MEASURING THE PERFORMANCE OF AGRI-SUPPLY CHAINS: A STUDY OF TRADITIONAL FRESH PRODUCE DISTRIBUTION SYSTEM IN ANDHRA PRADESH

A thesis submitted to the University of Hyderabad in partial fulfillment for the award of the degree of

DOCTOR OF PHILOSOPHY

By

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SCHOOL OF MANAGEMENT STUDIES
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DECEMBER, 2010

DECLERATION

I, SUDHAKAR MADHAVEDI, hereby declare that the research embodied in the present thesis titled '**Measuring the Performance of Agri-Supply Chains: A Study of Traditional Fresh Produce Distribution System in Andhra Pradesh'** is bonafide work for the full period prescribed under Ph.D ordinances of the University.

I also declare to the best of my knowledge that no part of this thesis was earlier submitted for the award of research degree to any university or institution.

Place: Hyderabad

Date: 30 December 2010

SUDHAKAR MADHAVEDI

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CERTIFICATE

This is to certify that this thesis entitled '**Measuring the Performance of Agri-Supply Chains: A Study of Traditional Fresh Produce Distribution System in Andhra Pradesh' submitted** by Mr. SUDHAKAR MADHAVEDI, Research scholar enrolled for Ph.D programme at the School of Management studies, University of Hyderabad, is the bonafide work done under my supervision and guidance as prescribed under Ph.D ordinances of the University.

This thesis has not been submitted earlier for the award of research degree of any University or institution.

Research Supervisor	**Dean**
(DR. G.V.R.K. ACHARYULU)	(PROF. V. VENKATA RAMANA)

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Sudhakar Madhavedi

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1.	SCM	-	Supply Chain Management
2.	ASCM	-	Agri-Supply Chain Management
3.	MT	-	Metric Ton
4.	HA	-	Hectare
5.	FP	-	Fresh produce
6.	FPSC	-	Fresh Produce Supply Chain
7.	ECR	-	Efficient Consumer Response
8.	CPFR	-	Collaborative Planning, Forecasting and Replenishment
9.	AMC	-	Agriculture Marketing Committee/ Agri-Produce Marketing Committee
10.	TQM	-	Total Quality Management
11.	TPL	-	Third Party Logistics
12.	CSCMP	-	Council of Supply Chain Management Professionals
13.	SCC	-	Supply Chain Cost
14.	SCOR	-	Supply Chain Operations Reference model
15.	JIT	-	Just-In-Time
16.	HACCP	-	Hazard Analysis for Critical Control Point
17.	PHC	-	Pre-Harvest Contractor
18.	Kg	-	Kilo grams (1000 grams)
19.	TCK	-	Tella Chakkera Keli
20.	PMS	-	Performance Measurement System
21.	ANOVA	-	Analysis of Variance
22.	VIF	-	Variance Inflation Factor
23.	df		Degrees of freedom
24.	MS	-	Sum of the means
25.	KPI	-	Key Performance Indicator
26.	ICT	-	Information and Communication Technology

CHAPTER-I

INTRODUCTION TO AGRI-SUPPLY CHAIN MANAGEMENT

DEDICATED TO MY
BELOVED PARENTS
MR.SAYANNA &
MRS. NAGAMANI

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CHAPTER – I

INTRODUCTION TO AGRI-SUPPLY CHAIN MANAGEMENT

1.1 INTRODUCTION

Supply Chain can be understood as a value-creation process, wherein all firms in a chain, link and align, to enhance the value of the chain as a whole (Porter, 1985). The process of value creation is achieved by firm operations, integration of processes, logistics and maintenance of products through quality control. Value creation throughout the chain is further improved by information flows, vertical integration and relationship management. Value creation occurs through operations, which include product transformation or processing product enhancement i.e. cleaning, grading, packaging and presentation (Woods, 2004). Value is created through the integration of processes along the chain, as the product moves from one point in the chain to the other, as a seamless inter-connect of processes.

In logistics, value is added to the supply chain where the product is being transported from one point in the chain to the next. Further value addition occurs where the quality preservation aspects such as grading, packing and cold chain procedures are involved. The value creation process in a supply chain requires clear information flows throughout the chain and links up the suppliers and intermediary customers with market demands and supply.

Indian economy holds traditional supply chain as a powerful force in the agri food distribution system. Conventional understanding demonstrates that the fresh produce distribution system in India performs poorly (Birthal et.al, 2007) and there are different schools of thought which explain the same. It has been observed that farmers receive a disproportionate share of the profits in the fresh produce supply chain when compared to traders and retailers (Narrod et.al, 2008); there is lack of trust between buyers and suppliers which acts as an impediment in supply chain performance; the quality of fresh produce being distributed is poor and the supply is inconsistent (Pandey & Tewari, 2010) and the post-harvest wastage rates are unacceptably high with poor market information flow. Experts opine that prescriptions for improving the performance of such traditional supply chains should vary from chain to chain.

1.2 SUPPLY CHAIN MANAGEMENT IN AGRICULTURE

Most industries are embracing the concept of consumer products and services as supply chains. The supply chain starts with the procurement of basic raw materials and ends with the delivery of final product to the consumer. Two broad principal explanations can be advanced for the increasing interest in Agricultural Supply Chain Management (ASCM): the industrialization of agriculture and the uncertainty associated with variations in product quality and safety (Henson and Loader, 2001).

Agriculture involves a wide range of distinct enterprises comprising farmers, processors, traders and retailers. It relies on inputs from distinct geographical locations and sources. In the case of fresh fruits and vegetables, mostly traders and retailers obtain their supply from diverse sources in order to meet their marketing and production targets (Horvath, 2001). Supply Chain Management (SCM) is an essential tool for integrating the activities of various suppliers within the distribution chain, in order to assure the consistent delivery of quality assured produce to the consumer (Ferentinos et.al, 2006). SCM focuses on improving the performance of the supply chain through the delivery of guaranteed safe, desirable and good quality food in a cost effective manner for the consumer and other stakeholders (Fearne & Hughes, 2000). The increasing transaction costs of intensive agriculture and the inherent need to reduce it, lies at the heart of interest in agricultural SCM. The six fundamental requirements for an efficient supply chain between fresh produce growers and the major retail customers include: scale of operation, strategic alliances, production flexibility, continuity of supply, quality control and communication (Ziggers & Trienekens, 1999).

Supply Chain Management in agriculture is defined as *"The management of movement of agricultural commodities, from the farm through the rural and urban markets to reach the doorsteps of end consumer- both household and industrial consumer; consists of various players, starting from the agricultural producer, through the middle men, commission agents and traders, the bulk purchasers or procurers, millers or intermediary processor, warehousing agents, or cold storage space providers and transporters, through whom material finally reaches either retail distribution system for raw consumption or the food processing industries where it goes through the value addition processes and moves through* *a distinct and a separate supply chain to reach the targeted consumers"(*Ramana & Ajoy, 2005).

The SCM in agriculture is illustrated in Fig. 1.1. From the farming of basic raw materials to delivery of final products to the consumers, each different step in the entire production process is viewed as link in the supply chain. Therefore it represents the management of the entire production, transformations, distribution and marketing activities by which a consumer is supplied with a desired product (Acharyulu & Sudhakar, 2007).

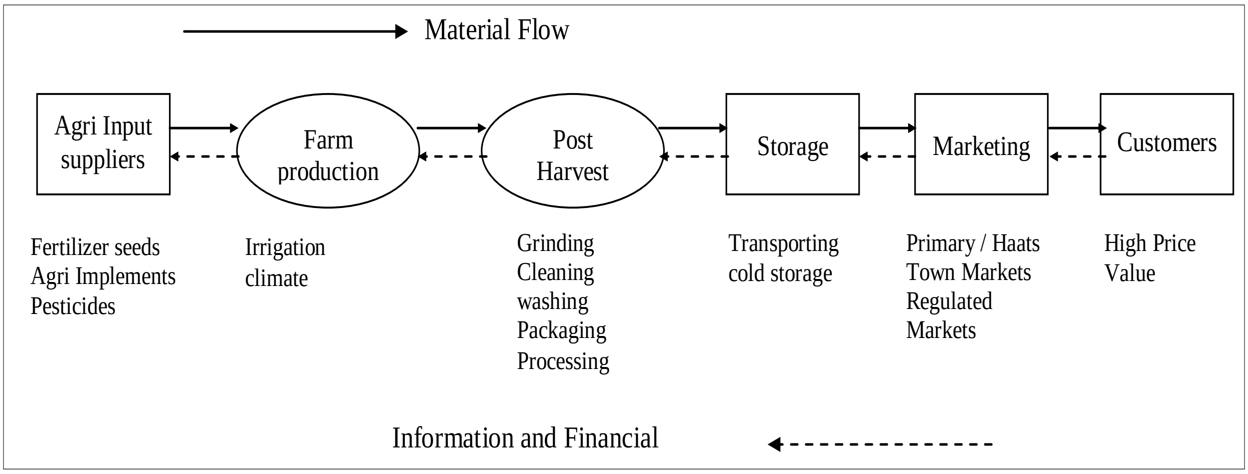

Fig 1.1: Supply chain management in agriculture

Since Indian farming is heterogeneous and small in production per landholding, the produce is gathered at village level and the produce exchange process takes place in the AMC market in the presence of commission agents appointed by government authorities. The wholesalers, exporters, and intermediary processors procure the produce from the market. Finally, the produce reaches the end users and food processors through the retail distribution system.

1.3 SUPPLY CHAIN MANAGEMENT IN FRESH PRODUCE DISTRIBUTION

The fresh produce supply chain model is similar to that of agricultural supply chain where agricultural supply chain model applies to all the other sub-sectors with minor changes due to the variations in the production and distribution methods and the nature of commodity.

Fresh fruits, vegetables and root crops, collectively called fresh produce are inherently perishable commodities and their physical distribution through the marketing system often leads to considerable losses. At present, modern and traditional retail firms are functioning in the distribution chain. The Indian Fresh Produce supply chain is characterised by high cost, low quality, high perishability and increased lead times at all levels (Raghunath & Ashok 2004).

In India, it is reported that approximately 60 percent of quality is lost while produce is transported from the farm to the final consumer in fresh produce supply chain. The efficient supply chain management of practices in fresh produce supply chain certainly benefits in terms of low price to customers and high revenues to producers (Mittal, 2007). The improved supply chain will reduce prices of fresh produce commodities by 35 percent due to the substantial reduction in wastage as well as multiple margins in the traditional supply structure. It is observed that the share of farmers in consumer price is about 30 percent whereas in developed countries it is as high as 70 percent (Raghunath et.al, 2005). Post-harvest losses vary significantly among commodities and varieties, in different regions and seasons. The wastage levels are as high as 24-40 percent in India but as low as 4 to 6 percent in developed countries (Deshingkar et.al, 2003). Hence it is apparent that India needs to emulate practices and expertise from the developed nations in supply chain management of fresh produce.

The major constraints in production of fresh fruits and vegetables have been identified in several research studies which urge for immediate techno-managerial solutions are: (i) non-availability of quality seeds (ii) inadequate irrigation facilities (iii) lack of soil testing facility and extension staff (iv) inefficiency in pest management (v) credit availability constraint (vi) high cost of production (vii) lack of information (viii) huge post-harvest losses due to lack of proper roads, cold storage and inadequate space for storage (ix) high transportation cost (Mittal, 2007).

The general distribution related constraints seen in the supply chain of fresh produce are (i) lack of timely delivery (ii) lack of uniform grading of harvested produce (iii) improper packaging (iv) poor quality of produce (v) poor market infrastructure (vi) improper pricing (vii) lack of standardised weights and measures. Besides these constraints, there is a poor dissemination of market information resulting in lowered productivity (Surendra et.al, 2009).

1.3.1 Post-Harvest Losses in Fresh Produce Supply Chain

The supply of fresh produce consumption increase by the proper integration of post-harvest technology into distribution chain is critical. Effective post-harvest management requires adequate and appropriate cooling and packaging facilities, hygienic and speedy transportation, careful handling and adequate environmental control. Improper post-harvest management in India's fresh produce supply chain has led to the wastage of 24 to 40 percent. The extent of losses of fruits and vegetables is estimated at about Rs. 10,000 crores to 12,000 crores per annum (Reddy et.al, 2010). The major causes of loss are improper handling, poor packaging, improper storage, uncontrolled temperature and others.

Post-harvest management reduces wastage and maintains the quality of fresh produce. Poor handling of produce lowers market quality and can substantially reduce returns. India has around 1,300 cold storage facilities, of which 50 percent used for potatoes and the rest remain under-utilised. In India, approximately 20 percent of fruits and vegetables go waste on account of the lack of cold chains (Viswanadham, 2006).

1.4 DEMAND AND SUPPLY TRENDS IN FRESH PRODUCE

Indian economy is moving towards a demand-driven economy giving scope for a change in consumption pattern and diversification in production. Total domestic demand for fruits is expected to increase from 17.43 million tons in 2010 to 25.47 million tons by 2020 in a scenario of economy growing at eight percent per annum. For vegetables, the demand is expected to increase from 103.16 million tons in 2010 to 137.25 million tons by 2020. Demand for both fruits and vegetables are expected to rise at the rate of 4 to 5 percent per annum in the next 10 years showing an increasing trend. The per capita demand also moves in the similar trend as shown in the table 1.1.

Table 1.1: Projected domestic demand of fruits and vegetables in India

Year	Total Demand (Million tons)		Per Capita Demand (Kg)	
	Fruits	Vegetables	Fruits	Vegetables
Base Year 2000	12.37	79.15	12.04	77.07
2010	17.43	103.16	14.78	87.51
2015	21.06	119.12	16.67	94.28
2020	25.47	137.25	18.93	102.00

Source: Mittal, 2007

The increase in demand of fruits and vegetables for domestic consumption is a challenge to the country. Diversifying land away from cereals to fruits and vegetables is a difficult task. The production of fruits and vegetables would increase from 66.9 million tons in 2010 to 131 million tons by 2015. The surplus margin of 20 to 25 percent of fruits and vegetables are moved from domestic market to export markets by reducing post-harvest losses. Much effort is thus required to minimise supply constraints and improve the growth rates of fruits and vegetables.

The table 1.2 shows the difference in production and actual supply. It also reveals the gap much higher and treated as post-harvest losses. The reduction of losses may increase the actual supply of produce for consumption. It is observed that production and actual supply are constantly growing from 83.8 million tons to 152 million tons in case of vegetables and 44.3 million tons to 74.9 million tons in for fruits. The actual supply of produce for consumption is increasing from 67.9 million tons to 123 million tons for vegetables and about 33.2 million tons to 56.2 million tons for fruits.

The area of cultivation of fruits and vegetables are going to remain unchanged during 2010-11 and 2015-16. It is also observed that the losses in distribution are increasing from 15.9 million tons to 29 million tons for vegetables and 11.1 million tons to 18.7 million tons for fruits. It can be understood that growing area of fruits and vegetables would reach to saturation level over a period of time. Hence it is necessary to reduce losses in fresh produce to meet the demand of growing population.

Table 1.2: Forecast of supply of vegetables and fruits

Year	Area (Million ha)	Yield (tons/ha)	Production (Million tons)	Actual Supply (Million tons)	Losses in distribution (Million tons)
Vegetables					
1999-00	5.82	14.4	83.8	67.9	15.9
2010-11	6.49	20.2	131.1	106.2	24.9
2015-16	6.49	23.5	152.5	123.5	29.0
Fruits					
1999-00	3.74	11.8	44.3	33.2	11.1
2010-11	4.43	15.1	66.9	50.2	16.7
2015-16	4.43	16.9	74.9	56.2	18.7

Source: Kumar and Kumar (2003)

1.5 PRODUCTION TRENDS IN BANANA AND TOMATO

1.5.1 Banana Production in India

India ranks first in the world banana production. The main varieties of banana crops grown in India are Dwarf Cavendish, Bhusaval Keli, Basrai, Poovan, Harichhal, Nendran, Amruthapani and Safed velchi. The table 1.3 shows the area, production and productivity of banana from 1991-92 to 2008-2009. It is found that the production of banana is growing in India at a constant rate from 7.7 million tons in 1991-92 to 26.2 million tons in 2008-09. The area of banana crop is also increasing in the same rate. It is interesting to note that the productivity of banana is almost doubled in the given periods from 20.3 tons to 37 tons and out of the total fruit production in India, banana represents 38 percent in the first position. The portion of area devoted for banana cultivation from total fruits is slowly diminished from 13.4 percent to 11.6 percent during the period.

Table 1.3: Area, Production and Productivity of Banana from 1991-92 to 2008-09

Year	Area (A)	% of Total Fruit Area	Production (P)	% of Total Fruit Production	Productvity (P/A)
1991-92	383.9	13.4	7.7	27.2	20.3
2001-02	466.2	11.6	14.2	33.0	30.5
2002-03	475.3	12.5	13.3	29.4	28.0
2003-04	498.6	10.7	13.8	30.4	27.8
2004-05	589.6	11.9	16.7	34.0	28.4
2005-06	569.5	10.7	18.9	34.1	33.2
2006-07	604.0	10.9	21.0	35.3	34.8
2007-08	658.0	11.2	23.8	36.3	36.2
2008-09	709.0	11.6	26.2	38.3	37.0

Note: i) Area in Thousand hectares ii) Production in Million tons

Source: Indian Horticulture Database (2009)

The table 1.4 shows the State wise area, production and productivity of banana during 2006-07 to 2008-09. Tamil Nadu is in the lead, with a share of 25.4 percent. The productivity varies from State to State and from year to year. Maharashtra has highest productivity of 62 tons per hectare; Kerala has lowest productivity of 7.9 tons per hectare. The national average of productivity in banana is 37 tons per hectare. Gujarat, Andhra Pradesh and Karnataka occupy third, fourth and fifth positions respectively in the order of production.

Table 1.4: Statewise, Production and Productivity of Banana from 2006-07 to 2008-09

State	2006-07			2007-08			2008-09		
	A	P	Pdy	A	P	Pdy	A	P	Pdy
Tamil Nadu	102.2	5019.4	49.1	114.1	6116.5	53.6	124.4	6667.0	53.6
Maharashtra	73.4	4621.9	63.0	80.0	4962.9	62.0	80.0	4960.0	62.0
Gujarat	53.4	2912.6	54.5	57.7	3157.7	54.7	60.9	3571.6	58.7
Andhra Pradesh	72.4	2173.3	30.0	75.2	2631.2	35.0	80.1	2804.0	35.0
Karnataka	60.8	1558.5	25.6	70.5	1793.3	25.4	75.4	1918.8	25.4
Madhya Pradesh	14.9	773.0	51.9	15.2	788.2	51.9	28.8	1498.0	51.9
Bihar	29.0	1125.1	38.8	30.5	1329.4	43.6	31.3	1373.6	43.9
West Bengal	31.7	802.1	25.3	37.4	892.2	23.9	39.3	954.1	23.9
Assam	43.3	598.9	13.8	44.1	610.9	13.9	47.9	852.6	17.8
Kerala	59.1	463.8	7.8	61.5	493.9	8.0	59.8	472.9	7.9
Others	63.3	949.4	14.9	71.7	1046.8	14.6	80.4	1144.5	14.2
Total	604.0	20998.0	34.8	657.8	23823.0	36.2	708.8	26217.2	37.0

Note: A=Area (000'HA) P=Production (000'MT) Pdy=Productivity (P/A)

Source: Indian Horticulture Database (2009)

1.5.2 Tomato Production in India

Tomato production in India of 27 percent in the global production places it in the third rank. The main varieties of Tomato are Pusa Ruby, Pusa Early Dwarf, Arka Abha, Arka Alok, Pant Bahar, Pusa hybrid-1, Pusa hybrid-2, MTH-6, Arka Vardan etc. The table 1.5 shows that the cultivation of tomato has gone up continuously from 4.2 million tons in 1991-92 to 11.1 million tons in 2008-09. Tomato contributes to 8.6 percent of total Indian vegetable production and 7.5 percent of the total area.

The area of tomato crop is almost doubled from 0.28 million hectares to 0.59 million hectares during the period. It is observed that the productivity of tomato is increased at constant pace in the given periods from 14.7 tons to 18.6 tons. The share of tomato production of the total vegetable production is 7.2 percent to 8.6 percent during 1991-2009 whereas the portion of area devoted for tomato cultivation from total vegetables area is slowly increased from 5.2 percent to 7.5 percent during the period.

Table 1.5: Area, Production and Productivity of Tomato from 1991-92 to 2008-09

Year	Area (A)	% of Total Fruit Area	Production (P)	% of Total Fruit Production	Productvity (P/A)
1991-92	289.1	5.2	4.2	7.2	14.7
2001-02	458.1	7.4	7.4	8.0	16.3
2002-03	478.8	7.9	7.6	9.0	15.9
2003-04	502.8	8.0	8.1	8.7	16.2
2004-05	505.4	7.5	8.4	8.7	17.5
2005-06	546.1	7.6	9.8	8.9	17.5
2006-07	596.0	7.9	10.0	8.7	16.9
2007-08	566.0	7.2	10.3	8.0	18.2
2008-09	599.0	7.5	11.1	8.6	18.6

Note: i) Area in Thousand hectares ii) Production in Million tons

Source: Indian Horticulture Database (2009)

Table 1.6 shows the State wise, production and productivity of tomato during 2006-07 to 2008-09. The major banana producing States are Andhra Pradesh-12.6 percent, Karnataka-14.1 percent, Orissa- 12.2 percent, Tamil Nadu- 25.4 percent and Bihar- 9.3 percent, West Bengal- 9 percent and others-17.8 percent. The productivity varies from State to State. Karnataka is in the lead when compared to other States highest productivity of 29.5 metric tons against India's average of 18.6 metric tons per hectare. Chhattisgarh has lowest productivity of 10.7 metric tons per hectare. The productivity is constantly raised from 14.7 metric tons per hectare to 18.6 metric tons per hectare as a result of increased hybrid varieties.

Table 1.6: State wise, Production and Productivity of Tomato from 2006-07 to 2008-09

State	Area (000'HA)			Production (000'MT)			Productivity HA/MT		
	2006-07			2007-08			2008-09		
	A	P	Pdy	A	P	Pdy	A	P	Pdy
Karnataka	46.1	1315.7	28.5	50.9	1498.8	29.5	53.4	1573.8	29.5
Andhra Pradesh	81.1	1540.3	19.0	74.1	1408.1	19.0	74.1	1408.1	19.0
Orissa	100.6	1337.5	13.3	100.7	1344.3	13.3	101.1	1360.5	13.5
Bihar	46.5	916.8	19.7	46.2	921.9	20.0	46.4	1037.2	22.4
West Bengal	51.0	868.7	17.0	51.1	956.7	18.7	52.3	999.7	19.1
Gujarat	28.5	676.1	23.7	30.8	739.6	24.0	30.5	746.2	24.4
Madhya Pradesh	22.0	331.0	15.0	22.7	340.5	15.0	30.0	450.6	15.0
Jharkhand	15.4	307.4	20.0	17.5	350.2	20.0	21.8	436.1	20.0
Chhattisgarh	75.6	474.5	6.3	37.7	404.1	10.7	39.2	420.4	10.7
Others	98.7	1605.3	16.3	102.4	1623.3	15.8	117.2	1984.1	16.9
Total	596.2	10054.6	16.9	566.3	10302.7	18.2	599.1	11148.8	18.6

Note: A=Area (000'HA) P=Production (000'MT) Pdy=Productivity (P/A)

Source: Indian Horticulture Database (2009)

1.6 AGRICULTURAL MARKETING IN INDIA

Marketing function is an important component of agricultural supply chain. Agricultural marketing involves buying and selling of agricultural produce. Earlier the village economy was self sufficient as the marketing of agricultural produce was based on the farmer selling the produce directly to the customer in exchange for cash or kind in the vicinity of the farm. But, modern marketing of agricultural produce includes a series of transfers before it reaches the end user. The three marketing functions that come into being during marketing include (i) assembling (ii) preparation for consumption (iii) distribution. The produce may be stored in the farm for a brief period or directly taken to the market for sale. It is sold without cleaning, grading, processing and packaging directly to the customer.

The produce is graded according to quality standards and delivered to traders or commissioning agents who in turn market the same to the retailers. The transactions are done directly or through a three tier system where there are distinct levels such as primary, secondary and terminal market levels. Distribution or dispersion involves the operations of wholesaling, retailing, a series of adjustments and equalising functions.

1.6.1 Marketing Functionaries

The functionaries may be individuals, partners or co-operatives who buy and sell at a price determined by forces of supply and demand. The involvement of these functionaries in the marketing of produce is very complicated and results in increased price of the produce. The bulk form of the produce, perishability and seasonal availability adds to the complexity in agricultural marketing.

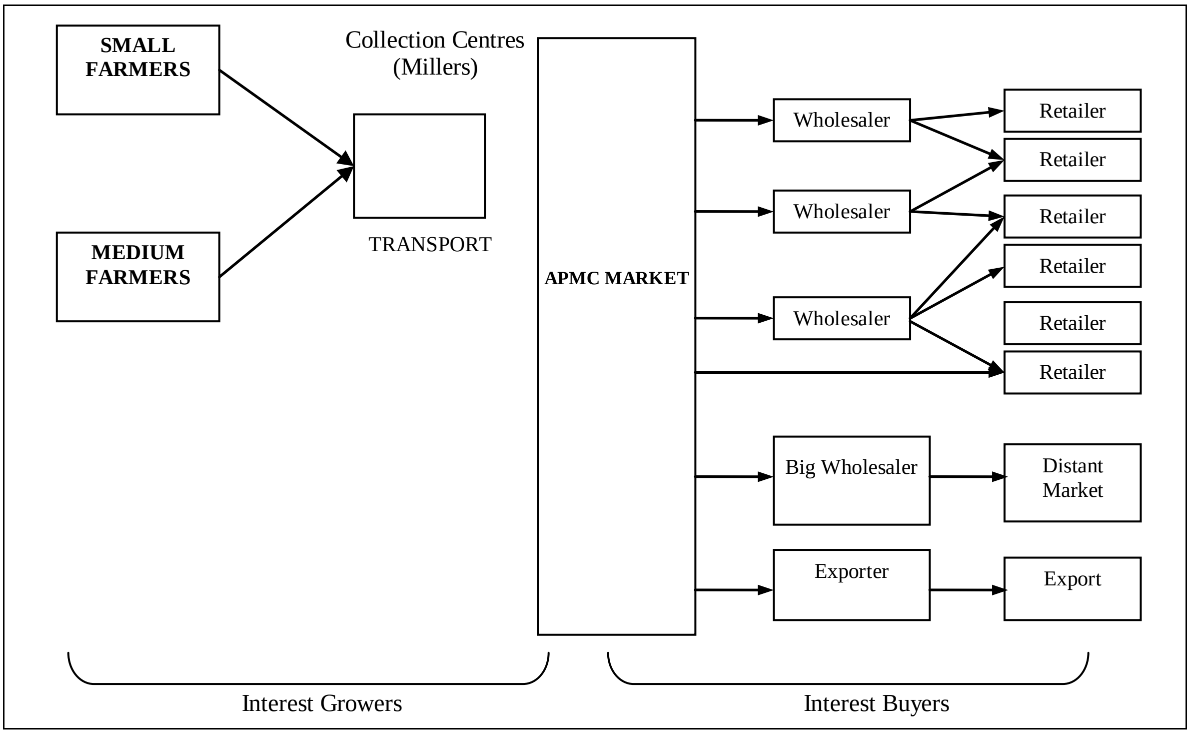

Figure 1.2: Diagram of agri-produce distribution chain

Source: www. krishiworld.com

The transfer of produce takes place through a chain of intermediaries or middlemen or agencies. The main functionaries are the producer, the village or itinerary merchant, pre-harvest contractors, commission agents and transport agents in the primary market. The processing and manufacturing agents are the additional functionaries at the secondary market level. At this level there can be agents such as money lenders, bankers and co-operatives who participate. The commercial analyst and shipping agent also get involved in the terminal market.

1.6.2 Issues in Present Fresh Produce Distribution System

Indian system of agricultural marketing distribution suffers from a number of shortcomings. The following are the bottleneck of the agricultural marketing system established by many of the scholar works.

a) *Improper warehouses:* The farmer is compelled to find substitutes for warehousing in the villages due to lack of proper infrastructural facilities for storage. The substitutes for warehousing for fresh produce are pits, mud-vessels, ‘Kutcha’ storehouses, etc, which leads to a considerable amount of wastage (up to two percent). Thus, there is substantial increase in supply of produce in the village market and the farmers are not able to get a fair price for their produce.

b) *Lack of grading and standardisation:* Agricultural produce is not graded properly by variety. The practice of heaping all qualities together known as ‘Dara sales’ and selling as one single lot discourages farmers who have better qualities because there is no assurance of a better price. Thus, the practice of grading and standardisation should be encouraged to ensure use of superior quality seeds and varieties.

c) *Inadequate transport facilities:* Inadequate transport facilities to the markets show the need for improved transportation. Bullock carts and auto rickshaws are the common means of transportation for farmers in villages which makes transport of perishable produce very difficult to far off places, resulting in low profits.

d) *Presence of a large number of middlemen:* Agricultural marketing involves a large number of middlemen who share the profits of the farmer. Farmer’s share in consumer’s price is reduced to 39 percent in case of vegetables and fruits 34 percent while 46.5 percent will go to the intermediaries.

e) *Inadequate market information:* The information on market trends and pricing is inadequate despite the governments’ efforts to provide information by radio broadcasts and TV telecasts. Most of the time the information that the farmer receives is not adequate to take the decision to hold or to sell the produce it being near impossible for farmers to obtain information on exact market prices in different markets thus relying on the price quoted by the traders which is less than the price of government.

f) Inadequate credit facilities: Poverty has led many Indian farmers to sell off the produce immediately after harvest at a very low price. The 'forced sale' can be avoided by providing adequate credit facilities which enable the farmer to wait for a better price. Such a credit facility prevents farmers from forced loans from money lenders, and pledging of produce to the traders at a price lower than the market value.

1.6.3 Role of Government in Agricultural Marketing System

The Directorate of Marketing and Inspection was set up by the Government of India to coordinate the agricultural activities and advise the State and Central government on the problems in agricultural marketing. In order to improve the agricultural marketing, the Government of India has adopted a number of measures such as: (i) establishment of regulated markets (ii) construction of warehouses (iii) provision for grading (iv) standardisation of produce (v) standardisation of weights and measures (vi) daily broadcasting of market prices of agricultural crops on All India Radio (vii) improvement of transport facilities.

Organisation of regulated markets has been done to protect the rights of farmers. The system of regulated markets addresses the problem of malpractices and setting up of standardised market practices by licensing the brokers and weighing men. Apart from the regulated markets, an extensive infrastructure for storage of fresh produce has been set up to prevent the losses incurred by farmers. A Central Quality Control Laboratory is set up at Nagpur and eight other regional laboratories are set up with the purpose of testing the quality and quantity of agricultural produce and applying for the governments 'Agmark' for standardised products. Further streamlining and enforcement of quality is being done by the government through inspections and improvement in grading.

1.7 RESEARCH QUESTIONS

The following research questions are emerged from the literature study and the interactions with fresh produce supply chain partners.

i) Is the assessment of fresh produce supply chain performance helps in identifying the area of improvement?
ii) What are the factors contributing to the perishability of fresh produce?

iii) Is there any gap between the existing practices of Fresh produce supply chain and Good Agricultural Practices?

iv) Is there any significant role of transportation in fresh produce perishability? How to resolve them?

v) Are the farmers lacking the facilities like grading, cleaning, washing and packaging which effect quality of fresh produce?

vi) Is supply chain management can handle the fresh produce losses substantially?

1.8 NEED AND SIGNIFICANCE OF THE STUDY

The Agriculture sector in developed nations having adopted the supply chain approach effectively integrating the logistic operations consequently experienced a reduction in lead times, losses, cost and uncertainty. The SCM brings effective coordination among the distribution chain partners such as input suppliers and growers, cohesiveness among warehousing partners and retailers resulting in maximisation of customer satisfaction and high value creation to customers in the developed nations whereas in under-developed nations agri-supply chain management is being used for vertical coordination.

It is obvious that the existing fresh produce supply chains are disjointed which consists of many intermediaries adding cost rather than value. These chains meet the food requirement of crores of people and provide livelihood to lakhs of intermediaries. The consumer pays a high price for inferior quality owing to limited option. Indian fresh produce supply chain lags behind in respect of improved procurement, warehousing and competitive retailing. In recent years, there is an increased involvement of organised retail companies in fresh produce distribution creating a highly competitive environment in which the survival of traditional suppliers is critical to face the market challenges (Bart Mintena et.al, 2010).

In Indian fresh produce distribution system, the supply chain management decision areas like procurement, cold logistics, transportation and information systems are not given much attention. As a result several micro level supply chains have evolved without synchronizing in the downstream of supply chain. In this context, SCM becomes crucial for capacity building in the fresh produce distribution system. The present study is an attempt to address these issues and help understand SCM practices for performance improvement in fresh produce distribution system.

In the context of globalization, there is greater need to study the SCM practices and measure the performance of agri supply chains to sustain in the highly competitive environment to track the efficiency failures of fresh produce distribution system. The aim of implementing a performance measurement system is to improve the performance of the individual firms in the fresh produce chain which will have typical characteristics like high transport cost, inconsistent supply, high perishability, long throughput times, seasonality, and quality (Batt and Noonan, 2009).

1.9 OBJECTIVES OF THE STUDY

The main objective of the study is to measure the performance of supply chain in fresh produce distribution system in Andhra Pradesh for tracking failures which may possibly lead to effective decision-making within the chain entities. In order to substantiate the main objective, the following secondary objectives of the study are framed:

1. to study the supply chain practices in fresh produce distribution system and to identify the gaps in the existing practices;
2. to measure the supply chain performance across distribution channels i.e., farmers, traders, retailers, consumers and transporters in traditional fresh produce distribution system;
3. to identify the key factors affecting road transport performance in fresh produce distribution system;
4. to identify the factors causing perishability in fresh produce distribution chain and to suggest preventive measures to improve quality of fresh produce; and
5. to develop an integrated supply chain model for fresh produce distribution system based on the performance measurement.

1.10 HYPOTHESES OF THE STUDY

Keeping in view the importance and significance of the study, the following hypotheses are setup for the study based on the review of literature.

1. Hypothesis (H1): The condition of roads will influence the damage level of fresh produce during the transit;
2. Hypothesis (H2): The amount of care taken while loading and unloading will have an effect on the damage of fresh produce;
3. Hypothesis (H3): Spoilage of fresh produce will affect the overall performance of fresh produce supply chain;
4. Hypothesis (H4): There is a significant gap between the promised delivery time and actual delivery time within the levels of supply chain;
5. Hypothesis (H5): The fill-rate is not uniform among the fresh produce supply chain partners such as farmers, traders and retailers;
6. Hypothesis (H6): There is a significant difference in customer response times in fresh produce supply chain entities i.e., farmers, traders and retailers; and
7. Hypothesis (H7): There is difference in level of trust within supply chain partners in fresh produce negotiations.

1.11 SCOPE OF THE STUDY

The present research work has been conducted in the State of Andhra Pradesh covering three regions namely Coastal Andhra, Rayalaseema and Telangana. The study is confined to measuring the performance of supply chain relating to aspects of traditional fresh produce distribution system in the agri-supply chain. The study focuses on the two important fresh produce commodities i.e., Tomato and Banana grown in Andhra Pradesh.

The data is collected from AMC markets, where all the fresh produce distribution chain stake holders are involved in the process of exchange and value creation. The respondents include farmers, traders, retailers, transporter and customers and their respective sample size are 305, 62, 120, 65 and 200.

1.12 CHAPTERISATION OF THESIS

The research work is presented in eight chapters covering broad areas including introduction, review of literature, fresh produce supply chain practices, fresh produce transportation and perishability, fresh produce supply chain performance, agri-produce supply chain models and observations and recommendations.

The Chapter-I discusses the need for measuring the performance of agri-produce supply chain focusing on fresh produce sector explaining the objectives and hypothesis of the study. It also describes the research methodology which consists of data sources, research instruments used and their reliability. A detail description is given on the sampling method and criteria used for selection of sample along with the sample profile.

The Chapter-II focuses on review of literature which presents findings of the various researchers under the sub-headings: supply chain concept, supply chain flows, coordination and integration, third part logistics, performance measurement, supply chain costs, SCM in agriculture, quality management in fresh produce sector, post-harvest losses and marketing infrastructure.

The Chapter-III chapter discusses the conceptual framework of fresh produce distribution system and supply chain performance measurement. This chapter also gives an overview on storage and transportation of fresh produce and also the various factors effect on fresh produce perishability. This chapter highlights the various parameters that can be used for the agri-supply chain performance measurement.

The Chapter-IV describe the fresh produce supply chain practices being followed at farmers, traders and retailers level focusing on grading, storage, packaging, maintenance of buffer stocks, traceability, use of pesticides etc. This chapter also describes performance measures such as shelf life, product lateness, delay in delivery, customer complaints, customer response time, produce quality etc.

The Chapter-V presents the regression analysis of: i) the factors that contribute to the road transport performance; ii) the factors that contribute to perishability fresh produce. The hypotheses framed for the study are tested using Chi-square and ANOVA techniques and presented in this chapter.

The Chapter-VI evaluates the performance of traditional fresh produce supply chain based on performance measures specially developed for agri-food supply chains includes efficiency, flexibility, responsiveness, product quality and process quality.

The Chapter-VII presents different models of agri produce distribution system in India. This chapter discuses constraints of agri-produce supply chain initially which necessitate for development of alternative models in the sector. In the later sections of this chapter will explain the various modified supply chain models (both ICT and non-ICT) discussed with a view to develop an appropriate model for fresh produce distribution.

The Chapter-VIII summarises the observations of the research under three key headings namely, supply chain practices, statistical inferences and supply chain performance. This is followed by a detailed list of recommendations that evolved from the findings. The different Annexure are presented at the end of the thesis.

1.13 RESEARCH METHODOLOGY

The study is descriptive, causal and analytical in nature. The descriptive study focuses on describing the variable pertaining to the supply chain practices in fresh produce distribution system. The variables used for descriptive study are grading, storage, packaging, buffer stock levels, traceability and use of pesticides. This study also describes performance measures such as shelf life, product lateness, delay in delivery time, loss of produce during distribution, customer complaints, customer response time and produce quality aspects such as loss of appearance, freshness and edibility. The variables in descriptive study are placed in the Part-B of farmers, traders and retailers questionnaires (See Annexure-III).

The causal study focuses on: (i) the factors that contribute to the road transport performance (ii) the factors contribute to perishability fresh produce. These two studies use the regression analysis to establish causal relationships. The variables used for collection of data for causal study are presented in the Part-C of farmers, traders and retailers questionnaires (See Annexure-III).

The analytical study focuses on the measurement of supply chain performance of fresh produce distribution system using key performance measures like efficiency, flexibility, responsiveness, product quality and process quality. In addition to performance measurement, the hypotheses have been tested using Chi-square and ANOVA techniques. The variables that are used for analytical are presented in the Part-C of farmers, traders and retailers questionnaires.

1.13.1 Data Collection

The data is collected from primary and secondary sources. The primary data is collected from the farmers, traders, retailers, consumers and transporters by administering structured questionnaire and also by interviewing the marketing officials of AMC markets. The detailed information on sampling and criteria for selection of respondents are explained in the subsequent sections of this chapter.

The secondary data on crop area, production and yield has been collected from the reports of Indian Horticulture Database, Directorate of Economics and Statistics, Ministry of Agriculture and FAO statistics. Most of the data is collected from National Horticultural Board for years 2000 to 2009. The data on wholesale prices, price index and market arrivals is obtained from 'Agmarknet' database and publication of the Directorate of Economics and Statistics. Apart from the data on agriculture and horticulture, the supply chain related literature is collected from the journals, online database and other web resources. During the research period, the data is also accessed from the various libraries of agricultural universities, State and Central universities and management institutes like Indian Institute of Management (Ahmadabad and Bangalore), National Institute of Agriculture Extension Management (MANAGE), National Institute of Agricultural Marketing, Institute of Public Enterprises besides others.

