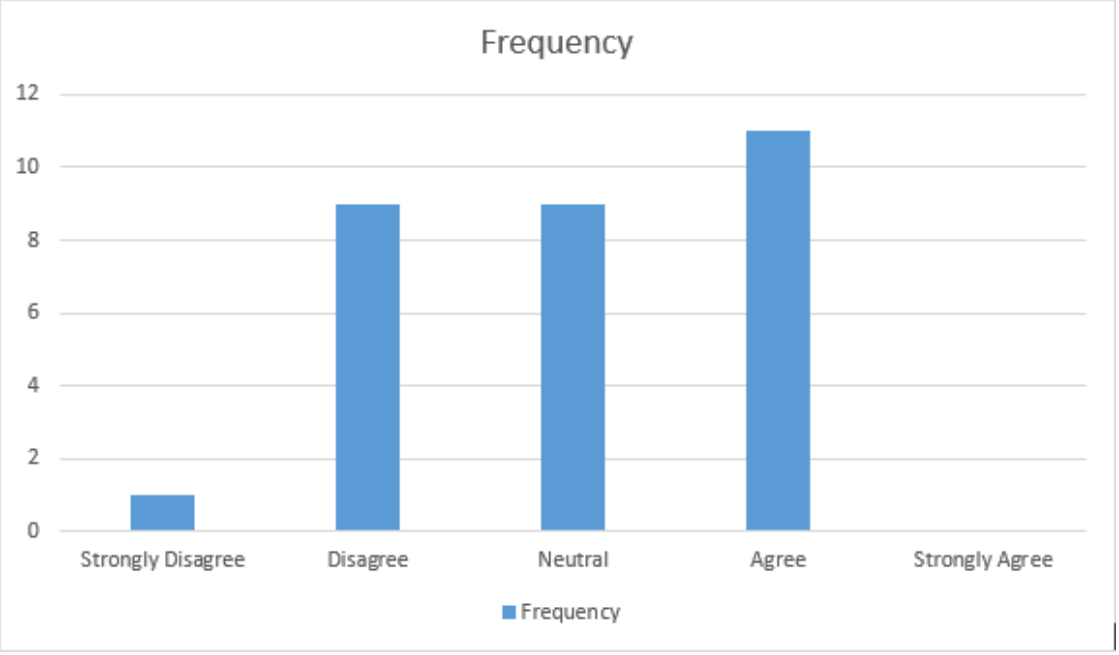
	Frequency	Percent
Strongly Disagree	8	26.67
Disagree	21	70
Neutral	1	3.33
Agree	0	0
Strongly Agree	0	0
Total	30	100.0



Interpretation: About 21 respondents (70%) expressed the view that they disagree with the Availability of cold chain infrastructure in the close proximity to the farm, followed by 8 (26.67%) are strongly disagree and 1 (3.33%) have neutral opinion. So we can conclude that most of the respondents disagree on the availability of cold chain infrastructure in the close proximity to the farm.

4.6 IS THE AVAILABLE INFRASTRUCTURE USABLE?

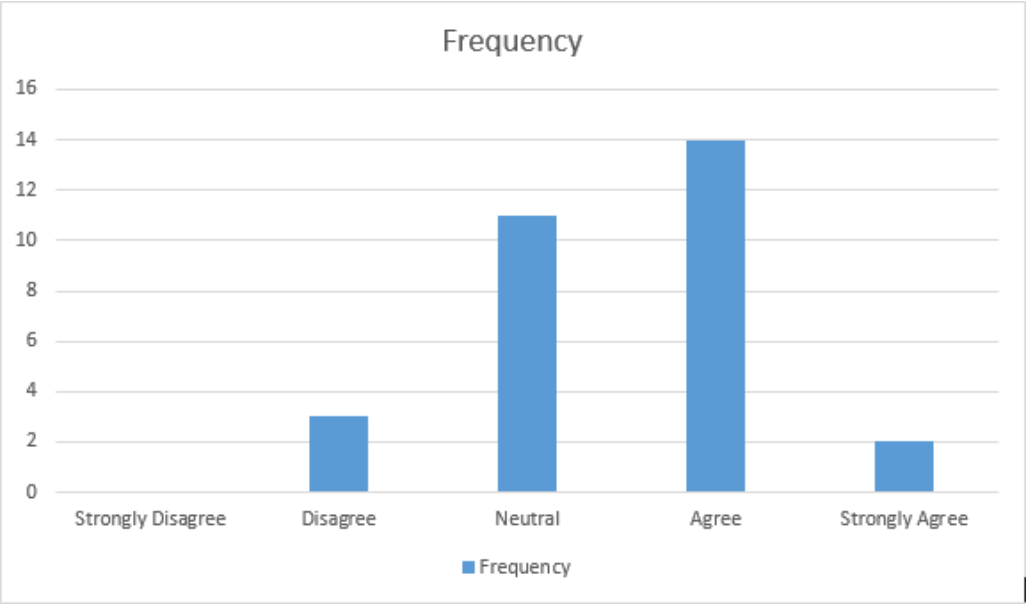
	Frequency	Percent
Strongly Disagree	1	3.33
Disagree	9	30
Neutral	9	30
Agree	11	36.67
Strongly Agree	0	0
Total	30	100.0



Interpretation: About 11(36.7%) of the respondents states that they agree with the available infrastructure are of their use, and about 9(30%) states that they disagree with the available infrastructure are of their use. 9 (30%) of the respondents have neutral opinion. And 1(3.33) strongly disagree. Hence we can conclude that most of them agree with the question.

4.7 DO YOU KNOW ABOUT COLD CHAIN TECHNOLOGIES?

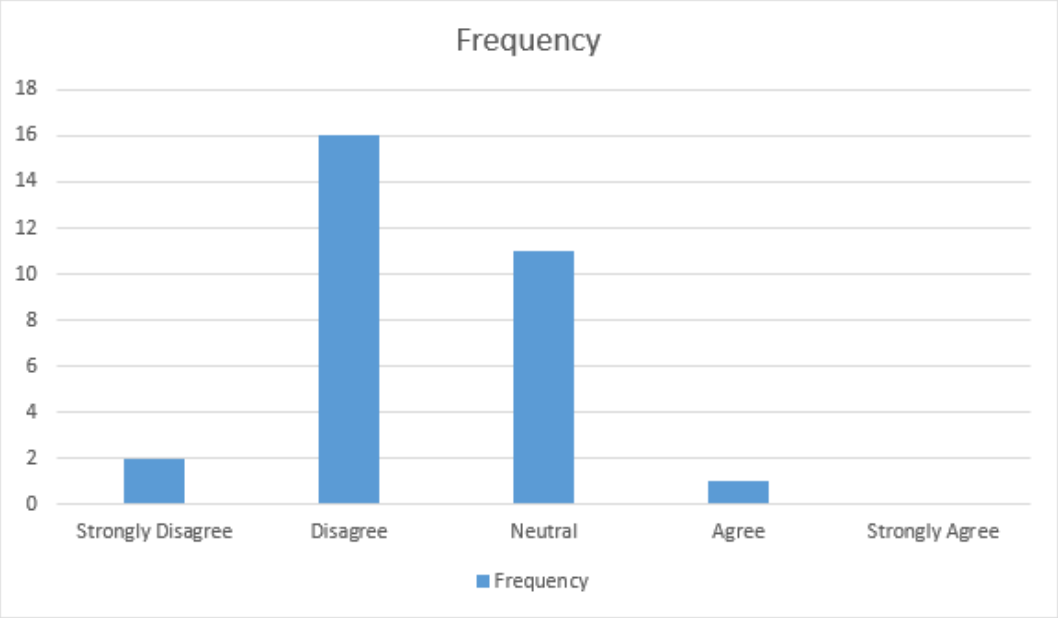
	Frequency	Percent
Strongly Disagree	0	0
Disagree	3	10
Neutral	11	36.67
Agree	14	46.67
Strongly Agree	2	6.66
Total	30	100.0



Interpretation: 14 (46.7%) of the respondents have agreed opinion on their knowledge on cold chain technologies, 11 (36.67%) of the respondents neutral that they have knowledge on the cold chain technologies and 3 (10%) of the respondents disagree with the above statement. And 2 strongly agree the statement. Hence this states that most of the respondents have agree opinion on the above statement.