1.13.2 Selection of Fresh Produce Commodities for Study

It is a known fact that the consumption of bananas and tomatoes is high in India and the crops are grown throughout the year. But the biggest challenge for fresh produce supply chain partners is to ensure quality of produce that has limited shelf life. Andhra Pradesh occupies first and fourth places in vegetable and fruit production respectively of which Banana and Tomato are the prime crops of production (Indian Horticulture Database, 2009). These commodities have highest level of post-harvest losses hence truly represents the family of fresh produce commodities.

The table 1.7 reveals that the post-harvest losses in fresh produce in India. It is observed that the tomatoes and bananas highly damaged in handling and transporting activities and the total losses are estimated to 25 percent and 22 percent respectively (which are highest) indicating the low shelf life. Since these two commodities are produced and marketed throughout the year, the study can be conducted without any seasonal interruptions.

Table 1.7: Post-harvest losses in fresh produce in India

Crops	Harvesting	Grading	Transportation	Marketing / Storage Wholesaler	Retailer	Total loss (%)
Orange	3.25	0.75	1.25	1.20	7.50	13.95
Pineapple	1.73	0.54	1.95	2.66	2.37	9.25
Banana	Nil	Nil	10.00	5.00	7.00	22.00
Ginger	1.5	2.25	1.50	2.75	2.50	10.50
Tomato	0.75	3.75	11.00	2.50	7.25	25.25
Cauliflower	Nil	2.75	7.50	1.75	3.75	15.75
Spine Gourd	Nil	8.30	4.30	1.80	2.70	17.10
Pointed Gourd	Nil	5.40	7.50	1.90	2.10	16.90

Source: Directorate of Research (2005)

Profiles of Tomato and Banana varieties:

The study includes commodities belongs to fresh produce family, namely tomato and banana. The bananas are classified as dessert types and culinary types. The culinary types have starchy fruits and are used in the mature unripe form as vegetables. Important cultivars include Dwarf Cavendish, Bhusaval Keli, Basrai, Poovan, Harichhal, Nendran, Amruthapani and Safed velchi. In this study Dwarf Cavendish variety is considered due to the wide spread of cultivation in Andhra Pradesh.

Tomatoes are cultivated in different temperature regions in India and the soils used for cultivation vary from arid to semi-arid. The main tomato varieties grown in India are Pusa Ruby, Pusa Early Dwarf, Arka Abha, Arka Alok, Pant Bahar, Pusa hybrid-1, Pusa hybrid-2, MTH-6, Arka Vardan etc. For this study Pusa varieties are considered as they are predominantly grown in the State of Andhra Pradesh. The specific features of Dwarf Cavendish and Pusa variety of fresh produce selected are explained in the following paragraphs.

Dwarf Cavendish: The Dwarf Cavendish is a popular commercial cultivar grown extensively for table and processing purpose in the States Maharashtra, Gujarat, Bihar and West Bengal. It is also popular in Tamil Nadu, Karnataka and Andhra Pradesh. The plant stature is Dwarf making it is less prone to wind damage. The bunch size, the fruit length and size is quite good though the keeping quality is poor. The average bunch weight with 6-7 hands and with about 13 fruits per hand is about 15-25 kg. The thick rind of the fruits retains to some extent the greenish colour even when the fruits are ripe. In combination with high-density planting and drip irrigation, Dwarf Cavendish is becoming a highly successful cultivar. It is highly susceptible to Sigatoka leaf spot disease in humid tropics restricting its commercial cultivation. The storage life of Dwarf Cavendish banana is 10-12 days at 14.5^{o}C temperature.

Pusa Hybrid: The Pusa Hybrid tomato grows well in India even in summer months. It needs temperatures around 20^{o}C up to 25^{o}C to set the fruit. It produces smooth, yellow, firm fruit that is resistant to nematodes, tiny worms that attack and destroy tomato plants. This variety is grown anywhere in India and suitable for cultivation in Andhra Pradesh. It comes to harvest in 60 days after planting. The fruits are medium in size with slight furrows, uniform red smooth and slightly larger fruits compared to other varieties. Crop duration is 125-130 days and gives a yield of about 30 tons/ha. The Pusa Ruby tomato matures early and can be grown the year-round in all of India's weather zones. The small to medium fruits are flattish-round and good for making ketchup and juice.

1.13.3 Sampling Method

The study followed the Multi-Stage sampling which is a form of cluster sampling. This method is adopted when all the sample elements in all the selected clusters may be prohibitively expensive or not necessary (Durbin, 1967; Kuno, 1976). The technique is also used often when a complete list of all members of the population does not exist and is inappropriate. In the first stage State is selected, secondly the districts, in third stage AMC markets and in the fourth stage the sample respondents are chosen. The selection of sample at the different stages is discussed as follows.

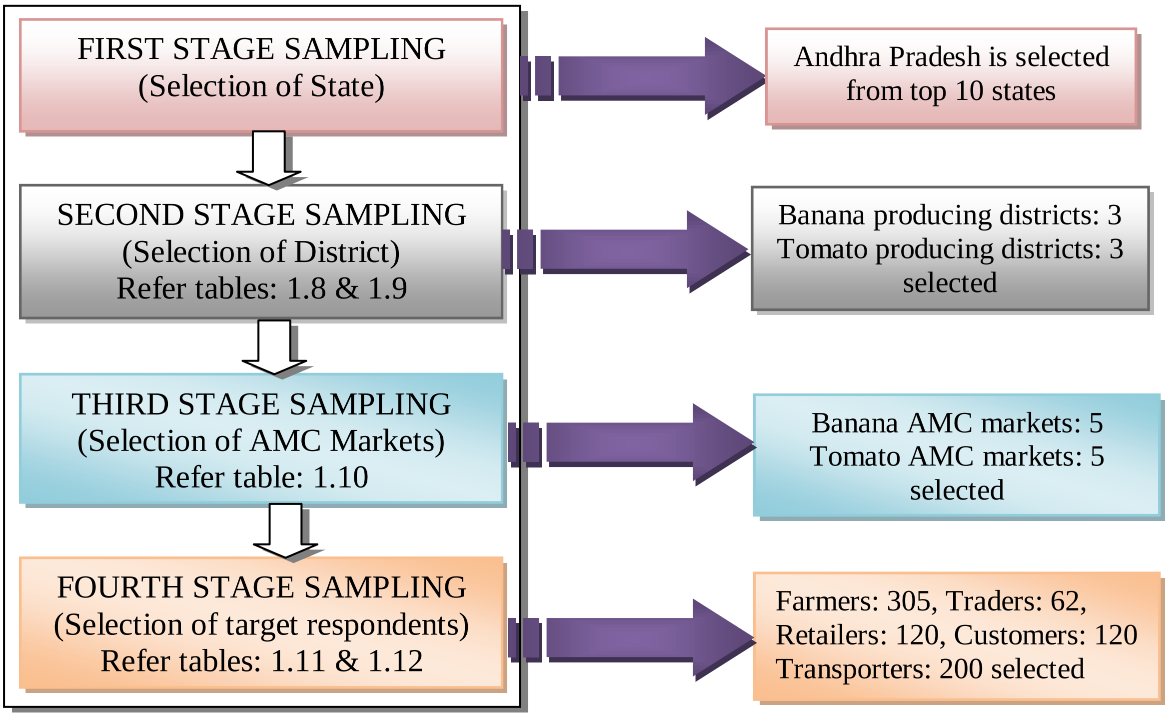

Figure 1.3: Multi-stage sampling method

First stage Sampling-Criteria for selection of Andhra Pradesh State

Andhra Pradesh stands top in the fruit and vegetable production since 1999-2000 to 2008-09 (Indian Horticulture Database, 2009) due to its largest area. Agriculture contributes 12.9 percent of the State GDP and employs 62 percent of the total workforce and horticulture contributes to approximately 4 percent of the State GDP. Horticulture crop covers 13 percent of the gross cropped area in the State. Mango, Sweet Orange and Banana are the leading fruit crops in Andhra Pradesh and account for over 86 percent of the area under fruit and over 77 percent of the total fruit production. The major vegetables grown in the State are Tomato, Onion, Tapioca, Brinjal and Okra. There are 299 Agriculture Market Committees constituted under the Act in the State with 870 notified markets. Of these, 39 markets have been notified exclusively for fruits and vegetables. Andhra Pradesh occupies third position in banana production and second position in tomato production.

The Annexure-I (A&B) shows the area and production of fresh fruits between 1999-2000 and 2007-08. Andhra Pradesh has a good potential for horticulture and has about 15.3 lakh hectares of area covered under horticulture crops. The horticulture sector is likely to contribute for 10 to 15 percent of the State’s gross domestic product in the next 10 years, growing at an average rate of 15 percent. Growth is expected to come mainly from exports and inter-State trade. The horticulture sector offers maximum scope in production and facilitates movement up the value chain.

Production of Banana: Andhra Pradesh is the fourth largest producer of banana in India accounting for 10.6 percent of total production. The Annexure-I (A) shows the area and production of banana between 2004-05 and 2007-08. Banana is cultivated over an area of 0.75 lakh hectares in the state and production is 26.31 lakh tons annually. In Andhra Pradesh, East Godavari district ranks first in banana showing a production of 5.41 lakh metric tons in an area of 0.15 lakh hectares. In contrast Mahaboobnagar district has the lowest production of 980 metric tons. West Godavari district stands second in production of banana to the tune of 4.81 lakh tons. In order of production the following districts are listed. They are Vizianagaram (2.6 lakh tons), Ananthapur (2.19 lakh tons), Guntur (1.99 lakh tons) and Medak (1.51 lakh tons). The change in production is a result of change in farm practices adopted from time to time.

Production of Tomato: Andhra Pradesh is the second largest producer of tomato in India accounting for 12.6 percent of total tomato production. The Annexure – I (B) shows the area and production of fresh vegetables between 2004-2005 and 2007-2008. Tomato is cultivated over an area of 2.98 lakh hectares in the State and tomato production amounts to 49.42 lakh tons annually. Medak district ranks first in area of 0.31 lakh hectares and production of 5.17 lakh metric tons whereas Warangal district shows a lowest yield of 0.60 lakh metric tons. Chittoor district occupies the second place in production (3.68 lakh tons). The following districts are given in order of production, namely- Adilabad (3.26 lakh tons), Visakhapatnam (3.09 lakh tons), Guntur (2.82 lakh tons) and Ranga Reddy (2.81 lakh tons).

Second Stage Sampling - Criteria used for selection of sample districts

A total of 3 districts have been selected for the study for each produce based on a specific criteria developed for this purpose. Prior to the selection of markets, the statistics on tomato crop for the years from 1999-2000 to 2008-2009 had been collected. In order to reduce the effect of cycle patterns and uneven production trends, the average area cultivated and yield generated during last ten years are taken and arranged in descending order for a purpose to list the district which has highest area grown with the highest production and the district which has low area with least production. This exercise is conducted for tomato and banana separately to identify the districts for selection of sampling.

The table 1.8 shows the districts growing tomato are segregated into three categories. The district growing more than 10,000 hectares of tomato are identified as first category, 5000 and 10000 the second category and between 1000 and 5000 categorised as the third. The districts lower than 1000 acres of tomato cultivation are not considered for the study as their effect on the study is minimal due to the lesser amount of supply chain activities. From every category, a single district is selected to draw the sample units for the study. The districts are randomly selected to avoid the biasness of the sample.

Table 1.8: Average area and production of tomato crop grown from 1999-2000 to 2008-2009

Sl.No	District	Area	Production	Category	Selected District
1	Kurnool	17397	232944	Category-I	Chittoor
2	Chittoor	12991	195298		
3	Ranga Reddy	8584	113694	Category-II	Ranga Reddy
4	Adilabad	6526	118067		
5	Prakasam	5340	81163		
6	Mahaboobnagar	4413	62185	Category-III	Krishna
7	Medak	3403	54499		
8	Cuddapah	2884	42798		
9	Anantapur	2431	33915		
10	Vishakhapatnam	1881	29124		
11	Nizamabad	1799	28565		
12	Karimnagar	1373	20986		
13	Krishna	1311	20141		
14	Guntur	1041	14775		
15	East Godavari	1015	15310		

Source: Directorate of horticulture of Andhra Pradesh

The method of selection of district for banana produce is similar to that of tomato though the basis for selection of the category differs slightly. The table 1.9 shows the district growing banana in more than one lakh hectares falls into first category, between 50000 and one lakh hectares in the second and between 10000 and 50000 hectares treated as third category. Since only one district falls in category-I, the East Godavari district is automatically considered for the sampling in this stage.

Table 1.9: Average area and production of tomato crop grown from 1998-99 to 2007-08

Sl.No	District	Area	Production	Category	Selected District
1	East Godavari	122364	3310249	Category-I	East Godavari
2	West Godavari	98181	2717814	Category-II	West Godavari
3	Guntur	65901	1752045		
4	Vizianagaram	62010	1656401		
5	Cuddapah	40158	1155029	Category-III	Krishna
6	Kurnool	38385	1059579		
7	Anantapur	23270	721892		
8	Khammam	19224	547396		
9	Krishna	18948	512134		
10	Vishakhapatnam	19244	512903		
11	Medak	16799	511748		
12	Srikakulam	12980	363271		
13	Chittoor	10030	283302		

Source: Directorate of horticulture of Andhra Pradesh

Third Stage Sampling - Criteria used for selection of sample AMC markets.

In the third stage sampling, the Agricultural Marketing Committees (AMCs) are selected within the selected districts. Every district has a range of 10 to 25 AMC markets mostly situated in Tehasil/Mandal and revenue division level and the markets handling banana and tomato are limited hence the study is considered. The markets which deal with banana and tomato are given in table 1.10. The AMC markets are selected on the basis of random selection method.

Table 1.10: District-wise AMC markets & Markets selected for the study

DISTRICT	AMC MARKET	Produce	Markets Selected
East Godavari	Ambajipeta	Banana	Ambajipeta & Ravulapalem
	Kothapeta	Banana	
	Ravulapalem	Banana	
	Peddapuram	Banana	
West Godavari	Eluru	Banana	Eluru & Tanuku
	Kovvuru	Banana	
	Penugonda	Banana	
	Tanuku	Banana	
	Unguturu	Banana	
Krishna	Gannavaram	Banana	Gannavaram & Nuziveedu
	Tiruvuru	Banana	
	Mylavaram	Tomato	

	Nuziveedu	Tomato	
Ranga Reddy	Quthubullapur	Tomato	Bowenpally & Shadnagar
	Medchal	Tomato	
	Bowenpally	Tomato	
	Shadnagar	Tomato	
	Tandoor	Tomato	
	Vikarabad	Tomato	
Chittoor	Mulakalacheruvu	Tomato	Madanapalle & Punganoor
	Madanapalle	Tomato	
	Palamaner	Tomato	
	Piler	Tomato	
	Punganur	Tomato	
	Somala	Tomato	
	Vayalpadu	Tomato	

Fourth Stage Sampling - Criteria used for selection of samples for farmers, traders, retailers, transporters and customers:

In the fourth stage sampling farmers, traders, retailers transport operators and customers' sample were drawn from their respective population. Farmers' population details have been collected from the nearest agriculture office of respective AMC. The traders' population data has been collected from the AMC office. The traders who are having more than five years of trading experience are included in the study. Regarding the population size of the retailers, there is no specific data available with any of the government offices (AMC's, Agriculture department, Municipality office and Panchayat) hence the study made an estimation of retailer population with the help of the information given by retail shops in the towns and traders in the AMCs regarding the number of retail shops.

The transporters population details are acquired from the lorry owners' office of a particular town and they have provided the list of transport operators who run their business for agricultural logistics in the AMC markets. Transport operators who have minimum of five years experience were considered for data collection. The customers population details are taken from the census of India data base from which the total house hold information are gathered. It is assumed that there will be a customer from each household who buy fresh produce for daily consumption.

Farmers are asked to provide the data on structured questionnaire designed. The data is also collected from traders, retailers and transport operators using questionnaire. The AMC market is made as centre for data collection where all the farmers, traders, transport operators and retailers regularly meet to perform their works. The AMC officers are heads of the market who generally observe and facilitate the transactions in the market and data collection becomes convenient at AMC markets. The data is collected from the lead farmers as they visit the market frequently to track the price movements. The table 1.11 discusses the sampling plan for banana produce.

Tab 1.11: Sampling plan for Banana

		1	2	3	4	5	Total	Percent of Sample
		Gannavaram	Ravulapalem	Ambajipeta	Eluru	Tanuku		
Farmers	Sample	30	30	30	30	30	150	1.33
	Population	964		5811		4488	11263	
Traders	Sample	10	5	5	5	5	30	17.44
	Population	60	21	26	30	35	172	
Retailers	Sample	12	12	12	12	12	60	14.22
	Population	73	85	76	105	83	422	
Transporters	Sample	6	8	6	6	6	32	11.59
	Population	44	77	47	50	48	276	
Customers	Sample	20	20	20	20	20	100	0.10
	Population	17855	14649	15993	37954	10755	97206	

The table 1.11 indicates the sample drawn for banana produce for all the five markets Gannavaram, Ravulapalem, Ambajipeta, Eluru and Tanuku. An individual sample of 30 farmers is considered for the study making a total of 150 farmers from all the markets representing 1.33 percent of population (11263). Ravulapalem and Ambajipeta represent the population of the same district i.e. East Godavari as also in the case of Eluru and Tanuku of West Godavari district. A total of 30 traders are taken into study out of 172 which contributes to 17.44 percent of the total trader population. About 5 traders included for four AMCs, except Gannavaram as the population of this particular AMC is 80 which needs more sample compared to rest of AMCs to represent its population.

In the selected markets the retailers' population is not available thus estimation is made with the help of information provided by traders and retail shops. It is estimated that population of retailers is 422 hence a sample of 60 is considered for the study by taking sample of 12 retailers from each market as the population does not differ much in all the markets. About six transport operators are included in the study except in Ravulapalem where the population of transport operators (77) is more compared to rest of the markets hence the sample of 8 is taken specifically for that market. On the whole 32 transport operators out of 276 represent the 11.59 percent of the total population. The customers are the end link in the fresh produce supply chain and their views are studied for performance evaluation of the chain. A sample of 20 customers is studied from each market and total sample of 100 customers will contribute to 0.1 percent of the customers' population. The following paragraph describes the sampling plan for the tomato produce.

Table 1.12: Sampling plan for tomato

		6	7	8	9	10	Total	Percent of Sample
		Nuziveedu	Madanapalle	Punganuru	Bowenpally	Shadnagar		
Farmers	Sample	30	30	30	35	30	155	
	Population	666		6255		4574	11495	1.35
Traders	Sample	10	5	5	7	5	32	
	Population	81	35	32	65	38	251	12.75
Retailers	Sample	12	12	12	12	12	60	
	Population	60	56	34	341	69	560	10.71
Transporters	Sample	6	6	6	9	6	33	
	Population	63	48	28	128	56	323	10.22
Customers	Sample	20	20	20	20	20	100	
	Population	11,543	23,429	8,976	9,380	11,268	64596	0.15

The table 1.12 indicates the sample drawn for tomato produce for all the five markets viz. Nuziveedu, Madanapalle, Punganoor, Bowenpally, and Shadnagar. For the study an individual sample of 30 farmers has been considered making a total sample of 155 farmers representing 1.35 percent of the population (11495). The population size for Madanapalle and Punganoor markets of Chittoor District and Bowenpalli and Shadnagar of Ranga Reddy district remain same. A total of 32 traders of 251 contributing to 12.75 percent of the total trader population are taken for study. About 5 traders are included for three AMCs viz. Madanapalli, Punganoor and Shadnagar. In case of Nuziveedu and Bowenpally the sample taken is 10 and 7 which indicates more sample due to more population compared to rest of the AMCs.

It is estimated that population of retailers is 560 hence a sample of 60 is considered for the study by taking sample of 12 retailers from each market. The Bowenpally market is situated in Hyderabad city where the tomato produce arrives from mandals of Ranga Reddy district. About six transport operators are included in the study, except in Bowenpally, where the population of transport operators is more (128) making the sample of 9 being taken for the study. On the whole 33 transport operators out of 323 represent 10.22 percent of total population. A sample of 20 customers is studied from each market and a total sample of 100 customers contributes to 0.15 percent of the total customers' population.

1.14 LIMITATIONS OF THE STUDY

The study is subjected to a few limitations. The first limitation can be attributed to the time period of the present study. Even the present research work commenced from second half of 2007, but the actual data collection began from June 2009 and completed in February 2010, covering the five districts from the different regions of Andhra Pradesh. There may be equal chances that the opinions of the respondents may vary due to present changes and the development during the gap period of six to eight months.

The second limitation of the study arises from its scope. The present study is conducted in the State of Andhra Pradesh and its results may not be applicable to all places/ regions/States in which fresh produce crops are grown (more specifically banana and tomato) due to the diverse range of political, social and economic factors that influence the outcome of the study. The Indian agriculture sector is extensive in which fresh produce sector occupies a good position and the study has limited its scope to two fresh produce commodities tomato and banana. In other words, the two selected commodities may not truly reflect all the characteristics of fresh produce commodities. However, in the study the commodities tomato and banana represent the family of fruits and vegetables and root crops are not considered for the study.

There may be hidden errors in the process of sampling, data collection, data analysis and interpretation, either from respondents' or from interviewers'. It is a known fact that the increased sample size would reduce the error rate and improve the validity of the research work. The performance measurement system indicators selected for the study are given by SCOR and many other research centres across the world but the exhaustive list of indicators is not considered due to the suitability of the indices with respect to the objective of the study. There may be a possible chance that the non selected performance metrics may have significant effect on the study. The present research work has also been subjected to changes in the macroeconomic conditions during the period of the study.

1.15 CHARACTERISTICS OF SAMPLE

The present study attempts to include the representation of all genders, age groups, literacy levels, social communities and ownership of businesses to reduce the biasness of the selected sample. The following table 1.13 describes the characteristics of sample included in the study

Table 1.13: Distribution of sample by Gender

	Female	Male	Total
Farmers	125(41)	180(59)	305
Traders	0(0)	62(100)	62
Retailers	60(50)	60(50)	120
Transporters	0(0)	65(100)	65
Customers	130(65)	70(35)	200
Total	315(41.89)	437(58.11)	752

Note: Figures in the brackets indicate percentage of column total

The study equally represents male and female respondents along the supply chain to minimise gender bias. The overall gender ratio of the respondents is approximately 42:58. At the retailers level the female and male respondents are represented equally. It is observed that there are no female traders in fresh produce trading. It is interesting to note that there is not a single female trader in all ten AMC markets perhaps attributable to the complex transactions at AMCs.

In some occasions the traders indulge in malpractices for profitable revenues and for survival of the business but women by nature keep away from malpractices. At customers' level, there were 65 percent male and 35 percent female respondents. In most cases, female customers are the decision makers in buying fruits and vegetables. There were no female transporters to include in the study and it has been observed that no female is operating the transport trucks and men being more physically stronger with an ability to handle situations like breakdown and crisis effectively handle the transport.

Table 1.14: Distribution of sample by Education

	Illiterate	Literate	Primary School	High school	Collegiate	Total
Farmers	68(22.3)	97(31.8)	60(19.7)	76(24.9)	4(1.3)	305
Traders	2(3.23)	10(16.23)	19(30.65)	28(45.16)	3(4.84)	62
Retailers	6(5)	20(16.67)	17(14.17)	39(32.5)	38(31.67)	120
Transporters	6(9.23)	10(15.38)	30(46.15)	15(23.08)	4(6.15)	65
Customers	45(22.5)	43(21.5)	34(17)	37(18.5)	41(20.5)	200
Total	127(16.89)	180(23.94)	160(21.28)	195(25.93)	90(11.97)	752

Note: Figures in the brackets indicates percentage of column total

The table 1.14 shows the different educational backgrounds of respondents ranging from illiterates to college-level literates being considered for the study. Of the total 752 respondents, 11.97 percent of the respondents have college level of education, 25.93 percent of the respondents belong to the high school level, 21.28 percent belong to the primary school level, 23.94 fall under the literate category defined as those who are able to read and write in the local language while 16.89 percent are illiterate. At the farmers' level, it was found that 51.5 percent were able to read, write and perform simple calculations, 26.2 percent of farmer respondents have education up to high school and college level while 22.3 percent are illiterate.

While 46.78 percent were able to read, write and solve simple calculations, 50 percent of trader respondents had education up to high school and college level while only 3.23 percent were illiterate. 30.84 percent of the retailers were able to read, write and solve simple calculations while 64.17 percent had education up to high school and college level while 5 percent were illiterates. At the transporter level 61.53 percent are literate, 29.23 percent have education up to the high school and college levels, while 9.23 percent are illiterate. 38.5 percent literates, 39 percent educated up to the high school and college levels and 22.5 percent illiterates have been considered from the consumers for the study.

Table 1.15: Distribution of sample by Age Group

	Up to 18 years	18 - 30 years	30 - 45 years	45 - 60 years	60 years above	Total
Farmers	6(2)	37(12.1)	134(43.9)	108(35.4)	20(6.6)	305
Traders	0(0)	3(4.8)	33(53.2)	24(38.7)	2(3.2)	62
Retailers	5(4.2)	12(10)	60(50)	34(28)	9(7.5)	120
Transporters	4(6.15)	17(26.15)	21(32.31)	19(29.23)	4(6.15)	65
Customers	6(3)	34(17)	67(33.5)	72(36)	21(10.5)	200
Total	21(2.79)	103(13.7)	315(41.89)	257(34.18)	56(7.45)	752

Note: Figures in the brackets indicates percentage of column total

The study attempted to represent all age groups from 15 years to 60 years and above, who are members of the fresh produce supply chain. The study sample comprises of age groups ranging from 15 years to 60 years and above. From the table 1.15 it is observed that of the majority of the respondents, 55.68 percent belong to the 18-45 years age group followed by 34.18 percent of respondents who belong to 45-60 years age group. Below 18 years age group contributed to 2.79 percent while 7.45 percent of respondents were found to be above 60 years of age. The majority of the farmers (79.3 percent) belong to the 30-60 years category, 12.1 percent between 18-30years, 6.6 percent above 60 years and only 2 percent of the farmers were below 18 years.

91.9 percent of the trader's belong to the 30-60years category, 4.8 percent of traders belong to the 18-30 years category, while only 3.2 percent are 60 years and above. There are no traders below 18 years due to the fact that only those traders who have over 5 years experience in trading were included in the study. At the retailers' level, 78 percent of the respondents were in the age group of 30-60 years, 10 percent between 18-30 years while 7.5 percent were above 60 years of age and 4.2 percent below 18 years category. At the transporters level, 61.54 percent are in the age group of 30-60 years, 26.15 belong to 18-30 years of age, while an equal representation from below 18 years and above 60 years of 6.15 percent had been included in the study. At the customer level, 69.5 percent are in the age group of 30-60 years, 17 percent belong to 18-30, 10.5 percent above 60 years and 3 percent below 18 years of age.

Table 1.16: Distribution of sample by Caste

	OC	BC	SC	ST	TOTAL
Farmers	133(43.6)	94(30.8)	58(19)	20(6.6)	305
Traders	32(51.61)	18(29.03)	9(14.52)	3(4.84)	62
Retailers	35(29.17)	38(31.67)	46(38.33)	1(0.83)	120
Transporters	31(47.7)	17(26.2)	8(12.3)	9(13.8)	65
Customers	89(44.5)	56(28)	36(18)	19(9.5)	200
Total	320(42.55)	223(29.65)	157(20.88)	52(6.91)	752

Note: Figures in the brackets indicates percentage of column total

The study represents all social groups such as ST, SC, BC and OC. The table 1.16 reveals that 42.55 percent of the respondents belong to the OC, 29.65 percent belong to BC, 20.88 percent to SC and 6.91 percent the ST category. At the farmers' level, 43.6 percent, 30.8 percent, 19 percent and 6.6 percent belong to OC, BC, SC and ST category respectively. The traders' level comprises 51.61 percent OCs, 29.03 percent BCs, 14.52 percent SCs and 4.84 percent STs.

About 29.17 percent of retailer respondents were from the OC category, 31.67 the BC category, 38.33 percent SC category and 0.83 percent from the ST category. At the transporters level 47.7 percent were from the OC category, 26.2 percent from the BC category, 12.3 percent from the SC category and 13.8 percent from the ST category. At the customer level, 44.5 percent, 28 percent, 18 percent and 9.5 percent were from the OC, BC, SC and ST category respectively. From the above, it can be stated that the study has representation from different communities, and in the decreasing order of representation OCs form the majority, followed by BCs, SCs and STs.

Table 1.17: Distribution of sample by produce

	Banana	Tomato	TOTAL
Farmers	150(49.2)	155(50.8)	305
Traders	30(48.4)	32(51.6)	62
Retailers	60(50)	60(50)	120
Customers	100(50)	100(50)	200
Total	340(45.21)	347(46.14)	687

Note: Figures in the brackets indicate percentage of column total

The study attempts to present the distribution of sample by produce. From the table 1.17, it has been found that there is almost equal distribution of respondents who deal with bananas (45.21 percent) and tomatoes (46.14 percent) in the fresh produce supply chain. At the farmers level 49.2 percent grow bananas while 50.8 percent grow tomatoes. At the traders' level, 48.4 percent of the respondents' trade in bananas and 51.6 percent in tomatoes. At the retailers' level, an equal proportion of 50 percent each are involved in retailing bananas and tomatoes. The customers who buy bananas and tomatoes represent 50 percent each in the study. Selection of customers was made on the basis of total customers available in the selected AMC markets.

Table 1.18: Distribution of sample by type of Business

	Sole Proprietary	Partnership	TOTAL
Traders	21(33.87)	41(66.13)	62
Retailers	105(87.5)	15(12.5)	120
Transporters	43(66.2)	22(33.8)	65
Total	169(68.42)	78(31.58)	247

Note: Figures in the brackets indicate percentage of column total

The respondents may be classified based on the type of business run. The ownerships of the business are categorised into 'sole proprietary' and 'partnership' among traders, retailers and transport operators. The table 1.18 shows that of the respondents about 68.42 percent were of the 'sole proprietary' and 31.58 percent were of the 'partnership type'. At the traders' level, 33.87 percent formed the "sole proprietary" and 66.13 percent the "partnership". About 87.5 percent of the retailers were of the 'sole proprietary' 12.5 percent were of the 'partnership' type of business. At the transporters level about 66.2 percent formed the 'sole proprietary' while 33.8 percent the 'partnership' type of business.

1.16 RELIABILITY OF INSTRUMENTS – CRONBACH'S ALPHA

In this section instruments for research are developed, administered and validated. Instruments to measure efficiency, responsiveness, product quality, process quality and transport are adopted from research studies with necessary modifications that is suitable to the local conditions (Gunasekharan and Ngail, 2005; Aramyan et.al, 2007). These instruments have been tested for reliability used in this research. After the data is collected the scales are analysed to achieve the reliability of scales which is tested using the Cronbach's Alpha. Reliability of construct refers to the accuracy with which the construct repeatedly measures the same phenomenon without much variation. The reliability of each construct and sub-construct in questionnaire was examined using Chronbach's alpha (Chronbach, 1951). An alpha score larger than 0.6 is generally acceptable as sufficient accuracy for construct (Nunnally, 1978).

The study made efforts to eliminate the gender bias at all the levels of distribution chain and almost equal representation had been given except at the traders' level. The overall gender ratio of the respondents is about 42 to 58 where as the gender proportion is equal at retailers' level. It is observed that number of female traders are nil due to the complex transactions at AMCs. Then male traders responded that the AMC traders need to do manipulation in trade otherwise the survival of business is at stake, therefore number of female traders are nil in the study. At customers' level, the gender ratio considered about 65 to 35. In most of the cases it is observed that female customers are the decision makers in buying fruits and vegetables. It is also noticed that no female is operating the transport trucks, as men are more physically stronger and their ability to handle the risk like breakdown, crisis handling effectively dealt by men.

For this study five instruments have been designed. Initially 59 questions were framed for farmers, traders and retailers instruments. The transporter and customer instruments consist of 17 and 11 items respectively. The pilot study is conducted during June and August, 2009 to test the reliability of the instrument. The table 1.19 shows the results of 150 respondents (60 farmers, 12 traders, 24 retailers, 12 transporters and 40 customers) are analysed. It is observed the alpha value of pilot study shows 0.56 which is statistically not significant in management studies.

In the next stage, item wise analysis is conducted and generated 'CITC values' and 'Alpha value-If item is deleted' using statistical software. CITC indicates whether the variable actually belongs to the construct or not. Variables showing scores lower than 0.5 are deleted. Some items with CITC values greater than 0.5 are also removed as the overall reliability of instrument improve as a result of deletion (by checking the 'Alpha if item is deleted'). Finally the reliability of instruments crossed a mark of 0.6 after the deletion of four items from transporters instrument, three items from customer's instrument and five items from farmers, traders and retailers instruments.

Table 1.19: Reliability Statistics of pilot study

	Farmers'	Traders'	Retailers'	Transporters'	Customers'
Cronbach's Alpha	.469	.420	.489	.560	.455
N of Items	59	59	59	17	11
N of cases	60	12	24	12	40
Cronbach's Alpha (After removal of items)	.613	.604	.627	.652	.609
N of items removed	5	5	5	4	3

The table 1.20 shows the final value of Chronbach's 'Alpha' generated after the completion of data collection. The target sample of 752 respondents includes 305 farmers, 62 traders, 120 retailers, 65 transporters and 200 customers that have been analysed. It is found that the Chronbach's alpha values of farmers' (0.769), traders'(0.720), retailers'(0.789), transporters(0.760) and customers'(0.655) are more significant as the value crosses 0.65 where as minimum acceptable value is prescribed as 0.6. In the later stages no item is removed from construct for the analysis.

Table 1.20: Reliability Statistics of final study

	Farmers'	Traders'	Retailers'	Transporters'	Customers'
Cronbach's Alpha	.769	.720	.789	.760	.655
N of Items	54	54	54	13	08
N of cases	305	62	120	65	200

The Annexure-II shows the items of farmers, traders, retailers and transporters values of 'Cronbach's Alpha if Item Deleted'. It is found that all the items are significant as the value of alpha does not differ much with deletion of an item.

1.17 CONCLUSION

The agri-supply chain management is concerned with establishing the coordination among the supply chain partners for the smooth flow of fresh produce distribution activity. The India's supply chain is constrained with logistical problems and hampering the development of the agricultural sector and also fresh produce sector. In order to meet the growing food requirement of India, it is a high time for the country to address the problems of fresh produce distribution like high perishability, longer lead times, low quality, poor coordination, high prices, poor information dissemination and other related aspects. The study assesses the failures and weak areas of fresh produce distribution.

The study is descriptive, causal and analytical in nature and based on the primary and secondary data sources. The hypothesis and objectives are prepared on the extensive review of literature. The study collects data from the fresh produce supply chain partners such as farmers, traders, retailers, customer and transporters using structured questionnaire and open-discussion method. The instruments' reliability are tested and proven to be valid to collect the data from the various sources. The study followed multi-stage sampling method to determine the sample size for the study. At the first level- State, second level- District, third level- AMC markets and at fourth level- target sample is selected based on the criteria developed for each level.

The next chapter describes the review of literature pertaining to the agri-supply chain management in general and fresh produce supply chain management in specific published by eminent authors across the world.

CHAPTER - II
REVIEW OF LITERATURE

The present chapter examines and reviews the studies conducted by various researchers in the field of supply chain management and agriculture. This chapter captures the findings under various sub-headings to understand the supply chain management in terms of the supply chain flows, coordination, logistics, performance measurement, supply chain costs, supply chain management in agriculture, quality management in fresh produce sector, post-harvest management and marketing infrastructure. These areas are covered in three sections viz. evolution of SCM, performance measurement in SCM and fresh produce SCM.

2.1 CONCEPT OF SUPPLY CHAIN MANAGEMENT

Supply chain as a concept had been described in several ways of which supply chain as flow of goods, flow of information or flow of finances are the most common definitions found in the literature on supply chain management. The term “supply chain” had been used in mid seventies (Banbury, 1975), while the term “supply chain management” appeared way back in the early eighties (Oliver & Webber, 1982). The pioneering works on Supply Chain Management (SCM), as a management approach, can be seen in the works of Novack & Simco (1991) and Jones & Riley (1985). According to Cigolini, Cozzi et al. (2004) there is a continuous chain of functional areas, extending from suppliers to final distributors, through which materials flow. The supply chain of a firm is often described in terms of upstream and downstream flows. They also highlighted the key characteristics listed below, which gave rise to the school of “supply chain awareness”:

- Most of the definitions show, that supply chain covers the materials flow from suppliers to end users.
- The emphasis is on all channel members, from beginning to end.
- The definitions highlight the flow of materials rather than that of information.

Several researchers agree that supply chain mainly comprises of three elements; physical or material flow, information flow and financial flow. It also consists of several members who are positioned upstream or downstream. However, the view of the supply chain has changed over time from an internal view point to a more external focus, in other words from an internal supply chain to an integrated synchronised supply chain.

Lee and Billington (1995) defined Supply Chain Management as "*a network of facilities that produces raw materials, transform them into intermediate goods and then final products, and deliver the final products to customers through a distribution system"*. It covers procurement, manufacturing and distribution.

Herbig & O'Hara (1996) have stated that procurement is a term describing purchasing, and extending it to the strategic activities of purchasing. Therefore, the firms must give special importance for purchasing activity as a part of organisational strategy. They opined that the distribution is the core function of materials management and includes both transports within and outside the organisation. Transport within the organisation is primarily the flow of materials in the organisation for production. Hence the inner-organisational transport has to be managed carefully from a timely perspective coupled with cost minimising techniques.

Christopher (1998) defines the supply chain management as "*The management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole*". He also states that the supply chain includes internal functions, upstream suppliers, and downstream customers. He described the information flow, which is related to the physical material flow, while the second introduces the important economic aspect i.e., financial flow.

Council of Logistics Management has defined the logistics as "*the process of planning, implementing, and controlling the efficient, effective flow and storage of goods, services, and related information from point of origin to point of consumption for the purpose of conforming to customer requirements".* This particular definition includes inbound, outbound, internal, and external movements and return of materials for environmental purposes

Slack (1998) argued with Council of Logistics Management (CLM) for using the term 'Origin' in its definition. He opined that "Origin" may refer to the original source of material or to the material and information flow associated with finished products. In this case logistics resembles Physical Distribution Management (PDM). They also stated that most of the logistics literature has been written by authors from marketing or physical distribution management background hence highlighted mainly on planning and control of finished products distribution in supply chain process.

Cox (1999) described the supply chain management characteristics, such as the primary logistical optimisation which include operative and strategic problems of the firm. He stated that the materials management is one of the parts of SCM, which is concerned with the supply side of the value chain and only with materials. He stressed on the responsibilities of SCM which coordinate business interfaces, coordinate communication and optimise the core processes. The main purpose of these activities is to align the strategic direction of the whole supply chain.

Slack et.al (1998) suggests three different but related definitions in use: i) SCM is the management of the internal supply chain; ii) SCM is the formation of a long-term partnership or relationship with suppliers, and iii) SCM is managing the entire network of supply from original source through meeting the needs of the end customer.

Hill (2000) described the origin and evolution of the supply chains in four phases. The first phase starts with the integration of the steps within the internal supply chain. The second phase emphasises on horizontal nature of the process inherent in the basic task of procurement, through the manufacturer of finished goods. The third phase concerns coordinating activities between businesses, for example tier-1 and tier-2 suppliers, and stages in the distribution channel. The final or fourth phase involves synchronising the planning and execution of activities across the supply chain.

Shapiro (2001) stated that the essence of supply chain management is integrated planning, which has three principal dimensions. First, supply chain management involves functional integration of decisions about purchasing, manufacturing, transportation, and warehousing within the company and between the company and its customers and suppliers. Second, supply chain management involves geographical integration of decisions made by managers in facilities situated in different locations. Third, supply chain management involves inter temporal integration of strategic, and operational decisions.

Mentzer (2001) defined importance of SCM as "*The systematic, strategic coordination of the traditional business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long term performance of the individual companies and the supply chain as a whole*".

Svensson (2002) considers that there are major similarities and only minor differences in the theoretical boundaries between SCM. He also pointed out that SCM is an influential factor in the field of marketing theory, as there is a close inter-relationship between marketing and logistics activities.

Mattson (2002) has depicted two types of supply chains. The first one is, the supply chain has internal actors from departments or functions within the own company handling value adding or moving of material. It could be purchasing, manufacturing, assembly, customer order handling and distribution. All these departments can be customers and suppliers to each other. Customers and suppliers are part of the systems surroundings, but are not within the system boundary. The second type is supply chains with external actors. He also highlighted the factors to be considered in setting up a supply chain and which include i) number of suppliers ii) number of sub suppliers including module suppliers or many sub-suppliers iii) distance to supplier iv) size of supplier v) co-operation with the supplier vi) direct shipments vii) storage location local, regional or central viii) Third-party logistics ix) number of distribution alternatives.

Cigolini et. al. (2004) focuses on product characteristics and type of supply chain, i.e. efficient, quick or lean supply chains, and concludes that:

- Mature and simple products require an efficient supply chain
- Mature and complex products require a lean supply chain
- Complex products in the growth phase require a lean supply chain
- Simple products in the introduction/decline phase require a quick supply chain

Christopher (1998) states supply chain is a value chain (Figure 2.1). In a supply chain, value (and cost) is created not just by the focal firm in a network, but by all the entities that connect to one another. According to Michael Porter (1985) the value chain activities can be categorised into two types: Primary activities (inbound logistics, operations, outbound logistics, marketing and sales, and service) and Support activities (infrastructure, human resource management, technology development and procurement).

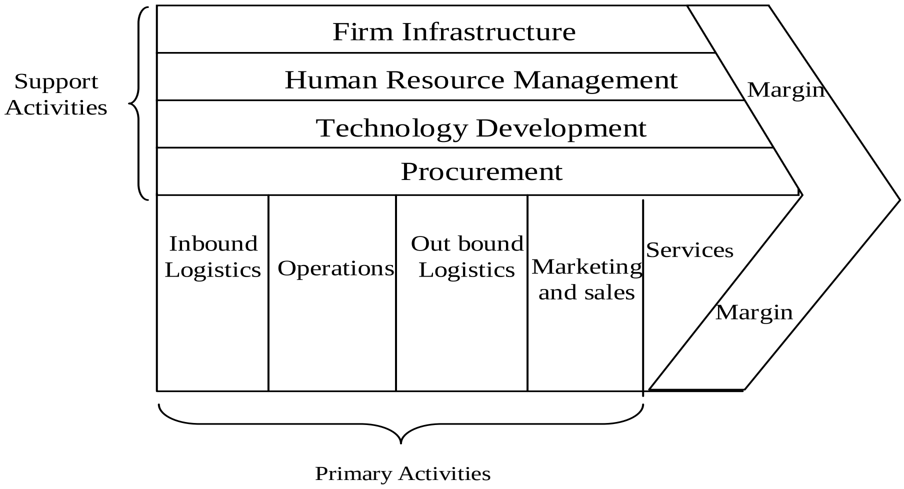

Figure 2.1: The value chain

Source: Christopher (1998)

2.1.1. Flows in Supply Chain Management

Supply chain management has material flows which are essential for the timely delivery for produce to the end-user whereas the information flows establish the coordination among the firms in a chain hence the study reviewed the works on supply chain flows.

Lambert et al. (1998); and Towill et al. (1992) emphasised on information flow in supply chain management. The Information refers to providing the actors within the supply chain with appropriate feedback to drive their actions. Christopher (1998) believed that information is greater downstream in the supply chain than the upstream. The upstream information only consists of confirmation of or information about delivery. He states that the information must come from the end customer and be moved downstream in the supply chain due to the fact that the demand originates from the end customer. However, this does not always apply, as a trend exists whereby suppliers seek information about customer demands in the customer’s information system.

Handfield & Nichols (1999) stated that the supply chains are essentially a series of linked suppliers and customers; every customer is in turn a supplier to the next downstream organisation until a finished product reaches the ultimate user. The supply chain encompasses all activities associated with the flow and transformation of goods from the raw materials stage, through to the end user, as well as the associated information flows. Material and information flow both up and down the supply chain.

Paulsson and Nilsson (2000) argued that the supply chain or value chain contains three major components which are different in their characteristics: the physical flow, information flow, and financial flow. The physical material flow is the flow of goods, packaging, loads, containers and transport. The main task of the information flow is to increase its efficiency and prevent disturbances in physical material flows. The financial flow should make it possible for the suppliers to get paid for their products with a minimum of delay and in a secure and cost effective way.

They also observed a close relationship between the physical material flow and information flow. An incomplete, irregular and slow information flow will create the need for extensive storage in order to provide a safety margin. However, a complete, regular, and up to date information flow will create the opportunity to optimise storage. However, the information flow can be divided into two separate approaches; firstly the information needed to produce the actual product or service, information (F) that is directly connected to the physical material flow i.e. order, delivery, quantity, information. Secondly, the information (-F) that is indirectly related to the physical material flow e.g. information about the customer, future markets, future changes or future customer demands etc.

Chaffe (2001) conducted a study to observe whether the information logistics can improve the productivity of an organisation. He identified that the access to high quality information is always an important strategic goal for an organisation. He stressed that the timely information improves the outcome of strategic planning, supports judicious decision-making and eases the management of ongoing operations. He further stated that “the concept of information logistics links the functions of business logistics and information management. It focuses on vertical coordination within firms and horizontal coordination within and beyond the boundaries of the firm.

Table 2.1 Summary of definitions of SCM on information and information flows

Authors	Definition
Hull (2002)	"An effective supply chain requires a smoothly operating information system. Accurate information must flow through the links in a timely and coordinated fashion, which minimises distortion."
Lambert et al. (1998)	"Supply chain management is the integration of the business process from the end user through original suppliers that provide products, services, and information that add the value for customers."
Harrington (1995)	"SCM deals with production and information flows encompassing all parties beginning with suppliers' supplier and ending with end-users."
Johannson (1994)	"SCM is an operations approach to procurement. It requires all participants of the supply chain to be properly informed. With SCM, the linkage and information flows between various members of the supply chain are critical to the overall performance."
Towill et al. (1992)	"The supply chain is a system, the constituent parts of which include material suppliers, production facilities, distribution services and customers, all linked together via the forward flow of materials and the feedback flow of information."

2.1.2 Coordination and Integration

The coordination and integration strengthen the supply chain as a whole and it is essential for all types of chain to improve cohesiveness among its firms. The following literature discusses the importance and how coordination and integration is established in the different chains.

Ellram (1991) described supply chain partnership as a collaborative relationship between a buyer and a seller which recognises some degree of interdependence and co-operation on a specific project or for a specific purchase agreement such a partnership emphasises direct, long-term association, encouraging mutual planning and problem solving efforts.

Andrew and David (2000) stated that improved supply chain integrity and greater consistency in the quality of fresh produce is achieved by rationalisation of the supply base, with retailers seeking to deal with fewer. This will reduce costs through greater control (either directly, through grower or co-operative partnerships or indirectly, through pre-packers with their own grower networks)

Bowman et.al (2000) suggests that an agile organisation promotes the free flow of product data among trading partners, resulting in virtual supply chain, wherein inventory is at least partly replaced by information. Retail-industry programs such as Efficient Consumer Response (ECR) and Collaborative Planning, Forecasting and Replenishment (CPFR) have helped to speed point-of-sale data up the chain to manufacturers and their suppliers. Supply chain partners can collaborate on short-term sales and promotions. Agile supply chains rely more on actual demand than on forecasting hence the companies must working with channel partners to build agile supply chains.

They also stated that CPFR is a new development in the field of supply chain management, which can bring drastic improvement in the supply chain activities of firms by allowing true collaboration among trading partners. According to them CPFR brings speed, accuracy, and demand planning, which enables to increase revenues with better customer services and enhances organisational agility.

Hertz et.al (2001) defined Integration as "*a process of coordinating activities, resources and organisations in order to perform from a loose co-operation to a high level of theoretical framework and synchronisation between the partners"*. The advantages from increased integration are including lower costs, higher customer value, shorter lead times and lower risks.

Stank et al. (2001) have studied the relationship between collaboration and service improvement in supply chains. They revealed that the higher levels of internal and external collaboration are expected to result in improved logistical service performance and internal and external collaborations have a positive influence on each of the above. The findings reveal that internal collaboration considerably influences logistical service performance, which implies that firms should promote co-operation and collaboration across internal processes to achieve logistical efficiency. The lack of support for a direct link between external collaboration and service performance is remarkable and suggests that collaboration with customers and suppliers will not improve performance.

Horvath (2001) has conducted a study on value creation with the joint collaboration of chain partners. He defined supply chain collaboration as "*two or more independent firms* *jointly working to align their supply chain processes so as to create value to end customers and stakeholders with greater success than acting alone*". When chain members involve in collaboration, there can be a dilemma between accommodating decisions that take into account the interest of the supply chain as a whole and preserving decisions in the interest of an individual firm. Companies benefit from focusing on identifying the constraint that prevents the chain members from achieving overall profitability. The constraint can be either physical or non-physical and internal or external.

Lee et al (1997) found a number of causes for bullwhip effect in real-life supply chains such as:

i) Order batching due to economies of scale in ordering (quantity discounts) and transportation(full truck loads) and the use of periodic planning systems;
ii) Price fluctuations driven by promotions; and
iii) Rationing and shortage gaming; i.e. the incentive to increase orders during shortages, place orders with multiple firms, and cancel orders once inventory arrives.

They also suggested several redesign strategies which are proposed to reduce demand amplification and improve supply chain performance:

i) Eliminate all time delays in goods and information flows from the supply chain;
ii) Exchange information concerning true market demand with parties upstream the supply chain;
iii) Remove one or more intermediate echelons in the supply chain by business take-over;
iv) Improve the decision rules at each stage of the supply chain: modify the order quantity procedures or their parameters.

Chopra and Meindl (2001) revealed that the traditional view on a supply chain is the cycle view. In this view the processes in a supply chain are divided into a series of cycles, each performed at the interface between two successive stages of a supply chain. This means that each cycle is decoupled from other cycles via an inventory therefore it can function independently, optimise its own processes and is not affected by problems of other cycles. A cycle view of the supply chain clearly defines the processes involved and the owners of each process (hence roles and responsibilities).

Simatupang and Sridharan (2002) talked about four modes of coordination including logistics synchronisation, information sharing, incentive alignment and collective learning. The first mode, logistics synchronisation is the matching between customer demands and the variety of goods that reach the market-place. To understand customer demands, plan inventory management and facilitating transportation will help to achieve a better match. Logistic synchronisation also assists members to resolve role conflicts so that each member can perform their core activities which provide value to the supply chain. The second mode is information sharing. Timely and accurate information is vital for decision makers. The information can be shared online using the internet or by using a specifically developed software. A high level of information visibility between the members of a supply chain will act as glue in the integration process.

The third mode of coordination is incentive alignment. Incentives are often introduced at one stage or with a short term perspective leading to negative effects on the overall performance of the supply chain. Incentive alignment introduces incentives linked to the global performance reflecting both value creation for the customers and profitability. The last mode, collective learning emphasises the spreading of knowledge throughout the chain. Special focus is on practical learning from one another and to ensure the key collaborators in the implementation phase. They have also proposed three forms of structures to differentiate an integrated supply chain i.e. i) horizontal, ii) vertical and iii) lateral integration.

Elg (2002) stated that the buyer-seller partnerships represent a state of interdependence with market-oriented common goals, co-operation, joint planning and trust, leading to mutual benefits. Market orientation has been defined as *"the active search for, generation of, dissemination of and reactive to market information on customers, competitors and environmental forces in order to satisfy the needs of the final customer in a supply chain to benefit the supply chain stakeholders"*.

Emiliani (2003) examined the source of conflict between buyers and sellers and related to the price of goods purchased for use in production. He concludes that conflict between buyers and sellers is an inevitable outcome when buyers make decisions principally centred upon the internal interpretation of management's role as agents of the board whose primary responsibility is to maximise shareholder value. His finding has widespread implications for both academics and practitioners, as making this linkage explicit defines the challenge for improving purchasing and supply chain management practices in a new way.

Sahay et.al. (2003) made a survey on supply management practices in Indian industry and found that customer service, demand management and inventory management rank high on the criticality scale of supply chain processes, backed up by management tools of Total Quality Management (TQM), benchmarking and JIT. With 22 percent of aggregate industry sales tied up in inventories in the supply chain, the key factors like velocity, visibility, scalability, innovation, customisation and cost, govern competitive advantage for organisations viewing the entire world as their market.

Harrison and Van Hoek (2005) defined ECR as part of the supply chain management methods which ensure that the entire supply chain is focusing on the end-customer and meet his demands. Meeting end-customer's requirements should be ensured by collaboration throughout the supply chain. According to them, the efficient customer response includes category management, continuous replenishment and enabling technologies.

They have also observed that the category management balances and demands between suppliers and customers in the supply chain towards the end-customer. Continuous replenishment is an inventory concept that allows suppliers and customers to manage their inventory efficiently, through joint-inventory management. Finally, enabling technologies are used to detect, analyse and implement end-customer needs.

Harrison & van Hoek (2005) stated the main task of SCM is collaboration of organisations in planning, forecasting and replenishment. Here collaboration is fostered on strategic and operational levels to ensure competitiveness of the supply chain. The main aim is to improve customer service while decreasing the costs in inventory management. Therefore, the trade-off between efficiency and effectiveness should be resolved by collaboration in planning and implementation between organisations within the chain.

2.1.3 Third Party Logistics (TPL)

The adoption of third party logistics is becoming widespread in the industry. In this section the literature review pertaining to definitions of third party logistics and the theoretical background for the development of third party arrangements are explained.

Cooper et.al (1997) in his article quoted the definition given by Council of Logistics Management (CLM) for logistics as “The process of planning, implementing and controlling the efficient flow and storage of raw materials, in process inventory, finished goods, services and related information from point of origin to point of consumption (including inbound, outbound, internal and external movements) for the purpose of conforming to customer requirements”.

Berglund et al. (1997) have given definition and specifies the functions that can be carried out by TPL firms. He defines TPL as *“activities carried out by a logistics service provider on behalf of a shipper, consisting of at least management and execution of transportation and warehousing”*. In addition, other activities can be included, for example inventory management, information related activities, such as tracking, tracing and value added activities like secondary assembly and installation of products.

Handfield and Nichols (1999) defined partnership in TPL as *“A tailored business relationship featuring mutual trust, openness and shared risk and reward that yields strategic competitive advantage”.* The partnerships reduce uncertainty and complexity in an ever-changing global environment and minimises the risk while maintaining flexibility. Third-party partnership provides the advantages of ownership without the associated burden and allows organisations to take advantage of “best-in-class” expertise, achieve customer service improvement, respond to competition, and eliminate non core capital assets.

La Londe (2001) described third party logistics service provider as ‘an independent economic entity that creates value for its client’. He focuses on the changes in value proposition that the TPL can offer its clients which today include highly integrated technological solutions and long term relationship building.

Bolumole (2003) has developed a framework consisting of six different roles for evaluating the extent of logistics outsourcing and the nature of the ‘Client-TPL relationship’ on the supply chain. The TPL companies have logistics expertise and can offer cost advantages to other firms since they relieve clients from tied up capital in warehouse and logistics related material such as trucks. TPL companies can also provide economies of scale as volumes increase.

Council of Supply Chain Management Professionals (CSCMP) and Vitasek (2008) defined Third Party logistics as *“a firm which provides multiple logistics services for use by customers. Preferably, these services are integrated by the provider”.* These firms facilitate the movement of parts and materials from suppliers to manufacturers and finished products from manufacturers to distributors and retailers. Among the services which they provide are transportation, warehousing, cross-docking, inventory management, packaging, and freight forwarding’.

Chen and Olsson (2009) states that third party logistics (TPL) firm to make profit and grow in an environment with very intense competition, they must either expand its customer base to face the effects of lowered profit per unit product sold or maintain the current customers and carry out internal cost cutting measures. At the same time the customers not only expects quality, reliability and competitive pricing but also customised product with just in time deliveries, hence a flexible organisation.

2.1.4 Supply Chain Cost

Bowersox and Closs (1996) define SCC (Supply Chain Cost) as cost components related to

a) Order handling
b) Purchasing
c) Stock handling
d) Systems needed to handle the Supply like for example the order system.
e) Manufacturing

Christopher (1998) describes two principles for logistics costing that are also applicable for SCC. The two principles are:

i) The system should reflect the flow of materials. It should be capable of identifying the costs that result from providing customer service in the market place.
ii) The system should be capable of enabling separate cost and revenue analysis to be made by customer type, market segment and distribution channel.

Christopher (1998) also summarises the dissatisfaction with conventional cost accounting related to logistics management as follows:

i) There is a general ignorance of the true cost of servicing different customers, channels or market segments.
ii) Costs are captured at a too high level.
iii) Full cost allocation still reigns supreme.
iv) Conventional accounting systems are functional rather than output oriented
v) Companies understand product costs, but not customer costs.

Simchi Levy et.al (2000) stated that the objective of supply chain management is to create efficient and cost effective system. According to him, the cost efficiency means consideration of the total system wide costs, from transportation and distribution to inventories of raw materials, work in process and finished goods and that the cost is minimised. The Supply chain management is not simply about minimising transportation cost and reducing inventories, but rather on taking a system approach to find improvement areas.

Shapiro (2001) discussed that the traditional objective of SCM is to minimise the total Supply chain cost to meet fixed and given demand. This total cost may include the following:

a) Raw material and other acquisition costs
b) Inbound transportation cost
c) Facility investment costs
d) Direct and indirect manufacturing cost
e) Direct and indirect distribution cost
f) Inventory holding cost
g) Inter-facility transportation cost
h) Outbound transportation cost

Sachan et al. (2005) have studied the total supply chain cost in the Indian grain chain. They define the total supply chain cost as the sum of farmer's price, total additional cost, total mark-up and total wastage. Farmer's price is the cost of growing and processing the grain and the margin for the farmer. The additional cost includes inventory holding cost, materials holding cost, transportation cost, order processing cost and packaging cost. They also identified that the total mark-up cost is an amount added to the cost price to get the selling price. Each participant in the chain has own mark-up percentage. Total wastage may be due to one or more of the following three reasons i) obsolete losses, ii) transit losses and iii) pilfering losses.

Byrne (2006) have worked on the impact of information sharing and forecasting in capacitated industrial supply chains: They have classified the SCC into five different categories in the case study viz. transportation cost, order processing cost, production setup cost, inventory cost and backorder cost. Transportation cost is the cost incurred for shipment of finished stock from the company to the distributor. Order processing cost is the cost for processing the orders. Production set-up cost is the cost associated with an order being set-up in the processing areas. Inventory cost is the cost for holding stock for one period. Backorder is the cost for backorders for one period.

Blackburn & Scudder (2008) examines supply chain design strategies for a specific type of perishable product- fresh produce, using melons and sweet corn as examples. Melons and other types of produce reach their peak value at the time of harvest; product value deteriorates exponentially post-harvest until the product is cooled to dampen the deterioration. Using the product's marginal value of time, the rate at which the product loses value over time in the supply chain, they showed that the appropriate model to minimise lost value in the supply chain is a hybrid of a responsive model from post-harvest to cooling, followed by an efficient model in the remainder of the chain. They also show that these two segments of the supply chain are only loosely-linked, implying that little coordination is required across the chain to achieve value maximisation.

2.2 MEASUREMENT OF SUPPLY CHAIN PERFORMANCE

Supply Chain Management is regarded as a means of improving firm's effectiveness and for better realisation of firm's goals. The supply chain needs to be continuously assessed for its performance and its activities benchmarked with respect to highest standards. While performance measurement helps management in providing feedback, assisting in diagnosing problems, revising firm's goals, reengineering business process etc., the coming paragraphs describes the research works on performance measurement system in detail.

Maskell (1989) offers seven principles of performance measurement system design:

i) The measures should be directly related to the firm's manufacturing strategy.
ii) Non-financial measures should be adopted.
iii) It should be recognised that measures vary between locations-one measure is not suitable for all departments or sites.
iv) It should be acknowledged that measures change as circumstances do.
v) The measures should be simple and easy to use.
vi) The measures should provide fast feedback.
vii) The measures should be designed so that they stimulate continuous improvement rather than simply monitor.

Camp (1989) worked on the best practices that lead to the superior performance of an industry. He has given a formal definition of benchmarking - "*it consists of a systematic procedure for identifying the best practice and modifying actual knowledge to achieve superior performance*". Benchmarking is a process for comparison against best practice.

Splendolini (1992) described the five basic purposes of benchmarking

i) Strategy: planning for short and long term
ii) Forecasting: predict trends
iii) New ideas: stimulate new thoughts
iv) Process comparisons
v) Setting objectives and targets: base them on best practice

Lee and Billington (1993) found that no adequate supply-chain metrics exist, and firms, even if they are participating in coordinated supply chains, only aim at achieving their own performance standards. Bowersox et.al (1996) describes the perfect order is a part of optimal operational performance. Quality in a supply chain is to do everything right the first time. The order should be complete in terms of service from order receipt to delivery.

They viewed the concept of a perfect order as the logical extension of quality. Another focus is on internal and external performance. Internal performance measures how a company performs from an internal perspective. Internal measures are important for detailed organisational monitoring. External performance measures how the company performs against the external customers. They identified that external performance is important to understand and maintain the focus on customer perspective. One way to perform the external measurements is to send surveys to customers. According to them, examples of categories in internal performance measurements are cost, customer service, productivity, asset management, Inventory Turnover (ITO) and Quality claims

Stewart (1995) conducted a study on supply chain performance benchmarking, as a tool for success or for supply chain excellence. The study identified the measures of delivery performance like delivery-to request date, delivery-to-commit date, and order fill lead-time. These types of measures are known as total chain measures, as they depict performance across organisational boundaries and measure the performance of the entire supply chain, including links to suppliers and customers.

Caplice and Sheffi (1995) claim that the performance metrics should be selected and maintained as a system, so that partners complement and support each other and provide a well balanced picture of logistics process. They propose that a good logistics performance measurement system should have the following six attributes: i) comprehensive ii) causally oriented iii) vertically integrated iv) horizontally integrated v) internally comparable vi) useful. Traditional logistics approaches have focused on five types of performance i.e. asset management, cost, customer service, productivity and logistics quality.

Bowersox and clox (1996) highlighted that to evaluate the relationship between customer service levels and associated cost when finalising a logistical strategy. The total cost concept is one of the central fundamentals of SCM. If the consumer is excluded any generated theory of SCM will not reflect the real world since the consumer is the crucial key for the outcome of successful SCM. According to him, customer service includes all activities and performance that adds value for the customer. Low price, short lead-time and accurate delivery dates are three important areas that are important for a customer.

He also discussed that there are at least three perspectives to create value for customers through supply chains even though there are a lot of different measurements that can be used to evaluate the efficiency of a supply chain that includes i) economic value, ii) market value and iii) relevancy value.

Kaplan and Norton (1996) have identified four general categories which comprises of i) financial measures, ii) customer-related measures, iii) internal performance and iv) learning. Financial measures focus on economic value added and return on investment and customer-related measures that have customer satisfaction and market share. Internal performance includes quality, response time and cost measures whereas the learning category includes employment aspects such as skill development, retention and information technology.

Beamon (1998) categorises performance measures in existing literature into two groups qualitative and quantitative. Qualitative measurements cannot be quantified. Some examples of qualitative measurements are customer satisfaction and Human capital index (HCI). Customer satisfaction can be measured by asking the customers to rate the company on a scale of 1 to 5. HCI measures the empowerment and other things related to the persons working on the company. Some examples of quantitative measurements are delivery precision and ITO. Delivery precision measure how many orders are delivered in time. In time means the date that has been stated on the order-acknowledgement. ITO measures how many times the inventory turns around per year.

Van Hoek (1998) and Holmberg (2000) tried to integrate the supply chain through the performance measurement. They observed a lack of balanced approach while integrating financial and non-financial measures. Examples of financial measures are supply chain cost and manufacturing cost per produced item. Supply chain cost is the total cost to run the whole supply chain. Examples of non-financial measures are lead-time and yield. Yield is the amount of items passing through the production process without any faults divided by the total amount of produced items.

Supply chain Council (2001) has developed the Supply Chain Operations Reference (SCOR) model. It is a reference model and the purpose of the model is to provide a standard language for SCM that can be used across-industry. It facilitates external benchmarking and to establish a basis for analysing supply chains and to compare the current supply chain with the target for the future. The SCOR model has three levels

i) Top level: defines the scope and content for the Supply chain.
ii) Configuration level: designs the Supply chain
iii) Process element level: gives detailed information on each process.

According to Christopher (1998), the SCOR model is based on four management processes:

i) Plan: balances supply and demand
ii) Source: procurement of products and services
iii) Make: transforming of products and services into finished goods
iv) Deliver: delivery of products and services.

A process is composed of process elements and the elements are composed of tasks. Tasks are a set of activities. The activities are standardised to make comparison between supply chains possible. The SCOR model has 12 performance metrics. The most effective way to develop a close customer relationship is by understanding customer behaviour and designing and sustaining a supply chain tailored to deliver value to each customer segment.

The SCOR model has 12 performance metrics which include i) delivery performance, ii) fill rate, iii) order fulfilment and lead time, iv) perfect order fulfilment, v) supply chain responsiveness, vi) production flexibility, vii) total logistic management cost, viii) value-added employee productivity, ix) warranty cost, x) cash to cash cycle time, xi) inventory days of supply and xii) asset turns. Huan et al. (2004) had conducted reviewed the analysis of supply chain operations reference (SCOR) model and further divided into eight groups such as i) delivery precision ii) lead-time iii) cost iv) inventory turnover v) internal performance vi) customer satisfaction vii) quality viii) service grade.

Beamon (1999) has carried out a study on the measurement of supply chain performance and identified three types of measures viz. resources, output and flexibility. Resources mean how efficient the personal resources in a company are used and how effective other resources like for example production equipment is. Output measures are number of products shipped versus invoiced amount of money. The extent of differentiated lead-times and differential customer service levels can be an example for flexibility measures.

Neely (1999) has presented seven drivers for increasing interest in supply chain performance measurements.

i) Changing nature of work,
ii) Increased competition,
iii) Specific improvements initiatives such as, JIT, TQM, BPR (Business process reengineering), etc,
iv) National and international quality awards,
v) Changing organisational roles changing from control to empowering employees by management by objectives,
vi) Changing external demands. Firms in the public sector must present information about their performance and
vii) The power of information technology.

Parker (2000) emphasises the need for organisations to measure performance that vary across organisations for the following reasons:

a) identify whether the firms are meeting customer requirements,
b) help firms understand their processes,
c) identify bottlenecks and suggest areas for improvement wherever necessary and
d) Ensure decisions that based on fact, not on supposition, emotion or intuition.

Christopher and Towill (2000) presented a model summarising the transition in personal computers supply chain operations. The model shows the market winners or qualifiers based on quality, cost, lead time and availability and how these changed over a 10 years period during 1980 to 1990. Table 2.2 shows different types of supply chains and the supply chain performance measures and metrics.

Table 2.2: Type of supply chain and its measures and metrics

Supply Chain Performance			
Type of Supply chain	**Supply chain measure**	**Supply chain sub measure**	**Supply chain metric**
Efficient	Cost, price (Market Winner)	Total chain cost Purchasing price	INR Purchased item
Quick/Agile /Market responsive	Delivery Quality Flexibility (Market winner) Cost	Delivery reliability Quality conformance Flexibility (mix) of - production Total chain Cost	% PPM % INR/Purchased item
Lean	Primary: Cost (market winner) Quality Secondary: Delivery, Novelty and customer service	Total chain cost Purchasing price Quality conformance Delivery reliability, Delivery (Lead time)	INR Purchased item PPM % Weeks
Hybrid (Lean & quick/agile/ market responsive)	Quality, Delivery, Cost, Flexibility	Quality conformance, Delivery reliability, Total chain cost-purchasing price Flexibility of Production	PPM % INR/Purchased item %

They also argued that the quick, agile or market responsive supply chain will have shorter lead times i.e. delivery as a primary measure, while flexibility (mix) of production and product quality are also primary measures. A shorter lead time from order to delivery is another important “lean supply chain” measure, but not to the same degree as cost i.e. cost is more important than delivery. A hybrid (lean & quick/agile/market responsive) supply chain focuses on shortening the lead times at component level but without incurring cost, while in order to accommodate customer requirements, it follows the agile (quick/market responsive) supply chain performance measures at product level i.e. delivery, flexibility and quality.

Braithwaite and Parsons (2001) have developed a supply chain performance measurement framework and they have suggested six key points to consider when examining the concept of a framework for supply chain performance management development: i) no single measure defines supply chain performance - there are many dimensions to measure, ii) measures can be in conflict - accentuating rather than breaking functional silo issues, iii) there is a need to obtain equilibrium throughout the supply chain and to be prepared for change, iv) measuring the overall performance is a first key step towards making improvements, v) this requires a considerable investment of time and commitment, vi) measurement and its interpretation is a valuable but complex skill.

Gunasekaran et al. (2001) discussed about three levels by which SCM can be measured namely strategic, tactical and operational levels. The top management in a company may be interested in measuring chain performance on a strategic level considering the company on the whole. The second level and third level management may be interested in measurements on a tactical level which considers measures that include only a part of the company. Measurements of supply chain on operational level would interest those working at an operational level. The SCM measurements are good tools for managing the daily work. Performances should focus beyond organisational boundaries.

They also point out that effective performance measurement reflects results, contains normalised metrics that may be used for benchmarking. It is practical and easy to understand, enables continual self-assessment, uses reliable and robust measures, provides intangible benefits; and has clear ownership of all measures.

Lambert and Pohlen (2001) conducted a study on supply chain performance using supply chain metrics in a manufacturing system. He claims that most of the performance measures known as supply chain metrics are not more than logistic measures that have an internal focus and do not actually capture how the firm derives value and profitability from the supply chain. He has argued that a supply chain performance metrics system consists of a set of parameters which can fully describe the logistics and manufacturing performance of the whole supply system, as perceived by end customers, as well as of each actor in the chain, as perceived by downstream players. Though, there are several supply chain performance measures and metrics which can be assessed. He identified most commonly used performance measures by practitioners as well as the most cited in research namely- quality, delivery, cost or price and flexibility.

Lai et al. (2002) evaluated the supply chain performance in transport logistics and identified three dimensions of supply-chain performance in transport logistics. The dimensions are service effectiveness for shippers, operational efficiency and service effectiveness for consignees. Within these dimensions they identified four performance indicators such as responsiveness, reliability, costs and assets.

Pagell and Krausse (2002) have developed a conceptual frame work of supply chain performance measurement for a manufacturing organisation. They have presented performance items for assessing organisational strategy, the main idea is to describe “priority” in the supply chain performance measures e.g. quality (reliability, durability, conformance), delivery (speed, reliability), flexibility (volume, mix), cost (price, total cost) and innovation (process, product) as well as the focus of the manufacturing and purchasing items.

Lockamy III and McCormack (2004) describe four processes such as plan, source, make and deliver as follows: Planning deals with the decision-making area, e.g. demand planning, which includes forecasting and development activities that has a significant impact on supply chain performance. Sourcing handles supplier transactional collaboration activities and has a significant impact on supply chain performance within the source decision area. Making planning process activities have a significant impact on supply chain performance within the make decision area. Activities include: collaboration among the sales, manufacturing and distribution functions.

2.3 SUPPLY CHAIN PERFORMANCE INDICES

The following scholarly works describe the various performance measures and indices used in their studies and their relevance.

Slack (1991) identified four types of system flexibilities where each type can be measured in terms of range and response: i) volume flexibility (the ability to change the output level of products produced), ii) delivery flexibility (the ability to change planned delivery dates), iii) mix flexibility (the ability to change the variety of products produced) and iv) new product flexibility (the ability to introduce and produce new products).

Christopher (1998) describes 'on time order fill' as "a combination of delivery reliability and order completeness". He discussed the various factors that can influence delivery speed including vehicle speed, driver reliability, frequency of delivery, and location of depots. An increase in efficiency in these areas can lead to a decrease in the inventory levels. By comparing these with the previously made agreement, it can be determined whether perfect delivery has taken place or not, and areas of discrepancy can be identified so that improvements can be made. Flexibility of delivery systems to meet particular customer needs refers to flexibility in meeting a particular customer delivery requirement at an agreed place, agreed mode of delivery and with agreed customised packaging.

Dorward et.al (1998) list the conditions for successful interlocking contracts between smallholders and agribusiness to address all the problems related to contract farming. The conditions are as follows:

a) A guaranteed outlet for the product
b) An effective repayment mechanism through loan groups of farmers
c) Access to market information by farmers to prevent exploitation and to strengthen bargaining power
d) Volume of transactions that are large enough to reduce transaction costs (this can be achieved through farmer co-operatives or farmer groups)
e) A well-established formal or informal network of traders to control rogue traders
f) Little alternative sources of raw material to prevent the trader or agribusiness from buying from other farmers

Beamon (1999) and Hill (2000) had defined flexibility as "*the extent to which a company intends to respond to market changes e.g. significant increases in demand*". Harrison and Van Hoek (2002) states that "flexibility is the management of reacting to changes in demand by preserving the resources of time, money, materials, people, plants and suppliers until they are specifically required". Both these definitions characterise flexibility as the capability to respond to individual customer requirements. This is a broad performance measure which includes: demand increases (volume), product range (mix), order handling (time), order size etc.

Li and O’Brien (1999) suggested a model to improve supply-chain efficiency and effectiveness based on four criteria: profit, lead-time performance, delivery promptness and waste elimination. Their model analyses the supply-chain performance in two levels i.e. chain level and operational level. At the chain level, assumptions for these four criteria are set for each supply-chain stage so that the supply-chain performance can meet the customer service objectives. At the operations level, manufacturing and logistics procedures are optimised under the given objectives and three different strategies. The results of the model revealed that lead-time performance is the most influential factor for the choice of the strategy. They also emphasise that the efficiency of supply chains can generally be improved by reducing the number of manufacturing stages, reducing lead-times, working interactively rather than independently between stages and speeding up the information flow.

Hoover et al. (2001) defined the objective of SCM as “*Efficiency improvements of the product delivery process from raw material suppliers to the end customer*”. The primary purpose for efficient supply chain is to fulfil demand at the lowest possible cost. Supply chain management can also impact the important customer value of price by significantly reducing costs. Customer value is also important for determining the type of supply chain required to retain customers. A customer’s supply chain strategy is determined by the type of products or services it offers and the value of various elements of this offering to the customer.

Duclos et al. (2003) had developed a conceptual model of supply chain flexibility. They have concluded that flexibility in the supply chain adds the requirement of flexibility within and between all partners in the chain, including departments within an organisation, and the external partners, including suppliers, carriers, third party companies and information system providers. It includes the flexibility to gather information on market demands and exchange information between organisations.

The authors have taken the different dimension to study the supply chain flexibility such as operation system flexibility, market flexibility, logistic flexibility, supply flexibility, organisational flexibility and information system flexibility to assess the performance of the supply chain and develop the conceptual model. The authors underline the importance of intercompany dimensions of supply chain flexibility.

Garavelli (2003) defined the supply chain flexibility as "*the ability of a supply chain to properly and rapidly respond to changes, coming from inside as well as outside the system*". He has taken process flexibility and logistic flexibility as the dimension to measure the supply chain flexibility. The study revealed that the supply chain configurations with limited flexibility provide relatively better performance than configuration with no or total flexibility considering the trade-off between costs and flexibility. The improvements in a supply chains' upstream flexibility capabilities tend to lead to better results than downstream activities.

2.4 AGRICULTURAL SUPPLY CHAIN MANAGEMENT INCLUDING FRESH PRODUCE

The Agri-supply chains are defined as "*the economic systems which distribute benefits and which apportion risks among participants*". Thus, supply chains enforce internal mechanisms and develop chain wide incentives for assuring the timely performance of production and delivery commitments. They are interconnected by virtue of shared information and reciprocal scheduling, product quality assurances and transaction volume commitments (Lombert et.al, 1998; Iyer & Bergen, 1997).

The authors also stated that process linkages add value to agricultural products and require individual participants to coordinate their activities as a continuous improvement process. Costs incurred in one link in the chain are determined by actions taken or not taken at other links in the chain. Extensive pre-planning and coordination are required up and down in the entire chain to affect key control processes such as forecasting, purchase scheduling, manufacturing programming, sales promotion, and new market and product launches.

Van der Vorst (2000) distinguished several performance indicators for food supply chains on three levels: supply chain, organisation and process. At supply chain level five indicators such as product availability, quality, responsiveness, delivery reliability and total supply-chain costs are differentiated. At organisation level again five indicators are distinguished: inventory level, throughput time, responsiveness, delivery reliability and total organisational costs. Finally at process level four indicators are distinguished: responsiveness, throughput time, process yield and process costs.

Van der Vorst (2000) and Van der Spiegel (2004) have summarised the following specific aspects of agri-food supply chains: shelf-life constraints, long production throughput time, seasonality in production, conditioned transportation and storage required, storage-buffer capacity restrictions, product safety, physical and product quality features like sensory properties such as taste, odour, appearance, colour, size and image.

Kader (2002) has described the quality of fresh plant products as a result of the combination of a mixture of many biophysical and biochemical parameters. Several characteristics, attributes and properties determine the commodity value for food or its enjoyment when consumed, and the relative importance of each quality factor depends on the type of commodity and its final use. He found the main quality factors as visual appearance (absence of defects, including chilling injuries), texture, flavour, nutritional value and safety. For each of these factors, there is a matching series of components (attributes) useful to evaluate the commodities in relation to the specifications of quality standards, selection in breeding programs, and evaluation of responses to environmental factors and post-harvest treatments.

Woods, (2004) has defined the supply chain management in agribusiness as "*managing the relationships between the businesses responsible for the efficient production and supply of products from the farm level to the consumers to meet requirements reliably in terms of quantity, quality and price*". In practice, this often includes the management of both horizontal and vertical alliances and the relationships and processes between firms.

Aramyan et.al (2006) proposed first time conceptual framework for measuring performance of the tomato supply chain using financial and non-financial indicators combined with the specific characteristics of agri-food supply chains. Four main categories of performance measures (i.e. efficiency, flexibility, responsiveness, and food quality) are identified as key performance components of the tomato supply chain performance measurement system.

Sriboonchitta et.al (2008) reviews literature related to contract farming in Thailand and special attention is given to roles played by government in the initial stage of contract farming development. They concluded that it is important for the public sector to create a favourable environment and infrastructure to encourage investment in agribusiness and to coordinate the concerned parties to raise agricultural productivity. They also evaluate the effectiveness of contract farming as a means to stabilise farmers' income and strategise agricultural development.

The findings show that the poorest farmers were not excluded from contract farming; special measures may be needed to encourage their full participation. In the long run, small farmers were able to accumulate production and management skills, thus improving their bargaining position. Together with improved infrastructure and a more competitive market due to farmers' innovation, the farmers' best choice may include non-contract production.

Sadhan et.al (2009) stated that to enhance the productivity of vegetables in the India needs policy support from the government to popularise the eco-friendly production technologies like crop diversification, organic farming and processing and by-product utilisation. These policy initiatives help to meet the food and nutritional requirements of growing population. As most of the developing countries suffer from deficiency of micro-nutrient and Vitamin-A. These deficiencies will weaken immune system of people contribute higher rates of anaemia, diarrhoea, measles, malaria and colour blindness.

2.5 FRESH PRODUCE QUALITY MANAGEMENT

Management of food quality is a rather complicated process. It involves the complex characteristics of food and their raw materials, such as variability, restricted shelf life, potential safety hazards, and the large range of bio-chemical, physical, and microbial processes. Moreover, human handling plays a crucial role in quality management and is rather unpredictable and changeable. As a consequence, the result of agribusiness and food industry, as the combined action of individuals striving for quality, is much more uncertain than often is assumed. In this study reviews explain the quality management issues in fresh produce distribution system.

Horticulture Research and Development Corporation (HRDC,1990) identified freshness, firmness, colour, variety and size as the most important attributes that helped consumers select fruit. Intrinsic quality attributes are closely related to the product and cannot be changed without changing the physical characteristics of the product like appearance, colour, size and shape often serve as intrinsic quality indicators for fresh fruit. Price is the most well known extrinsic indicator of quality. When no other information is available and the consumer must judge the quality of two similar products, the higher-priced alternative is generally expected to deliver superior quality. However, there is also evidence to suggest that most consumers rate quality as being more important than price.