4.8. GOVERNMENT SUPPORT ON COLD CHAIN INFRASTRUCTURE

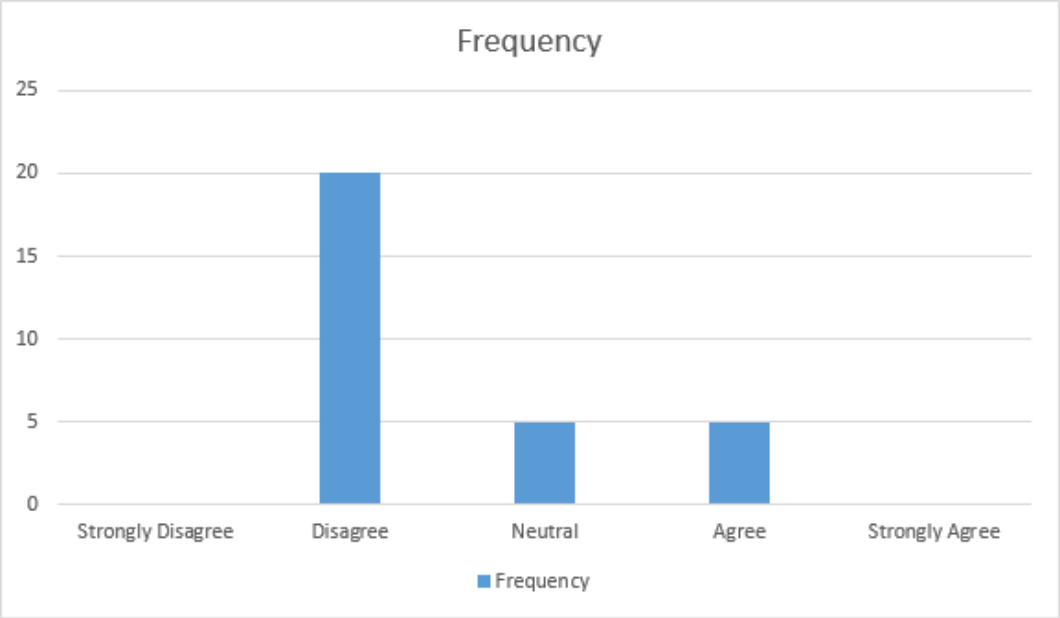
	Frequency	Percent
Strongly Disagree	2	6.67
Disagree	16	53.33
Neutral	11	36.67
Agree	1	3.3
Strongly Agree	0	0
Total	30	100.0



Interpretation: 16 (53.33%) of the respondents disagree on the government support on cold chain infrastructure. 11 (36.67%) of the respondents have neutral opinion on the government support. 2 (6.67) strongly disagree and 1(3.3) agreed to question. Hence most of the respondents disagree on the above statement.

4.9.SUFFICIENT PRIVATE PLAYERS EXISTING IN COLD CHAIN INDUSTRY

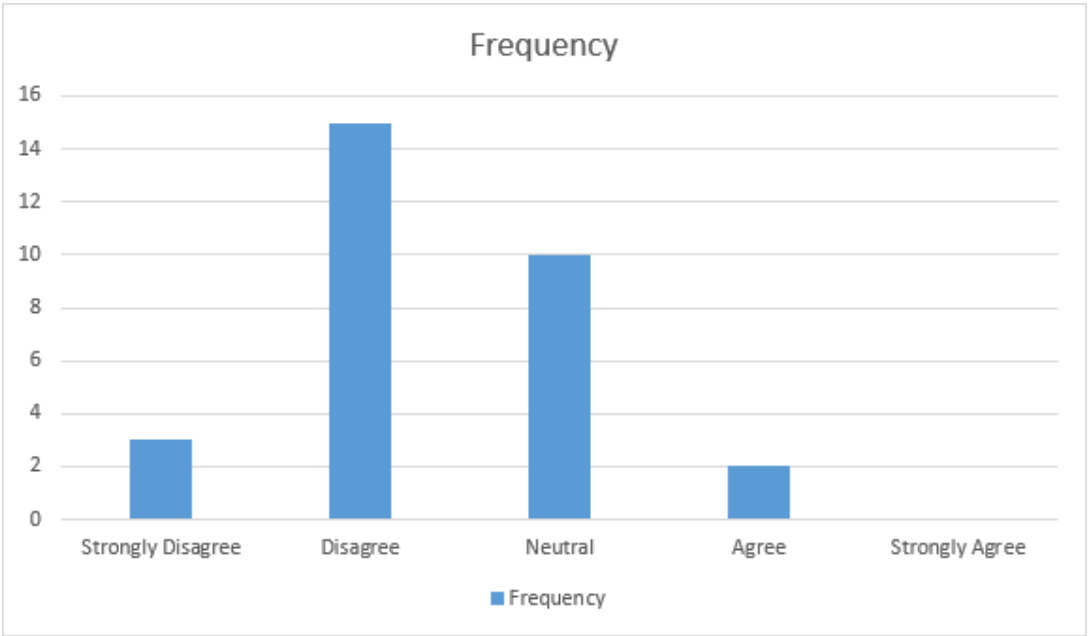
	Frequency	Percent
Strongly Disagree	0	0
Disagree	20	66.67
Neutral	5	16.66
Agree	5	16.66
Strongly Agree	0	0
Total	30	100.0



Interpretation: 20 (66.67%) of the respondents feels that there are no sufficient private players in cold chain in their area and 5 respondents have neutral opinion that there are sufficient private players in cold chain in their area. So we can conclude that most of the respondents feels that are no sufficient players in cold chain in their locality.

4.10. SUFFICIENT ENERGY AVAILABILITY FOR COLD CHAIN INFRASTRUCTURE

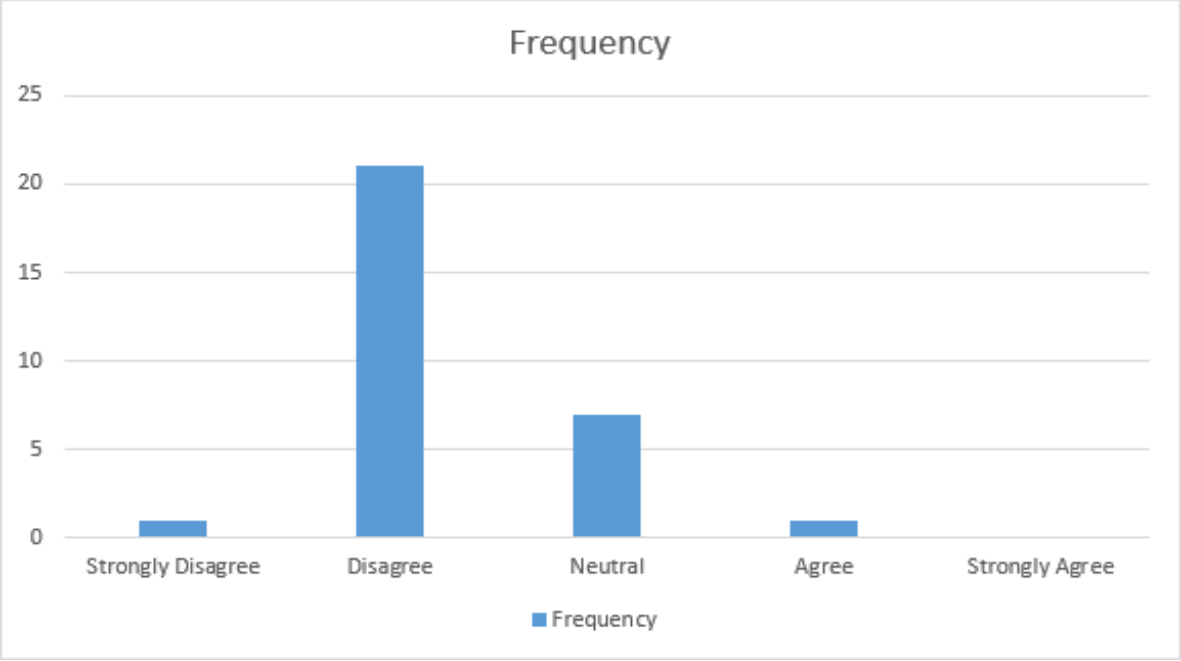
	Frequency	Percent
Strongly Disagree	3	10
Disagree	15	50
Neutral	10	33.33
Agree	2	6.67
Strongly Agree	0	0
Total	30	100.0



Interpretation: 15(50%) of respondents have disagree opinion on availability of ENERGY for cold chain infrastructure, 10 of the respondents neutral with the availability of the energy. 3 (10%) of the respondents strongly disagree on the availability of the energy and 2 (6.67%) agreed. So we can conclude that most of the respondents have neutral opinion and few disagree with the above statement.

4.11 **ADEQUATE COLD TRANSPORTATION IS AVAILABLE FOR YOUR PRODUCT**

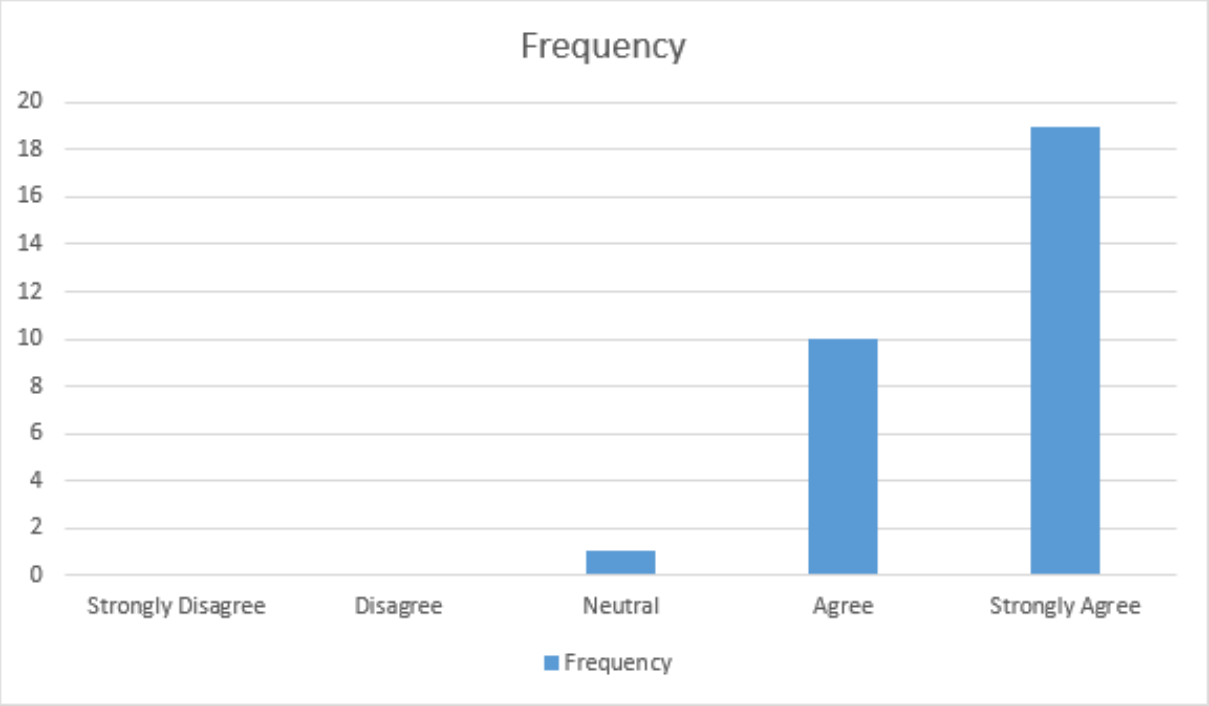
	Frequency	Percent
Strongly Disagree	1	3.3
Disagree	21	70
Neutral	7	23.33
Agree	1	3.3
Strongly Agree	0	0
Total	30	100.0



Interpretation: 21 (70%) of the respondents feels that there are no adequate cold transportation for their product.7 (23.33%) respond neutral. 1 (3.3%) strongly disagreed and agreed. Hence we can conclude that most of the respondents disagree with the above statement.

4.12. TRANSPORTATION TIME A CRITICAL FACTOR FOR YOUR PRODUCT

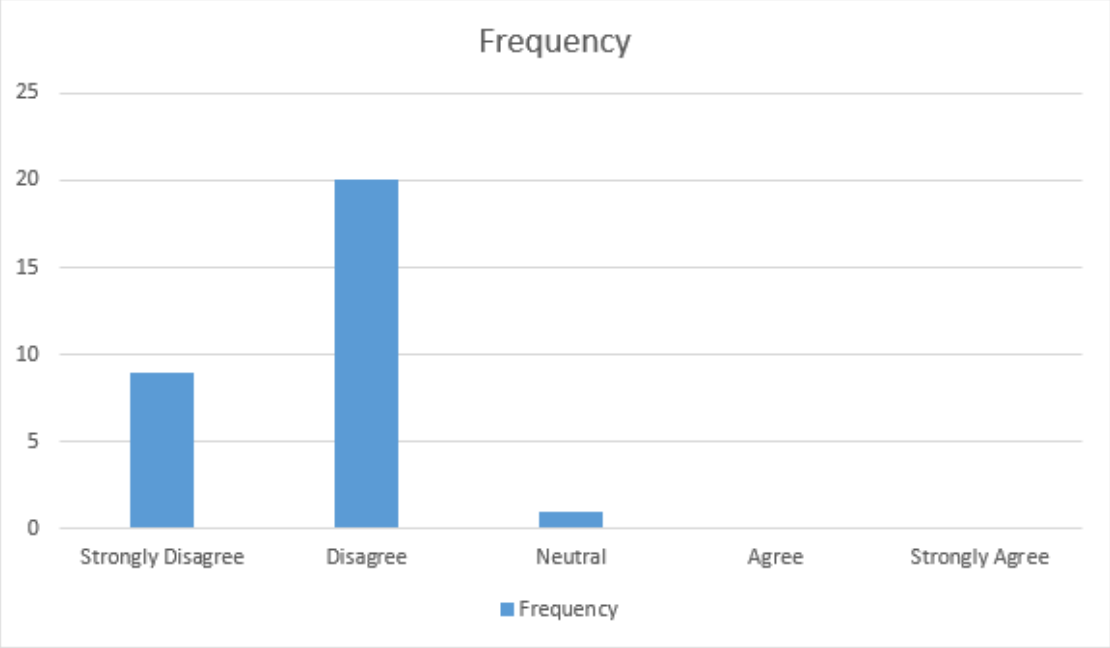
	Frequency	Percent
Strongly Disagree	0	0
Disagree	0	0
Neutral	1	3.33
Agree	10	33.3
Strongly Agree	19	63.33
Total	30	100.0



Interpretation: 19 (63.33%) of the respondents feels that transportation time is a critical factor for their product, 10 respondents who has agreed opinion and 1 (3.33%) feels neutral. Hence it clearly states that all of the respondents agree on above statement.

4.13 THE COST OF REEFER VEHICLE IS REASONABLE

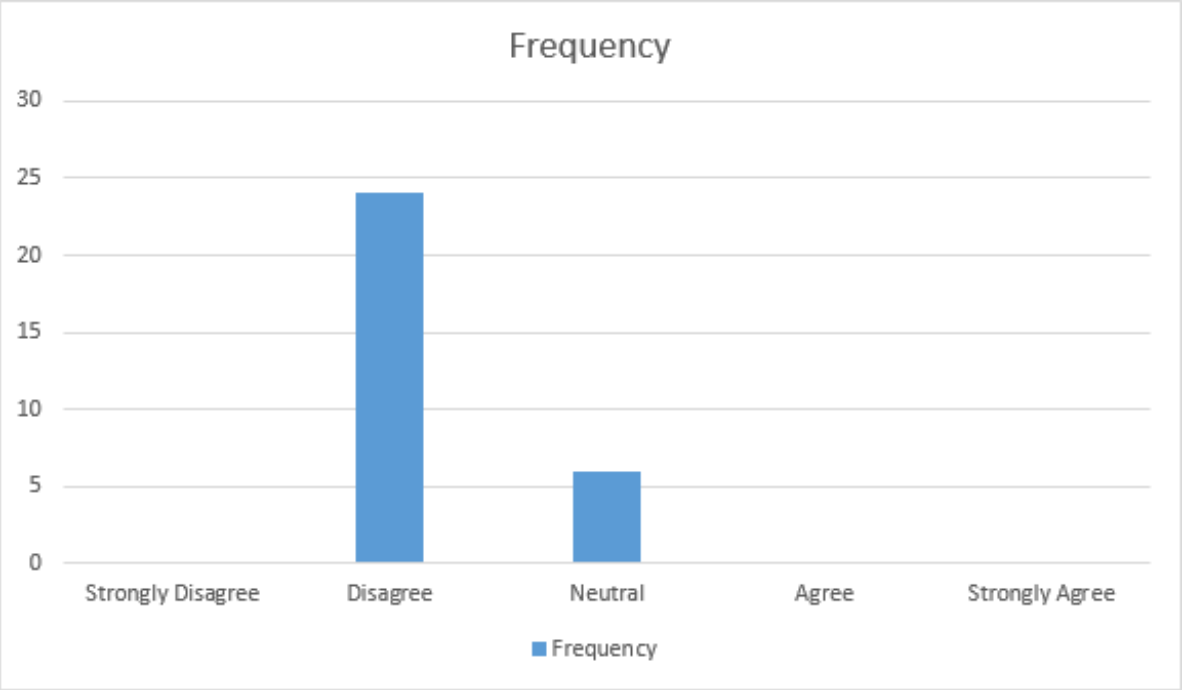
	Frequency	Percent
Strongly Disagree	9	30
Disagree	20	66.67
Neutral	1	3.33
Agree	0	0
Strongly Agree	0	0
Total	30	100.0



Interpretation: 20 (66.67%) respondents disagree the statement. 9 (30%) strongly disagree the statement and 1 (3.33%) neutral so feels that the cost of the reefer vehicles are not reasonable, hence this states that all the respondents disagree with the above statement.