Aaker (1991) conducted a study on managing brand equity and in which he defines perceived quality as the customer's perception of the overall quality or superiority of the product with respect to its intended purpose, relative to the alternatives. Perceived quality is therefore, an intangible, overall feeling about the product, which is usually based on some underlying dimensions including such variables as product reliability and performance.

Parasuraman et al. (1991) have conducted a study on understanding the customer expectation with regard to the services offered by a firm. They had written that customer service expectations have two levels, desired level and adequate level. The desired level is the service the customer hopes to receive. The adequate service level is what the customer finds acceptable. This is important to have in mind when setting up the supply chain towards a customer. The purpose of SCM is to set up a supply chain that meets the service level expected by the customer at as low supply chain cost as possible. The desired level can be totally out in the blue and can lead to a very high supply chain cost that will have an effect on the customer in the end. Therefore, it is very important to understand the customer expectations and focus on the adequate level.

Oude Ophuis and Van Tripp (1995) have stated that the credence attributes are desirable product benefits like nutritional value and wholesomeness that cannot be experienced directly. To assess the credence attributes, consumers must rely on the judgment or information of others that the product contains the desired attribute. They further identified that the health is a typical credence quality attribute that is becoming more important as consumers' disposable income increases.

Keebler (1999) has stated the three principal categories of measurements viz. time, quality and cost. Both time and quality can be included in the customer responsiveness scope.

He argued that the customer responsiveness usually includes lead-time, stocking probability and fill rate. Cost is the sum of inventory and operating cost. Fill rate is a measure that denotes the grade of the stock that is filled.

Ziggers and Trienekens (1999) in their study highlighted that the fresh produce is characterised by a direct relation between the internal attributes of the final product and those of the primary product. These developments emphasise the degree of interdependence among different levels of the supply chain.

Hill (2000) finds that the quality has been the driving force of an organisation since the late 1970s. He holds that the definition of the term quality has become wider and covers many dimensions, resulting in a lack of understanding and subsequent lack of direction. He has explained the reasons for the companies not competing in the quality domain, which is due to failure to explain required dimensions of quality that will provide the best result in given markets.

Luning et al. (2002) divided product quality and process quality into 3 aspects. The product quality aspects are: i) food safety and health, ii) sensory properties and shelf life, iii) product reliability and convenience and whereas the process quality aspects are production system characteristics, environmental aspects and marketing.

Martech (2005) has identified the environmental impact of food. He has differentiated the ‘eco-impact’ and ‘eco-image’. The eco-impact considers the contamination of soil and water resources with the consequent loss of fitness for both current and future uses. The eco-image is influenced by the consumer’s value system and includes such issues as animal welfare and responsible consumption. This includes recycling, sustainable production practices, a perception that natural is better and a sense that native flora and fauna need to be protected. Furthermore, the need to recognise and protect indigenous culture and values is increasing in importance.

Peri (2006) defines quality as fitness for consumption. Quality can thus be described as the requirements necessary to satisfy the needs and expectations of the consumer. To some, quality is considered synonymous with innate excellence which cannot be analysed, but only recognised through experience. Appearance, colour, size and shape often serve as intrinsic quality indicators for fresh fruit.

Visscher & Vellema (2007) analysed the evolution of the Hazard Analysis for Critical Control Point (HACCP) protocols with an interest in sustainability in commodity chains. The original idea of a HACCP system was to encourage learning and monitoring by the organisation itself. A central element of this approach is its reliance on the managerial and technological capacity of an individual organisation to handle hazards or dangers. Accordingly, HACCP requires the presence of learning and correction capacity inside an individual company for achieving food safety objectives. In principle, it is up to the individual company to decide how to achieve these objectives, as long as the company is “in control”.

Shepherd (2006) revealed that consumers’ assessments of fresh fruit and vegetable quality vary considerably according to country, sex, age, socioeconomic status and other factors. Nevertheless, criteria such as appearance, colour, uniformity, ripeness and freshness are invariably the major variables that influence the consumer’s decision to purchase. While other quality criteria such as flavour, aroma and texture cannot be assessed prior to purchase, consumers base their purchase decisions on previous experience.

Bollena et.al (2008) reveals that the traceability is an integral component of modern agricultural supply chains. Higher-precision traceability and finer granularity of identifiable units of product offer the opportunity to add value to the conventional track and trace information in terms of improved feedback to producers and benefits to supply system efficiency. The pack-house is the major transformer of identifiable units in a horticultural supply system and is the only source of information on these transformations. The major influences on the precision of traceability possible through a pack-house are mixing in the in feed system to the grader, mixing in the packaging system and the splitting of fruit stream to different packaging outlets. They have developed a mixing model that is able to assign the probabilities of bin origin to individual fruit at the point they are packed into their final packs.

Surendra et.al, (2009) study suggests that public private collaboration through contract or corporate farming would help understand functioning of domestic and global market and their implications. The private players can provide both backward and forward integration to the farmers as well as in building the capacities of all the Stakeholders. With the creation of specialised market infrastructure, post-harvest losses can be minimised if quality aspects are properly managed and would result in higher returns to the farmers and the consumers will get better returns.

Rosendo et.al (2009) argues that maintaining the quality and protecting the safety of fresh produce supplies necessitates the coordinated effort of everyone involved in supply chains from the grower to the consumer. In the area of post-harvest handling and transportation, improvement in bulk packaging of fresh produce through the adoption of reusable plastic crates has contributed significantly to maintaining quality and reducing losses. Proper physical and hygienic management of plastic crates is equally important in order to safeguard against chemical, physical and microbiological risks. The study provides basic principles and recommended practices for handlers and transporters to consider that will mitigate the various potential hazards associated with the reuse of plastic crates to ensure safety and wholesomeness of fresh produce as it moves through the chain from producer to consumer.

2.6 AGRICULTURAL MARKETING AND INFRASTRUCTURE

Agricultural marketing covers the services involved in moving an agricultural product from the farm to the consumer. Numerous interconnected activities are involved in doing this, such as planning production, growing and harvesting, grading, packaging, transportation, storage, agro-food processing, distribution, and sale. Such activities cannot take place without the exchange of information and are often heavily dependent on the availability of suitable finance. Efficient marketing infrastructure such as wholesale, retail and assembly markets and storage facilities are essential for cost-effective marketing, to minimise post-harvest losses and to reduce health risks. Markets play an important role in rural development, income generation, food security, developing rural-market linkages and gender issues. The study reviews the issues and problems involved in agricultural marketing focusing on India.

Siva Rama Prasad (1986) conducted a study on agricultural marketing in India, he identified that the largest movement of agricultural produce from the villages is in the bullock carts immediately after harvest. But shipment at the secondary level is almost entirely by trucks and rail with rail-roads as the dominant means on the longer hauls.

Bholerao et.al (1987) has indicated that the share of produce in the consumer's rupee for all the ten vegetables was less than 67 percent. It was higher for vegetables with less perishability or with cold storage facilities, while it was lower for vegetables with greater perishability like tomato, cucumber, ladies finger and cauliflower.

Pawar et al. (1990) studied organised and un-organised marketing of banana in Jalgaon district. The study revealed that co-operative fruit sale societies assigned specific grades to banana on the basis of the average weight of bunch at the time of harvesting. Producers were paid according to the grades of their produce. The group sale agency and private agency made the payment on the basis of average price received in the market. Marketing channels are results through which agricultural products move from producer to consumer. It is the chain of intermediaries through whom the products pass from producers to consumer. The length of channel varies from commodity to commodity depending on the quantity to be moved, the form of consumer demand and degree of regional specialisation in production.

Nawadkar et.al (1991) revealed that there are several channels which handle banana in its marketing. They include growers, contractors, inherent merchant's forwarding agents or commission agents, fruit growers association and co-operative producers marketing and other hawkers and vendors. Agents, wholesale merchants, brokers, agent of fruit merchants, forwarding agents and co-operative sale societies play their respective role in retail distribution.

Adelien (1998) stated that six main banana producing countries namely-India, Brazil, Indonesia, Ecuador, Philippines, and China, account for 57 percent of total world production. Indonesian production has been underestimated, but has been increasing significantly over the last decade.

Nagraj et al (1998) conducted a study in Karnataka with the main focus on market channels and main channels observed in different fruits are presented in table 2.3.

Table 2.3: Distribution channels of different fruits grown in Karnataka

Fruit	Distribution Channel
Apple:	I: Producer → PHC → WS → CA → Retailer → Consumer II: Producer → PHC → WS/CA → Cast/Vender → Consumer
Grapes	I: Producer → PHC → WS/CA → Retailer → Consumer II: Producer → PHC → WS/CA → Hawker →Consumer III: Producer → Co-operative Society → Consumer IV: Producer → Co-operative Society → Retailer → Consumer
Orange	I: Producer → PHC → CA → Retailer → Consumer II: Producer → PHC → CA → Hawker → Consumer III: Producer → PHC → Retailer → Consumer IV: Producer → CA → Retailer → Consumer
Guava	I: Producer → PHC → CA → Retailer → Consumer

(PHC: Pre-Harvest Contractor, C.A: Commission Agent, WS: Wholesaler)

Paul (2002) described the production and marketing of banana in Andhra Pradesh. His study revealed that the banana in the State has been reportedly being cultivated in a traditional type of manner. By and large, the farmers are cultivating only traditional varieties of banana. The price behaviour in banana crop has been violently fluctuating and the farmer is put to great loss and the consumer is also not benefited. Thus the major share of the consumer's price is reportedly knocked away by middlemen or intermediaries. His study highlighted that there are several problems in exporting banana to foreign countries. The main problem is quality. Besides the facilities like processing, quick transport, cold chains, cheap air cargo are lacking.

Gokul Patnayak (2002) discussed that the horticulture marketing practices are lacking systems approach. Trading and marketing structure is traditional consisting of a long chain of intermediaries. About 75 percent of farmers sell their produce at farm level. They cannot afford to go to distant *mandies'* on account of lack of facilities, expensive transportation and malpractices in the assembling markets. The longer chain of intermediaries between the farmer and the retailer, add up to 6 to 7 times cost but no value to the product.

Veerakumaran and Satheesh (2002) analysed the consumer behaviour of users of fruits and vegetable co-operative stores. He revealed that the traders indulge into malpractices in weighing the fresh produce and add many harmful chemicals to preserve freshness of the produce.

Silpa et.al (2009) conducted a case study in the Indian agriculture chain, which shows how a trading house used information technology to reengineer procurement practices, involving the activities of aggregation of volumes and quality control that can also be found in fresh produce supply chains. In this scheme, a local farmer operates an information centre linked to the internet in his village. This centre was linked to numerous transactions in the chain such as weighing, grading, or pricing.

They have also highlighted the access to information on technology and markets supported the integration of farmers into the supply chain and resulted in a sustainable commercial engagement by providing a viable procurement practice. The viability was related to the opportunities the information centre offered for obtaining knowledge about weather conditions, for articulating crop-specific interventions the trading house might be able to provide, and for communicating information, making the price−quality relationship transparent.

Annamalai and Rao (2003) in their case study on e-choupal revealed that rural India is a difficult business location. Transport, electric power, and information infrastructure are inadequate. Business practices are underdeveloped or outdated. Lack of access to modern resources has resulted in an under-trained workforce. Rural society is structured around subsistence and is unprepared for modern products and services. These constraints, along with many others, have dissuaded most companies from taking on the challenge of rural commerce. However such an engagement can serve a dual agenda: bridging rural isolation and the resulting disparities of education and economic opportunities, while at the same time creating a potentially large profit opportunity for the organisation willing to tackle the inefficiencies.

National Commission on Farmers (2004) Report defined agricultural marketing as *"All activities in the movement of agricultural produce from farm, where it is produced, to the consumers/industries and trade as per the demand".* The definition covers physical handling and transportation, initial processing and packaging, grading and quality control for sales transaction for meeting the requirements of the different consumers/users and storage. The report highlighted several weaknesses such as, distress sales immediately after harvest, absence of grading and packaging at the farm level and inter-locking of credit and commodity markets continued. Further, the regulated marketing system did not offer the farmers virtually any options, the market charges became high and the farmers complain about lack of transparency in weighing and auction was also the poor treatment given to them at the market yards.

They also identified that there are localised monopolistic tendencies and manipulations which often adversely affect the interest of growers due to infrastructural bottlenecks, geographically dispersed market places, absence of a well organised futures market. The commission report stated that, in spite of a large chain of intermediaries, the value addition is almost insignificant. The worst situation is in the case of vegetables/fruits. Because only about two percent of the fruits and vegetables are processed, there are very little backward linkages from the processors. The fresh fruits and vegetables do have large export potential particularly to the Middle East and Western countries with large Indian population. However, poor infrastructure (storage, transportation, cargo space/rates, facilities at the air/sea ports, etc), lack of adequate institutional support (credit and market development) and insufficient research efforts are constraints in realising the potential.

Singh and Chauhan (2004) conducted a study on marketing of vegetables in Himachal Pradesh. The study identified the following marketing channels presented in table 2.4

Table 2.4: Marketing channels of vegetables in Himachal Pradesh

Channel I	Producer → Consumer
Channel II	Producer → Retailer → Consumer
Channel III	Producer → Wholesaler → Commission agent → Retailer → Consumer (Local Market)
Channel IV	Producer → Commission agent → Wholesaler →Retailer → Consumer (Distant market)

Shepherd and Galvez (2004) in his study concluded that in marketing systems with many levels it is difficult to handle significantly different qualities at the same time, particularly if one of the quality criteria is safety. Marketing of safe food requires monitoring on-farm practices, pesticide use and water cleanliness, as well as the provision of advice to farmers. Cost renders regular testing for pesticide residues impossible. Where a wholesale market trader buys from unnamed farmers through rural traders, it is exceedingly difficult to develop traceability. Moreover, rural traders and transporters are not equipped to keep different qualities separate. While some grading is carried out, usually on the basis of size, there is little quality differentiation as traders are rarely able to buy other than “fair average quality” and are thus unable to provide the necessary incentives for farmers to improve quality. Most traditional marketing systems are not presently equipped for separate handling of different qualities en route to the consumer.

He further stated that the standard of fruit and vegetable handling in the marketing chain is often so bad that even if it were possible for traders to buy different qualities from farmers, there may be little quality differentiation by the time the consumer makes the purchase. At the farm level, farmers face problems with polluted water and other contamination. They have inadequate information about the dangers of bacterial infection and pesticide misuse and are often illiterate and forced to rely on the local pesticide retailer as their main source of information. Pesticide use is often encouraged by horticultural produce buyers, because this can lead to “attractive” fruit with no blemishes, but recommended practices are rarely followed. Produce is often harvested too soon after the last chemical application.

Maurice (2004) highlighted that weak incentives have led to significant underinvestment in agricultural marketing and processing, as well as production. Marketing chains are highly fragmented, often including six to eight intermediaries, and are dominated by small scale enterprises. Rural road and transport infrastructure remains poor and relatively costly. Because markets are inefficient, farmers tend to receive a small share of the consumer price only about 25 percent in the case of unprocessed vegetables. Physical losses in the food chain are high as well approximately 40 percent for horticultural products. Inefficient marketing also raises the cost of imported foods, as high margins are taken by wholesalers, retailers, and intermediaries exacerbate the effect of high tariffs.

Raghunath et.al (2005) have estimated that with strengthening the supply chain the benefits to consumers and producers can increase by 20 to 25 percent in the most perishable commodity like tomato. Due to inefficiency in the supply chain the price received by the farmers is only about 24 to 58 percent of the retail price the consumer pays.

Directorate of Agriculture (2005) in their study revealed that after harvesting Tomato, the farmers bring their produce to the market for sale. Their mode of transport from field to the market is preferably by bullock/buffalo cart, which is the cheapest among the available transport. Packaging is almost absent in the farmers' field. However, few farmers use paddy straw as cushioning material in the cart to carry the tomatoes to the market. In the market, the middlemen pack the tomatoes in paper cartoon of 20 kg capacity (approx) having no ventilation and send them to distant market. Once the consignment reaches the market, damaged and decayed fruits are sorted out either at wholesaler or retailer level and these are sold at throwaway prices if there are any takers. In the whole process right from farmers field to the consumer the percent of loss goes up to 25.25 percent.

Huang Zu-hui et.al (2007) stated that the complicated distribution or marketing channels in the chain usually determine the final success of a firm. In reality, professional managers often face a lot of channel options. They have to do a lot of planning and negotiations before they determine the channel structure. Even after they determine the channel structure, these channels constantly change due to various factors. So, the ultimate goal is to establish an excellent channel with competitive advantages.

They also identified the following characteristics and requirements for the management of the supply chain of the fresh produce: i) fresh produce shall be moved from the field to the table as soon as possible; ii) the quality of fresh produce during transportation shall be maintained; iii) consumers shall be provided with fresh and safe varieties; iv) the waste during the transportation shall be decreased; v) fresh produce shall be a core competitive advantage for the supermarkets lowered down.

Planning Commission of India (2007) study concluded that the development of agriculture in India needs some critical management inputs particularly that of supply chain management-collaboration among various stake-holders along with efficient vertical and horizontal integration. The horticultural sector in particular has to prioritise development of research in the issues of genetics, biotechnology, integrated and sustainable production systems, post-harvest handling, storage, marketing and consumer education. Government should create a policy environment that will ensure a mutually beneficial relationship between farmers and organised sector.

There is also an immediate need to integrate the production, marketing and processing processes of the produce to get maximum benefits from fruits and vegetables cultivation. There are problems with price structure in the marketing as the price offered by them is not justifying the prevailing wholesale price or even the cost of production of the produce. Further successful implementing of the core marketing strategies will help in future expansion of the domestic and international markets

Huang Zu-hui et.al (2007) states that supply chain management of fresh produce in the supermarkets should include two aspects: one is the management of the logistics of fresh produce, including the development and management of different varieties, implementation of criteria, supervision of quality, packaging, transportation, storage, processing and distribution; the other is the management of the relation and organisation, including the selection of suitable logistic channels and partners, determination of contracts, allocation of added value, and maintenance of long-term partnership and smooth running of the supply chain.

They further identified that logistics of fresh produce sold in the supermarkets includes transportation, packaging, loading and unloading, storage, processing and distribution. Each link of the process needs the technical guarantee and management optimisation. The logistic situation of the fresh produce sold in the supermarkets determines its profit margin. In foreign countries, the quality of produce is improving from fields to the supermarkets; while in the process we find that in China its quality is declining. There is no effective technical support in this process because there is no strict produce quality and safety management system. These technical and management obstacles make the management of fresh produce supply chain less effective.

Sarode (2009) revealed that the Jalgaon district in the State of Maharashtra, In India is one of the largest producers of banana which contributes about 44 percent of banana production in the State. He observed that the banana fruit fetches price depending on size in the market. The size of fruit is measured in terms of weight of bunches and number of hands per bunch at the farm level. The bunches are graded according to weight grade A (above 15 kg), grade B (13 to 15 kg), grade C (11 to 13 kg), grade D (9 to 11 kg) and grade E (below 9 kg). Marketing management of banana is an important activity along with production and it is helpful to banana growers in knowing the importance of various management practices, specifics markets, their marketing cost and price spread in marketing channels preferred by them.

Debashis Chakraborty (2009) observed from the literature that barring minor exceptions, contract farming has broadly been a successful affair. The author expected a better outcome if a number of systemic reform measures are undertaken at the earliest. On one hand, the infrastructure level ought to be massively augmented and on the other, contract farming should be formalised in all States, so as to make it binding on both concerned parties.

Sanjay (2010) identified the major constraints in fruits and vegetables are non-availability of quality seeds, inadequate irrigation, lack of soil testing facilities and inadequate extension infrastructure, inefficient pest and decease management, low availability of credit, huge cost of production, lack of marketing information, huge post-harvest losses, lack of infrastructure like roads, cold storage, poor marketing intelligence, high transportation cost, etc.

He also states that higher resource allocation for agricultural research and infrastructure development are essential to reduce post-harvest losses and increase per unit area productivity of quality and safe produce. He concluded that there is a strong need of government interventions in removing infrastructural constraints like setting up distribution centres, cold chains, roads to the markets, etc.

2.7 POST-HARVEST MANAGEMENT AND LOSSES

The post-harvest sector includes all points in the value chain from production in the field to the food being placed on a plate for consumption. Post-harvest activities include: Harvesting, handling, storage, processing, packaging, transportation and marketing. The amount of resources used and the efficiency of production are contingent upon use of appropriate technologies, infrastructure, storage, processing, marketing and transportation (Mrema and Rolle, 2002). Insufficiencies in one of these areas result in significant amounts of horticultural crops that are lost due to harvesting at an incorrect stage of produce maturity, water loss, drought, extreme temperatures, physical damage, contamination by pests and market competition. ‘In developing countries, losses of the order of 40-75 percent have been reported’ (Kumar and Kumar, 2003). Post-harvest loss results not only in the loss of the actual crop, but also losses in the environment, resources, labour needed to produce the crop and livelihood of individuals involved in the production process. When 30 percent of a harvest is lost, 30 percent of all the factors that contributed to producing the crop are also wasted (World Resources Institute, 1998).

Harvey et.al (1972) classified post-harvest losses in fresh fruits and vegetables by causal agents. He separated losses into three categories: mechanical injuries, parasitic diseases, and non-parasitic disorders. He also stated that mechanical injuries include all cuts, bruises, punctures, abrasions, insect scars, hail scars, crushing, cracking, and freezing. The parasitic diseases, or decays and other defects caused by fungi, bacteria, viruses and other biological agents, constitute a well-defined category. Non-parasitic disorders include the various physiological responses of fresh fruits and vegetables to the post-harvest environment, such as internal breakdown of peaches, scald of apples, hollow heart and sprouting of potatoes, shrivelling of various products, and rind breakdown of citrus.

Harvey (1978) revealed that there are many factors that affect the maintenance of quality and the incidence of post-harvest losses in fresh fruits and vegetables such as (a) the initial quality of the commodity; (b) the temperature at which the product is held during handling, storage, transport, and distribution; (c) the relative humidity of the post-harvest environment; (d) the use of controlled or modified atmospheres during storage or transit; (e) chemical treatments for the control of decay or physiological disorders; (f) heat treatments for decay control; and (g) packaging and handling systems. He also stated that for perishable commodities the cold chain is often considered the most vital segment in the marketing chain.

He pinioned that the successful functioning of the marketing chain also depends on effective methods of packaging and handling, and on the massive transportation system that moves monumental quantities of perishable commodities to domestic and worldwide markets, many of which are distant from production areas. He stressed that the task of reducing post-harvest losses in perishable commodities starts with the grower and ends with the consumer, but involves everyone who handles the product during marketing. Educating the many individuals who are involved in the system on the consequences of poor handling and to the rewards of good handling practices should assure progress towards the goal of providing all peoples of the world with an adequate supply of wholesome food.

Shewfelt (1986) expressed that the "shelf life" or "storage life" refers to the period of time during which a commodity retains a certain level of quality under specific storage conditions. The main objective when endeavouring to achieve optimal handling and shelf life of fresh non-climacteric fruit and vegetables is to minimise deterioration (by lowering metabolism), while in climacteric products maturation must be optimised depending on the final use (consumed fresh or processed). The optimal maturity stage at harvest of a plant product is the main factor conditioning its final quality and shelf life, which are commonly determined according to sensory properties and microbial safety.

Sharma et.al (1995) have examined in their study that the losses in percentage were highest during harvesting, transportation for tomato (21 percent) and capsicum (15 Percent), whereas, the assembling and marketing operations caused major loss for beans and peas (18 percent)

Reid (2002) conducted a study on the maturation and maturity indices of post-harvest crops. He defined the maturity of fresh produce "*as the stage of development of a plant organ at which, after harvesting and handling, its quality will be at least at the minimum level of acceptance to the final consumers".* He also concluded that the ripening starts in the last stage in maturity and could be considered as the beginning of senescence. During ripening, the intracellular organisation begins to deteriorate, the gas permeability of cell membranes is reduced, inducing anaerobic respiration, and toxic compounds (such as ethanol, acetaldehyde and ethyl acetate) accumulate and cause cell death. During senescence, plant organs become increasingly susceptible to microbial attacks, not only because biochemical changes induced promote microbial development, but also through loss of natural immunity.

Allende et.al (2002) observed that the spoilage of fresh fruit and vegetables may occur at any stage between harvesting and consumption, such as handling, processing, packaging, storage, transport, distribution, retail display, and use by the consumer. Therefore, production of safe food includes screening materials entering the food chain, suppressing microbial growth, and reducing or eliminating the microbial load by processing and preventing post-processing contamination. Increasingly, new pathogens or food safety issues may arise as a consequence of factors outside the control of the food producer. The most important goal to achieve in order to maintain the quality of fresh processed vegetables is the reduction in the microbial spoilage flora, as such flora induce both decay and safety problems. Infiltration of pathogens into cracks, crevices, and the intracellular spaces of fruits and vegetables has been demonstrated and will depend upon different factors such as temperature, time and pressure.

Bruhn (2002) conducted a study on the consumer issues in quality and safety in horticultural crops. He identified that Consumers are increasingly concerned with plant food quality, safety, and security, and gives freshness very high priority when purchasing chilled foods. The most frequent food safety concern is pesticide residues associated with produce, followed by mishandling and cleanliness. For this reason, some supermarkets ensure that produce meets legal pesticide residue minimums or contains no residues, and increasingly offer organic produce. But consumers are also focused on healthy eating patterns related to the composition of foods, and monitor their fat, cholesterol, sodium, and micronutrient intakes.

Cantwell (2002) and International Institute of Refrigeration (IIR, 2000) concluded that the chilling helps to maintain quality by preserving freshness and avoiding spoilage, essentially by slowing microbial growth in general and that of pathogenic microorganisms in particular (e.g. Salmonella spp., E. coli or Clostridium spp.). However, although a selected low temperature (depending on the product) should be maintained throughout shelf life, plant foods can still spoil, as evidenced by fungal attacks and detrimental quality changes. Requirements and recommended optimal storage conditions under conventional, controlled or modified atmosphere, and alternative treatments for practically all perishable foodstuffs are available for users from different sources.

Mrema and Rolle (2002) indicated an evolution of priorities within the post-harvest sector of developing countries from a primarily technical focus geared towards the reduction of losses, to a more holistic approach designed to link on-farm activities to processing, marketing, and distribution. However, the major constraints continue to be high post-harvest losses, poor marketing systems, weak research and development capacity, and inadequacies in policies, infrastructure, and information exchange.

Suslow (2003) conducted a study on the Ozone application for post-harvest treatment of vegetables. The study identified that the temperature control during transportation is a critical link in the cold chain to ensure produce quality, and reduces risks related to microbial safety, especially for fresh-cut packaged produce. For many pathogens, the maintenance of low temperature is an effective method of control. Throughout transportation and shipment, the container must be clean and must effectively maintain the desired temperature. Ducts should be clean of particles that may restrict airflow and prevent circulation of cooled air around the load. Also, documentation and recording of the cold chain control and history during distribution is a critical component of performance for both quality and safety.

Sreenivasa et.al (2004) conducted a study on post-harvest losses on grapes in Karnataka. Their study revealed that improper packaging and transportation are the major causes of post-harvest loss and effort should be initiated to reduce the loss by developing efficient packaging material to reduce injury to the berries during transportation. In addition, it is also important to develop appropriate cushioning material to absorb the shocks and reduce the detachment of berries during transportation. Standard pre-harvest practices and harvest method needs to be developed and given to the farmers to reduce the loss at field level.

Ajay and Singh (2004) conducted an economic analysis of post-harvest losses in the States of Orissa, Jharkhand and Uttar Pradesh. The study revealed that the post-harvest losses for tomato at farm level, wholesale level and retail level are 3.75 percent, 9.25 percent and 11.75 percent respectively. The overall average quantitative loss of tomato in all cities is 24.75 percent.

Meena and Yadav (2004) discussed that Manual handling of fruits and vegetables sometimes causes damage to the produce. It is against this background that the packaging has to be congenial. It has to be recognised as a vital link in the total marketing chain, from production to consumption. Packaging has wide ramifications- resource utilisation, loss minimisation, market penetration, market expansion, brand projection, consumer protection and environment preservation. The system of direct loading on trucks using paddy straw or agricultural waste as cushion material is very common in respect of orange, pineapple and mango.

The study highlighted that lots of time is consumed in loading and unloading operations where truck is detained for 4 to 8 hours for this purpose alone. The adoption of waste material contributes to rapid decay of fruits in transit. They also add garbage in assembling market places. Bamboo baskets and wooden boxes are used for packaging tomatoes, capsicum and cauliflower. Jute bags and bamboo baskets of extremely poor quality are used for transporting vegetables to nearby small markets and cannot be used for long distance shipping. Brushing, crushing, moisture losses and spoilage are higher in jute bags and bamboo baskets. Ripening process is faster in bamboo baskets.

They estimated that about 25 to 30 percent of the produce goes waste on account of inadequate post-harvest management and information, technologies and infrastructural facilities. It is estimated that the value of perishable horticulture produce, comprising fruits and vegetables are quite high. Even if the waste is to the extent of 25 percent, the total annual loss to the farmers and consumers comes to a huge quantity. Reduction in post-harvest losses will increase availability of fruits and vegetables.

Sudha et.al (2005) concluded that post-harvest losses occur in Tella Chakkera Keli (TCK) banana at various stages in the marketing network based on assessment by physical examination. Post-harvest loss was assessed at field level, wholesale market level, retail market level and retail sale level. Post-harvest losses have been classified into different categories based on the cause of loss as physical losses due to mechanical injuries or sunburn; those due to disease causing pathogens and others. They also revealed that market intermediaries especially the wholesalers are actively involved in procuring grapes directly from farm gate and supplying to distant markets, as there is a substantial profit margin. Mobile procurement units either by the farmers' co-operative societies or the government organisations would bring down price spread and benefit for both the producers and consumers. In addition, this process could also reduce the post-harvest loss due to specialised transport vehicles and less number of handling of produce.

Directorate of Agriculture (2005) conducted a study on post-harvest practices and loss assessment of some commercial horticultural crops of Assam and the study revealed that the post-harvest losses varied from crop to crop and within different stages (Table 2.5). Among the crops, the highest total loss was recorded in tomato (25.25 percent) followed by Banana (22 percent). The highest post-harvest losses were recorded during transportation in tomato and banana. Maximum loss during marketing was recorded in banana (12 percent) followed by tomato (9.75 percent).

Table 2.5: Post-harvest Losses (%) of horticulture crops at various stages of handling

Crops	Harvesting	Grading	Transportation	Marketing/ Storage wholesaler	Retailer	Total Loss (%)
Orange	3.25	0.75	1.25	1.20	7.50	13.95
Pineapple	1.73	0.54	1.95	2.66	2.37	9.25
Banana	Nil	Nil	10.00	5.00	7.00	22.00
Ginger	1.5	2.25	1.50	2.75	2.50	10.50
Tomato	0.75	3.75	11.00	2.50	7.25	10.50
Cauliflower	Nil	2.75	7.50	1.75	3.75	15.75
Spine Gourd	Nil	8.30	4.30	1.80	2.70	17.10
Pointed Gourd	Nil	5.40	7.50	1.90	2.10	16.90

The study also highlighted that banana recorded the highest monetary loss of Rs. 128.34 crores per year due to losses during handling and marketing as against the lowest monetary loss of Rs. 4.33 crores in oranges (refer to table 2.6). This has reflected the drainage of hard earned revenue due to non adoption of appropriate post-harvest management practices and lack of storage facilities in the State.

Table 2.6: Post-harvest losses of some horticulture crops in Assam in 2001-02

Crops	Production (‘000MT)	Monetary Loss (Crores/Year)
Banana	583.38	128.34
Orange	62.07	4.33
Pineapple	209.00	19.33
Ginger	111.08	11.66
Tomato	332.00	41.99
Cauliflower	232.80	11.03

Kishore et.al (2006) conducted a study on economic analysis of post-harvest losses in vegetables in Karnataka. His study revealed that in perishable crops like fruits and vegetables, proper and scientific storage, packaging, transport and handling techniques are not adequate and hence, considerable amount of produce is wasted. The vegetable crops because of their moisture content are inherently more liable for deterioration in quality and quantity especially under tropical conditions. Moreover, they are biologically active and carry out transpiration, respiration, ripening and other biochemical activities, which contribute towards deterioration in quality of the produce. Post-harvest losses in vegetables during post-harvest operations due to improper handling and storage are enormous.

The study concluded that the post-harvest losses occur due to faulty methods of harvesting, threshing, cleaning, drying, storage, transportation, processing and distribution of agricultural products. The study attempted to estimate post-harvest losses in two major vegetables grown in Karnataka. The storage loss at different stages added up to about 38 percent of the total loss while farm harvest operations accounted for about 17 percent of the total losses. Transit loss was another important component of post-harvest loss contributing to about 25 percent of total loss.

Mittal (2007) conducted a study on success and failures of Indian Horticulture sector. Her study revealed that one of the weaknesses of the supply chain is that it is a multi-layered marketing channel lacking in infrastructure. Efficient supply chain requires strengthening all the levels of infrastructure such as the inputs delivery, credit, irrigation, improved procurement, minimising post-harvest loses, cold storage chains, better and efficient processing and marketing techniques, efficient storage, warehouse and also efficient and competitive retailing. The infrastructure to improve efficiency and the linkages of the supply chain is very poor, which is affecting the growth potential of the horticultural sector. Timely availability of inputs, development of organised input market and infrastructure for its storage and distribution will add to the productivity of the sector.

Development of cold chain network will help in reducing the post-harvest losses of fruits and vegetables. Major constraints in production and marketing in fresh fruits and vegetables as listed in the literature are non-availability of quality seeds, inadequate irrigation facilities, lack of soil testing facility and extension staff. Inefficiency in pest management, credit availability constraint, high cost of production, lack of information, huge post-harvest losses, lack of roads, cold storage, inadequate space, poor market network and high transportation cost.

Post-harvest technology of fresh fruits and vegetables in recent years gained enormous momentum to save losses during harvesting, handling, storage and transpiration quality and quantity. The extent of losses of fruits and vegetables in India is estimated at about Rs. 10,000 crores to 12,000 crores per annum, and the loss of quantity ranges between 10 percent and 80 percent in the most perishable fruits and vegetables. The major causes of loss are improper handling, poor packaging, improper storage, uncontrolled temperature, etc.

Mittal (2007) also revealed that the traditional markets have a non-existent infrastructure of packaging, grading, sorting and cold storages. The commission agents and traders dominate the supply chain and are the major price setters. Most of the farmers depend on commission agents for farm credit. She also revealed that ITC with its e-choupal, Mahagrapes farmers co-operatives and many other private initiatives in this direction are trying to remove the inefficiencies in the existing supply chains and reduce post-harvest losses, increasing the incentive to the farmer that motivate them to produce efficiently. She concluded that the post-harvest losses generally range from 5 to 10 percent for non-perishable commodities and about 30 percent for the perishable commodities; hence there is an urgent need to address the issues related to losses in the market chain.

Meenakshi and Ranveer (2008) conducted a study on post-harvest losses in fruits and vegetables in Himachal Pradesh, they found that during harvest season, most of the fruit and vegetable growing areas of the Himachal Pradesh State are confronted with road blockage. Simultaneously during transit there are long interruptions at various check posts within the State. Resultantly, there is time lag in delivery of fruits and vegetables. The situation is further aggravated because of poor storage facilities at the producer’s level. Such delay enhances the chances of increased physical and physiological post-harvest losses to fruits and vegetables. Any reduction in post-harvest losses is important to increase the availability of fruits and vegetables in the economy. It will also help producers in getting full returns and reduce cost of marketing and thus, lower consumer prices.

The study revealed that post-harvest management of fruits at the farm level in Himachal Pradesh needs a lot of improvement on various fronts including grading, packaging, storage, transportation and marketing of fruits and vegetables. In the case of post-harvest losses, lack of appropriate packaging, safe transportation and cold storage in producing and consuming markets are the major problems.

Rohit et.al (2010) attempted to study the awareness, behaviour and practices among Indian consumers, regarding maintenance of cold chain from retailer’s place to home and at homes within the framework of food safety. The study reveals that the consumers do not have adequate awareness about refrigeration practices for maintaining cold chain and food safety. The authors hopeful that findings could assist government, non-government organisations, industry, academia and community in collectively developing effective public education programs, to alert and motivate the consumers against the possible hazards of ignorance of healthy practices for cold chain maintenance at homes.

2.8 CONCLUSION

This chapter discussed the literature contribution of scholars in the fields of supply chain management, agri-business, logistics and information systems. The variables that have been used in the works are studied in-depth to carry on with the objectives framed for this study. The existing study is built on the theories of performance measurement in agri-food distribution system, post-harvest management and therefore enough emphasis is given.

The next chapter looks into theoretical frame of fresh produce distribution and supply chain performance measurement. The chapter discusses the various practices, activities and methods involved in fresh produce distribution system. The performance measurement system concepts function, its uses and how it is deployed in the chain are discussed in the detailed manner to augment the strength of the argument in favour of the present study.

CHAPTER - III
CONCEPTUAL FRAMEWORK OF FRESH PRODUCE SUPPLY CHAIN PERFORMANCE MEASUREMENT

This chapter discusses the framework of fresh produce distribution explaining the mechanism of distribution and includes the channels of distribution. It gives an overview of the transportation of fresh produce, storage systems, as well as, effects of various factors on produce leading to perishability. The key issues in supply chain management of fresh produce and performance management are explained in detail.

3.1 FRAMEWORK OF SUPPLY CHAIN MANAGEMENT

A supply chain is a set of three or more organisations linked directly by one or more of the upstream or downstream flows of products, services, finances, and information from a source to a customer. Supply chain management involves proactively managing the two-way movement and co-ordination of goods, services, information and funds (i.e. the various flows) from raw material through to end user.

There are several factors driving an emphasis on supply chain management. First, the cost and availability of information resources between entities in the supply chain allow easy linkages that eliminate time delays in the network. Second, the level of competition in both domestic and international markets requires firms to be fast, agile, and flexible. Third, customer expectations and requirements are becoming much more stringent. Therefore to satisfy the consumers, SCM system should operate with the two main objectives of timeliness and quality. The supply chain operates under four broad categories with wide range of activities that are explained in the following paragraphs.

3.1.1 Supply Chain Operations

This model identifies four categories of operations such as supply chain operations, plan, source, make, deliver (Gunasekaran, 2001) and which are discussed briefly as under.

- *Plan:* Refers to all the operations needed to plan and organise operations in the other three categories.

- *Source:* Operations in this category include the activities necessary to acquire the inputs to create products or services. These operations are procurement, credit and collection.
- *Make:* Includes the operations required to develop and build the products and services that a supply chain provide.
- *Deliver:* These operations encompass the activities that are part of receiving customer orders and delivering products to customers.

3.1.2 Activities of Supply Chain Management

A large set of activities besides purchasing is part of supply chain management. Each of these seemingly diverse activities is part of a network that will define how efficiently and effectively goods and information flow across a supply chain (Lambert & Pohlen, 2001). The activities include

i. Purchasing: Most organisations include purchasing as a major supply chain activity since purchasing is the central focus.

ii. Quality control: Almost all organisations recognise the importance of supplier quality and the need to prevent rather than simply detect quality problems. Progressive organisations work directly with suppliers to develop proper quality control procedures and processes.

iii. Demand and supply planning: Demand planning identifies forecasts of anticipated demand, inventory adjustments, orders taken but not filled and spare part and after-market requirements. Supply planning is the process of taking demand data and developing a supply, production, and logistics network capable of satisfying demand requirements.

iv. Material or inventory control: The material group is often responsible for determining the inventory level of finished goods required to support customer requirements, which emphasises the physical distribution (i.e., outbound or downstream) side of the supply chain. The inventory control group is often responsible for determining the inventory level of finished goods required to support customer requirements, which emphasises the physical distribution (i.e., outbound or downstream) side of the supply chain.

v. Order processing: Order processing helps ensure that customer receive material when and where they require it. It represents a link between the producer and the external customer.

vi. Production planning, scheduling and control: Production planning, scheduling and control involve determining a time-phased schedule or production, developing short-term production schedules, and controlling work-in-process production.

vii. Warehousing / distribution: Warehousing / distribution is particularly important for companies that produce according to a forecast in anticipation of future sales.

viii. Customer service: Customer service includes a wide set of activities that attempt to keep a customer satisfied with a product or service.