4.14 GOOD LOGISTICS FACILITIES AVAILABLE IN YOUR AREA TO REACH COLD CHAIN STORAGE

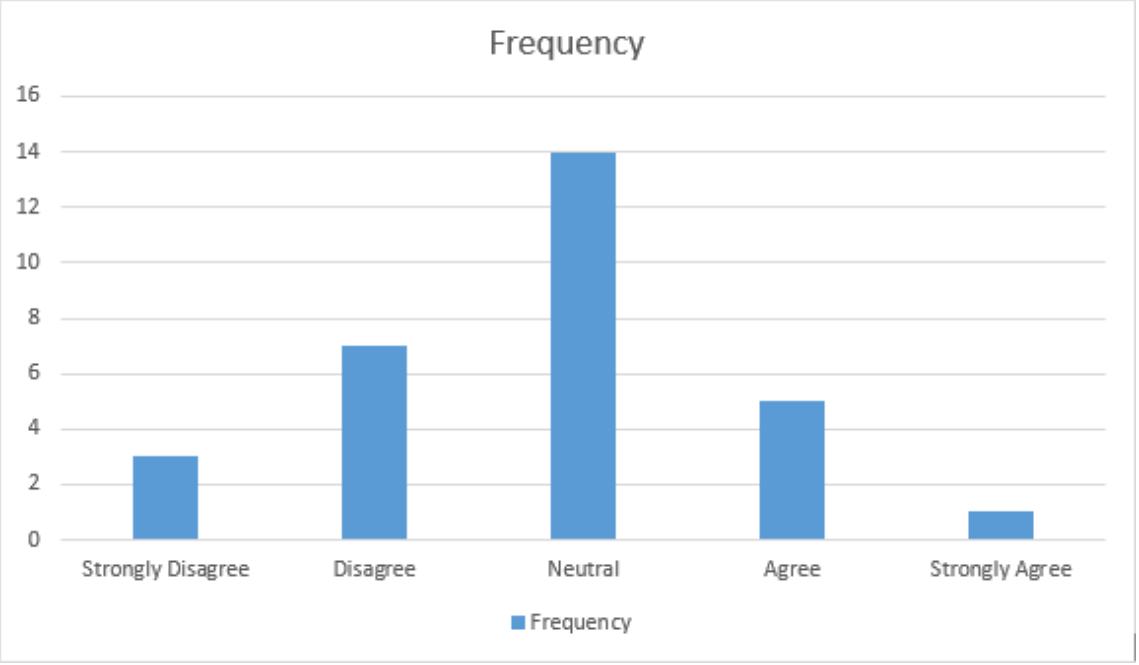
	Frequency	Percent
Strongly Disagree	0	0
Disagree	24	80
Neutral	6	20
Agree	0	0
Strongly Agree	0	0
Total	30	100.0



Interpretation: 24 (80%) of the respondents disagree that good logistics facilities available in their area and 6 (20%) respond neutral. Hence this clearly states that most of the respondents disagree with the above statement.

4.15 YOUR PRODUCT CAN BE TRANSPORTED ALONG WITH OTHER PRODUCTS

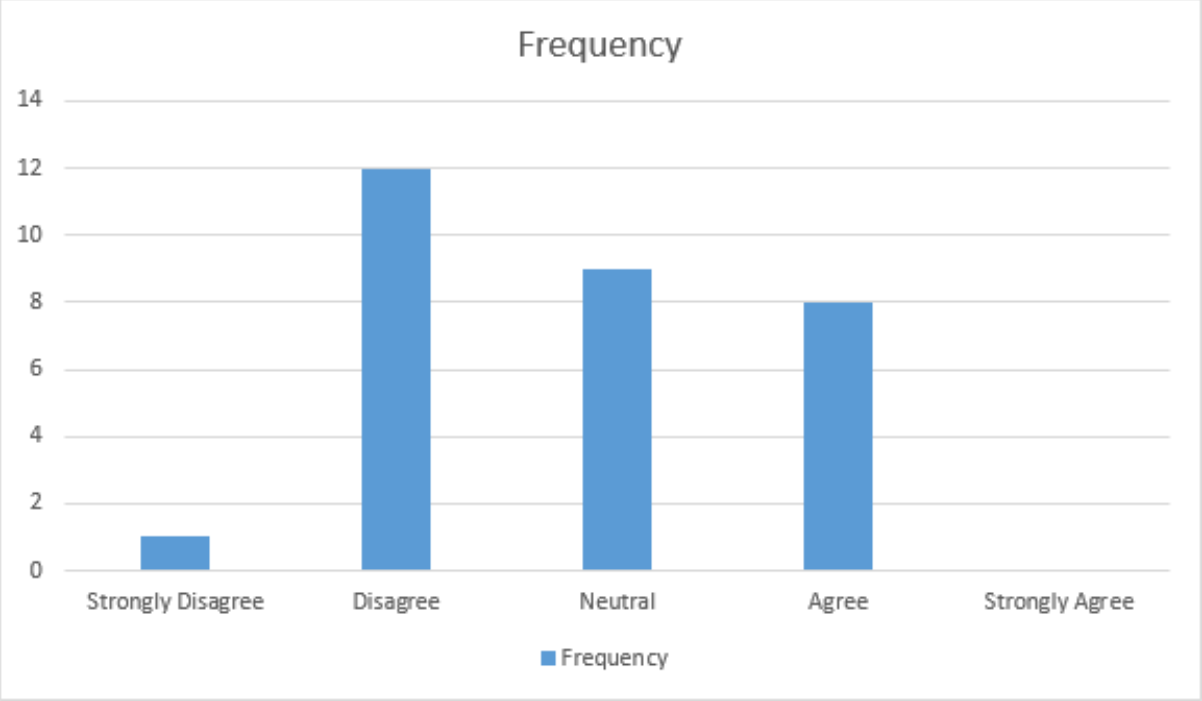
	Frequency	Percent
Strongly Disagree	3	10
Disagree	7	23.33
Neutral	14	46.67
Agree	5	16.67
Strongly Agree	1	3.3
Total	30	100.0



Interpretation: 14(46.67%) of the respondents neutral that their product can be transported along with other products, 7 of the respondents have disagree opinion. 5 of the respondents agree with the statement. 3 strongly disagree and 1 strongly agreed Hence it states that most of the respondents neutral that their products can be transported with other products.

4.16 IT IS DIFFICULT TO COLLECT THE PRODUCT FROM FARM GATE

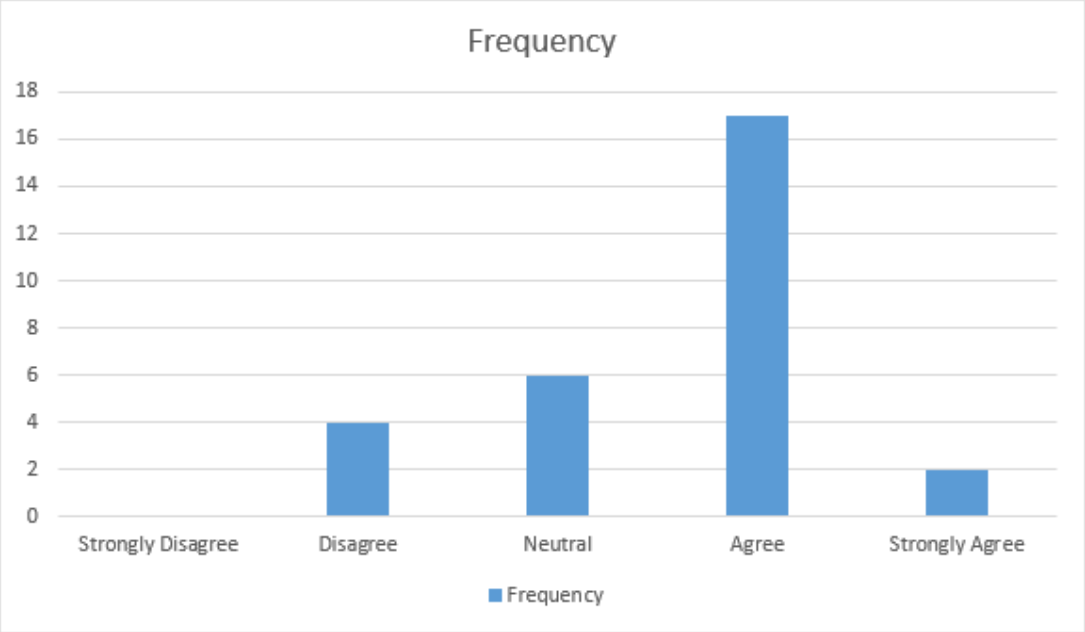
	Frequency	Percent
Strongly Disagree	1	3.3
Disagree	12	40
Neutral	9	30
Agree	8	26.67
Strongly Agree	0	0
Total	30	100.0



Interpretation: 12(40%) of the respondents feels that it is not difficult to collect the product from the farm gate and 9 of the respondents feels neutral to collect the product. 8 agreed statement and 1 strongly disagreed Hence this states that most of the respondents have disagree opinion on the above statement.

4.17 YOU KNOW THE POST-HARVEST PROCESS OF HANDLING AND STORAGE OF YOUR PRODUCT

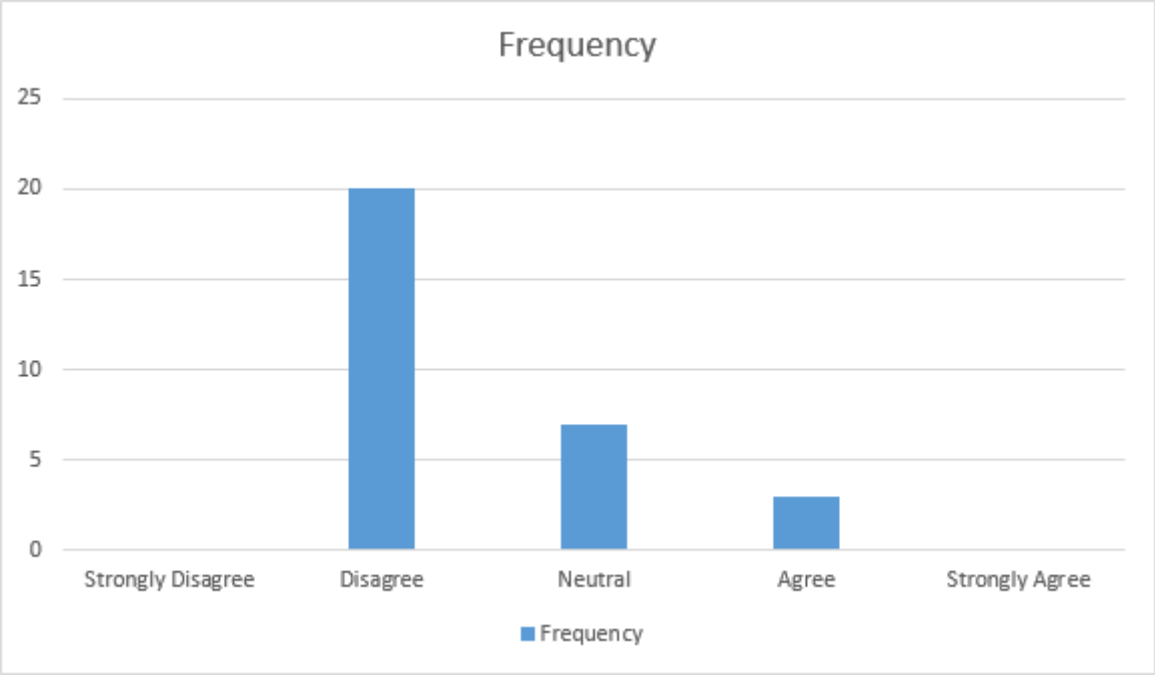
	Frequency	Percent
Strongly Disagree	0	0
Disagree	4	13.33
Neutral	6	20
Agree	17	56.67
Strongly Agree	2	6.67
Total	30	100.0



Interpretation : 17 (56.67%) of the respondents agree that they know the post-harvest process of handling and storage of their products, 6 of them have neutral opinion, 4 of the respondents disagree with the statement and 2 strongly agreed. Hence most of the respondents agree with the above statement.

4.18 SERVICES OF COLD CHAIN STORAGE ARE AFFORDABLE FOR YOUR PRODUCT

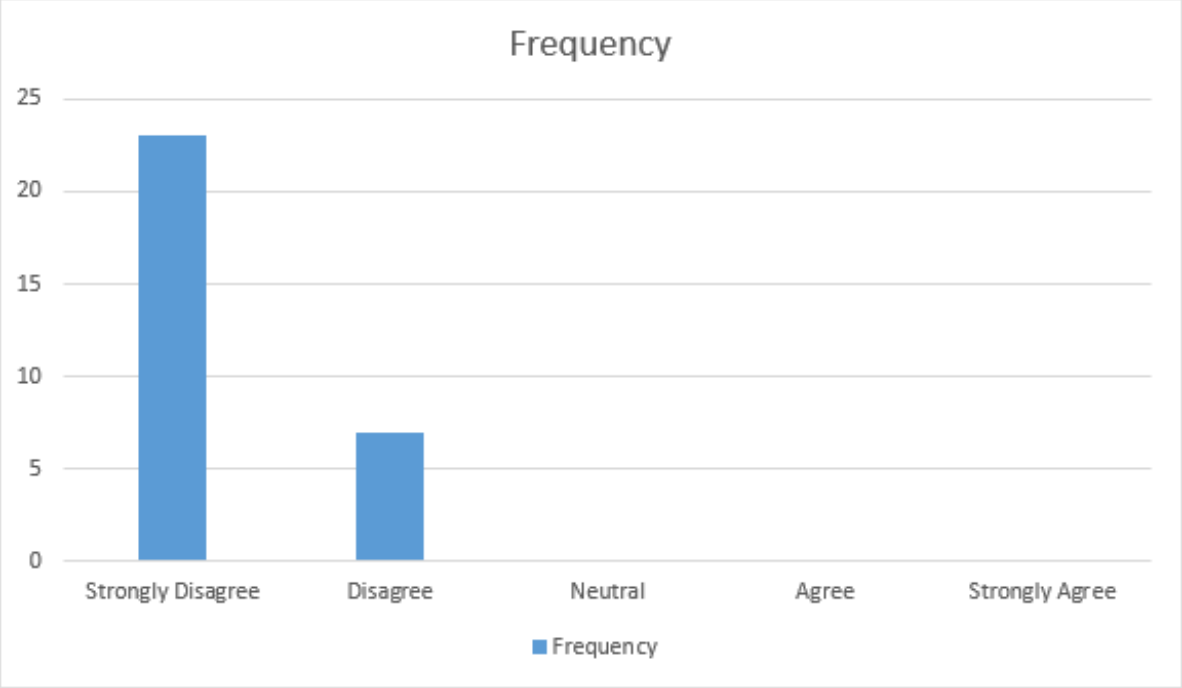
	Frequency	Percent
Strongly Disagree	0	0
Disagree	20	66.7
Neutral	7	23.33
Agree	3	10
Strongly Agree	0	0
Total	30	100.0



Interpretation: 20 (66.7%) of the respondents disagree that services of cold chain storage are affordable for them, 7 of them have neutral opinion and 3 agreed. Hence most of the respondents disagree with the above statement.

4.19 NEW AND ADVANCED TECHNOLOGIES ARE AVAILABLE AT THE COLD CHAIN STORAGE

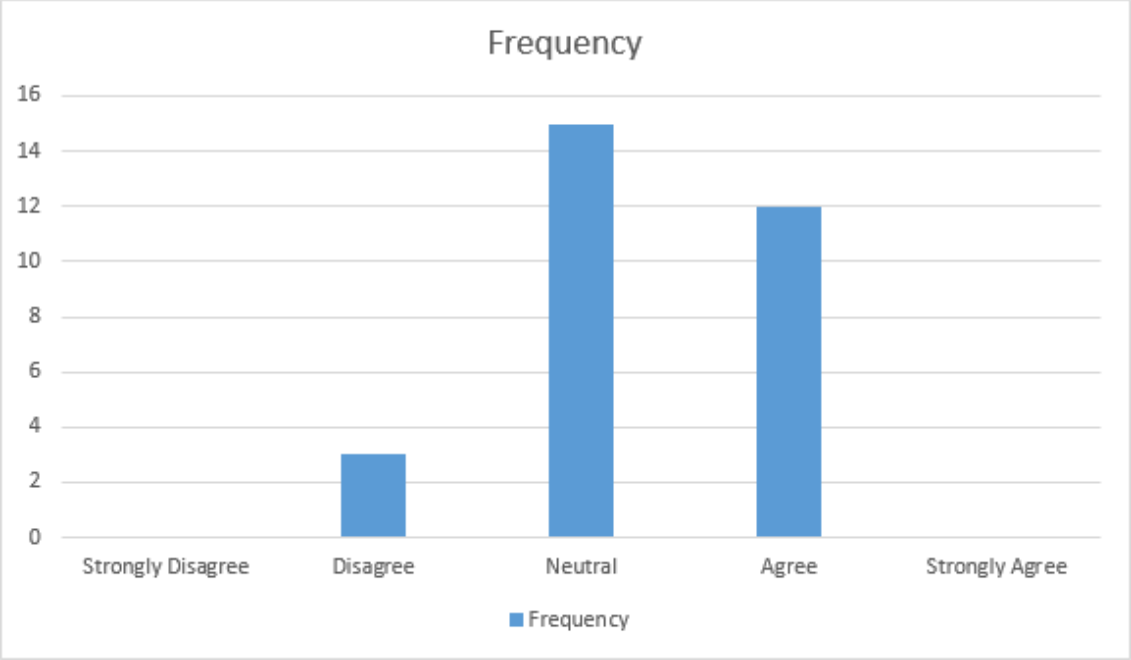
	Frequency	Percent
Strongly Disagree	23	76.7
Disagree	7	23.3
Neutral	0	0
Agree	0	0
Strongly Agree	0	0
Total	30	100.0



Interpretation: 23(76.7%) of the respondents strongly disagree that new and advanced technologies are available in cold storage, 7 of them disagree with the statement. Hence this clearly states that all of the respondents disagree with the above statement.