3.2 DECISION AREAS IN SUPPLY CHAIN MANAGEMENT

3.2.1 Purchase Issues

Over the last decade, the traditional purchasing function has evolved into an integral part of supply chain management. Purchasing is an important strategic contributor to overall business strategy. It is the largest single function in most organisations, controlling activities and transactions valued at more than fifty percent of sales. Purchasing personnel interact with customers, users, and supplier, finance, marketing and operation personnel in addition to top management. This information helps the firm to provide better, cheaper and timelier products and services to both internal and external customers.

Competitive advantage can be achieved by organisations working closely with their suppliers. Absence of a shared vision, mutual benefits, and top management commitment, partnerships are likely to be short-term. Other ingredients necessary for developing and managing lasting supplier relationships are trust, creating personal relationships, effective change management, and information sharing, and using performance metrics to create superior capabilities. The mutually agreeable measures to monitor supplier performance provide the basis for continuous improvement to enhance supplier quality, cost, and delivery.

Supply chain management success starts with the sourcing activity and the strategic role played within the firm by the purchasing function and the impact of purchasing on the management of supply chain. Firms that fail to recognise this importance will simply not experience the same level of success in the long run. Firms can maximise this advantage by developing effective supply chain strategies and then assessing and revising these strategies periodically as markets, competitors, and technologies change.

3.2.2 Operations issues

In Supply chain management, the just-in-time, and total quality management concepts make up a competitive advantage. Similarly, the primary ingredient in the success of a Just-in-time (JIT) program is the use of total quality management (TQM) and its improvement tolls. Proper demand forecasting enables better planning and utilisation of resources for business to be competitive. Forecasting is an integral part of demand management since it provides an estimate of future demand and the basis for planning and making sound business decisions. A mismatch in supply and demand could result in excessive inventories and stock-outs and loss of profits and goodwill. Both qualitative and quantitative methods are available to help companies forecast demand more realistically. The qualitative methods are based on judgment and intuition, whereas the quantitative methods use mathematical techniques and historical data to predict future demand.

3.2.3 Dıstrıbutıon issues

This section includes the importance of transportation to any industrialised society and to supply chains in particular. There are some elements within transportation which gives adequate understanding of the entire field of transportation. These elements included the models of transportation, transportation pricing, regulation and deregulation of transportation, third-party transportation providers, warehousing, international transportation, transportation management, and e-commerce issues in transportation.

Customer relationship management is really all about just treating customers right; for as long as there have been businesses, some firms have been very successful at keeping customers satisfied and coming back, while others have not. For the past ten or fifteen years, though, both the level of competition in the market place and the available computer technology and software capabilities has been increasing quite dramatically. Firms today are learning how to combine many channels of customer contact to serve customers better, resulting in better service and more sales.

Services constitute a large and growing segment of the Indian economy. Managing the supply chains of services is thus becoming an important part of an overall competitive strategy for services. Successful managing of services involves managing productive capacity, managing waiting lines, managing distribution channels, and managing service quality. These four concerns are the foundations of service response logistics.

3.3 SUPPLY CHAIN PERFORMANCE MEASUREMENT

Measuring the performance of supply chains and their member firms is critical for identifying underlying supply chain problems and in keeping end customers satisfied in today's highly competitive, rapidly changing marketplace (Sahay et.al, 2003). Good performance measures drive performance and can turn a mediocre supply chain into a superior supply chain that benefits all of its members. Financial performance is important to provide information regarding the long-term effectiveness of the firm in satisfying customers. Thus, use of measures about the firm's product quality, productivity, and customer service capabilities has begun to be used successfully in many organisations.

Performance measurement systems should be a mix of financial, nonfinancial, quantitative, cost oriented, process-oriented and customer oriented measures that effectively link the actions of the firm. Firms trying to manage their supply chains have an added layer of performance measure requirements-measures must be added that link the operations of member firms as well as linking the actions of the firms to the competitive strategies of the supply chain.

3.3.1 Principals of Supply Chain Performance Measurement:

A well-designed PMS should help supply chain managers understand and improve performance of supply chain operations. The existing literature on supply chain, PMS reveals a set of criteria or principles that serve as guidelines when designing PMS. Takle and Gabrielsen (2006) presented the following list a summary of the criteria and principles.

- *Holistic approach* – Performance measurement in the supply chain should take a holistic system perspective beyond the organisational boundaries (Chan and Qi, 2003).

The performance of supply chain needs to be assessed across the organisations in order to encourage global optimisation along the supply chain channel.

- *Process-based* – Successful supply chain management requires a change from managing individual functions to integrated activities within key supply chain business processes (Lambert and Cooper, 2000). Supply chains metrics should reflect this change and focus on supply chain processes rather than functions.
- *Aligned with strategy* – The performance measurement system must be consistent with the overall strategy of the supply chain. For instance, if the overall supply chain objective is short delivery times, logistic strategies that emphasis low cost could be in conflict (Coyle et al., 2003).
- *A dynamic system* – An important criterion for performance measurement system is that the system needs to be dynamic (Folan and Browne, 2005). The supply chain is a dynamic system that evolves over time, and the performance measurement system must have the ability to change over time to incorporate the changes in the supply chain and to continually remain relevant (Kennerly and Neely, 2003).
- *Balanced approach* – The purpose is to distribute performance measurement on a set of parameters that is representative for the most part of the business/supply chain. Supply chain performance measurement systems should provide a balance between financial and nonfinancial measures (Gunasekaran et al., 2004, Chan and Qi, 2003, Lambert and Pohlen, 2001). Financial measures are important for strategic decisions and external reporting, while non-financial measures handle the day to day control of manufacturing and distribution operations.
- *A managerial tool* – The performance measurement system is supposed to be a managerial tool, and the system must be able to arrange the transition from “measurement” to “management” (Basu, 2001). As a result, the performance measurement system needs to be simple to understand and provide timely and accurate feedback.
- *Cover strategic, tactical and operational level* – The performance measurement system should assess and give relevant information to the appropriate level of management. Strategic level measures influence the top level management decisions, tactical level deals with resource allocation and operational level measurements and metrics assess the results of decisions of low level managers (Gunasekaran et al., 2004).

3.3.2 Measures of Supply Chain Performance:

It is crucial that the measurement of supply chain performance indicators are synchronised with the overall supply chain strategy. Supply chain performance indicators are classified into two clearly defined but closely interrelated categories - functional indicators and end-to-end supply chain indicators. One measures the effectiveness of the function and second measures how well these functions are coordinated. While they are measured separately, they must not be considered in isolation. The choice of functional indicators depends upon industry verticals. Traditionally organisations measure functional indicators and hence have a good understanding of them. With the beginning of supply chain and focus on overall coordination and effectiveness, some of the functional indicators come out to be contradictory and counterproductive. The end-to-end measures are more generic in nature and can be classified in three sub-categories:

Assets related:

- Cash to Cash Cycle time: Inventory days of Supply + Days of Sales outstanding - average payment period for materials (time it takes for a Rupee to flow back into a company after it has been spent for raw materials)
- Inventory days of Supply: Total gross value of inventory at standard cost before reserves for excess and obsolescence divided by Cost of goods sold (COGS) and multiplied by 365 days
- Asset turns: Total Net product revenue divided by Total net assets

Costs related:

- Cost of goods sold (COGS): The cost related with buying raw materials and producing finished goods. This cost includes direct costs (labour, materials) and indirect costs (overhead)
- Supply chain management cost: The costs associated with the supply chain including execution, administration and planning
- Value added productivity: Total product revenue less material purchases divided by total employment in full time equivalents
- Warranty cost: Warranty costs include materials, labour and problem diagnosis for product defect

Customer service related:

- Fill rates: The percent of orders shipped within 24 hours of order receipt. For services, this metric is the proportion for services that are filled so that the service is completed within 24 hours
- Perfect Order fulfilment: The percent of orders that are delivered complete, on time, with complete documentation and in perfect condition
- Delivery performance to Customer commit date: The percent of orders that are fulfilled on or before the original scheduled or committed date
- Responsiveness lead-time: The average elapsed time, including all delays, to receive a customer order and transform resources into goods and services, through to the point of customer receipt. (assuming zero inventories in the system)
- Production flexibility: Number of days required to achieve an unplanned sustainable 20 percent increase in deliveries

A key component to successful transformation of individual business units into a fully operational supply chain is to design Performance Measurement System (PMS) with a holistic supply chain focus. Hence, there is now an increasing focus on supply chain measures and the overall performance. This also implies that each entity will be held responsible for the overall performance and not only own performance (Gunasekaran et.al, 2001). The arguments for the development of PMS for supply chains are many. Gunasekaran et al. (2004) mentions that control of supply chain processes through measurement is crucial in improving performance and that managers will be more likely to reach overall corporate goals and business strategies with the support of a PMS. Within supply chain management, performance measurement also facilitates inter-understanding and integration among supply chain members.

The next section discusses the broad frame work in which fresh produce distribution system functions which includes various distribution functions like packaging, transportation, storage and temperature control, spoilage and retailing. This will be useful in understanding of the concept of fresh produce distribution system and its performance measurement in the perspective of supply chain.

3.4 FRESH PRODUCE DISTRIBUTION SYSTEMS IN INDIA

Fresh produce distribution system includes all activities of handling and movement, loading and unloading, grading, packaging, storage and subsequent dispersal through the markets to consumers. In addition, the important secondary functions like production planning, production and dissemination of market information, financing of markets, the activities of marketing intermediaries, training and extension to individuals and groups involved in marketing and research activities which seek to improve the marketing system as a whole (Mangal et.al, 2007).

The marketing systems will evolve to satisfy the needs of the consumers and the producers. This depends on the types of producers, consumers, and relation to each other in terms of distance, transport and communication links, and the consumer's preferences. In the marketing process initially farmers sell their produce to consumers who live close to them in a rural place reasonably in a self-sufficient area. The farmer sells the rest of the produce to the immediate community for local consumption. The marketing of a single fresh produce commodity can involve different individuals and organisations, who are largely unknown to each other and they must communicate in a precise way in order to complete the sales activity.

Fresh produce includes all fresh fruits and vegetables which are inherently perishable commodities. The physical distribution of fresh produce often results in significant level of post-harvest losses through quality decline, physiological spoilage and pathological spoilage from pest and disease or simply from over-supply to a market that cannot absorb the volume sent to it (Venkatesan et.al, 2010). These post-harvest losses frequently occur because of improper application of the post-harvest practices and also the considerations including production planning.

The channel is an important aspect of agricultural distribution which affect the prices paid by consumers and shares of them received by the producer. If the channel is shorter then there will be low market costs and cheaper commodity price to the consumer. In case of any lengthy channels which include more number of intermediaries, results in high prices to consumer in which the producer's share is less (Singh & Chauhan, 2004). The channel which provides commodities at cheaper price to consumer and also ensures greater share to producer is considered. The following table indicates the various commodity groups and the producer's share in consumer's price. It is noticed that the producers share in food grains is ranged from 55 to 65 percent. In case of fruits and vegetables the producer's share is 30 to 50 percent.

Table 3.1: Producer's share in consumer's price in different commodity groups

Sl.No	Commodity group	Producer's share
1	Food grains	55 to 65%
2	Other commodities	60 to 70%
3	Fruits	30 to 40%
4	Vegetables	40 to 50%

Source: Tamil Nadu Agriculture University (TNAU) Agritech Portal

The following typical channels are mostly used in fresh fruits and vegetables distribution system across the country.

i. Producers–consumer (village sale)
ii. Producer–retailer–consumer (local sale)
iii. Producer–trader—retailer–consumer. (district level)
iv. Producer–commission agent–trader-retailer–consumer (Inter district level)
v. Producer–primary wholesaler–secondary wholesaler– retailer– consumer (distant market in the region).
vi. Producer – pre-harvest contractor – commission agent – secondary wholesaler – retailer–consumer (Inter-State level).

These channels have enormous influence on distribution costs such as transport, commission charges, etc. and market margins received by the intermediaries such as trader, commission agent, wholesaler and retailer. The channel is considered to be efficient when the produce available to the consumer at the cheapest price also ensures the highest share to the producer (TNAU Agritech, 2010).

3.5 FRESH PRODUCE PACKAGING

A package is created when fresh produce is brought together and contained. The package could possibly contain different types, sizes, grades, or stages of maturity of produce. The package is to provide a more convenient and efficient unit for the marketing of produce and allow for the weighing of produce as well as handling and transport to be accomplished in fewer steps. The package should protect the produce at all stages of the distribution process from the producer to the consumer (Barbosa, 2007).

Fresh produce is inherently perishable and needs to be protected particularly from mechanical damage inflicted during handling. Mechanical injury to a produce, including cuts, compressions, impacts and vibration rubbing, will all lead to wounding and bruising of the produce and will seriously shorten the marketable life of the produce (Kalia &Gupta, 2008). Packaging also has a role to play in acting as the interface with the environmental conditions. Fresh produce must be ventilated or it will die from lack of oxygen, fruits such as bananas must be ventilated in the package if they are to be ripened with ethylene (Paine &Paine, 1992).

3.5.1 Types of Packages

There are different types of package available throughout the world, many of which have been carefully evaluated with respect to produce and market systems, at the same time the other type of packages are adopted for general use without evaluation. Package types include sacks and nets, wooden crates, plastic crates, baskets, pallet boxes and other such shipping containers (Mangal et.al, 2007). The various uses, advantages and disadvantages of each of these packaging types are described in coming sections in detail.

3.5.2 Sacks and Nets

The sacks and nets of various description, sizes and materials are widely used in Andhra Pradesh for domestic and regional marketing of root crops such as sweet potato, dasheen, brinjal, carrot, pumpkin and fruits including citrus. The material used for the sacks may be woven natural fibres or more commonly nowadays the synthetic materials especially polypropylene. The disadvantage of sacks as packaging materials is difficult to clean and sterilise and allow the build-up of decay organisms during multiple uses (Barbosa, 2007).

3.5.3 Baskets &Wooden Crates

The baskets have the advantage that they are relatively cheap and are made from locally available and readily renewable resources. The basket offers extremely little protection to the produce when several baskets or other containers are stacked on top of each other. In addition, because of their spherical shape they may be rolled around. However, this rolling around is one of the worst features of the basket because the weight of the produce inside distorts the shape of the basket and the produce is alternately rubbed against the rough interior and crushed by the produce around it (Stephen,1988).

Wooden crates are relatively resistant to different weather conditions and offer good ventilation for the produce. In addition, wooden-crates are often the only suitable container for very large commodities such as water melon. The disadvantages of wooden crates are chiefly concerned with the material itself. Untreated wood can easily become contaminated with decay organisms and may be difficult to wash effectively and keep clean. In addition, the rough surface of the wood may injure the produce unless it is planed down and/or a liner is used with the package (Singh et.al, 2006).

3.5.4 Plastic Crates, Paper, Plastic Film and Plastic Bags

The plastic crates have a long lifetime and used on rental basis for many journeys unless transport, wholesale and retail is closely integrated. The plastic crates are not suitable for the export markets. Plastic crates are manufactured in variety of specifications and always preferred choice for packaging raw fresh produce from field to traders (Singh et.al, 2006). Paper or plastic film is widely used as lining material and dividers for other forms of packaging. Shredded paper or plain Kraft paper helps prevent produce rubbing together or against the package walls and is generally only used with high value delicate commodities.

3.6 TRANSPORTATION OF FRESH PRODUCE

Transportation is often the most costly factor in the marketing channel. The method of transportation for fresh fruits and vegetables is determined by distance, perishability and the value of the product. The principle reasons for losses in transport of the fresh produce are given under:

- Loading and unloading
- Longer transmit times
- Physical injuries during transit
- Shake and movement during the handling
- Overheating and Water loss
- Lack of preservative condition
- Lack of maintain of relative humidity and air circulation (Philip, 2003).

3.6.1 Handling and Storage during Transportation

Physical distribution of fresh produce inherently means moving the produce. The commodities are handled, manually several times from harvest and through the distribution process before the customer buys them to consume. Handling operations are rarely given much consideration by the individuals directly involved in moving the process, particularly when the produce is only moved short distances. Hand-carts can carry more produce but need to be used on flat-grounds. Trucks are used widely for handling and movement of fresh produce in Andhra Pradesh.

Dropping of packages during loading and unloading is a frequent cause of damage to the produce (Mittal, 2007). The method of loading of the produce in the transport vehicle will depend on the pack, the commodity, the type and size of the vehicle but there must be all the time care to be taken to minimise both the physical and environmental damages.

3.6.2 Road Transportation

For domestic transportation, the use of road vehicle offers considerable advantages of convenience, availability, and flexibility to permit door-to-door delivery and reasonable cost of transport. The fresh produce may be transported by pick-up, enclosed truck, open truck or refrigerated vehicle (Campbell et.al, 1986)

i. *Enclosed vehicle* - this kind of vehicles are suitable for short journeys, unless provided with a cooling system, since the produce inside heats up rapidly. However, they protect the produce from pilferage and physical injury, and are often used for urban retail delivery.

ii. *Open vehicle* - pick-ups and open trucks are the commonest type of road transport in India and especially Andhra Pradesh. They are often fixed with frames to ease stacking and covering. The open vehicles permit natural ventilation which is normally sufficient to prevent overheating of produce. The vehicles are most flexible type has a fixed roof and tarpaulin hangings which can be pulled along the sides and back to allow access for loading and unloading at any point.

3.7 STORAGE & TEMPERATURE CONTROL IN FRESH PRODUCE

In temperate countries much of the production of fruits and vegetables is confined to relatively short growing seasons and thus storage becomes essential for provision of fresh produce out of the harvest season. In tropical countries like India production is often extended but storage may still be necessary or desirable for extended supply to the consumer. Produce may be stored for a few days or weeks as part of the normal marketing process but some temperate produce may also be stored for periods up to 12 weeks. The reasons for storage are:

- Because there is a lack of immediate buyer.
- Because transportation or some other essential facility is not available in time.
- To extend the marketing period and increase the volume of sales.
- To wait for a price increase.

There are various different forms of storage, the choice of which will depend on its cost and the produce to be stored. However, before considering storage of fresh produce there are other factors which must also be taken into account i.e., the maximum storage life of a harvested crop depends on its production history and quality and maturity at harvest. The actual storage life which can be achieved in practice may be quite different and depends upon harvesting and handling procedures and the storage environment.

3.7.1 Temperature and Humidity

Most rapidly maturing tropical fruits, soft fruits of all kinds, and leafy vegetables with a large surface area tend to have high respiration rates and normally have short storage lives. In contrast, most temperate fruits, cured potatoes and onions, and vegetable root crops often have lower respiration rates and consequently longer storage lives. Respiration of all produce increases with temperature which is why all storage techniques aim for a reduction in temperature of the produce.

Lower storage temperatures offer the additional advantage of greatly reduced water loss from the produce with reduced transpiration. High relative humidity slows down water loss and enhances storage life of the produce. Stores should ideally be maintained at the highest relative humidity (RH) that the crop can tolerate. It is important to retain adequate circulation of the air within a store and around the produce to ensure efficient cooling. However, over-rapid air movement can drastically increase water loss by the produce.

3.7.2 Ventilated Storage

Ventilated storage is ambient air storage which makes use of controlled ventilation for cooling of the produce and maintenance of lower temperatures. It requires lower capital investment and operating costs compare to refrigerated storage and is suitable for those crops and conditions where:

- production is being stored for local use;
- the crops to be stored have a relatively long natural storage life;
- regular inspection is possible to remove spoilage centres;
- there is a significant difference between day and night temperatures;
- The need is for relatively short storage periods.

In Andhra Pradesh the tropical monsoon climate has less opportunity for ventilated storage of most commodities beyond a few days. There are a few exceptions in that property onions, garlic, and potato may keep up to two to six weeks. In all the aspects of harvesting, curing, drying and handling are properly addressed and the store itself is thoroughly clean, well ventilated and protected from the rain.

3.8 PERISHABILITY OF FRESH PRODUCE

Fresh fruits and vegetable crops grown in Andhra Pradesh offer the consumer a wide diversity from tropical, subtropical and even temperate commodities depending on the season in which the crops are grown. Most of the fresh produce is highly perishable and it has to reach the consumer in the right condition with appropriate packaging and handling methods.

Failure to address these issues leads to stress on the produce, rapidly followed by spoilage and losses.

All fruits, vegetables and root crops are still alive after harvest. They contain 65 to 95 percent water, depending on the type of produce. For example, watermelons contain about 95 percent water, while potatoes, yams and other starchy root crops are from 65 to 70 percent water (Acharya, 2005). They also contain food materials which enable living processes to continue. As soon as fresh produce is harvested, the processes lead to breakdown; however, it may be slowed up by employing appropriate handling methods after harvest. The conditions to which produce is exposed after harvest will govern its deterioration. These are:

i. The temperature of the produce, which is related to the temperature of the environment, and the heat of respiration of the produce.
ii. The extent of damage inflicted during market operations, including physical and physiological damage.
iii. The moisture content of the environment.
iv. The effect of infection by decay organisms (e.g. fungi or bacteria).

3.8.1 Effect of Injuries

The injuries take many forms including cuts, scraping of outer surfaces, internal and surface bruising, sunburn, heat damage and cold damage (Roy & Thorat, 2008). Their effect on harvested produce is to:

i. Speed up the rate at which water is lost by as much as five times.
ii. Provide sites for attack by decay agents such as moulds and bacteria.
iii. Increase the rate of heat production at injury sites.
iv. Cause dis-colouration due to internal damage.
v. Cause off-flavours to develop.

3.8.2 Effect of Pests and Disease

The post-harvest decay occurs when produce is washed before packaging. The bacteria cause decay requires drying the washed produce. It may also be a problem where concentration of water occurs on the surface of produce when it is moved from cold stores to high ambient temperatures, or when produce is exposed to rain after harvest.

Produce saturated with water, from rain or other causes may become 'soft' and more easily damaged than when dry. This damage not only provides opportunity for infection by decay agents but may in itself leave unsightly surface damage, leading to down-grading and lower prices. This is frequently observed in citrus fruits, where fruit harvested when wet develop the skin blemish. It may not always be possible to keep produce dry but field-men should avoid harvesting freshly wet produce (Ruben, 2007).

All produce mature and become weaker due to the breakdown of cell structure and integrity during storage, marketing and distribution. The produce is thus stressed and less able to withstand invasion and infection by disease organisms. The pests cause serious problem during production of fresh produce which in the tropics must be controlled by the use of careful cultural practices and controlled application of insecticides provided that no harmful residues remain on the crop at harvest. Infested produce at harvest is relatively easy to spot and separate from clean produce (Roy & Pal, 1991).

Post-harvest infection of fresh produce by fungi and bacteria may cause physical injury, water loss and increased respiration leads to rapid deterioration and spoilage of the produce. The bacterial contamination usually occurs due to contact of produce with infected water or by contact with soil-hold bacteria (Moss, 2008).

3.9 WHOLESALING AND RETAILING OF FRESH PRODUCE

Wholesaling is the business of selling comparatively large quantities of fresh produce to retailers or other merchants rather than to consumers. It also serves as the main outlet for nearby growers and, through transporter/traders and commission agents, for those producers further to destination.

The absence of a central wholesale market creates special problems relating to market information and intelligence and the maintenance of stable prices for domestic produce. Without proper market information on daily or weekly prices and produce availability, prices obtained by farmers can and do fluctuate considerably with the result that while a few farmers occasionally benefit from high prices, most may only recover production costs or possibly make a loss.

3.9.1 Retailing of Fresh Produce

Retailing is selling the produce to the consumer and is the last commercial act before fresh produce is consumed. Consequently, the fruits and vegetables offered for sale at retail may have passed through many different hands from the time they were harvested. Post-harvest losses occur at all stages through marketing and distribution but tend to be greater at retail. A significant proportion of the produce purchased by the retailer may never make a sale due to spoilage soon after reception by the retailer, or during storage at his shop (Gajanana, 2010).

Retailing fresh produce is a risk oriented business and the high price mark-ups made by the retailer are necessary to cover the cost of the post-harvest losses as well as the general overheads for the shop and still give a profitable income. The retailers will make more profit if he or she can reduce post-harvest losses by selling more of what they buy. They can sell a greater volume of produce at a slightly lower price and attract more customers and a greater market share. There are four major groups of retailers distribute fresh produce in Andhra Pradesh.

3.9.2 Hawkers, Street Vendors and Market Vendors

The retailers sell their produce in open public places, frequently streets and busy corners where they can attract passing customers. They are opportunistic salesmen often depending on impulse buying of small quantities by the public. Individually, the sales volume of each vendor is relatively small but collectively the volume of produce sold is often very large.

The market vendors' retailers are mostly engaged in selling fresh produce at the busy weekend markets in the cities or towns. Market vendors are more institutionalised in that whether they sell from permanent stalls within the Public Market building or from make-shift and temporary portable stalls in the open outside the market, they must take license or pay stall fee for the benefit. Market vendors are mostly women and may be related to the producer from whom they bought the produce, or they may be independent in their operations. As with the street vendors, the individual sales volume of the market vendor is very small, but collectively is significant even though an ever increasing proportion of fresh produce sales are being diverted to the higher volume shops.

3.9.3 Shops and Supermarkets

The shop keeper sells fresh produce as part of a whole range of consumable items, most of which are not perishable. Although some refrigeration is often in place in the shop, it is not often used for fresh produce but more commonly for dairy products. These shops are temporary structures sell quite high volumes of produce. Farmers with a shop may be selling their own or other farmers produce. However, the roadside shops presently satisfy a need among consumers by offering a convenient supply of freshly harvested produce.

Supermarkets are rapidly becoming the principal retail suppliers in many of the town and cities. Supermarkets usually have some form of refrigerated retail display for fresh produce and the larger supermarkets also have larger refrigerated stores exclusively for fresh produce. The fresh produce may be delivered in a variety of packages, grades and maturities. Considerable skill is needed by the supermarket manager or buyer in selecting the produce if substantial post-harvest losses are to be avoided. Fresh produce is frequently sorted, graded, washed and packed and priced prior to refrigerated retail display.

The above sections explain the concept of supply chains and issues involved in it for the development of framework for the study. The next section of this chapter explains the broad frame work in which the agri distribution function performs and the issues involved in each stage or activity has been described.

3.10 CONCEPTUAL FRAMEWORK OF FRESH PRODUCE SUPPLY CHAIN PEFORMANCE MEASUREMENT

This section of the study proposes the integrated framework. For the purpose of developing relationships, in addition to the supply chain management literature, operations management, marketing, and technology literatures were also considered. The following sub-sections look at the previously mentioned interrelationships in detailed manner. The integrated framework provides overall framework for linkage between SCM dimensions, SCM performance, and organisation performance.

Performance Measurement System (PMS) is defined as "*a system that enables a firm to monitor the relevant performance indicators of products, services and production processes in the appropriate time frame* (Rosenau et al., 1996)*"*. Performance indicators are the criteria with which the performance of products, services and production processes can be evaluated. in addition, performance indicators are operationalized process characteristics, which compare the efficiency and/or effectiveness of a system with a norm or target value (Van der Vorst, 2000). A PMS comprises systematic methods of setting business goals together with periodic feedback reports that indicate progress against those goals (Simons, 2000).

According to Bititci et al. (1997), the integrated PMS provides more comprehensive measurement of entire supply chain performance than single-measure approaches do. The SCOR Model advocates a set of supply chain performance indicators as a combination of:

1. reliability measures (e.g. fill rate, perfect order fulfilment);
2. cost measures (e.g. cost of goods sold);
3. responsiveness measures (e.g. order fulfilment lead-time); and
4. Asset measures (e.g. inventories) (Supply Chain Council,2004)

Beamon (1999) suggested a system of three dimensions (in manufacturing):

1. Resources (i.e. efficiency of operations)
2. Output (i.e. high level of customer service)
3. Flexibility (i.e. ability to respond to a changing environment)

The following section discusses the measurement of performance system exclusive for fresh produce supply chains.

3.11 MEASUREMENT OF FRESH PRODUCE SUPPLY CHAIN PERFORMANCE

The aim of implementing a performance measurement system is to improve the performance of the organisation. Measuring the performance of chains and networks received little attention in the field of food and agribusiness. Fresh produce supply chains have many specifications, which set them apart from other types of supply chains. Examples are: 1) Shelf life constraints for raw materials and perishability of product, 2) Long production throughput time 3) Seasonality in production 4) Physical product features like sensory properties such as taste, odour, appearance colour, size and image 5) Requires conditioned transportation and storage 6) Product safety issues and many more.

This literature review shows that many efforts have been made to develop a PMS for various supply chains. Despite their importance, little attention has been paid in the literature to integrated PMS. To our knowledge no integrated measurement system exists in fresh produce supply chains that combine different aspects of performance (e.g. financial and non-financial, qualitative and quantitative) into one measurement system.

The latest socio-economic developments have resulted in a change in performance requirements for food supply chains as a whole and for all stages in the supply chain. Consumers focus on different attributes of food such as quality, integrity, safety, diversity and services (Van der Vorst, 2005). The use of pesticides and other chemicals has a negative impact on consumers' buying behaviour. As a result, consumers have high demands towards quality aspects like food safety, production characteristics, sensory properties, shelf life, reliability, convenience (Van der Spiegel, 2004). Thus, when developing a PMS for fresh produce supply chains, the indicators that reflect the quality aspects of product and processes are important and together with other financial and non-financial indicators should be included in a PMS.

The following paragraphs discuss a conceptual framework for measuring the performance of fresh produce supply chains. Based on literature review on performance indicators, a conceptual framework for measuring the performance of fresh produce supply chains has been developed (Aramyan et al., 2006). Fresh produce supply chain performance indicators are grouped into four main categories such as efficiency, flexibility, responsiveness and food quality.

These four categories are the outcome of the PMS. Each of these main categories contains more detailed performance indicators (Figure 3.1). The suggested performance indicators can be used at the firm's level as well as at the supply chain level. This means that supply chain members have a common set of performance indicators within four main categories besides their own set of performance indicators. Indicators help firms' to evaluate their own performance and the performance of the chain.

1. Efficiency measures how well the resources are utilised (Lai et al., 2002). It includes several measures such as production costs, profit, return on investment and inventory.
2. Flexibility indicates the degree to which the supply chain can respond to a changing environment and extraordinary customer service requests (Bowersox and Closs, 1996; Beamon, 1998). It may include customer satisfaction, volume flexibility, delivery flexibility, reduction in the number of backorders and lost sales.
3. Responsiveness aims at providing the requested products with a short lead-time (Persson and Olhager, 2002). It may include fill rate, product lateness, customer response time, lead-time, shipping errors, and customer complaints. The specific characteristics of fresh produce supply chains are captured in the measurement framework in the category 'food quality'. The latter is based on the framework of food quality developed by Luning et al. (2002). Food quality is divided into product and process quality.
4. Product quality consists of product safety and health, sensory properties and shelf-life, and product reliability and convenience. Within product safety and health, health (salubrity) refers to food composition and diet. Product safety refers to the requirement that products must be "free" of hazards with an acceptable risk. Sensory perception of food is determined by the overall sensation of taste, odour, colour, appearance and texture, which are determined by physical features and chemical composition.
5. The shelf-life of a product is defined as *"the time between harvesting or processing and packaging of the product, and the point in time at which it becomes unacceptable for consumption"*. Product reliability refers to the compliance of actual product composition with product description, and convenience relates to the ease of use or consumption of the product for the consumer (Luning et al., 2002).

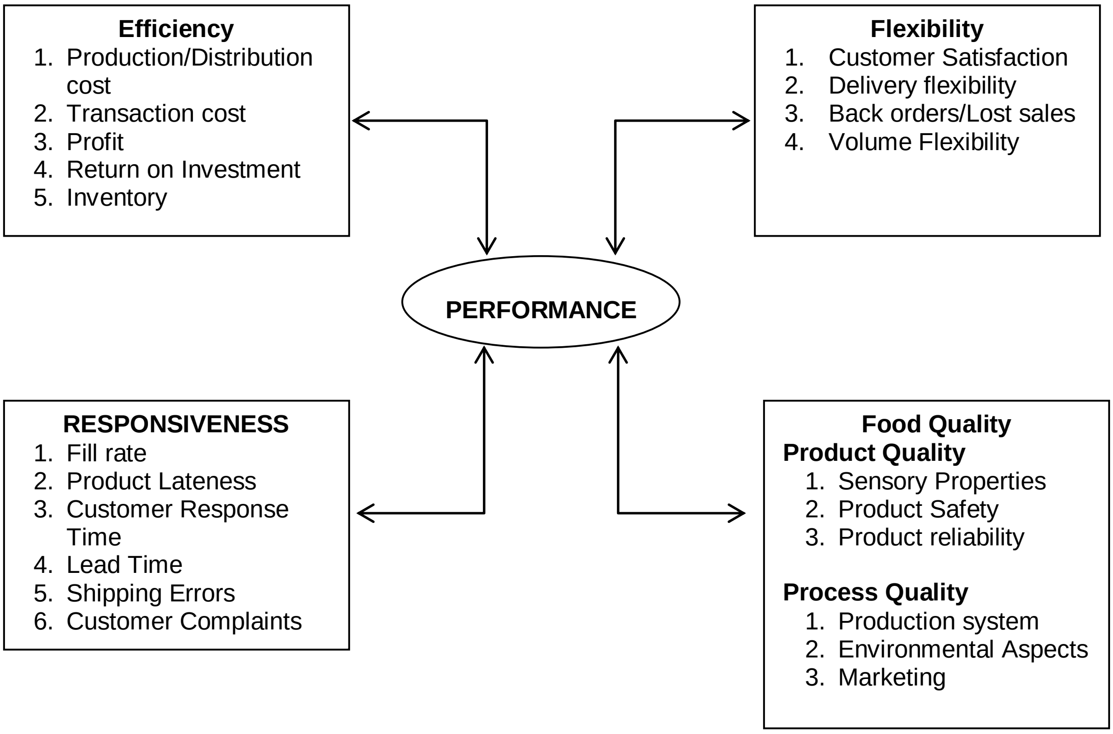

Figure 3.1: Performance indicators used to measure agri-produce supply chains
Source: Aramyan et.al (2006)

6. Process quality is divided into production system characteristics, environmental aspects; and marketing. Production system characteristics refer to the way a food product is manufactured and includes such factors as pesticides used, animal welfare and the use of genetic engineering. Environmental implications of fresh produce products refer mainly to the use of packaging and food waste management. Marketing efforts determine quality attributes (e.g. promotions, service), affecting quality expectation (Luning et al., 2002).

The following table 3.2 describes and defines the key performance indicators used in measuring the performance of fresh produce distribution system in Andhra Pradesh. The table also describe how the performance of indicators is measured.

Table 3.2: Definitions of performance indicators used in the framework

Categories	Indicators	Definitions	Measure
Efficiency	Production costs/ distribution costs	Combined costs of raw materials and labour in producing goods/combined costs of distribution, including transportation and handling cost	The sum of the total costs of inputs used to produce output/services (fixed and variable costs)
	Transaction costs	The costs other than the money price that are incurred in trading goods or services (e.g. searching cost, negotiation costs, and enforcement costs)	The sum of searching costs (the costs of locating information about opportunities for exchange), negotiation costs (costs of negotiating the terms of the exchange), enforcement costs (costs of enforcing the contract)
	Profit	The positive gain from an investment or business operation after subtracting all expenses	Total revenue less expenses
	Return on investments	A measure of a firm's profitability and measures how effectively the firm uses its capital to generate profit	Ratio of net profit to total assets
	Inventory	A firm's merchandise, raw materials, and finished and unfinished products which have not yet been sold	The sum of the costs of warehousing of products, capital and storage costs associated with stock management and insurance
Flexibility	Customer satisfaction	The degree to which the customers are satisfied with the products or services	The percentage of satisfied customers to unsatisfied customers
	Volume flexibility	The ability to change the output levels of the products produced	Calculated by demand variance and maximum and minimum profitable output volume during any period of the time
	Delivery flexibility	The ability to change planned delivery dates	The ratio of the difference between the latest time period during which the delivery can be made and the earliest time period during which the delivery can be made and the difference between the latest time period during which the delivery can be made and the current time period
	Backorders	An order that is currently not in stock, but is being reordered (the customer is willing to wait until re-supply arrives) and will be available at a	The proportion of the number of backorders to the total number of orders

		later time	
	Lost sales	An order that is lost due to stock out, because the customer is not willing to permit a backorder	The proportion of the number of lost sales to the total number of sales
Responsiveness	Fill rate	Percentage of units ordered that are shipped on a given order	Actual fill rate is compared with the target fill rate
	Product lateness	The amount of time between the promised product delivery date and the actual product delivery date	Delivery date minus due date
	Customer response time	The amount of time between an order being made and its corresponding delivery	The difference between the time an order is made and its corresponding delivery
	Lead time	Total amount of time required to produce a particular item or service	Total amount of time required to complete one unit of product or service
	Customer complaints	Registered complaints from customers about product or service	Total number of complaints registered
	Shipping errors	Wrong product shipments	The percentage of wrong shipments
Product quality *Sensory properties and shelf life*	Appearance	First sight of the tomato, combination of different attributes (colour, size and form, firmness, lack of blemishes and damage)	Amount of damage, colour scale, size and form scale
	Taste	Determined by the sweetness, mealness and aroma of a vegetable/fruit	Brix value, which is measurement of a soluble dry substance in a liquid (providing an approximate measure of sugar content)
	Shelf life	The length of time a packaged food will last without deteriorating	The difference in time between harvesting or processing and packaging of the product and the point in time at which it becomes unacceptable for consumption
Product quality *Product safety and health*	Salubrity	The quality of the products being healthy and nutritious	Nutritional value and lycopene content
	Product safety	Product does not exceed an acceptable level of risk associated with pathogenic organisms or chemical and physical hazards such as	Lab checks and monitoring processes according to certification schemes

		microbiological, chemical contaminant in products, micro-organisms	
Product quality *Product reliability and convenience*	Product reliability	Refers to the compliance of the actual product composition with the product description	Number of registered complaints
	Convenience	The information provided on the packaging is useful, complete and easy understandable	Number of registered complaints
Process quality *Production system characteristics*	Traceability	Traceability is the ability to trace the history, application or location of an product using recorded identifications	Information availability, use of barcodes, standardisation of quality systems
	Storage and transport conditions	Standard conditions required for transportation and storage of the products that are optimal for good quality	Measure of relative humidity and temperature, complying with standard regulations
	Working conditions	Standard conditions that ensure a hygienic, safe working environment, with correct handling and good conditions	Standard conditions that ensure a hygienic, safe working environment, with correct handling and good conditions Compliance with standard regulations
Process quality *Environmental aspects*	Energy use	The amount of energy used during the production process	The ratio of cubic meters of gas used per square meter of glasshouse
	Water use	The amount of water used during the production process	The ratio of litres of water used per square meter of land under the vegetables
	Pesticide use	A permitted amount of pesticides used in the production process	The amount and the frequency of pesticide use complying with standard regulations
	Recycling/reuse	Collected used product from crop, packaging, etc., that is disassembled, separated and processed into recycled products, components and/or materials or reused, distributed or sold as used, without additional processing	Percentage of materials recycled/reused

Process quality *Marketing*	Promotion	Activities intended to increase market share for product (e.g. branding, pricing and labelling)	Increase in number of customers and sales
	Customer service	The provision of labour and other resources, for the purpose of increasing the value that buyers receive from their purchases and from the processes leading up to the purchase	Ratio of provision of recourses used to increase customer service to increased sales
	Display in stores	Demonstration of the product in the store	Increase in number of customers and sales

Sources: Beamon (1998, 1999), Bowersox and Closs (1996), Hobbs (1996), Van der vorst (2000), Persson and Olhager (2002), Lai et al. (2002), Womack and Jones (2002), Gunasekaran et al. (2001), Supply Chain Council (2004), Berry (2006), Luning et al. (2002), Van der Spiegel (2004), Valeeva (2005), Beamon (1999), Aramyan et al.(2005)

CHAPTER – IV

SUPPLY CHAIN MANAGEMENT PRACTICES IN FRESH PRODUCE DISTRIBUTION SYSTEM

The present chapter analyses supply chain practices in fresh produce distribution system focusing on grading, storage, packaging, buffer stock levels methods used for cultivation and use of pesticides. This chapter also describes performance measures such as shelf life, product lateness, delay in delivery time, loss of produce during distribution, satisfaction on services offered by transporters, customer complaints, customer response time and produce quality aspects such as loss of appearance, freshness and edibility.

4.1 SUPPLY CHAIN PRACTICES AT CHAIN LEVEL

A descriptive analysis on the supply chain management practices at distribution chain level is discussed initially and the issues exclusively concerned with individual supply chain entities such as farmers, traders and retailers are discussed separately in later sections of the chapter.

4.1.1 Grading of Fresh Produce

The primary objective of grading produce is to segregate the spoilt produce without delay as a result the quality of entire lot of fresh produce is preserved. At the farmers' level it is observed that the grading activity performed is poor. Table 4.1 shows that about three-fourths of farmers do not undertake any grading exercise as their focus is primarily on disposing off their produce to AMC markets for trading immediately after harvest. The produce is offered for sale at AMC market not later than the next day, therefore the time delays are reduced and freshness is preserved. In the next level of supply chain (Traders' level) 53.2 percent of the traders grade the produce based on the parameters like quality, quantity and maturity level.

In some occasions grading activity is partly performed at the farmer level. This depends on the relationship between the farmer and the trader. At retailers' level, 60.8 percent of the respondents reported that they grade the produce based on maturity level, size, colour and weight. It is also observed that most of the retailers buy graded fresh produce from the traders. The traders determine the prices on the basis of the grading. Of the total respondents, it is observed that only 39 percent of respondents grade the produce while 61percent do not.

Table 4.1: Availability of grading facilities

	Farmers	Traders	Retailers	Total
NO	221 (72.5%)	29 (46.8%)	47 (39.2%)	297 61.0%)
YES	84 (27.5%)	3 (53.2%)	73 (60.8%)	190 (39.0%)
Total	305 (100%)	62 (100%)	120 (100%)	487 (100%)

4.1.2 Cleaning and Washing of Fresh Produce

Cleaning and washing plays a very significant role in preserving the freshness of the produce. Table 4.2 shows that from the total respondents, about 67.1 percent do not perform the cleaning and washing measures prior to selling produce to next level. The farmers harvest crop and fill it in the plastic crates to transport them immediately to AMC markets. They strongly believe that cleaning and washing of produce will reduce the quality and fasten the ripening process. Farmers have an opinion that cleaning/washing is an important activity at retailers' level to attract the customer by presenting fresh and quality produce.

Table 4.2: Availability of cleaning and washing facilities

	Farmers	Traders	Retailers	Total
NO	218 (71.5%)	36 (58.1%)	73 (60.8%)	327 (67.1%)
YES	87 (28.5%)	26 (41.9%)	47 (39.2%)	160 (32.9%)
Total	305 (100%)	62 (100%)	120 (100%)	487 (100%)

It is observed that the farmer removes unnecessary plant debris such as plant leaves, foreign bodies, etc. from the banana and tomato produce. Hence, the cleaning is completed partly at farmer level itself. It is observed that at the farmers' level washing is performed only by 28.5percent but at traders stage this percent increased to 58.1. This is because the traders are more concerned with protecting the produce from spoilage while shipping produce to distant places for retailing. In case of Retailers, it is observed that only 39.2percent actually perform cleaning tasks in order to make the produce appear fresh to the customers.

4.1.3 Cold Storage & Cold Logistics Facilities

It is observed from the study that the facilities available for storage in the vicinity of the farming fields are moderate. Basically tomato and banana are not stored in cold storages due to their physical properties but generally stored in ventilated storages which give an appropriate storing temperature conditions ranging from 10°C to 15°C. Cold storages are not used for storage owing to their physical and biological properties and it is also observed that the cost of storing is much higher for banana and tomato and shelf life may be extended to a maximum of 10 days hence, the farmer's sometimes dispose-off the produce even for low prices.

Table 4.3: Availability of cold logistics facilities

	Farmers	Traders	Retailers	Total
NO	229 (75.1%)	51 (82.3%)	90 (75.0%)	370 (75.9%)
YES	76 (24.9%)	11 (17.7%)	30 (25.0%)	117 (24.1%)
Total	305 (100%)	62 (100%)	120 (100%)	487 (100%)

The cold logistic containers maintain an appropriate temperature to preserve the freshness and quality of the fresh produce. The organised retailers have their own facilities for storing and transporting the fresh produce within the temperature conditions. Table 4.3 reveals that about 75.9 percent of the respondents stated that there are no cold logistics facilities and only 24.1 percent respondents declared that there are limited facilities in cold storage which are offered by modern retail firms as a part of their retail procurement function. The response from the farmers (75.1 percent), traders (82.3 percent) and retailers (75 percent) voice a comparatively similar opinion in this regard.

4.1.4 Information on Cultivation Methods (Traceability)

Traceability of agricultural products is the ability to locate an agricultural product and re-trace its history in the supply chain forward (from source to consumer) or backward (from consumer to source) by means of recorded identification. It relies on three key pillars of information in order to be effective: identification of products, identification of premises and movement tracking.

Farmers provide the information to the traders about the variety of the crop and seeds they have used in cultivation. The specific information on the use of pesticides, fertilisers, post-harvest treatments is not being shared with the immediate supply chain partner. Table 4.4 reveals that about 83.9 percent of the farmers do not provide any information on cultivation except generic information.

Table 4.4: Information on cultivation methods

	Farmers	Traders	Retailers	Total
NO	256 (83.9%)	53 (85.5%)	113 (94.2%)	422 (86.7%)
YES	49 (16.1%)	9 (14.5%)	7 (5.8%)	65 (13.3%)
Total	305 (100%)	62 (100%)	120 (100%)	487 (100%)

Information on source of procurement, date of harvest, instruments used in cultivation, pesticide residue level are not provided to the customer by any of the supply chain partners namely the farmer including the trader or retailer who also fail to provide information to the next level in the supply chain. On the whole, the supply chain appears to have a shortage of information considering the responses provided by the farmers (83.9 percent), traders (85.5 percent) and retailers (94.2 percent).

4.1.5 Maintenance of Buffer Stock

Farmers generally prefer not to hold buffer stock due to immediate need for liquidation and the belief that produce may perish if they hold it for few days. Table 4.5 revealed that a limited number of farmers hold buffer stock for a very limited period of time i.e. a day or two, for realisation of better prices. This situation would be different if there are adequate and appropriate storage facilities to maintain buffer stocks at low cost. Retailers hold the buffer stock for a relatively longer duration of 2 to 5 days.

Table 4.5: Maintenance of buffer stocks by supply chain partners

	Farmers	Traders	Retailers	Total
NO	215 (70.5%)	19 (30.6%)	7 (5.8%)	241 (49.5%)
YES	90 (29.5%)	43 (69.4%)	113 (94.2%)	246 (50.5%)
Total	305 (100%)	62 (100%)	120 (100%)	487 (100%)

Buffer Stock Levels

As per the data given in table 4.6, the farmers who maintain buffer stocks limit the stock up to 20 percent (92.2 percent farmers) and the rest up to 21-40 percent (7.8 percent farmers). About 72.1 percent of the traders hold a stock ‘up to 20 percent’ and 27.9 percent of the traders hold buffer stock between 21 to 40 percent whereas retailers maintain stocks between 21 to 40 percent to avoid stock-out situations.

Table 4.6: Buffer stock levels maintained by supply chain partners

	Farmers	Traders	Retailers	Total
0 - 20 percent	83 (92.2%)	31 (72.1%)	73 (64.6%)	187 (76.0%)
21- 40 percent	7 (7.8%)	12 (27.9%)	12 (27.9%)	40 (35.4%)
Total	90 (100%)	43 (100%)	113 (100%)	246 (100%)

From the total respondents 76 percent of the respondents hold stocks up to 20 percent and about 35.4 percent of respondents store the stocks between 20-40 percent and rest of respondents face stock-out situation as they do not maintain the buffer stocks.

4.1.6 Awareness on the Use of Pesticides & Chemicals

The Government has set a standard for the use of pesticides and chemicals. These standards determine the optimal level of pesticide residues that can be permitted in fresh produce considering their negative effects on the consumers’ health when they are used in higher quantities.

Table 4.7: Use of pesticides and chemicals as per the standards

	Farmers	Traders	Retailers	Total
NO	214 (70.2%)	36 (58.1%)	90 (75.0%)	340 (69.8%)
YES	91 (29.8%)	26 (41.9%)	30 (25.0%)	147 (30.2%)
Total	305 (100%)	62 (100%)	120 (100%)	487 (100%)

If the crop is attacked by pests and predators resulting in loss of yield it leads to losses to the farmers. In other words it affects the overall revenue accrued by the farmers as observed from the study in the farmers lacking awareness on usage of pesticides and set standards combined with a shortage of services being provided by agricultural extension officers who are required to fill this knowledge gap that affects the consumers and farmers equally.

The Table 4.7 reveals that supply chain partners are lacking awareness on standards set by the government. About 70.2 percent of farmers use pesticides higher than the quantity prescribed by agricultural extension officers as they lack complete awareness on quantity to use and its adverse effects. It is also observed that most of the time the pesticide dealers provide information to farmers on what brand to use, how to use, and what quantity to be used. Farmers also gain knowledge on the use of pesticide brand and quantities from their fellow-farmers.

The middle men apply chemicals on the fresh produce for preservation, freshness and to speed up the ripening process. The middle men are also not aware of the pesticide residue levels and the quantity to be used. Apart from the farmers, about 58.1 percent of the traders and 75 percent of the retailers do not use the pesticides as per the standards specified by government mechanisms. Overall, it is observed that only a 30.2 percent of the respondents said that they are using pesticides as per the given standards not exceeding the given limit to avoid higher pesticide residue level.

4.1.7 Measures to Improve Shelf Life

Farmers take precautionary measures in fresh produce transportation and storage by effective packaging. For tomato produce plastic crates are predominantly used in transportation whereas for banana produce the packaging is made using the banana leaves. Traders give more importance for packaging to ensure preservation of the produce for longer shelf life. In the AMC markets produce is kept in unhygienic conditions which may cause perishability. The methods adopted for improved shelf life is very minimal and will not hold good for a longer period.

Table 4.8: Measures to improve shelf life

	Farmers	Traders	Retailers	Total
Refrigeration	20 (6.6%)	14 (22.6%)	99 (82.5%)	133 (27.3%)
Cold Logistics	55 (18.0%)	8 (12.9%)	0 (0.0%)	63 (12.9%)
Effective Packaging	217 (71.1%)	40 (64.5%)	0 (0.0%)	257 (52.8%)
Washing & Cleaning	10 (3.3%)	0 (0.0%)	21 (17.5%)	31 (6.4%)
Chemical Treatment	3 (1.0%)	0 (0.0%)	0 (0.0%)	3 (0.6%)
Total	305 (100%)	62 (100%)	120 (100%)	487 (100%)

The retailers clean and wash the fresh produce to remove foreign bodies so that the produce is not spoilt and freshness is preserved. Table 4.8 reveals that 71.1 percent of the farmers and 64.5 percent of the traders using effective packaging as a measure to improve shelf life but in retailers' case 82.5 percent of the respondents use refrigeration for shelf life improvement.

The use of cold logistics is very poor in the process of shelf life improvement. On the whole, 27.3 percent of total respondents employ refrigeration as an alternative method to improve shelf life. It is also observed that chemical treatment is done by only 0.6 percent of the total respondents. Mere washing, cleaning and packaging of produce does not increase the shelf life to the maximum extent and it needs post-harvest treatment. The chemical treatment is not practiced for improving the shelf life due to cost implications and lack of knowledge on the same. Besides, there is lack of specialised chemical treatment facilities available in the fresh produce markets.

4.1.8 Transportation of Fresh Produce

Farmers use auto rickshaws and two wheelers for the transportation of fresh produce from the fields to the market for the simple reason that the cost of transport is low and they are the reliable mode in villages. Small farmers can afford the auto rickshaw to easily transport small quantities of produce. Traders use trucks, auto rickshaws and two wheelers in transportation of fresh produce. Only when large quantity of fresh produce is to be shipped to a distant place, trucks are used.

Table 4.9: Mode of fresh produce transportation

	Farmers	Traders	Retailers	Total
Truck/Lorry	0 (0.0%)	18 (29.0%)	20 (16.7%)	38 (7.8%)
RTC Bus	3 (1.0%)	3 (4.8%)	7 (5.8%)	13 (2.7%)
Tractor	17 (5.6%)	0 (0.0%)	0 (0.0%)	17 (3.5%)
Auto Rickshaw	91 (29.8%)	20 (32.3%)	86 (71.7%)	197 (40.5%)
Bicycle/Two wheelers	194 (63.6%)	21 (33.9%)	7 (5.8%)	22 (45.6%)
Total	305 (100%)	62 (100%)	120 (100%)	487 (100%)

From table 4.9, it is seen that about 40.5 percent and 45.6 percent of the total respondents use auto rickshaw and two wheelers for transportation of fresh produce respectively. About 63.6 percent of respondents at farmers' level use bicycles/two wheelers whereas 29.8 percent of farmers employ auto-rickshaws for transportation.

The traders prefer both trucks and auto-rickshaws for transportation but are not using trains for transportation of both banana and tomato distribution. The local traders hire bicycles to transport banana to the retailers. In the case of retailers, about 71.7 percent respondents said they were using auto-rickshaw for transportation for retailing fresh produce such as tomato whereas local retailers use two wheelers and RTC buses for transportation of produce. Auto rickshaws and bicycles play a major role in transportation of fresh produce whereas in larger AMC markets–the transport modes like trucks, lorries, tractors and auto-rickshaws are employed.

4.1.9 Product Lateness

There is a considerable time gap between promised delivery time and the actual delivery time of the product. Table 4.10 indicates that the farmers supply the produce immediately within 6 hours as and when they receive the order in harvest period. This is due to pre-agreed contracts/agreement between the farmer and the trader. It is reported by the respondents that traders communicate with the farmers to have a forward agreement as to when the crop reaches harvest, as a result in many situations the produce is supplied within 24 hours time.

Traders maintain good relationships with the retailer and vice versa. Some of the traders maintain buffer stock of fresh produce hence they fulfil the requirement of the retailer immediately. In majority of the cases the trader will supply the produce within 24 hours. In case of emergency requirement, the trader contacts the farmer and asks them to replace the quantity demanded immediately.

Table 4.10: Product lateness in supply of fresh produce

	Farmers	Traders	Retailers	Total
0 to 6 hours	153 (50.2%)	18 (29.0%)	67 (55.8%)	238 (48.9%)
6 to 12 hours	86 (28.2%)	26 (41.9%)	20 (16.7%)	132 (27.1%)
12 to 24 hours	30 (9.8%)	15 (24.2%)	20 (16.7%)	65 (13.3%)
24 hours and more	36 (11.8%)	3 (4.8%)	13 (10.8%)	52 (10.7%)
Total	305 (100%)	62 (100%)	120 (100%)	487 (100%)

For distant place orders the traders ask for 2-3 days time to refill their demand but these situations do not occur frequently. It is witnessed in many a retailers' case that, in stock out situation they approach the traders for immediate replacement. If traders are not in a position to replace, they buy the produce from AMC market even at higher prices to meet the customer demand. Hence, majority of the retailers replenish their stock within 0-12 hours. Overall, the fresh produce is supplied at a very convenient time so that the demand is fulfilled. Around 89.3 percent of fresh produce is supplied within 24 hours. The supply chain relationships play a crucial role in delivery. In fresh produce, supply is highly disjointed and only telephonic communications are used in coordinating the supply chain. Coordination is not there in the entire supply but sufficient coordination between the two immediate chain partners perhaps exists.

4.1.10 Occurrence of delay in delivery

The delay in delivery time is an important determinant of the supply chain performance and shows the extent of delay between the supply chain partners. Table 4.11 shows that the respondents said that there is always a delay of in delivery of about 4 percent among the farmers 14.5 percent among traders and 2.5 percent among retailers. In most of the occasions the delay in delivery time of fresh produce was found to be 32.8 percent among farmers 22.6 percent among traders and 19.2 percent among retailers.

Table 4.11: Occurrence of delay in fresh produce distribution

	Famers	Traders	Retailers	Total
Always	13 (4.3%)	9 (14.5%)	3 (2.5%)	25.0 (5.1%)
Most of the occasions	100 (32.8%)	14 (22.6%)	23 (19.2%)	137.0 (28.1%)
Half of the occasions	105 (34.4%)	23 (37.1%)	56 (46.7%)	184.0 (37.8%)
Seldom	61 (20.0%)	13 (21.0%)	28 (23.3%)	102.0 (20.9%)
Never	26 (8.5%)	3 (4.8%)	0 (8.3%)	39.0 (8.0%)
Total	305 (100%)	62 (100%)	120 (100%)	487.0 (100%)

In half of the occasions the delay seems to be more among retailers compared to traders and farmers. Delay seldom occurred in 20 percent of farmers, 21 percent of traders and 23.3 percent of retailers. Delay never occurred in 8.5 percent of the farmers, 4.8 percent of traders and 8.3 percent of retailers. Thus, there is a need to reduce the delay in delivery time of fresh produce at the respective supply chain partner level. The lost demand is one of the adverse effects of delay in delivery time of fresh produce. This can be addressed by establishing coordination and communication with transport operators and supply chain partners.

4.1.11 Loss of Produce in Distribution System

Most of the time, the fresh produce is damaged during transit due to long waiting time of loading and unloading. It is observed from table 4.12 that in all stages there is a minimum of 10 percent of transport perishability. From the total respondents, about 58.1percent respondents reported that there is up to 10 percent perishability whereas 25.7 percent of the respondents reported that the perishability ranges within 10-20 percent. Road conditions in rural areas are poor which contributes to the damage of the produce. Particularly, farmers are at a loss while transporting the produce from fields to AMC because the quality of the produce is affected due to lack of protection.

Table 4.12: Percent of fresh produce damaged during transportation

	Farmers	Traders	Retailers	Total
0 to 10 percent	185 (60.7%)	35 (56.5%)	63 (52.5%)	283 (58.1%)
10 to 20 percent	70 (23.0%)	21 (33.9%)	34 (28.3%)	125 (25.7%)
20 to 30 percent	50 (16.4%)	6 (9.7%)	23 (19.2%)	79 (16.2%)
Total	305 (100%)	62 (100%)	120 (100%)	487 (100%)

The total loss of 10-20 percent occurs in fresh produce at the farmer, trader and retailer levels at the rate of 23 percent, 33.9 percent and 28.3 percent respectively. The loss of 20 to 30 percent is reported by farmers and retailers at 16.4 and 19.2 percent respectively. It is also observed that traffic jams, bumpy roads in cities are contributing to perishability during transit. Most of the time, the produce is exposed to extreme temperatures and wind which intensifies ripening process leading to shortened shelf-life. At the retailers' level, the perishability is a little higher compared to the farmers and traders because the produce needs to reach long distances for retail consumption.

4.1.12 Satisfaction on services offered by Transport Operators

Table 4.13 indicates that around 30 percent of the farmers are satisfied with services and about 38.7 percent of the farmers are dissatisfied with the services offered by the transport operators. 48.4 percent of the traders are satisfied with the transport operators' services and around 22.5 percent of them are highly dissatisfied. The retailers satisfied from the services offered by transport operators is 34.2 percent and 33.4 percent of retailers are dissatisfied.

Table 4.13: Level of satisfaction of supply chain partners on transport services

	Farmers	Traders	Retailers	Total
Completely dissatisfied	55 (18.0%)	3 (4.8%)	5 (4.2%)	63 (12.9%)
Somewhat dissatisfied	63 (20.7%)	11 (17.7%)	35 (29.2%)	109 (22.4%)
Neither satisfied nor dissatisfied	95 (31.1%)	18 (29.0%)	39 (32.5%)	152 (31.2%)
Somewhat satisfied	73 (23.9%)	18 (29.0%)	27 (22.5%)	118 (24.2%)
Highly satisfied	19 (6.2%)	12 (19.4%)	14 (11.7%)	45 (9.2%)
Total	305 (100%)	62 (100%)	120 (100%)	487 (100%)

The respondents who are neither happy nor dissatisfied with services offered with the transport operators are 31.2 percent of farmers, 28 percent of traders and 32.5 percent of retailers. On the whole 33.4 percent of the respondents are satisfied, 3 percent of the respondents are dissatisfied with services offered by the transport operators.

4.1.13 Price realisation for Fresh Produce

Fresh produce prices are highly volatile and realised in different ways. Many a time, the produce prices are determined by the demand-supply forces. Prices are usually stabilised during the full harvest season and rise at the crop ending season. The prices are determined by the auction system. It is observed from table 4.14 that about 40.7percent of farmers responded that the prices are determined by the demand - supply forces and 20.3 percent of farmers agreed that the prices are determined by them when the supply comes to the declining stage. When the supply to the market is more, the prices are generally determined by the agent and here the role of farmers in determining prices is very low. The study revealed that 16.4 percent of farmers feel that the prices for their fresh produce commodities are determined by agents.

Table 4.14: Method of price realisation in fresh produce market

	Farmers	Traders	Retailers	Total
Demand & Supply forces	124 (40.7%)	11 (17.7%)	13 (10.8%)	48 (30.4%)
Farmer self decided (Seller)	62 (20.3%)	12 (19.4%)	53 (44.2%)	127 (26.1%)
Agent self decided (Buyer)	50 (16.4%)	24 (38.7%)	13 (10.8%)	87 (17.9%)
Government decided MSP	15 (4.9%)	6 (9.7%)	0 (0%)	21 (4.3%)
Combination of above	54 (17.7%)	9 (14.5%)	41 (34.2%)	104 (21.4%)
Total	305 (100%)	62 (100%)	120 (100%)	487 (100%)

The traders (38.7 percent) agreed that the prices are determined by them following more than one method in determining the prices of fresh produce and 19.4 percent of traders also responded that the prices are determined by the demand-supply forces. Even in case of retailers, they follow more than one method to determine the prices for fresh produce and they also expressed that most of the time the prices are determined by farmers (44.2 percent).

On the whole, the fresh produce market has more than one-way to determine the prices. About 30.4 percent of the total respondents reported that the prices are determined by demand and supply forces, 26.1 percent that the farmers decided the price, 17.9 percent attributed it to the agents and 21.4 percent of total respondents reported that a combination of the above has a role in realising prices.

4.1.14 Fill-Rate

The study explored into the fill rate at each level. Table 4.15 reveals almost 90 percent of the respondents are able to fill the demand about of 80 to 95 percent which clearly indicates that there is fulfilment of the basic demands at each level of the supply chain. It has been noted that 66 percent of the farmers are able to the fill 80-90 percent of the fresh produce orders of the next level. Among traders, 67 percent of the respondents are able to fill 85-95 percent of the orders of retailers. Considering the retailers 56 percent come under 85-95 percent fill rate. Overall observation is that approximately ten percent of the total respondents are filling 95-100 percent demand.

Table 4.15: Total fill rate in fresh produce distribution chain

	Famers	Traders	Retailers	Total
100-95 Percent	31 (10.2%)	10 (16.1%)	5 (4.2%)	46 (9.4%)
90-95 Percent	61 (20%)	15 (24.2%)	15 (12.5%)	91 (18.7%)
85-90 Percent	116 (38%)	26 (41.9%)	52 (43.3%)	194 (39.8%)
80-85 Percent	85 (27.9%)	9 (14.5%)	30 (25%)	124 (25.5%)
Below 80 Percent	12 (3.9%)	2 (3.2%)	18 (15%)	32 (6.6%)
Total	305 (100%)	62 (100%)	120 (100%)	487 (100%)

Thus, it is concluded that there is significant fill rates due to an understanding of relationships and mutual benefits in the supply chain. For effective management of the supply chain one can suggest mechanisms that contribute to improving the fill rate and the need for collaborative demand forecasting to reach 100 percent fill rate.

4.1.15 Customer Response Time

The customer response time is calculated to see the difference between the order times and produce delivery times. The study focused on the time taken by the farmers to deliver the fresh produce. Table 4.16 represents the customer response time in fresh produce distribution chain. It was found that 76 percent of the farmers require less than 24 hours to meet the demand in the season of harvest. Among the traders, about 72.6 percent are able to supply and meet the fresh produce demand within 24 hours at any given time.

Approximately 64 percent of the retailers are able to supply within 24 hours. It may be observed that 24 percent farmers, 27 percent traders and 32 percent retailers consume more than 24 hours to deliver the produce to the next entity in the chain. This trend is common due to the following reasons:

1. Harvesting delays
2. Transport delays
3. Weather conditions
4. Market work hours are only in the morning in a fixed time.

Table 4.16: Customer response time in fresh produce distribution chain

	Famers	Traders	Retailers	Total
Up to 6 hours	42 (13.8%)	69 (9.7%)	2 (1.7%)	50 (10.3%)
6 to 12 hours	62 (20.3%)	16 (25.8%)	33 (27.5%)	111 (22.8%)
12 to 24 hours	128 (42%)	23 (37.1%)	47 (39.2%)	198 (40.7%)
1 to 2 days	59 (19.3%)	16 (25.8%)	26 (21.7%)	101 (20.7%)
More than 2 days	14 (4.6%)	1 (1.6%)	12 (10%)	27 (5.5%)
Total	305 (100%)	62 (100%)	120 (100%)	487 (100%)

4.1.16 Customer Complaints

The customer complaints can be described as the number of customer complaints received orally from the downstream customers. The frequency of complaints received has been recorded based on the respondents recall on the quality and delivery aspect of the fresh produce. It is understood from Table 4.17 that nearly 69.9 percent of the farmers received less than 15 complaints and only 30.1 percent received more than 15 complaints. About 69.4 percent of the traders have received up to 15 complaints while 70 percent of the retailers received up to 15 complaints. Thus, retailers and traders receive almost similar number of complaints on quality and delivery aspects of produce.

In general it has been observed that there are no major differences in number of complaints received between the supply chain partners. This can be attributed to the bargaining nature of the customers who complain on quality in order to receive the produce at a lower price. It is essential to note that there is no standardised system of recording complaints in the fresh produce supply chain distribution system to arrive at a scientifically valid interpretation.

Table 4.17: Customer complaints per month received by supply chain partners

	Farmers	Traders	Retailers	Total
1-5 Complaints	27 (8.9%)	5 (8.1%)	3 (2.5%)	35 (7.2%)
5-10 Complaints	69 (22.6%)	14 (22.6%)	34 (28.3%)	117 (24.0%)
10-15 Complaints	117 (38.4%)	24 (38.7%)	47 (39.2%)	188 (38.6%)
15-20 Complaints	85 (27.8%)	18 (29%)	27 (22.5%)	130 (26.7%)
20-30 and Above Complaints	7 (2.3%)	1 (1.6%)	9 (7.5%)	17 (3.5%)
Total	305 (100%)	62 (100%)	120 (100%)	487 (100%)

4.1.17 Loss of Fresh Produce Appearance

Loss of appearance is due to ineffective packaging, damage during transport, microbial activity, multiple handling besides others. A significant contribution to the quality of fresh produce is measured by the loss of appearance. This includes the first sight of tomatoes or bananas in combination of different attributes such as, colour, size, firmness, lack of blemishes and damages.

Table 4.18: Intensity of loss of appearance

	Famers	Traders	Retailers	Total
No loss	11 (3.6%)	5 (8.1%)	4 (3.3%)	20 (4.1%)
Somewhat loss	37 (12.1%)	21 (33.9%)	31 (25.8%)	89 (18.3%)
Moderately	92 (30.2%)	16 (25.8%)	41 (34.2%)	149 (30.6%)
More Loss	126 (41.3%)	18 (29.0%)	34 (28.3%)	178 (36.6%)
Complete Loss	39 (12.8%)	2 (3.2%)	10 (8.3%)	51 (10.5%)
Total	305 (100 %)	62 (100%)	120 (100%)	487 (100%)

It is observed from the Table 4.18 that about 41.3 percent of the farmers, 29 percent of traders, and 28.3 percent of retailers reported more loss. 12.8 percent of the farmers, 3.2 percent of the traders and 8.3 percent of retailers reported that the produce appearance is spoiled in the chain. A total of 47.1 percent of the total respondents said the loss of appearance is high in the chain.

When one compares the no loss of appearance, it is very minimal in fresh produce and averages to 4.1 percent. 48.9 percent of the respondents said there is a moderate loss in fresh produce appearance in the chain.

4.1.18 Loss of Freshness

The factors which contribute to loss of appearance may also cause loss of freshness of the produce. From Table 4.19, it is seen that 14.4 percent of farmers reported no loss of freshness in the produce, about 29.2 percent of farmers said that there was somewhat loss, 31.5 percent of farmers reported moderate loss of freshness, 21 percent reported substantial loss and 3.9% reported complete loss. 33.9 percent of the traders reported no loss of freshness, 30.6 percent reported some loss, 27.4 percent reported moderate loss of freshness and 6.5 percent reported more loss and 1.6 percent reported complete loss of freshness.

Table 4.19: Intensity of loss of freshness

	Famers	Traders	Retailers	Total
No Loss	44 (14.4%)	21 (33.9%)	29 (24.2%)	94 (19.3%)
Somewhat loss	89 (29.2%)	19 (30.6%)	40 (33.3%)	148 (30.4%)
Moderately	96 (31.5%)	17 (27.4%)	37 (30.8%)	150 (30.8%)
More Loss	64 (21.0%)	4 (6.5%)	6 (5.0%)	74 (15.2%)
Complete loss	12 (3.9%)	1 (1.6%)	8 (6.7%)	21 (4.3%)
Total	305 (100%)	62 (100%)	120 (100%)	487 (100%)

Among retailers 24.2 percent mentioned no loss of freshness, 33.3 percent reported some loss and 30.8 percent reported moderate loss of freshness. 5 percent reported more loss and 6.7 percent reported complete loss. Thus, it is concluded that the loss of freshness of produce is more at traders' level and retailers' level. The farmers soon after harvest ship their produce to immediate next level so that the freshness is preserved. In later stages the produce freshness is lost subject to many injuries and varied temperature conditions.

4.1.19 Loss of Edibility

The quality of the food being safe to eat and retaining its nutritional value is given by its edibility. The fresh produce may lose its wholesomeness in the process of distribution. The study attempted to know to what extent the produce loses its edibility in the chain so that necessary supply chain interventions can be applied to prevent the loss. From Table 4.20, it has been observed that the complete loss of edibility is reported to be minimum at 4.5 percent in the entire chain. Around 30 percent of respondents across the farmers, traders and retailers have reported no loss of edibility.

Around 21.8 percent of total respondents reported moderate loss in edibility while 16 percent reported more loss. This demonstrates that the quality of fresh produce can be retained if the loss of edibility is minimised. The majority of the respondents expressed that the produce loses its edibility to moderate extent. No loss of edibility reported by farmers is 29.5 percent, traders 29 percent and retailers 30.8 percent. Somewhat loss and moderate loss can be converted by using appropriate post-harvest technology.

Table 4.20: Intensity of loss of edibility

	Famers	Traders	Retailers	Total
No loss	90 (29.5%)	18 (29.0%)	37 (30.8%)	145 (29.8%)
Somewhat loss	54 (17.7%)	21 (33.9%)	31 (25.8%)	106 (21.8%)
Moderate loss	88 (28.9%)	16 (25.8%)	32 (26.7%)	136 (27.9%)
More loss	65 (21.3%)	2 (3.2%)	11 (9.2%)	78 (16.0%)
Complete loss	8 (2.6%)	5 (8.1%)	9 (7.5%)	22 (4.5%)
Total	305 (100%)	62 (100%)	120 (100%)	487 (100%)

4.1.20 Replenishment of Stocks in Stock-Out Situations

Traders need to respond to the stock-out situations and need to handle such situations immediately in order to effectively handle the customer’s demand. Table 4.21 reveals in majority of the situations produce is refilled within 24 hours and 54.8 percent of the traders responded that the stock is being replenished within 6 to 12 hours. About 14.5 percent of the respondents said that the stock is refilled within 0-6 hours.

Table 4.21: Replenishment time at all levels of supply chain

	Traders	Retailers	Total
0 to 6 hours	9 (14.5%)	40 (33.3%)	49 (26.9%)
6 to 12 hours	34 (54.8%)	47 (39.2%)	81 (44.5%)
12 to 24 hours	7 (11.3%)	14 (11.7%)	21 (11.5%)
24 hours and more	12 (19.4%)	19 (15.8%)	31 (17.0%)
Total	62 (100%)	120 (100%)	182 (100%)

The refilling of stocks at retailer levels is similar to that of traders. Hence, it is observed that at all levels in the distribution chain the fresh produce is replenished within 24 hours. About 44.5 percent of total respondents reported that the produce is refilled within 6 to12 hours and 26.9 percent that the produce is refilled within 0 to 6 hours. Only 17 percent of the respondents said that the produce is refilled after 24 hours. There is much scope for reducing the replenishment time from 24 hours to 12 hours by using effective communication within the chain partners.

4.1.21 Lost Sales

A lost sale is the order that is lost due to stock-out or calculated as the proportion of number of lost sales to the total no of sales. The lost sale is not measured for the farmers but is an important quality indicator for traders and retailers in a supply chain. Table 4.22 shows that about 66.1 percent of traders and 58.4 percent of retailers have a lost sale percent of 3-9 percent. 24.2 percent of the traders and 35.9 percent retailers have been identified in the 9-12 percent and above category of lost sales.

Table 4.22: Lost sales in fresh produce supply chain

	Traders	Retailers	Total
0-3 Percent	6 (9.7%)	7 (5.8%)	13 (7.1%)
3-6 Percent	24 (38.7%)	26 (21.7%)	50 (27.5%)
6-9 Percent	17 (27.4%)	44 (36.7%)	61 (33.5%)
9-12 Percent	11 (17.7%)	35 (29.2%)	46 (25.3%)
12 Percent and above	4 (6.5%)	8 (6.7%)	12 (6.6%)
Total	62 (100%)	120 (100%)	182 (100%)

Thus, the percent of lost sales in general is found to be significantly high among traders and retailers. The stake is higher for retailers compared to traders on lost sales in supply chain of fresh produce. Lost sale can be attributed to the short supply of fresh produce due to various factors including lack of continuous supply of fresh produce.

4.2 SCM PRACTICES AT FARMER'S, TRADER'S & RETAILER'S LEVEL

4.2.1 Information on Ongoing Prices

The information about ongoing prices in the surrounding markets will enable the farmer to sell their produce in different markets and negotiate with the traders for better prices in the existing market. It is observed that cordial relationships are being maintained between farmer- trader and trader- retailer, thus, enabling them to share information on prices of produce in the different markets. Figure 4.1 explains the availability of information on on-going prices at farmers' level. The study revealed that about 55 percent of the respondents are not having any information about prices in the surrounding markets. The farmers dispose their produce for a lesser price due to the need for immediate liquidation to buy inputs for the next crop.

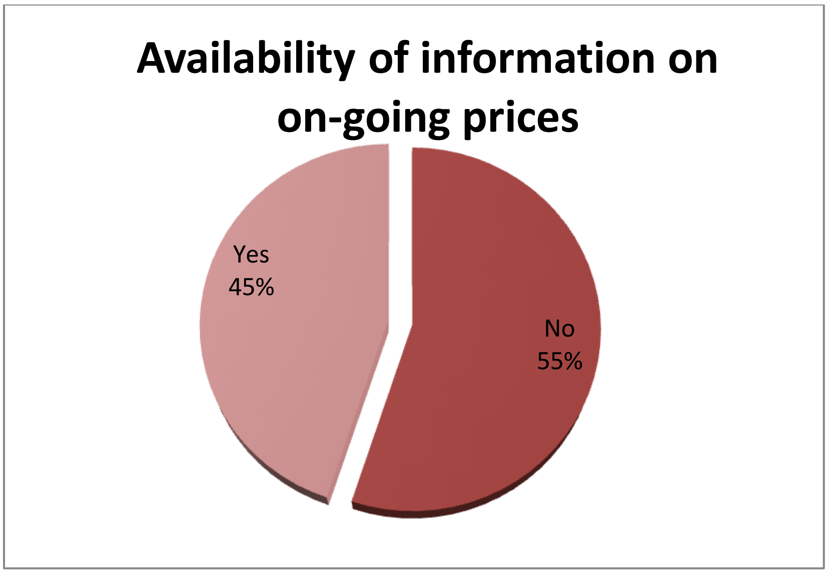

Figure 4.1: Availability of information on on-going prices at farmers' level

There is no information mechanism that is provided by the government on surrounding markets to compare the prices. Only 45 percent of the farmers said that they are informed about ongoing prices in surrounding markets from the fellow farmers. It is crucial and necessary that the AMC provides price related information to all the farmers, traders and retailers through blackboards, signboards and public announcement system.

4.2.2 Relationships with organised Retail Companies

The modern retail companies have innovative supply chain procurement practices. It involves an agreement amongst the company, the traders & farmers for supply of fresh produce in bulk quantities for longer periods at pre-agreed prices or prices that are kept constant irrespective of market fluctuations.

This initiative enables farmers to negotiate an assured demand, better prices and also reduce the cost incurred on transport of produce. The figure 4.2 explains that 45percent of the farmers are already having contacts with such organised retail companies and about 55 percent of the farmers are not associated with organised retailers.

The organised retail firms approach a limited number of farmers who can meet the demand at their nearest retail shop. The retail farms like Reliance Fresh and Heritage have contact with farmers. Even though 45 percent of the farmers have contacts with retailers the actual agreement for procurement is limited to a very small number.

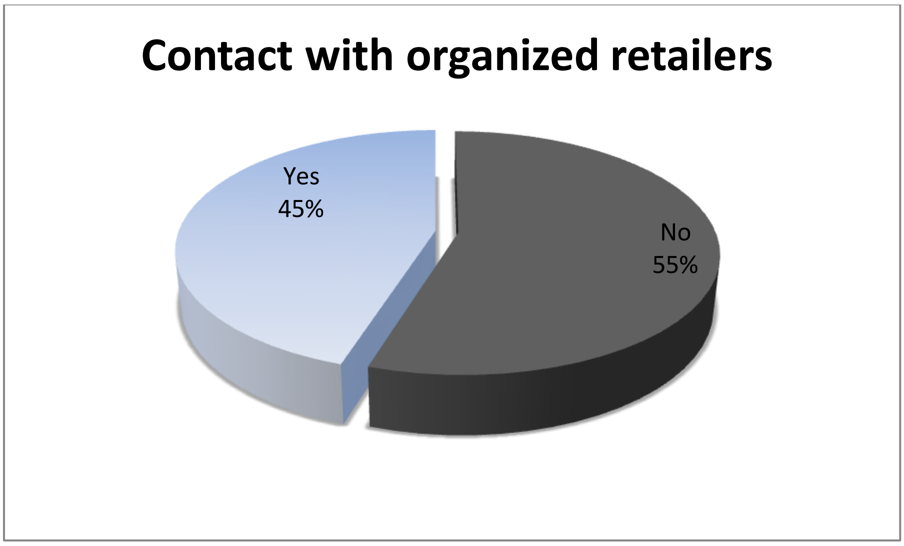

Figure 4.2: Contact with organised retailers at farmers' level

The advantage derived by a retail company out of this kind of arrangement is freshness of produce, stable prices, low market taxes and perfect weight measurement. It is observed that un-organised format of supply chain has more potential in distribution of fresh produce rather than organised due to lower expansion rate of organised retailing and their inability to work in rural areas due to high operating cost.

4.2.3 Difficulties being faced with Respect to Agri-Inputs

In fresh produce supply chain, the procurement of vital inputs like seeds, fertilisers and pesticides play a vital role. When the input cost is more it results in higher cost to the customer. Keeping this in mind, the study attempts to find various difficulties faced by farmers in relation to the procurement of agricultural (Fresh Produce) inputs. Figure 4.3 revealed that 39 percent of 305 respondents are facing difficulty with the high prices of inputs. The dealers charge much above the mark-up price that is determined by the government. They also reported that the formal co-operative set up failed to function when there is a huge need for agricultural inputs.