4.20 SUITABLE PACKING FACILITIES OF YOUR PRODUCT FOR COLD CHAIN

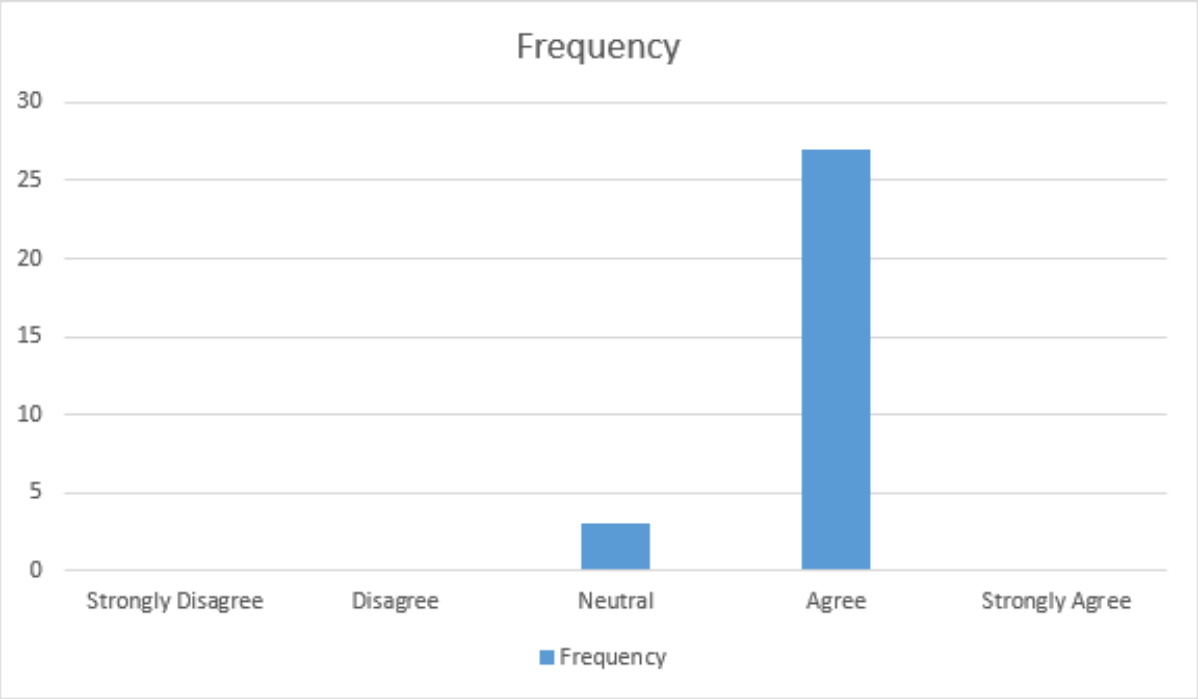
	Frequency	Percent
Strongly Disagree	0	0
Disagree	3	10.0
Neutral	15	50
Agree	12	40
Strongly Agree	0	0
Total	30	100.0



Interpretation: 15 (50%) of the respondents have neutral opinion on suitable packing facilities for their product, 12 of the respondents agree with the statement and 3 disagreed. Hence this statement most the respondents have neutral opinion on the above statement.

4.21 PERISHABLE CARGO REQUIRES SPECIAL CARE WHILE HANDLING

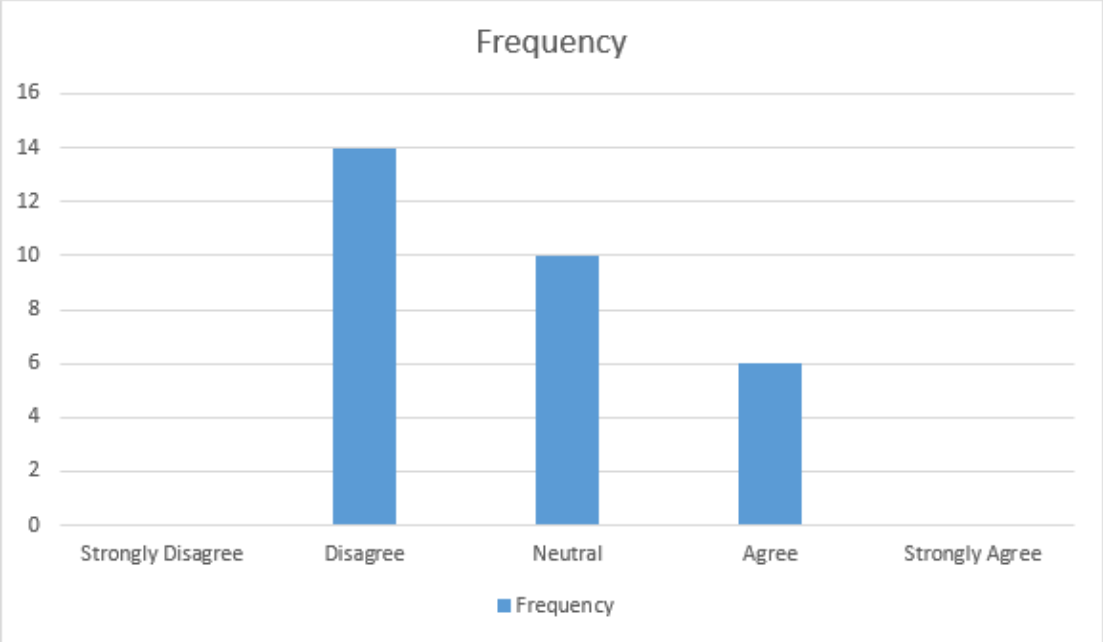
	Frequency	Percent
Strongly Disagree	0	0
Disagree	0	0
Neutral	0	0
Agree	3	10.0
Strongly Agree	27	90.0
Total	30	100.0



Interpretation: 27(90%) of the respondents strongly agree that perishable cargo requires special care while handling, and 3 of them agree with the statement. Hence this states that all of the respondents agree with the above statement.

4.22 COLD STORAGE CENTERS HAS PROPER HANDLING FACILITY

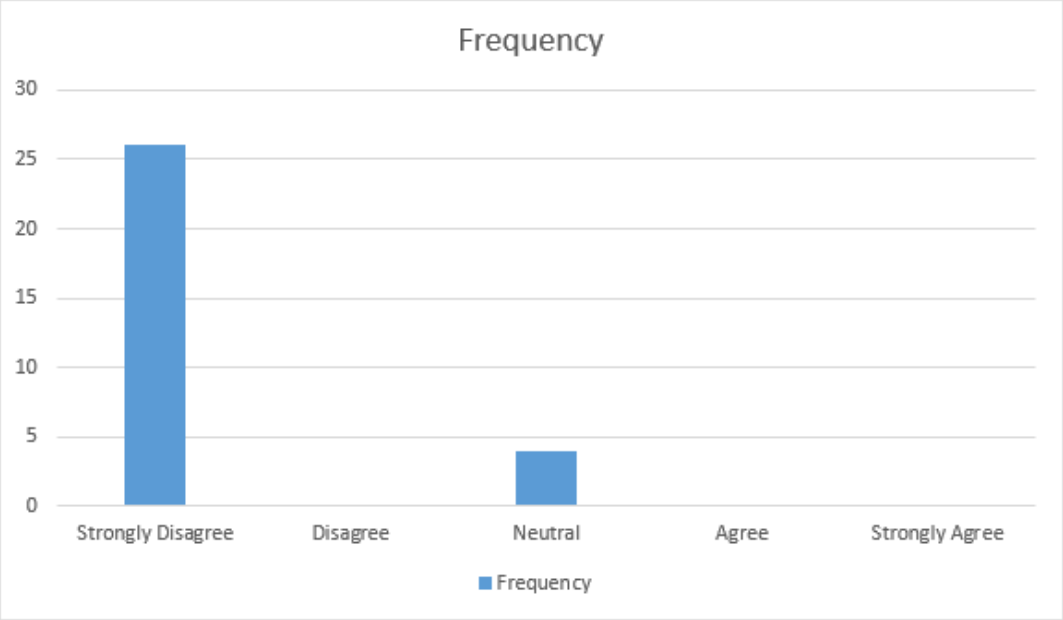
	Frequency	Percent
Strongly Disagree	0	0
Disagree	14	46.67
Neutral	10	33.33
Agree	6	20
Strongly Agree	0	0
Total	30	100.0



Interpretation: 14 respondents disagree that cold storage centers has proper handling facility, 10 has neutral opinion and 6 agreed the statement.