The private dealers, who are into agri-input trading, take maximum advantage of the scarcity situation that prevails in the market. The farmers report that most of the dealers, sell their inputs on credit so that the farmer will have no voice against the higher price charged by the dealers. This situation is a result of low working capital that the farmers usually possess. The study shows that 31 percent of the farmers are finding difficulty in procuring the agri inputs in time. Due to improper supply of inputs, the farmers are required to wait for longer period until the agri inputs are supplied. The farmers reported that in many situations they have not sown the seeds when they were supposed to.

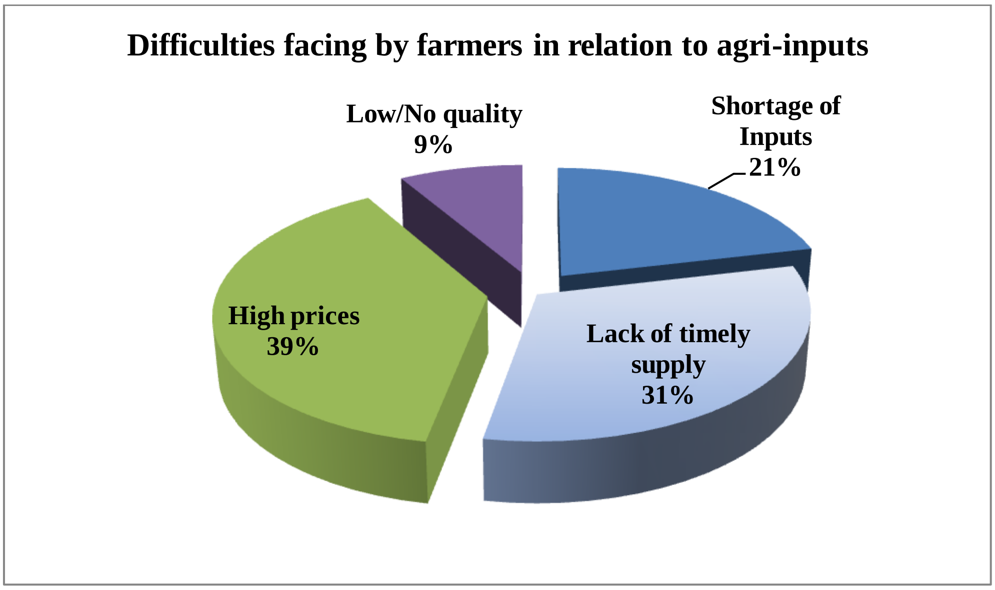

Figure 4.3: Farmers’ difficulties in relation to agri-inputs

About 21 percent of the farmers responded that they are facing shortage of inputs. The farmers not receiving the required quantity of inputs (seeds, fertilisers) are encouraged by the government to resort to rationing to effectively meet the demand. About nine percent of the farmers reported that the poor qualities of inputs are procured from market. Procurement of desired agri-input has been identified as a constraint by every farmer.

4.2.4 Buyers of Fresh Produce Stock

From Figure 4.4, it is observed that 69 percent of respondents from 305 farmers replied that they are selling their produce at the nearest APMC market agents. Large quantities are not being sold in any market because finding buyers for large quantities is very difficult. About 16 percent of the farmers said that they sell the produce to small traditional retail shops (dealing with vegetables only) that approach them directly at APMC market and village level mundi. In fact they replied that selling produce to retail shops directly will reduce the transport cost, reduce the weighing losses and lower the wastage.

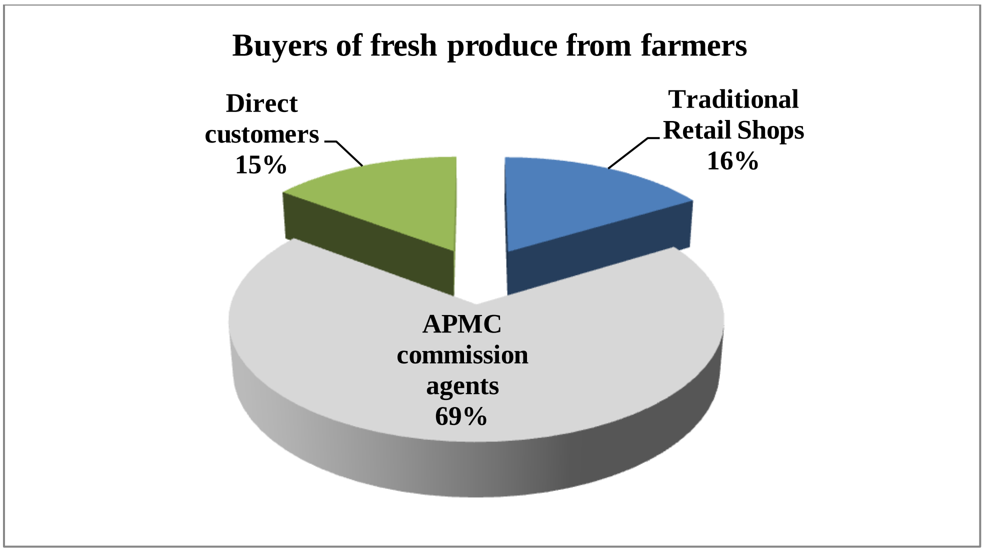

Figure 4.4: Buyers of farmers' fresh produce stocks

About 15 percent of the respondents said that they sell their produce directly to the customers. This kind of marketing occurs only in few cases i.e. whose landholding is less and production is low. The farmers find it is not feasible to sell the produce in AMC market where the prices are low as compared to selling the produce to the direct customers. It is also noticed that no farmer follows a single method of marketing their produce being dependent on the risk taking ability of the farmer.

4.2.5 Consolidation Agents

Consolidation agents are people who gather the produce to a common place to facilitate storing and transportation activity. Consolidation agents collect a fixed amount from farmers or traders. They hire transport vehicles, loading and unloading workers and pay local taxes on behalf of the trader or farmers and recover in turn these expenses from farmers or traders. In some case it was observed that the consolidation agents work more or less as a trader but they will not have trader registration with AMC.

The figure 4.5 revealed that 57 percent of the traders are taking the help of consolidation agents in order to reduce their burden of procurement of fresh produce from villages. The traders whose level of business is very high generally prefer to take the assistance of consolidation agents. About 43 percent of the traders do not take the assistance of consolidation agents or their level of activity is moderate. They also believe that by hiring the consolidation agents, their profits will reduce. Some of the traders reported that the consolidation agents do not pay attention while loading and unloading and gathering produce to a common place resulting in damage of produce and affect their profits.

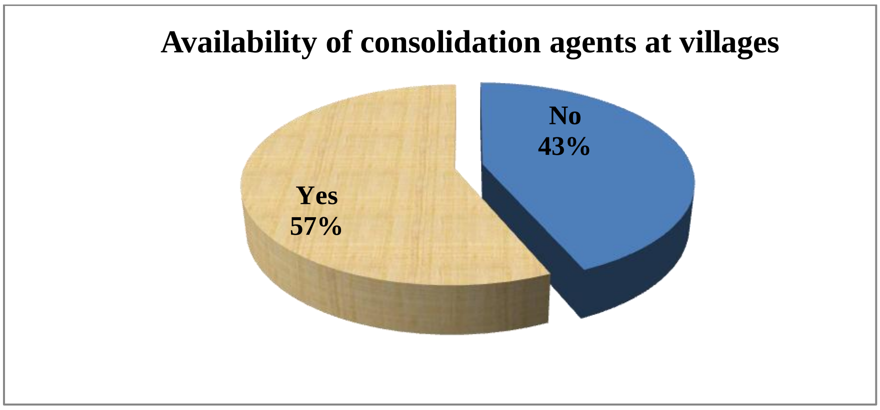

Figure 4.5: Availability of consolidation agents in villages

4.2.6 Packaging Facilities

Packaging plays a key role in protecting the produce from the outside environment. In banana trading banana leaves are used for packaging the produce while moving from one place to another. Tomatoes are packed in plastic crates for transportation. The availability of packaging material will enable the supply chain partners to preserve the produce for longer period making the produce qualitative throughout the chain. To know on the availability of packaging facilities available in AMC and spot markets the farmers are asked to respond on the question. Figure 4.6 shows that about 76 percent of traders reported that packaging facilities are available in rural AMC and spot markets. These facilities are made available to farmers and consolidation agents by traders only, for which the farmer pays a nominal charge.

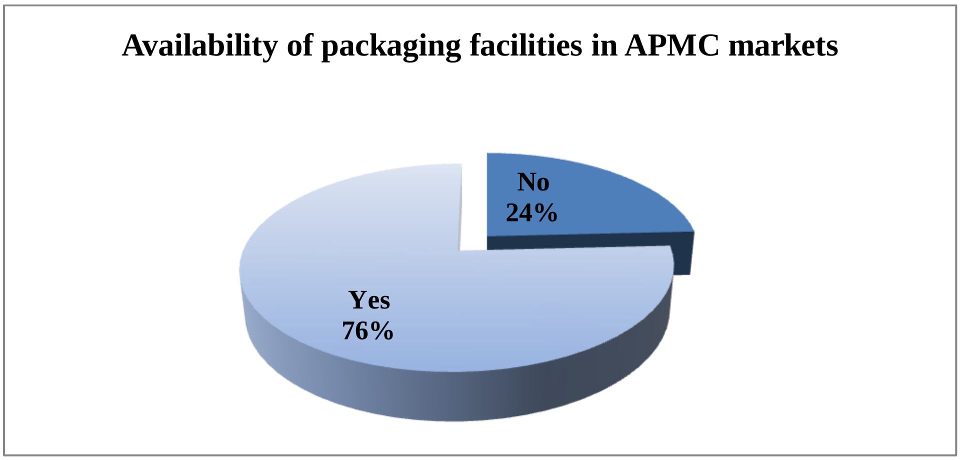

Figure 4.6: Availability of packaging facilities in APMC and spot markets

In case of banana marketing, the leaves are sold to the traders by those farmers whose fields are harvested and the life of the banana crop is ended. In normal cases the produce is packed in AMCs, later loaded into trucks and transported to distant places. About 24 percent of the traders reported that they do not have packaging facilities at AMC and spot markets. This indicates that the packaging facilities are not available uniformly in all the AMC markets. Usually the AMC has licensed staff to meet the packaging requirement separately.

4.2.7 Volume of Produce buying from Farmers daily by Traders

The study also attempted to find out the quantum of produce that each traders buy in a single day from farmers or consolidation agents. This exercise enables to assess the financial capacity of the traders. Figure 4.7 revealed that about 63 percent of the traders buy up to 10 tons of fresh produce from the farmers and consolidation agents. About 27 percent of the traders buy fresh produce to the extent of 11-20 tons per day and nearly 10 percent of the traders said that they buy up to 21-30 tons per day.

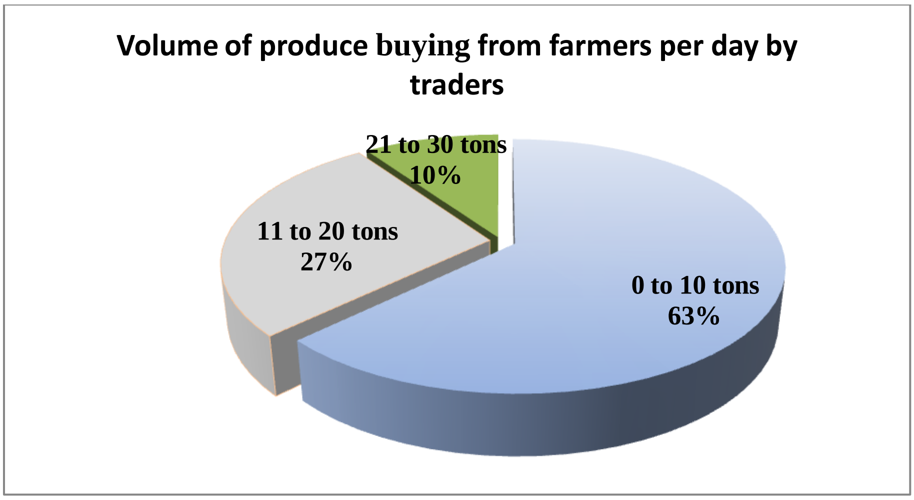

Figure 4.7: volume of produce buying from farmers per day by traders

This indicates that there are small, medium and large traders in terms of volume of sale in an approximate ratio of 6:3:1 respectively. Majority of the fresh produce is traded by the small traders only. The ratio of small, medium and large traders is more or less similar to the ratio of small, medium and large farmers.

4.2.8 Problems Faced by Traders in AMC Markets

The study explored various problems faced by the traders in AMC markets and how they address the problems in view of improving the efficiency of the supply chain. Figure 4.8 shows problems faced by traders at AMC markets. The traders (39 percent) responded that they are facing difficulty with the facilities available. It is observed that most of the AMC markets are lacking infrastructures like auction platforms, road transportation and lighting facilities.

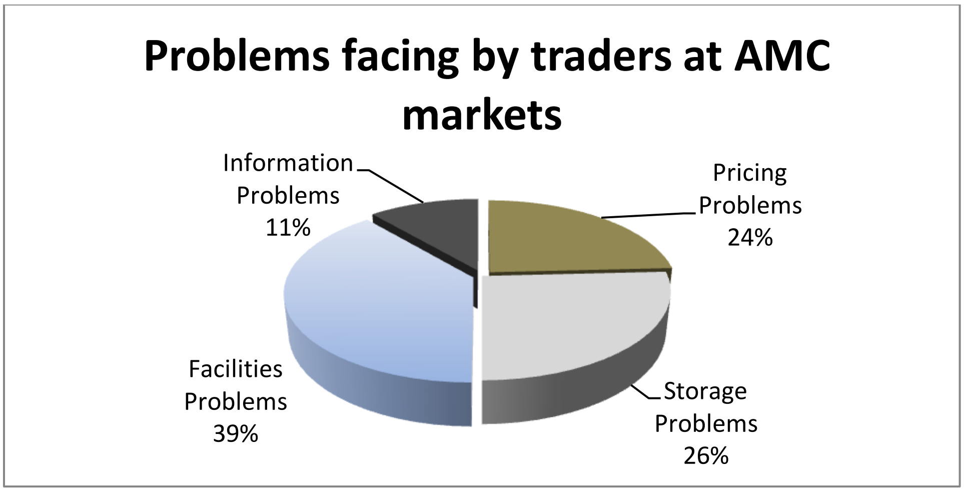

Figure 4.8: Problems faced by traders at AMC markets

About 26 percent of the respondents reported that they are facing difficulty with the storage related facilities. It is observed that the traders store the produce in a safe place for few hours/day before the produce is sold to the retailer and in the meanwhile the produce is packed and necessary post-harvest treatment is finished. Due to lack of storage space in the AMC markets, the traders are disposing the fresh produce even for a lower price. Traders (about 24 percent) responded that they are facing difficulty with pricing. The traders often find difficulty with volatile supply and prices. Traders (about 11 percent) held that they were not informed about the ongoing prices in surrounding markets.

4.2.9 Information on on-going prices of fresh produce in markets

It is observed from Figure 4.9 that 67 percent of the retailer respondents found out the price of fresh produce through news papers which are a common media for providing price information on a regular basis facilitating the knowledge of commodity prices in different cities. About 11 percent of the retailers said the source of information on prices is through AMC information bulletins & signboards. The AMC price lists display whole sale prices and thus can only guide the retailers to determine the FP prices.

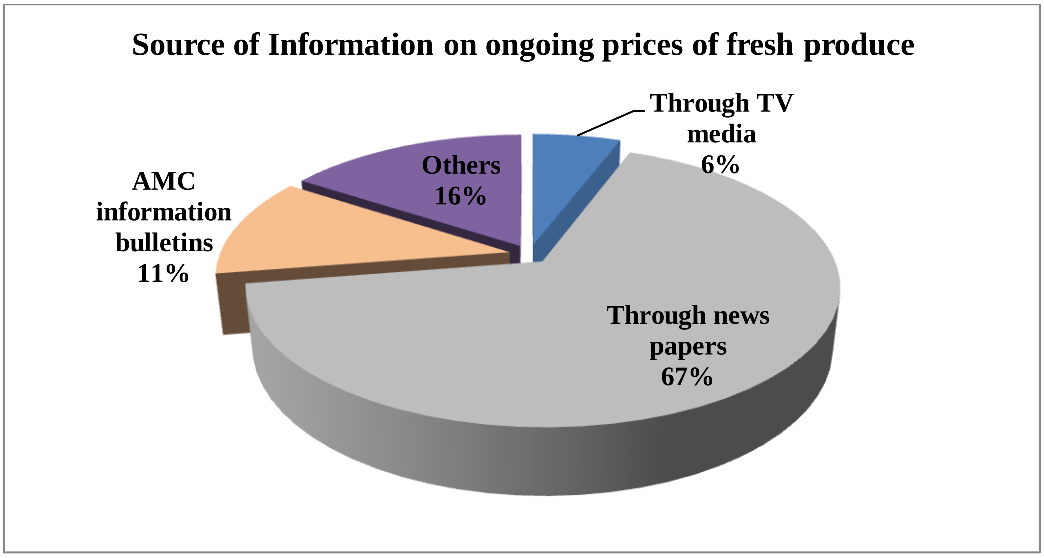

Figure 4.9: Information on on-going Prices of fresh produce by retailers

About 16 percent of the retailers get information from fellow retailers', traders and Rythu bazaars about prevailing prices and only 6 percent of the retailers know the prices patterns from electronic media like TVs which provide market prices bulletin and provide regular price variations of fresh produce.

4.2.10 Source of Procurement of Fresh Produce by retailers

Retailers procure their fresh produce from different sources depending on the distance and quantity. Figure 4.10 revealed that about 72 percent of the retailers procure the fresh produce from AMC markets. Retailers find more varieties in AMC markets and they buy them in bulk quantities by which the price options available are widened. About 11 percent of the retailers procure produce from the whole sale merchants.

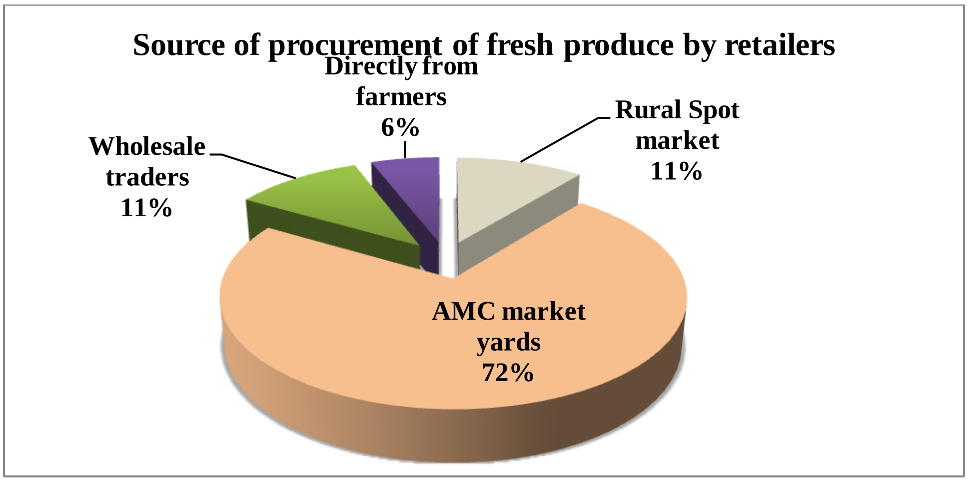

Figure 4.10: Various source of procurement of fresh produce by retailers

These merchants buy bulk quantities from traders and sell their produce to retailers. 11 percent of the retailers told that they are procuring the fresh produce from rural spot market. Usually retailers get fresh qualitative produce at an affordable price. About 6 percent of the retailers responded that they procure the produce directly from the farmers. This is not the usual practice and not followed at all times except when there is extreme shortage of fresh produce.

4.2.11 Customer Response Time for Retail Counter Sale

Figure 4.11 revealed that 63 percent of the retailers respond to the customer's request at the counter. About 13 percent of the respondents said that they respond within 5-10 minutes due to the heavy rush at the counter for weighing, measuring and counting of produce. Sometimes the retailers crowd the market and are seen waiting for their turns in long queues for weighing of fresh produce and counting cash.

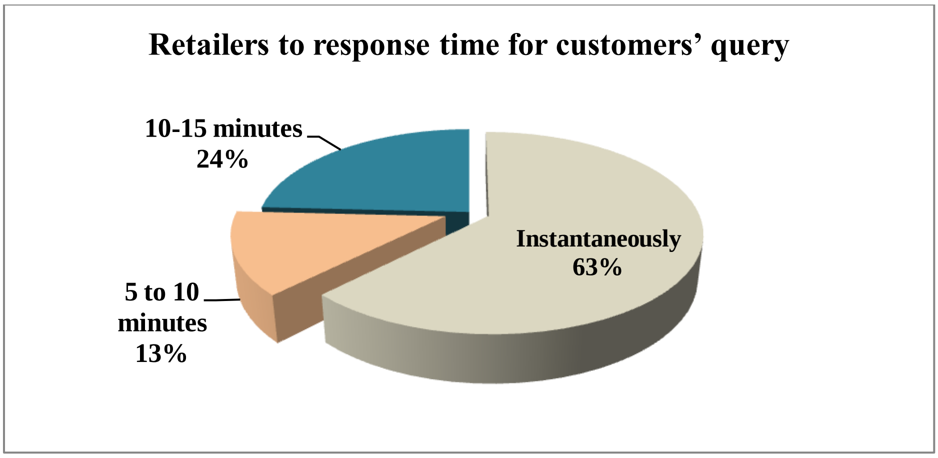

Figure 4.11: Time taken by retailers to respond for customers' query

This inconveniences the customers who are made to wait for long hours at the counter. About 24 percent of the respondents wait at the counter for 10-15 minutes due to special request for fresh produce to be supplied or for any complaint that needs to be addressed.

4.3 CONCLUSION

The present study analysed the generic fresh produce supply chain practices and it is found that grading, cleaning, washing, and maintaining of buffer stocks are not followed considerably by the chain entities. Farmers have negative apprehensions and stated that cleaning and washing activities of fresh produce lead to reduction in quality and shelf-life. The study reveals that information management across supply chain is not being shared among the supply chain partners hindering the percolation of the concept of supply chain management in fresh produce sector.

The study also observed delays and spoilage in the downstream of the supply chain and the need for establishment of moderate temperature chambers in village and AMC levels to reduce the ripening speed and enable the farmers to hold the stock for a longer period, until effective price is realised. Delay in delivery and replenishment time in stock-out situations are found high among the supply chain partners and can be reduced by appropriate sharing of information. The study concludes that most of the supply chain practices in fresh produce distribution are traditional and need to be modernised.

The next chapter will examine the factors influencing the transport performance and factors influencing the perishability of fresh produce using the regression model. The chapter also analyses the most prevalent type of wastage in fresh produce distribution, overall customer satisfaction, mean time of different supply chain activities and test the various hypotheses framed for this study.

CHAPTER – V

TRANSPORTATION AND PERISHABILITY IN FRESH PRODUCE SUPPLY CHAIN

Transportation is a vital aspect in fresh produce logistic system. The effective transportation will not only reduce the delays in delivery and wastage but also preserve the freshness in produce. The present chapter discusses the various supply chain factors that contribute to the transport performance and analyses the factors contributing to perishability with a view to reduce the wastage in the distribution chain. In addition to causal analyses, fresh produce supply chain activities mean time and mean rank analysis for most prevalent wastage are analysed, hypotheses are tested and results discussed in the subsequent sections.

5.1 CAUSAL STUDY ON TRANSPORT PERFORMANCE

Transportation in a logistics system is usually an intermediary that facilitates the physical flow of goods from a point of origin (i.e., shipper) to a point of destination (i.e., consignee). Firms in transport logistics perform the physical distribution function to move goods from one place to another (Coyle et al., 1996). The Transport performance is a measure to evaluate the efficiency and effectiveness of service to meet the goals of all parties, i.e., shipper, service provider and consignee (Kleinsorge et al., 1991).

The dimensions of transport performance are service effectiveness (for shippers and consignees) and operational efficiency (for transport service providers). From these dimensions of transport performance various attributes are identified to study the performance of road transport operation in the fresh produce supply chain. The independent variables that have relationship with transport performance are taken from the literature (Rosendo et.al, 2009; Huang Zu-hui et.al, 2007; Directorate of agriculture, 2005; Van der Spiegel, 2004; Simatupang and Sridharan, 2002; Lai et al., 2002; Van der Vorst, 2000; Handfield and Nichols, 1999; Herbig & O’Hara, 1996;). The independent variables have been cross checked with truck operators, farmers, traders and retailers to identify those variables that are important in their day to day transport operations. Transport Performance (y) is the major dependent variable which is influenced by the nine independent variables (x1 to x9).

Transport Performance (y): It is a dependent variable to measure and evaluate overall performance of road transport services offered by an operator to meet logistics goals. It is considered as a key performance indicator of business while assessing overall performance of the chain. Transport operators move the fresh produce from any point of origin to any point of destination within the distribution chain in a specified time so as to minimise the perishability. The overall performance of transportation is influenced by the number of independent variables in transport operations. The relationship between the dependent variable and independent variable is expressed as follows.

$$\text{Transport Performance (Y)} = \text{f}\{X1, X2, X3, \ldots . X9\}$$

Independent variables (x_1 to x_9): Transport performance of the fresh produce transport operators influence with the operational variables such as frequency of services, vehicle capacity, loading and unloading time, availability of special equipment, skills of driver and loss during the transit due to internal or external conditions like temperature, moisture humidity and cleanliness.

i)	X1	=	Capacity of vehicle (Capacity)
ii)	X2	=	Loss or Damage during transit (Damage)
iii)	X3	=	Frequency of services (Frequency)
iv)	X4	=	Time taken to load and unload (Load Unload)
v)	X5	=	Information sharing (Information)
vi)	X6	=	Reliability of delivery (Reliability)
vii)	X7	=	Availability special equipment (Equipment)
viii)	X8	=	Skills of drivers (Skills)
ix)	X9	=	Condition of vehicle (Equipment)

Prior to running of regression model, the Pearson’s correlation statistic has been run to determine the variability among the dependent and independent variables for which the following correlation matrix (Table 5.1) has been generated. The Pearson correlation coefficient indicates that there is no incidence of strong correlation that exists positively with the coefficient value ranging from 0.6 to 1.0 among independent variables. It indicates that there is an absence of multi-colinearity among the variables. Consequently, a multivariate statistical technique, multiple regression method is run to analyse the cause and effect relationship. After running the multiple regression analysis, it is observed that Eigen values in the multi-colinearity diagnostic matrix were found to be more than 1.0 for all the variables hence no independent variable is dropped from the regression model.

Table 5.1: Correlations of transport performance variables

	Trans_ Perfor-mance	Capacity	Damage	Freque ncy	Load_ unload	Infor mation	Relia bility	Equip ment	Skills	Condi tion
Trans_ Performance	1									
Capacity	0.646*	1								
Damage	0.693*	0.126	1							
Frequency	-0.622*	-0.272	0.096	1						
Load_unload	-0.739*	-0.169	0.342*	0.43	1					
Information	0.673*	0.273*	0.273**	0.137	-0.015	1				
Reliability	0.633*	0.113	0.236	0.021	0.014	-0.062	1			
Equipment	0.706*	0.196	-0.076	-0.133	-0.092	-0.109	-0.137	1		
Skills	0.714*	0.226**	-0.177	-0.035	-0.211	0.185	-0.199	0.292**	1	
Condition	0.604*	-0.343	0.03	0.122	0.164	-0.094	-0.011	-0.48	-0.57	1
*. Correlation is significant at the 0.05 level (2-tailed).										
**. Correlation is significant at the 0.01 level (2-tailed).										

From the Table 5.2, it is observed that the coefficient of multiple determination (R) is 0.842. The variation in the dependent variable is explained by 79.6 percent through the quadratic relationship with the predictor which appears to be significant for making predictions. From the Table 5.2, Durbin–Watson value of 2.236 indicates there is no presence of autocorrelation among the independent variables.

Table 5.2: Multiple Regression[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.842[a]	.796	.748	.607	2.236
[a] Predictors: (Constant), capacity, damage, frequency, load-unload, information, reliability, equipment, skills, condition					
[b] Dependent Variable: Trans_performance					

Table 5.3 reveals that there is a significant contribution of predictors (capacity, damage, frequency, load-unload, information, reliability, equipment, skills, condition) on transport performance which is denoted by ANOVA statistic value of 23.883 and explained by the probability value i.e., 0.000.

Table 5.3: ANOVA[b]

	Sum of Squares	Df	Mean Square	F	Sig.
Regression	54.792	9	6.088	23.883	.000(a)
Residual	14.020	55	.254		
Total	68.812	64			
[a] Predictors: (Constant), capacity, damage, frequency, load-unload, information, reliability, equipment, skills, condition					
[b] Dependent Variable: Trans_performance					

In regression with multiple independent variables, the coefficient tells how much the dependent variable is expected to increase when that independent variable increases by one, holding all the other independent variables constant. Table 5.4 lists all the coefficients of variables which indicate reliability of delivery (Reliability), information sharing (Information), time to load and unload (Load_unload) and capacity of vehicle (Capacity) that are observed to be statistically significant at 0.05 level which indicates that these variables will influence the performance of transport in the fresh produce distribution system.

Table 5.4: Coefficients[a]

Model	Variables	Unstandardised Coefficients		Standardised Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	.173	.630		.274	.785
	Reliability	.261	.080	.270	3.285	.002
	Condition	.082	.111	.071	.737	.466
	Information	.908	.096	.789	9.504	.000
	Frequency	.073	.080	.073	.912	.368
	Equipment	.034	.087	.036	.397	.694
	Skills	.016	.100	.015	.157	.876
	Damage	-.183	.094	-.194	-1.950	.059
	Load-unload	-.221	.097	-.211	-2.277	.028
	Capacity	.195	.088	.214	2.200	.034
[a] Dependent Variable: Trans_performance						

From the Table 5.4, the multiple regression model is depicted as:

$$y = 0.173 + 0.261\ x_1 + 0.082\ x_2 + 0.908\ x_3 - 0.073\ x_4 + 0.034\ x_5 + 0.016\ x_6 - 0.183\ x_7 - 0.221\ x_8 + 0.195 x_9$$

The other independent variables such as Loss or damage during transit (Damage) and Time to load and unload (Load-unload) have negative regression coefficients. The performance of the transport (Trans_performance) is high when the loss or damage during transit (Damage), time to load and unload (Load-unload) is less in fresh produce transportation. The rest of the independent variables have insignificant effect on the transport performance as the P-value is higher than 0.05.

5.2 CAUSAL STUDY ON PERISHABILITY

Fresh fruits and vegetable crops grown in Andhra Pradesh offer the consumer a full assortment of commodities depending on the season. Most fresh produce crops are highly perishable though have an extended shelf life owing to the high water and food material content even after the harvest. The fresh produce must reach the consumer in the right condition and marketed with appropriate packaging and handling methods. If any of supply chain firm fails to address these issues it possibly leads to spoilage and losses. Hence the present study has made an effort to identify the variable that causes the perishability of fresh produce using Regression model.

Perishability (y): Perishable products worse in quality over time, and become lesser in value. The common perishable goods include Fruits and vegetables, Dairy and Aquatic products which are examples of time and temperature-sensitive perishable products that can spoil easily. The literature review and the interviews with the supply chain partners revealed that the perishability of fresh produce is affected by several independent variables (X1 to X9). The relationship between the perishability (Y) and the independent variables that affect the perishability (X1 to X9) is expressed as follows.

$$\textit{Perishability } (Y) = f\{X1, X2, X3, \ldots. X9\}$$

Independent variables (x_1 to x_9): Perishability of the fresh produce will be influenced by many factors which fall under technical and non-technical categories. The technical category variables are concerned with the science of horticulture that deals with seeding/planting of fresh produce crop to the post-harvest management whereas, Non-technical factors deals with marketing and logistics of fresh produce. In this study the independent variables which are highly contributing to the perishability (combination of technical and non-technical variables) are considered. The independent variables X1 to X9 are identified from the literature (Mittal, 2007; Kishore et.al, 2006; Sudha et.al, 2005; Meena & Yadav, 2004; Sreenivasa et.al, 2004; Cantwell, 2002; Allende et.al, 2002; Reid, 2002; Sharma et.al, 1995; Harvey, 1978) as the most prominent independent variables that have a significant relationship with the fresh produce perishability. The independent variables (X1 to X9) are given as under.

i) X1 = Damage during the harvest by the farm men (PR_farm_men).
ii) X2 = Road conditions causes the physical damage to the fresh produce (PR_physical_damage),
iii) X3 = Lack of effective packaging (PR_lack_packaging),
iv) X4 = Living organism like Bacteria, Fungus, insects etc. (PR_living_organism),
v) X5 = Non-removal of foreign bodies causes perishability (PR_foreign_bodies),
vi) X6 = Lack of plastic crates during the transportation (PR_plastic_crates),
vii) X7 = Lack of cleaning and washing (PR_washing),
viii) X8 = Lack of enough care while loading and unloading (PR_care_load_unload),
ix) X9 = Lack of effective care during road transport (PR_packing_perishability),

Prior to the running of the regression model, the Pearson's correlation analysis has been run to determine the variability among the independent variables. The following correlation matrix Table (Table 5.5) has been generated. The Pearson correlation co-efficient indicates that no incidence of strong correlation exists positively with the coefficient value ranging from 0.6 to 1.0 among independent variables. It indicates that there is no multi-collinearity among the variables. Consequently, a multivariate statistical technique and multiple regression model are applied to analyse the data. The Enter method is selected for running the Regression model.

Table 5.5: Correlation among perishability variables

	Perishability	Farm_men	Physical_damage	Lack_packaging	Living_organism	Foreign_bodies	Plastic_crates	Washing	Care_load_unload	Packing_perishability
Perishability	1									
Farm_men	.623*	1								
Physical_damage	.732*	.346**	1							
Lack_packaging	.639*	.299**	.124*	1						
Living_organism	.783*	.118*	-0.08	0.04	1					
Foreign_	.682*	.145*	0.098	0.013	.168**	1				

Bodies										
Plastic_ crates	.823*	.328**	0.086	.167**	.234**	0.04	1			
Washing	.648*	0.091	0.09	0.03	.181**	.247**	0.007	1		
Care_ Load_Unloa d	.776*	0.035	0.075	0.063	0.02	-0.025	0.059	-0.103	1	
Packing_ perishability	.603*	0.056	-0.015	0.004	.120*	0.042	0.003	0.085	-.212**	1
*. Correlation is significant at the 0.05 level (2-tailed).										
**. Correlation is significant at the 0.01 level (2-tailed).										

The R-square of the regression model is the fraction of the variation in the dependent variable that is accounted for (or predicted by) independent variables. (In regression with a single independent variable, it is the same as the square of the correlation between your dependent and independent variable.) The R-squared is generally of secondary importance, unless main Adjusted R-Square makes accurate predictions.

In this study, the Table 5.6 describes the model summary and indicates coefficient of multiple determination (R) is 0.773. The variation in the dependent variable is explained by 65.9 percent through quadratic relationship with the predictor which appears to be significant for making predictions. From the Table 5.6, Durbin–Watson value of 1.841 indicates there is no autocorrelation among the independent variables.

Table 5.6: Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.773a	.659	.635	.286	2.058
[a] Predictors: (Constant), PR_packing_perishability, PR_lack_packaging, PR_farm_men, PR_plastic_crates, PR_care_load_unload, PR_physical_damage, PR_living_organism, PR_foreign_bodies, PR_washing					
[b] Dependent Variable: Perishability					

Table 5.7 indicates that there is a significant contribution of predictors (PR_packing_perishability, PR_lack_packaging, PR_farm_men, PR_plastic_crates, PR_care_load_unload, PR_physical_damage, PR_living_organism, PR_foreign_bodies, PR_washing) on Perishability which is denoted by F value of 8.595 and explained by the probability value 0.000.

Table 5.7: ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.337	9	.704	8.595	.000a
	Residual	4.260	52	.082		
	Total	10.597	61			

[a]. Predictors: (Constant), PR_packing_perishability, PR_lack_packaging, PR_farm_men, PR_plastic_crates, PR_care_load_unload, PR_physical_damage, PR_living_organism, PR_foreign_bodies, PR_washing

[b]. Dependent Variable: Perishability

Table 5.8 provides complete information about the model i.e. coefficients. The predictor variables have a variance inflation factor (VIF) value less than 2. (The VIF value shows the degree of collinearity among the independent variables. The acceptable value of VIF is 1 to 10) There is no significant multi-collinearity problem in the model; in other words, there is no variable in the model that is measuring the same relationship/quantity as is measured by another variable or group of variables.

The multiple-regression model is represented in the following equation as:

$$y = .473 + 0.136\, x_1 + 0.054\, x_2 + 0.100\, x_3 + 0.122\, x_4 + 0.055\, x_5 + 0.141\, x_6 + 0.118\, x_7 + 0.046\, x_8 + 0.073\, x_9$$

Table 5.8: Coefficients[a]

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.473	.306		1.547	.128		
	PR_farm_men	.136	.037	.336	3.688	.001	.932	1.073
	PR_physical_damage	.054	.037	.136	1.451	.153	.884	1.131
	PR_lack_packaging	.100	.037	.271	2.742	.008	.793	1.261
	PR_living_organism	.122	.036	.318	3.381	.001	.873	1.146
	PR_foreign_bodies	.055	.045	.129	1.212	.231	.687	1.455
	PR_plastic_crates	.141	.033	.414	4.290	.000	.830	1.205
	PR_washing	.118	.044	.285	2.679	.010	.685	1.460
	PR_care_load_unload	.046	.042	.103	1.095	.278	.873	1.146
	PR_packing_perishability	.073	.042	.174	1.715	.092	.752	1.330

[a]. Dependent Variable: Perishability

It is clear that road conditions cause physical damage to the fresh produce (PR_physical_damage), non-removal of foreign bodies cause perishability (PR_foreign_bodies), lack of enough care while loading and unloading (PR_care_load_unload) and lack of effective care during road transport

(PR_packing_perishability) are showing insignificant effect on the perishability of the fresh produce as their probability value is higher than the acceptable limit of 0.05.

Table 5.8 indicates the significant values of predictors that affect the dependent variable. It is found that the impact of the damage during the harvest by the farm men (PR_farm_men), lack of effective packaging (PR_lack_packaging), living organism like bacteria, fungus, insects etc. (PR_living_organism), and lack of plastic crates during the transportation (PR_plastic_crates), lack of cleaning and washing (PR_washing) variables are at the probability values of 0.001, 0.008, 0.001, 0.000 and 0.010 respectively.

5.3 CALCULATION OF ACTIVITES MEAN TIME

It is identified from the literature that the time consumption to carryout different logistic activities in the chain is high resulting in delays in distribution. Delays in distribution have adverse effect on rate perishability, sales turnover, price realisation, quality of produce at different levels of the chain (Meenakshi and Ranveer, 2008; Mittal, 2007; Sreenivasa et.al, 2004; Paulsson and Nilsson, 2000).

The present study made an attempt to calculate the time consumed to accomplish different activities in fresh produce distribution from the farmers' level to the traders' level. This will enable the farmers and traders to plan their distribution by comparing their activities time with the mean time and make remedial actions to minimise the time consumption and also help in identifying activities that are time consuming so as to reduce delays in distribution system.

The Figure 5.1 shows the mean time taken in fresh produce distribution right from the time of loading the produce at the field to disposing the produce to retailers at AMC markets. The time taken at various stages was calculated in minutes and includes,

Activity 1: Time consumed for loading fresh produce at village level

Activity 2: Time consumed for unloading fresh produce at AMC market

Activity 3: Time taken for arranging the fresh produce for auction at AMC market,

Activity 4: Time taken for auctioning the produce in AMC market

Activity 5: Time taken for settlement of sales transaction and

Activity 6: Time consumed for loading at the traders' level (towards downstream).