4.23 ROUGH HANDLING MAJOR REASON FOR WASTAGE OF PRODUCT

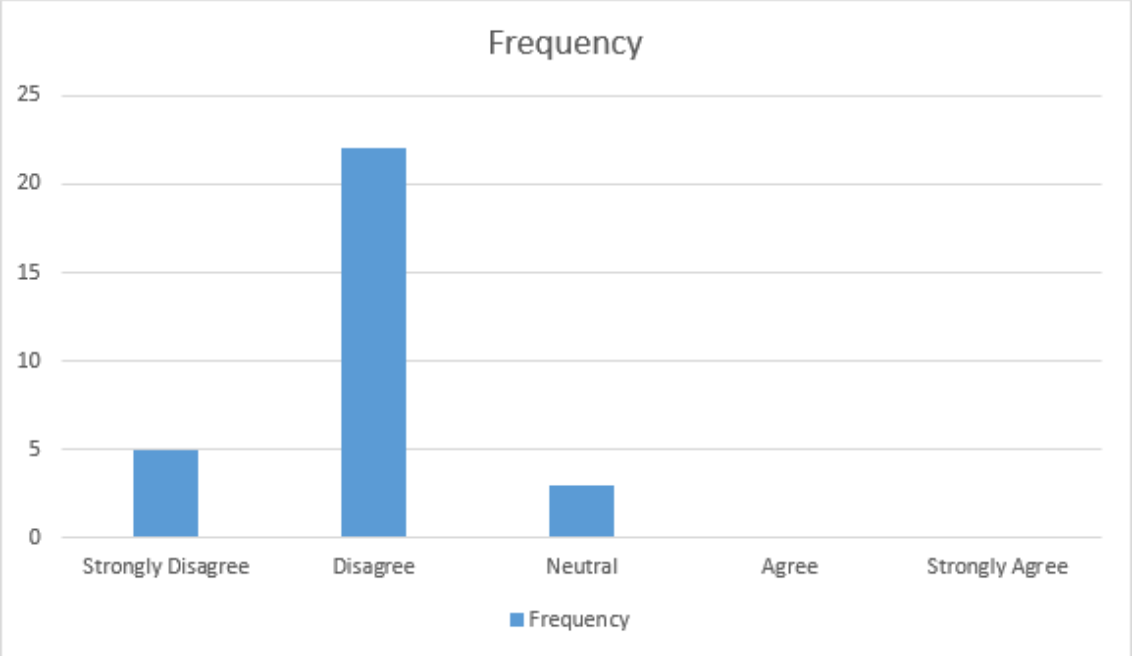
	Frequency	Percent
Strongly Agree	26	86.67
Agree	0	0
Neutral	4	13.33
Disagree	0	0
Strongly Disagree	0	0



Interpretation: 26 (86.67%) of the respondents strongly agree that rough handling is the major reason for wastage of product and 4 respond neutral.

4.24 FARMERS HAVE KNOWLEDGE ON COLD CHAIN

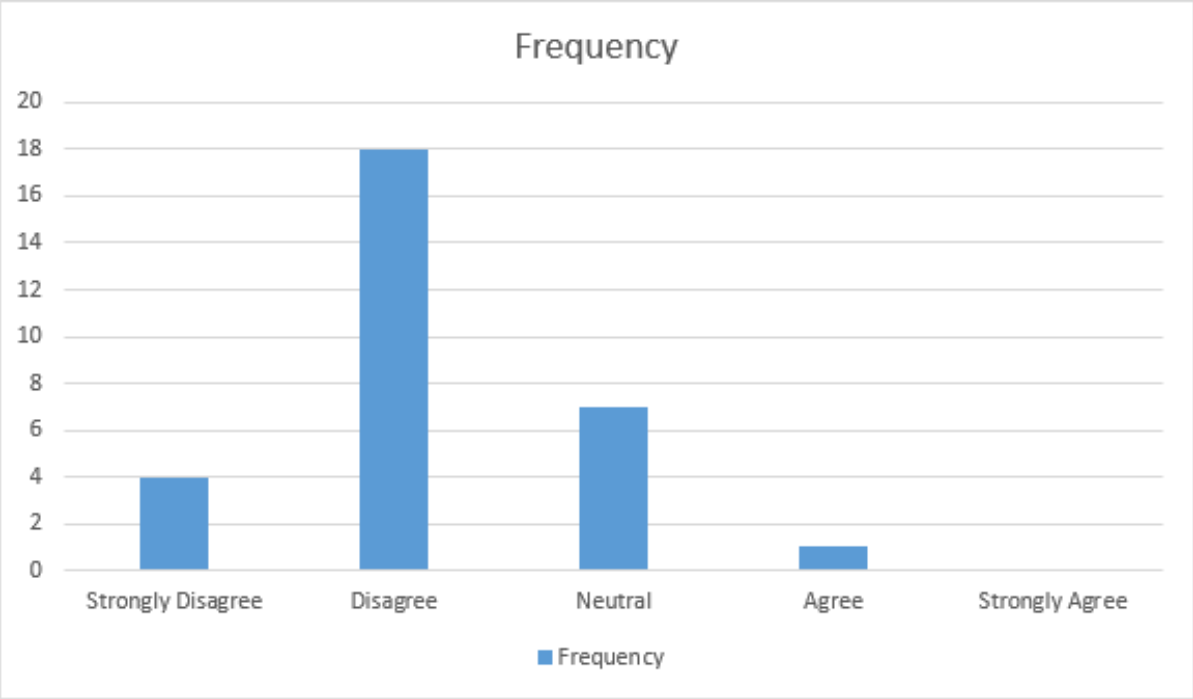
	Frequency	Percent
Strongly Disagree	5	16.7
Disagree	22	73.33
Neutral	3	10
Agree	0	0
Strongly Agree	0	0
Total	30	100.0



Interpretation: 22 of the respondents disagree that farmers have knowledge on cold chain, 5 strongly disagreed and 3 neutral respond.

4.25 FARMERS ARE AWARENESS OF POST-HARVEST COLD CHAIN TECHNOLOGIES

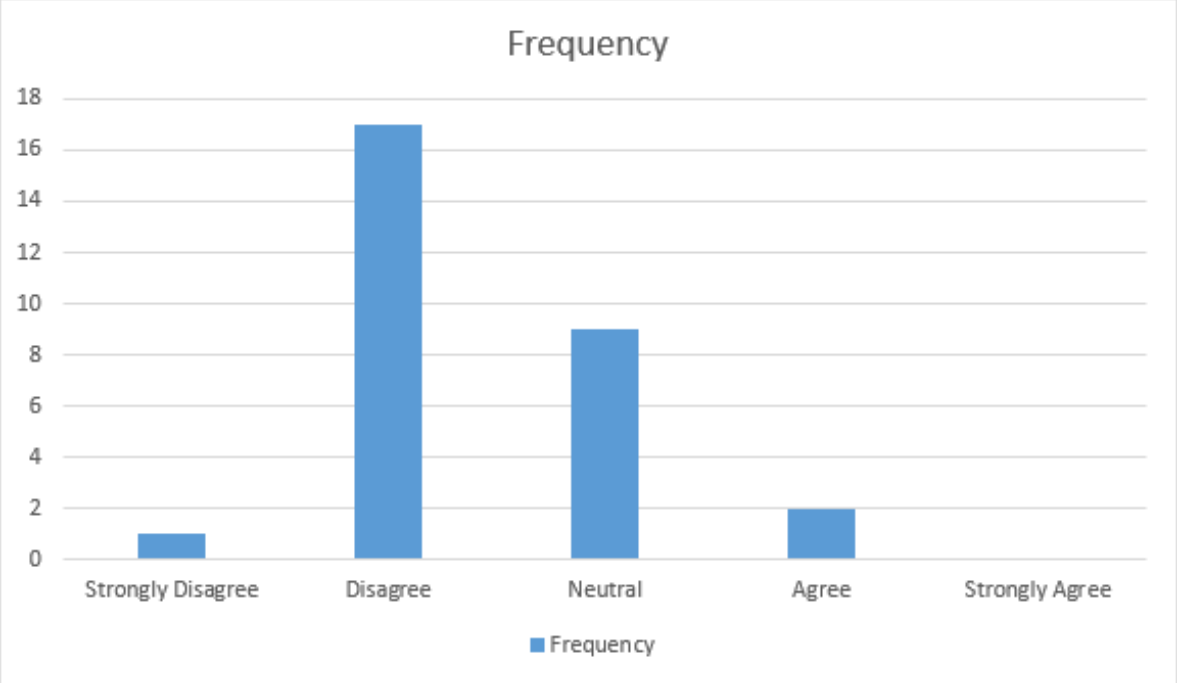
	Frequency	Percent
Strongly Disagree	4	13.3
Disagree	18	60.0
Neutral	7	23.33
Agree	1	3.33
Strongly Agree	0	0
Total	30	100.0



Interpretation: 18 of the respondents disagree that farmers are aware of post-harvest cold chain technologies, 7 have neutral opinion, 4 strongly disagree option and 1 have agreed option. So this states that most of the respondents disagree with the above statement.

4.26 COLD CHAIN INFRASTRUCTURE AFFORDABLE TO FARMERS

	Frequency	Percent
Strongly Disagree	1	3.3
Disagree	17	56.67
Neutral	9	30.0
Agree	2	6.67
Strongly Agree	0	0
Total	30	100.0



Interpretation: 17 of the respondents disagree that cold chain infrastructure are affordable to farmers, 9 have neutral opinion, 2 agreed statement and 1 strongly disagree.

CHAPTER 5
SUGGESTIONS AND CONCLUSION

5.1 FINDINGS

As the Indian food industry continuous its efforts to become self-sufficient, cold storage is quickly becoming the most sought-after demand driver. In recent years, the Government has developed a number of plans to improve the cold storage infrastructure, and assist the agriculture and pharmaceutical industries to solve the challenges that paved their growth. As a result, it has the potential to transform the game completely for India's food and agricultural industry. India wastes a lot of food on its way from farms to processing plants to deliveries which might be avoided if India has a better laid cold storage infrastructure. Temperature-controlled storage space, efficient and trained service employees and transportation are all part of a well-functioning cold chain infrastructure.

Mainly there are two types of Cold Storages available in the market for different requirements. They are Active Cold stores and Passive Cold stores. Active cold stores are used for products on daily routines like ice-cream, frozen foods, etc. have dynamic storage applications, and various temperature zones are developed within the same warehouse for storing different products requiring different temperatures. Passive cold storage is created for storing the perishable goods for a long-term period, for example, storage of seeds, potato, onion, etc. In terms of production, growth, consumption, and export the food processing industry is one of India's most important sectors. The cold chain is the backbone of food production and processing at this scale. However, the main source of concern is that the agriculture industry loses a significant amount of produce each year due to various contributing factors. The lack of an efficient cold chain infrastructure which includes refrigerated transport, pack houses, collection centers, and cold storage is one of the leading reason of food waste. This suggest that simply having cold storage is insufficient.

Despite having the best cold storage, moisture in cold stores can create a series of reactions that can lead to discomfort. Frosted goods, slippery floors, ice-build up on conveyor belts, and cooling coils are all caused by Moisture. It leads to frost build-up near the loading docks and fog to form inside. Moisture absorption promotes softening and sagging in cardboard cartons, making them unstable and dangerous. Humidity also has an impact on defrosting costs, storage space limitations, frequent shutdowns, mold and mildew growth, and decrease in the cooling efficiency due to water vapor loads and evaporator coil clogging.

The load is highest at the dock. Opening of doors and Ingress of fresh air, these are the two

sources that 90 percent of the total load comes from. Moisture load from fresh air intrusion can be reduced by inducting enough dehumidified fresh air in to the loading dock area to maintain dry air moving out of the building even when trucks are parked at the doors. How to avoid frosting on evaporators, ice build-up on the conveyer, these are the typical challenges that have to face while designing cold stores.

Installing a dehumidification system in place is the simple solution for this problem. A cost-effective and energy-efficient technology that prevents cooling coil fogging and frosting by providing cool dry air at a dew point lower than that of the cold room. The dehumidifiers are designed to deliver dry air continuously, regardless of the ambient conditions, at a very low dew point.

The dehumidification technologies and systems have adopted by the food firms all over the world, have witnessed a rise in demand with the changing needs of consumers. With changing needs, it is time to adjust the strategy and reduce food waste.

5.2 MEASURES FOR IMPROVING SUPPLY CHAIN OF PERISHABLE GOODS AND ITS EFFECTIVENESS

Cold chain management has become more sophisticated and crucial for food and beverage retailers as America's demand for fresh fruits, vegetables, meats, seafood and dairy steadily grows. Fortunately, Internet of Things (IoT) techniques, technologies and tactics are making the tough task of guaranteeing optimal shelf life for produce and other products that may travel thousands of miles before reaching at local supermarkets.

Developing efficient and effective supply chain has to be the concerted effort of the entire stakeholder present in the supply chain of Fruits and Vegetables sector. There has to be structural adjustments at various stages of the supply chain which includes Farmers, Local Intermediaries, Wholesale, Retailers and consumers. The government, business sector, public-private partnerships, cooperative societies, technology suppliers, agricultural educational institutions and non-governmental organizations (NGO) all have an important role to play in improving the supply chain conditions. Infrastructure pertaining to agriculture sector like cold chain, sorting grading and packaging facilities, collection centers, road connectivity from farm to collection centers; Information and Communication Technology (ICT); Well established Transportation system. Proper demand forecasting is one of the important requirements that enable effective supply chain to meet future demand. Due to poor forecasting and knowledge

regarding market demand, there is imbalance between the actual demand and the surplus supply. Proper mechanism needs to be developed to forecast the demand.

Loading and unloading are very important steps in the logistical handling of Fruits and Vegetables, however they are frequently overlooked. In India, individual handling of packaged products results in mishandling and to high postharvest losses. In order to minimize produce mishandling, substantial consideration should be given to the installation of pillarization and mechanical loading and unloading of produce, especially with the use of fork-lift trucks, with the introduction of CFB boxes. To avoid losses in extremely perishable fresh horticulture output, on-farm storage is required in remote and inaccessible areas of India. Many parts of India are unable to use refrigerated storage due to the high cost and high energy requirements of refrigeration, as we'll as the difficulty of installing and operating refrigerated facilities in remote areas. Physically damaged fruits and vegetables that are not infected can be converted into value added goods by processing low-cost, low-energy, environmentally friendly cool chambers manufactured from locally available materials, and based on the principles of evaporative cooling.

Current powered by partners with leading food retailers to imagine new possibilities in shops and behind the scenes, such as intelligent cold chain management solutions that help tie supply, storage and stocking activities together to attract customers and reduce waste. In this review, looking at the trends that are shaping the future of cold chain management in the grocery sector:

I. Consumers are Flocking to Fresh Foods

According to researchers at market research firm IRI and the Food Marketing Institute, health trends are pulling more consumers away from the main aisles and toward the perimeter of the store, where growth has outperformed other food and beverage departments over the last four years. In fact, the only departments at physical grocery stores with positive volume growth last year were Bakery (+.6%), Meat (+.1%) and Produce (+.6%), reports The Wall Street Journal, which further noted that volume growth for Packaged Foods fell by 1.2% in 2017.

All evidence point to consumers demanding more fresh diet options in the future. The value of having a ripe, crisp, and ample assortment is obvious to grocers.

II. Shoppers Say, Show Me the Journey!

The need of authenticating fresh foods is highlighted by Chain Store Age. The stores must

communicate—and justify—their fresh foods story. Retailers now have more information on how foods remain fresh from "farm to table". It is only because of the digital tools and intelligent devices. This information can be used to gain a competitive advantage by enhancing the authenticity of their brand. Future technology and laws will make an even more transparent route for fresh foods, and leading retailers will find innovative ways to transform this data into marketing messages in order to retain loyal customers.

III. Real-Time Data is Driving Ultra-Responsive Operations

By making it easier to maintain unbroken temperature control intelligent assets are helping retailers and suppliers in ensuring the quality of fresh foods in transit. For example, IoT sensors and cloud-based software applications can be used to remotely monitor and control an increasing number of refrigerated cargo containers. Beyond standard refrigeration equipment, smart reefer containers can use ozone generating units, venting valves and other methods to create optimal conditions for perishable products. These acclimatizing devices are connected to sensors and transmitters on the reefer that communicate with the online management platform, sharing information like temperature and CO2 levels, or if light is entering the container. The container may also use automatic techniques to maintain the temperature and atmosphere to strict parameters, sending its location and status to the cloud every few minutes. It's just one way that enhanced visibility into the cold chain is producing new efficiencies for those tasked with managing supply and minimizing loss.

IV. Cloud Platforms are Powering New Possibilities

Meeting the demand for real-time data needs an IT infrastructure capable of collecting, analyzing and sharing the data when it's needed. Organizations can only use the date that exists within their physical environments to unlock business value across the cold chain in the form of decreased waste, brand equity and rapid ROI by harnessing IoT technologies. Of course, because of logistics, maintenance and other factors, effectively managing this process can be costly. Unexpected changes in temperature, machinery problems or truck breakdowns all have the potential to increase the risk of unhappy customers, damaged brand reputation and/or wasted food. The sophisticated IoT software solutions can now provide access to new streams of data from both legacy and modern devices, without the need for replacement infrastructure and all through one single view of the cold chain. Only the most actionable data is pushed up through the system for use, storage, process automation and resolution and the web-based platforms use real-time information from the production, manufacturing, storage and

distribution stages to help companies effectively monitor and manage temperature, asset health, vehicle location, work flow and environmental data.

There is no doubt in the coming years, edge-to-cloud techniques will become critical for reducing waste, reallocating resources, improving maintenance schedules, and assuring the highest-quality meats and produce.

5.3 CONCLUSION

The nature and the dynamics of the agricultural and food supply chains in the country, even for the same commodity/product, are very complex and there is no single point solution to this. In addition to this, the problems and challenges hindering the development of the cold chain sector are interdependent on diverse aspects. The need for creation of integrated solutions is the need of the hour to address the problems like colossal food wastage despite high production, increasing competition in agri-exports from other countries marring the growth of forex and importantly, improvement of local supply chains to benefit the stakeholders from farmers to consumers.

Poor Infrastructure, Large number of Intermediaries, Improper and poor Harvesting, Poor Transportation, Lack of market Information, Lack of Knowledge and Awareness of farmers and Poor Storage and Handling are some of the major factors contributing to losses and wastage in the supply chain of Fruits and Vegetables sector in India.

Proper measures to improve the supply chain efficiency, development of cold chain infrastructure and food processing units will help to improve the scenario of agricultural sector and will give better returns to the farmers and also help to enhance and improve the food economy of India.

BIBILOGRAPHY

Journals

- Indian cold chain: modeling the inhibitors Rohit Joshi, Devinder Kumar Banwet and Ravi Shankar ,Department of Management Studies, Indian Institute of Technology, Delhi, New Delhi, India
- NCCD report
- Journals by Saurav Negi and Neeraj Anand
- The associated chamber of commerce and industry of India journals

Website

- https://nccd.gov.in
- www.apeda.gov.in
- www.currentbyge.com
- www.igi-global.com
- encyclopedia2.thefreedictionary.com
- http://www.arena-international.com