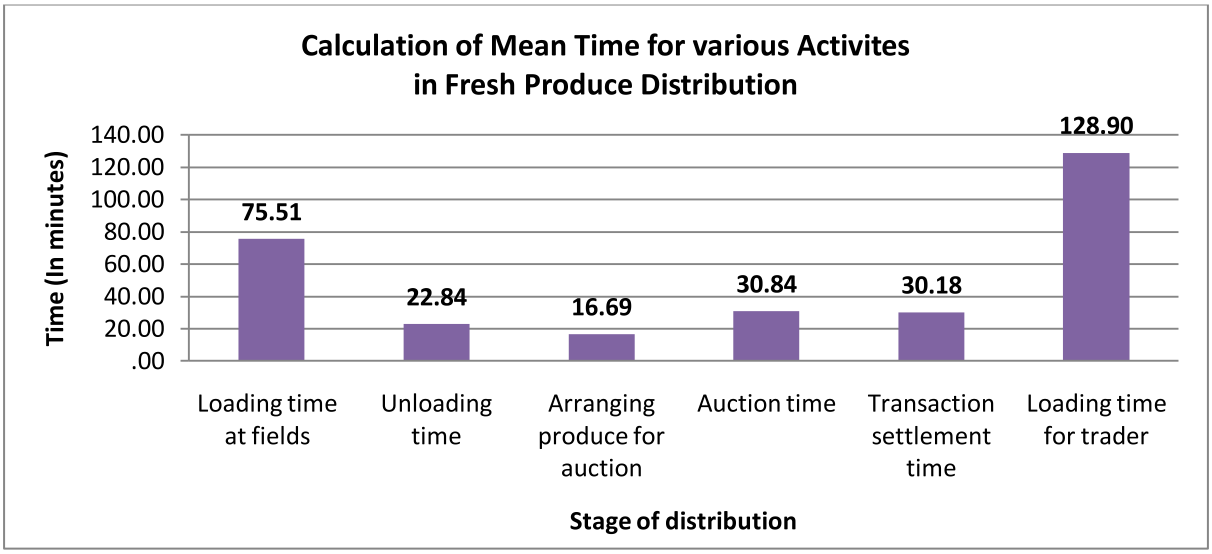

Figure 5.1: Calculation of Mean Time for various Activities in Fresh Produce Distribution

Figure 5.1 illustrates the calculated mean time for Loading at the field from the responses given was 75.51 minutes by the farmers and the mean unloading time was found to be 22.84 minutes. The mean time for arranging the produce for auction was about 16.69 minutes and for auction time was 30.84 minutes. The transaction settlement time was up to 30.18 minutes indicating that considerable amount of time is spent on arriving at an appropriate price level until the settlement. The mean loading time for trader was the highest at 128.90minutes. The mean loading time also includes the time taken for post-harvest treatment, hiring a transport carrier and packing the fresh produce to avoid transport damages.

On the whole, the time taken to reach the produce from the field to the trader is 5 hours and 8 minutes excluding the two factors of harvesting and transit time. It may be noted that the two factors are case specific and cannot be included in calculating the mean time although they are part of the distribution system. This study can be extended to calculate the mean time taken at various stages in downstream namely trader to retailers and retailers to customers.

5.4 CUSTOMERS OPINION ON FRESH PRODUCE SUPPLY CHAIN

Customer opinion was included in the study taking parameters like timely availability, damage and spoilage, colour and fragrance, mealness and sweetness, cleanliness of fresh produce and relationships with retailer. Figure 5.2 shows the value for customer satisfaction on timely availability at 3.63 showing that the customers are fairly satisfied with the timely availability of produce. The value for satisfaction on damage and spoilage are at 3.12 which show scope for improvement.

Figure 5.2: Customers opinion fresh produce supply chain

Colour and fragrance are at a score of 3.53 which is within acceptable levels while mealness or sweetness shows a value of 3.49 with a scope for better performance. The cleanliness of fresh produce is valued at a low satisfaction level of 3.04 and this may be attributed to lack of adequate facilities for cleaning and washing of fresh produce. The customers are not satisfied with the relationships with retailer as denoted by the low value of 2.98. Thus, the study on customer satisfaction of fresh produce shows possibilities for improvement.

5.5 MEAN RANK ANALYSIS FOR FINDING MOST PREVALENT WASTE IN FRESH PRODUCE DISTRIBUTION CHAIN

Fresh produce are perishable commodity which need greater attention in logistics. The lack of enough care results in spoilage of fresh produce by affecting physical and biological properties. The spoiled produce is eventually a form of waste which is a loss to the supply chain partners. There are different types of wastages in fresh produce distribution system that needs to be reduced in order to minimise the losses. Hence the present study conducted to identify the most prevalent wastages out of Transport waste, Re-handling waste, Harvesting wastage, Waiting-time wastage, over production wastage and Excess inventory waste.

In the study, the highest prevalent waste is given lowest rank i.e. 1 and the lowest prevalent waste is given highest rank i.e. 6. The analysis may be useful to the supply chain partners to be aware of the highest prevalent wastage causative in the chain and consequently enough attention paid to reduce it.

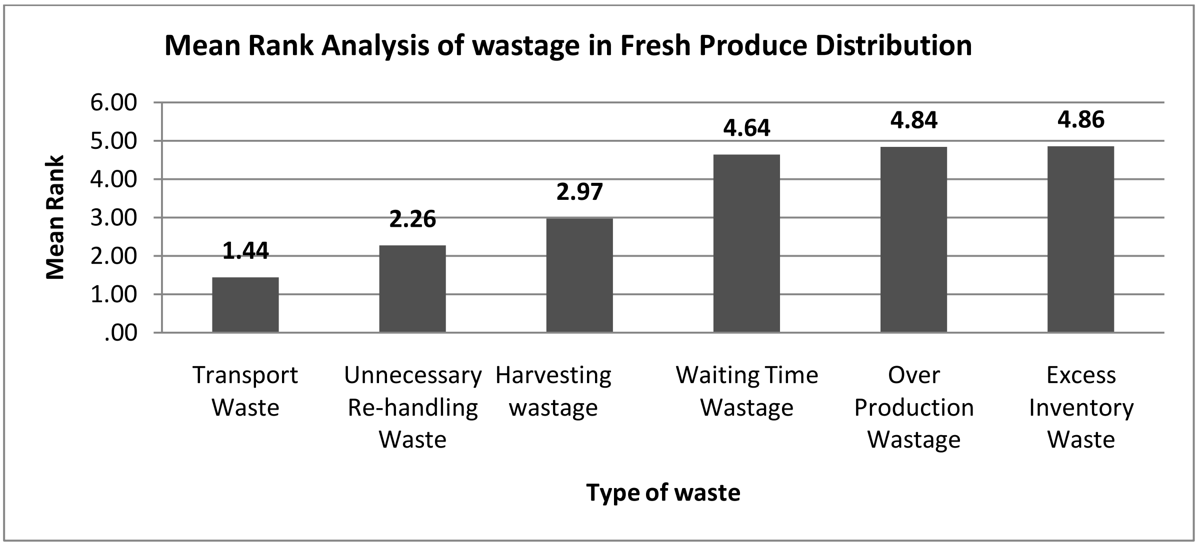

Figure 5.3: Mean rank analysis for prioritising different wastage in produce distribution

The Figure 5.3 indicates that the transport waste was found to be the highest showing a mean rank of 1.44. The Re-handling waste was found to be 2.26 and the ‘Harvesting wastage’ was valued at 2.97. The ‘Waiting time wastage’ showed a lower wastage showing a mean rank of 4.64 and the ‘Overproduction wastage was valued at 4.84. The ‘Excess-inventory wastage’ was the least ranked at 4.86. This shows that the produce is susceptible to damage at various stages and protection measures are inadequate, contributing to increased wastage.

In the order of ranking wastage, it was found that the ‘Transport waste’ takes the first position as it shows the highest wastage. Second in the order of wastage ranking is ‘Unnecessary handling of produce’ that can be completely avoidable. Wastage during harvesting is relatively high and ranks three in the analysis. The ‘Waiting time wastage’ and ‘Overproduction wastage’ are almost in the same position in the order of wastage and the ‘Excess inventory wastage’ is the least and ranks six in the order of ranking. Hence, wastage can be minimised at various stages by taking appropriate steps to minimise avoidable wastage specific to handling, transportation and harvesting.

5.6 TEST OF HYPOTHESIS - CHI-SQUARE ANALYSIS

Chi-square test is performed to substantiate the research hypotheses (H1 to H3) framed for this study for which the level of significance is fixed at 5 percent (i.e. $\alpha = 0.05$). The tests are carried out using statistical software tool i.e., SPSS 17. The summary table 5.17 presents the hypothesis from H1 to H3 with their respective probability value, calculated value and result of the test.

Hypothesis (H1): The condition of roads will influence the damage level of fresh produce during the transit.

The 5 X 5 matrix cross tabulated values relating to condition of roads and damage during transit is presented in the table given below.

Table 5.9: Condition of Roads vs. Damage during transit

		Damage level during transit					Total
		Very low	Moderately low	Medium	Moderately high	Very high	
Condition of Roads	Very good	0	5	1	1	0	7
	Good	2	2	13	8	1	26
	Neither good nor bad	2	2	7	6	0	17
	Fair	1	1	6	3	0	11
	Poor	1	1	1	0	1	4
Total		6	11	28	18	2	65

Table 5.12: Chi-Square Tests

	Value	df	Sump. Sig. (2-sided)
Pearson Chi-Square	27.998a	16	.032
Likelihood Ratio	22.130	16	.139
Linear-by-Linear Association	.040	1	.842
N of Valid Cases	65		
a. 22 cells (88.0 percent) have expected count less than 5. The minimum expected count is .12.			

The above table 5.12 indicates calculated value of Chi-Square is 27.998 at 5 percent level of significance and 16 degrees of freedom {(5-1) X (5-1) = 4 X 4} whereas the critical value is 26.296.

The asymptotic value is 0.032 which is lower than 0.05 and shows that the Chi-square value is greater than table value which strengthens the alternative hypothesis statement and rejects the null hypothesis. Hence, it is concluded that the condition of roads will influence the damage level of fresh produce during the transit.

Hypothesis (H2): The amount of care taken while loading and unloading will have an effect on the damage of fresh produce

The 5 X 5 matrix cross-tabulated values relating to care taken in loading and unloading and damage of fresh produce is presented in the table given below.

Table 5.13: Care in loading and unloading Vs. Damage of fresh produce

		Damage of fresh produce					
		Very low	Moderately low	Medium	Moderately high	Very high	Total
Amount of care taken while loading and unloading	Very high	0	1	1	0	0	2
	Moderately high	1	7	6	6	1	21
	Medium	0	0	11	4	3	18
	Moderately low	5	4	5	3	0	17
	Very low	1	0	1	0	2	4
Total		7	12	24	13	6	62

Table 5.14: Chi-Square Tests

	Value	Df	Sump. Sig. (2-sided)
Pearson Chi-Square	31.626a	16	.011
Likelihood Ratio	35.356	16	.004
Linear-by-Linear Association	.204	1	.651
N of Valid Cases	62		
a. 22 cells (88.0 percent) have expected count less than 5. The minimum expected count is .19.			

The above Table 5.14 indicates calculated value of Chi-Square is 31.626 at 5 percent level of significance and 16 degrees of freedom {(5-1) X (5-1) = 4 X 4} where as critical value is 26.296.

The asymptotic value is 0.011 which is lower than 0.05 and prove the Chi-square value is greater than the table value which strengthens the alternative hypothesis statement and rejects the null hypothesis. Hence, it is concluded that the amount of care taken while loading and unloading will have an effect on the damage of fresh produce.

Hypothesis (H3): Spoilage of fresh produce will affect overall performance of fresh produce supply chain.

The 5 X 4 matrix cross Tabulated values relating to opinion on the spoilage of fresh produce and overall supply chain performance of fresh produce is presented in the table given below.

Table 5.15: Spoilage of fresh produce Vs. Overall supply chain performance of fresh produce

		Overall supply chain performance of fresh produce					Total
		Very good	Good	Neither good nor bad	Fair	Poor	
Spoilage of fresh produce	Very High	0	1	0	1	0	2
	Moderately High	4	2	7	5	2	20
	Medium level	17	33	65	50	8	173
	Moderately Low	2	12	42	49	5	110
Total		23	48	114	105	15	305

Table 5.16: Chi-Square Tests

	Value	df	Asymp Sig (2-sided)
Pearson Chi-Square	22.479a	12	.032
Likelihood Ratio	23.432	12	.024
Linear-by-Linear Association	9.390	1	.002
N of Valid Cases	305		
a. 8 cells (40.0 percent) have expected count less than 5. The minimum expected count is .10.			

The above Table 5.16 indicates calculated value of Chi-Square is 22.479 at 5 percent level of significance and 16 degrees of freedom {(5-1) X (4-1) = 4 X 3} whereas the critical value is 21.026.

The asymptotic value is 0.032 which is lower than 0.05 and indicates that the Chi-square value is greater than Table value which argues in favour of the alternative hypothesis statement and rejects the null hypothesis. Hence it can be concluded that the spoilage of fresh produce will influence the overall performance of fresh produce supply chain.

Table 5.17 presents the summary of hypotheses from H1 to H4 with their respective Chi-square p-values, calculated values at 5 percent level of significance and the result is also commented upon the P-value.

Table 5.17: Summary of hypotheses statements (H1-H3) and results

Sl. No	Hypothesis statement	P-value	Result
Hypothesis (H1)	The condition of roads will influence the damage level of fresh produce during the transit	.032	significant
Hypothesis (H2)	The amount of care taken while loading and unloading will have an effect on the damage of fresh produce	.011	significant
Hypothesis (H3)	Spoilage of fresh produce will affect the overall performance of fresh produce supply chain.	.032	significant

In the next section the hypotheses (H4 to H7) framed for the study are tested using Analysis of Variance (ANOVA) test to measure the variance among the fresh produce supply chain partners on the issues pertaining to supply chain performance.

5.7 TEST OF HYPOTHESIS - ANALYSIS OF VARIANCE

Analysis of Variance (ANOVA) test is conducted to test the hypothesis (H4-H7) framed for the study for which the level of significance is fixed at 5 percent (i.e. $\alpha = 0.05$). The tests are carried out using statistical software tool i.e., SPSS 17. The summary table 5.27 presents the hypothesis from H4 to H7 with their respective probability value, calculated value and their significance at 5 percent i.e. $\alpha = 0.05$.

Hypothesis (H4): There is a significant gap between the promised delivery time and actual delivery time within the levels of supply chain

The table 5.19 shows the level of agreement on the time gaps among fresh produce supply chain entities such as farmers, traders, and retailers and their samples are 305, 65 and 120 respectively. The table 5.20 describe the ANOVA statistics and which shows that the critical value of F is 3.014 at 2 (Between the groups) and 484 (Within the groups) degrees of freedom. The level of significance (α) is 0.05 and calculated value of one way ANOVA (F) is 1.248.

Table 5.19: Opinion of farmers, traders and retailers on fresh produce delivery times

Time gap	Farmers	Traders	Retailers
0 to 6 hours	40	3	3
6 to 12 hours	85	19	29
12 to 24 hours	72	18	49
24 to 36 hours	89	20	33
More than 36 hours	19	5	6
Total	305	65	120

Table 5.20: ANOVA

Source of Variation	SS	df	MS	F	P-value	Result
Between Groups	2.57	2	1.28	1.248	0.288	Insignificant
Within Groups	498.65	484	1.03			
Total	501.22	486				

The results of the reveal that calculated value of ‘F’ is less than the critical value which can be observed in ‘P – value’ i.e., 0.288. Therefore, the population means for the three categories on the opinion relating to ‘Delivery time’ is indeed same and it is concluded that the null hypothesis (H_0) is accepted hence the alternative hypothesis is rejected and it is commented that there is no significant gap between the promised delivery time and actual delivery time within the levels of supply chain.

Hypothesis 5: The fill-rate is not uniform among the fresh produce supply chain partner such as farmers, traders and retailers.

The table 5.21 shows the fill rate is being observed by all the fresh produce supply chain stakeholders such as farmers, traders, and retailers and their samples are 305, 65 and 120 respectively. The table 5.22 describe the ANOVA statistics and which shows that the critical value of F is 3.014 at 2 (Between the groups) and 484 (Within the groups) degrees of freedom. The level of significance (α) is 0.05 and calculated value of one way ANOVA (F) is 10.746.

Table 5.21: Fill-rate observed by farmers, traders and retailers in supply chain

Fill Rate	Farmers	Traders	Retailers
100-95 Percent	12	2	5
90-95 Percent	85	9	15
85-90 Percent	116	26	52
80-85 Percent	61	18	30
Below 80 Percent	31	10	18
Total	305	65	120

Table 5.22: ANOVA

Source of Variation	SS	df	MS	F	P-value	Result
Between Groups	22.40607	2	11.20304	10.746	0.000	significant
Within Groups	504.5426	484	1.042443			
Total	526.9487	486				

The results of ANOVA indicate that calculated value of 'F' is greater than the critical value which can be observed in 'P – value' i.e., 0.000. Therefore, the population means for the three categories on the opinion relating to 'Fill-rate is indeed differ and it is concluded that the null hypothesis (H_0) is rejected hence the alternative hypothesis is accepted and it is stated that the fill-rate is not uniform among the fresh produce supply chain partners such as farmers, traders and retailers.

Hypothesis 6: There is a significant difference in customer response times in fresh produce supply chain entities i.e., farmers, traders and retailers.

The table 5.23 shows the opinions on the customer response time within fresh produce supply chain partners (farmers, traders and retailers) during negotiations and their samples are 305, 65 and 120 respectively. The table 5.24 describe the ANOVA statistics and shows that the critical value of F is 3.014 at 2 (Between the groups) and 484 (Within the groups) degrees of freedom. The level of significance (α) is 0.05 and calculated value of one-way ANOVA (F) is 3.826.

Table 5.23: Customer response times among farmers, traders and retailers

Customer response time	Farmers	Traders	Retailers
Time gap	14	1	2
Spontaneously	59	18	33
Within 15 minutes	128	24	47
15 to 30 minutes	62	16	26
30 to 60 minutes	42	6	12
Total	305	65	120

Table 5.24: ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*Result*
Between Groups	7.994926	2	3.997463	3.826	0.022	significant
Within Groups	505.5656	484	1.044557			
Total	513.5606	486				

The results reveal that calculated value of ‘F’ is higher than the critical value which can be identified through the ‘P – value’ i.e., 0.022. Therefore, the population means for the three categories on the opinion relating to ‘Customer response times is indeed vary and it is concluded that the null hypothesis (H_0) is rejected hence the alternative hypothesis is accepted and it is commented that ‘there is a significant difference in the delay response times in fresh produce supply chain partners i.e., farmers, traders and retailers.

Hypothesis 7: There is difference in level of trust within supply chain partners in fresh produce negotiations.

The table 5.25 discusses the level of trust within the supply chain partners such as farmers, traders and retailers and their samples are 305, 65 and 120 respectively. The table 5.26 describe the ANOVA statistics and which shows that the critical value of F is 3.014 at 2 (Between the groups) and 484 (Within the groups) degrees of freedom. The level of significance (α) is 0.05 and calculated value of one way ANOVA (F) is 1.248.

Table 5.25: The level of trust within among farmers, traders and retailers

Level of Agreement	Farmers	Traders	Retailers
Very high level of trust	33	2	5
High level of trust	89	10	18
Moderate level of trust	89	23	48
Somewhat trust	85	25	41
No trust at all	9	5	8
	305	65	120

Table 5.26: ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*Result*
Between Groups	11.32737	2	5.663687	5.605	0.003	significant
Within Groups	488.9971	484	1.010325			
Total	500.3244	486				

The results of ANOVA indicate that calculated value of ‘F’ is greater than the critical value which can be observed in ‘P – value’ i.e., 0.003. Therefore the population means for the three categories on the opinion relating to ‘Trust among the supply chain entities’ is indeed different and it is concluded that the null hypothesis (H_0) is rejected hence the alternative hypothesis is accepted and it is concluded that there is difference in trust within Supply Chain Partners in fresh produce sales negotiations.

The Table 5.27 presents the summary of hypotheses from H4 to H7 with their respective ANOVA’s P-value, calculated values at 5 percent level of significance and the result is commented upon the P-value.

Table 5.27: Summary of hypotheses statements (H4-H7) and results

Sl. No	*Hypothesis statement*	*P-value*	*Result*
Hypothesis (H4)	There is a significant gap between the promised delivery time and actual delivery time within the levels of supply chain.	0.288	Insignificant
Hypothesis (H5)	The fill-rate is not uniform among the fresh produce supply chain partners such as farmers, traders and retailers.	0.000	significant

Hypothesis (H6)	There is a significant difference in customer response times in fresh produce supply chain entities i.e., farmers, traders and retailers.	0.022	significant
Hypothesis (H7)	There is difference in level of trust within supply chain partners in fresh produce negotiations.	0.003	significant

5.8 CONCLUSION

Transportation is a vital aspect in fresh produce logistic system therefore the study analysed various factors that contribute to the transport performance and is concluded that reliability in delivery, information sharing, loading and unloading and capacity of vehicles are influencing the performance of transportation. The study also made an attempt to identify the factors influencing fresh produce perishability and study concluded that lack of effective packaging, living organism like bacteria, fungus, insects etc., lack of plastic crates during the transportation, and lack of cleaning and washing are showing significant impact on the fresh produce perishability. Several hypotheses have been tested using Chi-square and Analysis of variance and all results are proven to be significant.

The next chapter measures the performance of fresh produce distribution channels in Andhra Pradesh. The study used the performance indices such as efficiency, flexibility, responsiveness and quality includes product quality and process quality for measurement of the distribution chain.

CHAPTER – VI

SUPPLY CHAIN PERFORMANCE IN FRESH PRODUCE DISTRIBUTION SYSTEM

This chapter evaluates the performance of fresh produce supply chains based on performance indicators developed for agri-food supply chains by Aramyan et al., 2006; Kooten, 2007. Agri-food supply chain performance indicators are grouped into four main categories viz. Efficiency, Flexibility, Responsiveness and Food quality. These four categories are the bottom line of the Performance Measurement System (PMS). Each of these main categories contain more detailed performance indicators and these common set of performance indicators are used at the supply chain level besides their own set of performance indicators.

6.1 ASSIGNING SCORES FOR FRESH PRODUCE SUPPLY CHAIN PERFORMANCE INDICATORS

The study has common set of indicators to evaluate complete supply chain identified as key performance indicators. The appropriate recommendations are given in the chapter on conclusion for improvement on performance of responsiveness indicators at traders' level. Efficiency measures how efficiently the resources are utilised (Lai et al., 2002). It includes several measures such as production costs, profit, return on investment and inventory. Flexibility indicates the degree to which the supply chain can respond to a changing environment and extraordinary customer service requests (Bowersox and Closs, 1996; Beamon, 1998). It may include customer satisfaction, volume flexibility, delivery flexibility, reduction in the number of backorders and lost sales.

Responsiveness aims at providing the requested products with a short lead-time (Persson and Olhager, 2002). It may include fill rate, product lateness, customer response time, lead-time, shipping errors, and customer complaints. The specific characteristics of agri-food supply chains are captured in the measurement framework in the category "food quality". Food quality is divided into product and process quality. Product quality consists of product safety and health, sensory properties and shelf-life and product reliability and convenience. Process quality is divided into production system characteristics, environmental aspects and marketing.

The following Table 6.1 indicates the performance scores of fresh produce supply chain on Likert's five point rating scale. The higher score close to 5 indicates the performance of the indicator favourable and score close to 1 specify the poor performance of the indicator. The indicator score, category scores and overall supply chain scores are calculated as follows.

1 Mean Score at Supply chain partner level (X/Y/Z/T) $= \frac{\Sigma \text{ scores assigned by Respondents}}{\text{Number of Respondents}}$

2 Mean Score of indicators in Supply chain (I) $= \frac{\Sigma \text{ Mean scores at supply chain partner level}}{\text{Number of parners in supply chain}}$

3 Category Score at Supply chain (CE/CF/CR/CP/CQ) $= \frac{\Sigma \text{ Mean scores of indica tors}}{\text{Number of indicators in the category}}$

4 Category Score at farmers' level in Supply chain $= \frac{\Sigma\text{Mean scores of indicators of the category}}{\text{Number of indicators in the category}}$

5 Category Score at traders' level in Supply chain $= \frac{\Sigma \text{ Mean scores of indicator s of the category}}{\text{Number of indicators in the category}}$

6 Category Score at retailers' level in Supply chain $= \frac{\Sigma \text{ Mean scores of indicators of the category}}{\text{Number of indicators in the category}}$

7 Category Score at transporters' level in Supply chain $= \frac{\Sigma\text{Mean scores of indicators of the category}}{\text{Number of indicators in the category}}$

Table 6.1: Performance of supply chain measures in fresh produce distribution chain

		MEAN SCORES OF SC PARTNERS				INDICATOR	
Category	Indicator	Farmers(X)	Traders(Y)	Retailers(Z)	Transporters (T)	Mean(I)	Std Deviation (D)
Efficiency	Production Costs	3.633	4.080	3.567	3.900	3.795	1.074
	Transaction Costs	3.649	2.290	2.192	3.985	3.029	0.955
	Transportation Costs	2.954	3.629	2.108	NA	2.897	0.814
	Profit	2.239	2.984	3.175	3.745	3.036	0.924
	Return on Investment	4.600	4.338	3.650	2.345	3.733	1.044
	Mean of Indicators (CE)	3.415	3.464	2.938	3.494	**3.328***	

Flexibility	Customer Satisfaction	2.921	2.935	3.483	3.283	3.156	1.082
	Volume Flexibility	2.345	2.698	4.351	2.480	2.969	0.901
	Delivery Flexibility	2.198	2.752	3.674	3.290	2.979	0.987
	Mean of Indicators (CF)	2.488	2.795	3.836	3.018	**3.034***	
Responsiveness	Order Fill Rate	2.954	2.645	3.342	4.390	3.333	1.021
	Customer Response Time	2.807	2.839	3.108	3.984	3.185	1.046
	Customer Complaints	2.921	2.935	3.042	3.645	3.136	1.022
	Lead time	2.957	2.790	3.158	3.490	3.099	1.008
	Shipping Errors	2.597	2.565	3.442	2.392	2.749	1.077
	Mean of Indicators (CR)	2.847	2.755	3.218	3.580	**3.100***	
Product Quality	Appearance	4.475	3.905	3.125	NA	3.835	1.007
	Taste	3.695	3.726	3.267	NA	3.229	1.045
	Shelf Life	4.357	3.726	3.292	NA	3.792	1.077
	Salubrity/Nutrition	3.492	3.855	3.083	NA	3.477	1.080
	Product Safety	3.439	3.903	3.175	NA	3.506	0.703
	Mean of Indicators (CP)	3.892	3.813	3.188	NA	**3.564***	
Process Quality	Traceability	2.948	2.123	2.765	NA	2.612	0.977
	Storage & Transport Condition	2.767	2.794	3.193	NA	2.918	0.977
	Pesticide/ Chemical use	2.423	3.125	4.093	NA	3.213	1.108
	Promotion	1.234	3.239	2.456	NA	2.309	0.894
Mean of Indicators(CQ)		2.343	2.820	3.126	NA	**2.763***	
OVERALL PERFORMANCE (OP) SC PARTNER WISE		2.997	3.129	3.261	3.363	**3.158***	

Note: * Scores may not tally due to rounding the numbers to nearest third unit from the decimal and fractions after the third unit is not shown but considered for calculation of scores.

NA- indicates that the given indicator is not measures for that particular supply chain entity.

6.2 PERFORMANCE OF KEY INDICATORS IN FRESH PRODUCE SUPPLY CHAIN

Table 6.1 and Figure 6.1A present the performance of key indicators. The overall score of fresh produce supply chain calculation is 3.158 and the score represents all the entities of the supply chain that include all indicators of the performance measurement. The indicators considered are as follows Efficiency (3.328), Flexibility (3.034), Responsiveness (3.10), Product Quality (3.564) and Process Quality (2.763). The scores indicate that the performance of process quality is poor and also lower than overall score of the fresh produce supply chain performance. This can be attributed to poor performance of indicators such as traceability (2.612), storage and transport conditions (2.918) and promotion (2.309). The responsiveness and flexibility indicators almost function with the similar pace but still there is much scope for improvement because the total supply chain performance lies within these two indicators.

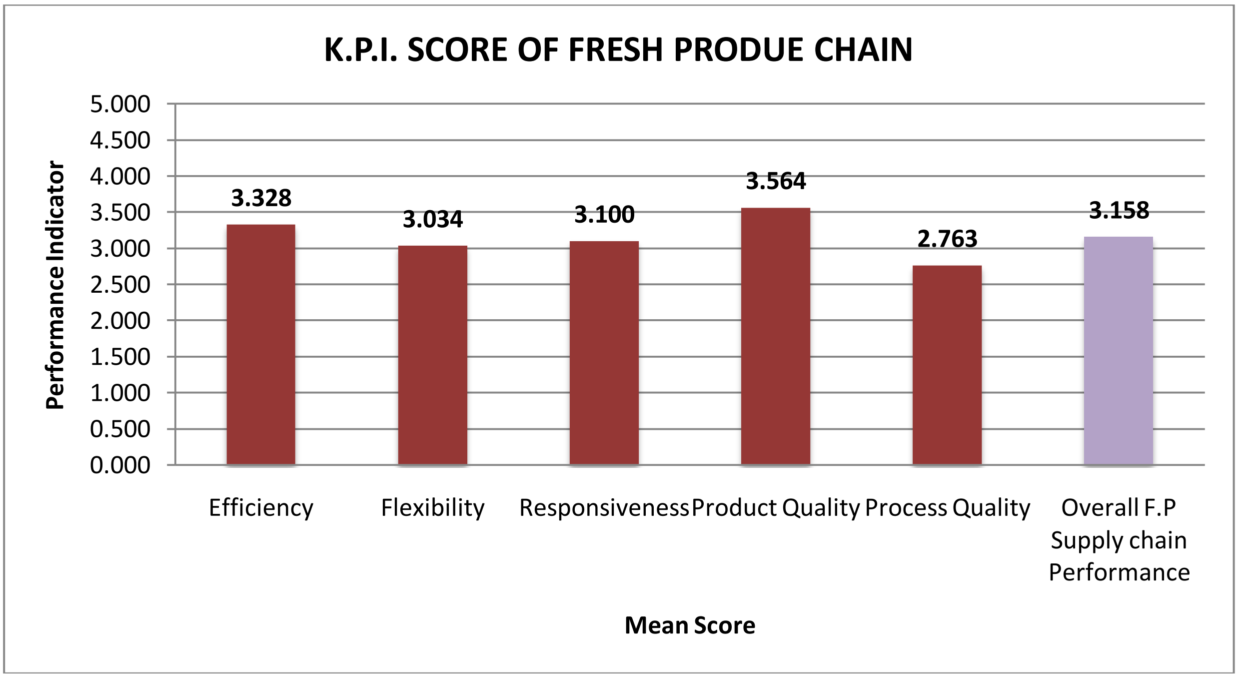

Figure 6.1: Performance of Key performance measures of fresh produce supply chain

The product quality indicator is performing moderately well when compared to the rest of the key performance indicators. The product quality's indicators such as Appearance, Shelf life and Product safety are performing moderately high whereas the other indicators in the same KPI need to improve their performance by using appropriate post-harvest measures.

The efficiency indicators are performing moderately but the indicators of transportation costs (2.897) and transaction costs (3.029) show lower performance that need to be addressed.

On the whole, the score of fresh produce supply chain performance is 3.158. It indicates the performance is said to be moderate. The following indicators scores that contribute positively to the score are Production costs (3.795), Return on investment (3.733), Appearance/freshness (3.835), Shelf life (3.792), Food safety (3.506), Salubrity (3.477) and Order fill rate (3.333).

Whereas the indicators that have contributed low to the supply chain performance are transportation cost (2.897), volume flexibility (2.969), delivery flexibility (2.979), shipping errors (2.749), traceability (2.612), storage and transport condition (2.918) and promotion of fresh produce (2.309) and these indicators are needed to be taken-up for the improvement. The rest of the variables have moderate effect on the supply chain performance however, these need to be improved further in enhancement of the scores. The overall fresh produce supply chain performance score at farmers, traders, retailers and transporters level are 2.997, 3.129, 3.261, and 3.363 respectively. These scores indicate that there is no much difference among the entities and performance seems to be moderate and more or less similar.

In the coming sections, a complete performance analysis will be discussed key indicators-wise (KPI). The each KPI is analysed sub-indicator-wise and supply chain entity-wise. The analysis gives a true image of entire supply chain performance in fresh produce distribution system of Andhra Pradesh.

6.3 PERFORMANCE OF EFFICIENCY INDICATORS

Efficiency measures how well the resources are utilised. In this study, it includes several measures such as production costs, transportation cost, transaction cost, profit, and return on investment. The efficiency indicator is analysed entity wise first and indicator wise later in the subsections of this section.

6.3.1 Farmers' Level

A mean score of 3.415 on the performance of efficiency indicators at farmers' level was observed which includes all measures of efficiency indicators considered for the study such as production cost, transaction cost, transportation cost, profit and return on investment. The measures like production cost, transaction cost and return on investment costs are higher than the mean indicating scores of 3.633, 3.649, and 4.600 respectively. This shows that the performance is efficient at the farmers' level.

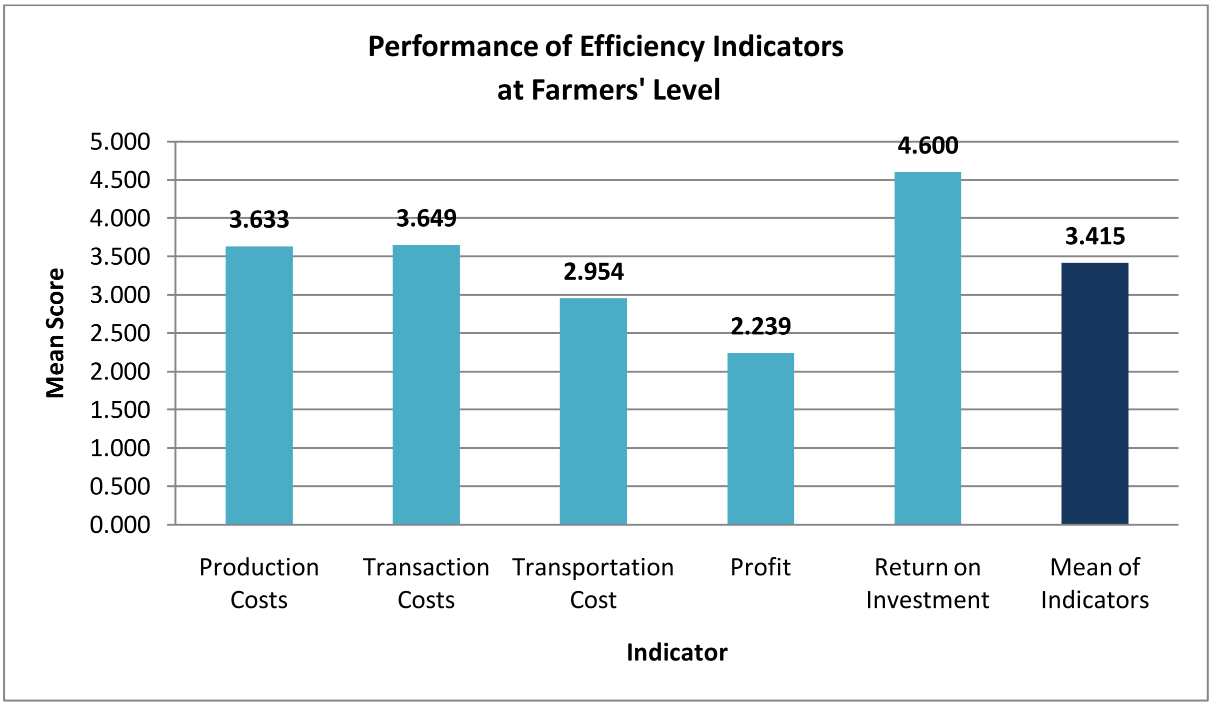

Figure 6.1A: Performance of efficiency indicators at farmers' level

The transportation cost shows a score of 2.954 which means that the transportation cost are relatively high at the farmers' level. The profit are less than the mean scores and shows a score of 2.239 due to the fact that a high cost on transportation is incurred at the farmers level reducing the profitability. Thus, from the Figure 6.1 we can say that when compared to the mean score of the all indicators, the transportation costs are high and profits are moderate.

6.3.2 Traders' Level

The mean score for the performance of efficiency indicators at traders' level is 3.464. This shows that the performance seems to be moderate at the traders' level. The study includes all measures of efficiency indicators considered for the study such as production cost, transaction cost, transportation cost, profit and return on investment which are shown in figure 6.2. The measures like production cost, transportation cost and return on investments are higher than the mean indicating scores of 4.080, 3.629, and 4.338 respectively. While considering the profit indicator it is rather low at 2.984.

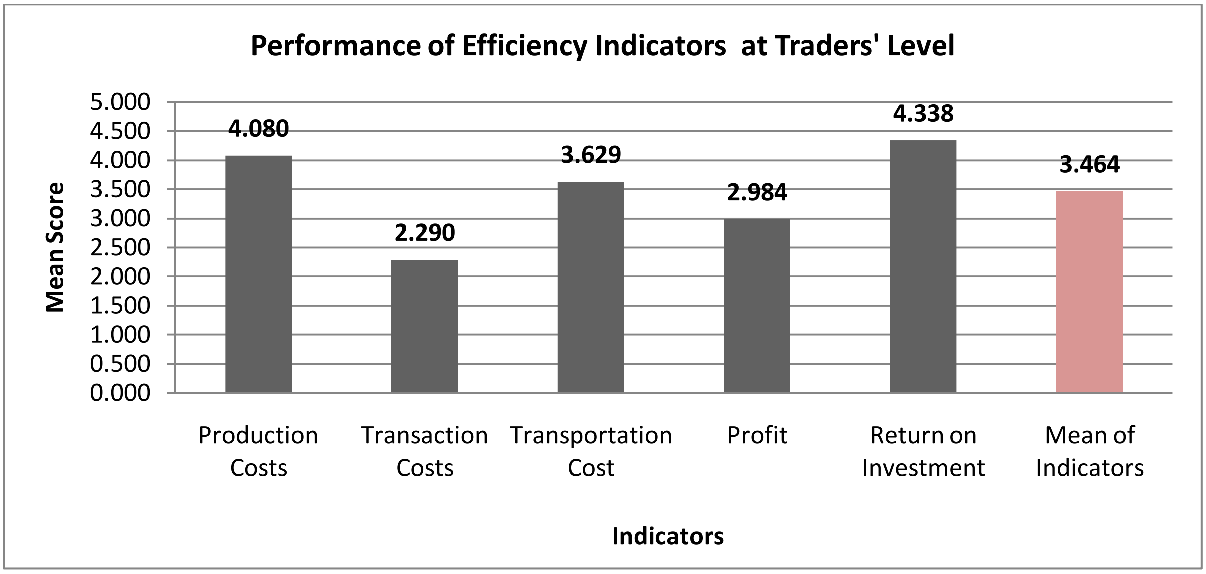

Figure 6.2: Performance of efficiency indicators at traders' level

The transaction cost shows a score of 4.338 which is below the mean score. Thus, from the figure 6.2, it is concluded that the performance of indices production and transportation cost are low and return on investment is high. The transaction costs and profits seem to be much lower than mean scores at the trader's level.

6.3.3 Retailers' Level

From the figure 6.3, it is observed that the mean score is 2.938 on the performance of efficiency indicators at retailers' level and includes all measures of efficiency indicators such as production cost, transaction cost, transportation cost, profit and return on investment. The measures like production cost, profit and return on investments are higher than the mean indicating scores of 3.567, 3.175 and 3.650 respectively.

The mean score of 2.938 indicates that the performance is considered to be poor at the retailers' level. Besides, the transaction costs indicator shows a score of 2.192 which means that the cost associated with the production and marketing are high and the transaction cost indicator is also lower than the mean of indicators at 2.108. Thus, from the above table 6.1, it is concluded that though the indicators such as production cost, profit and return on investment are moderate, whereas transaction cost and transportation cost indicators showing poor performance.

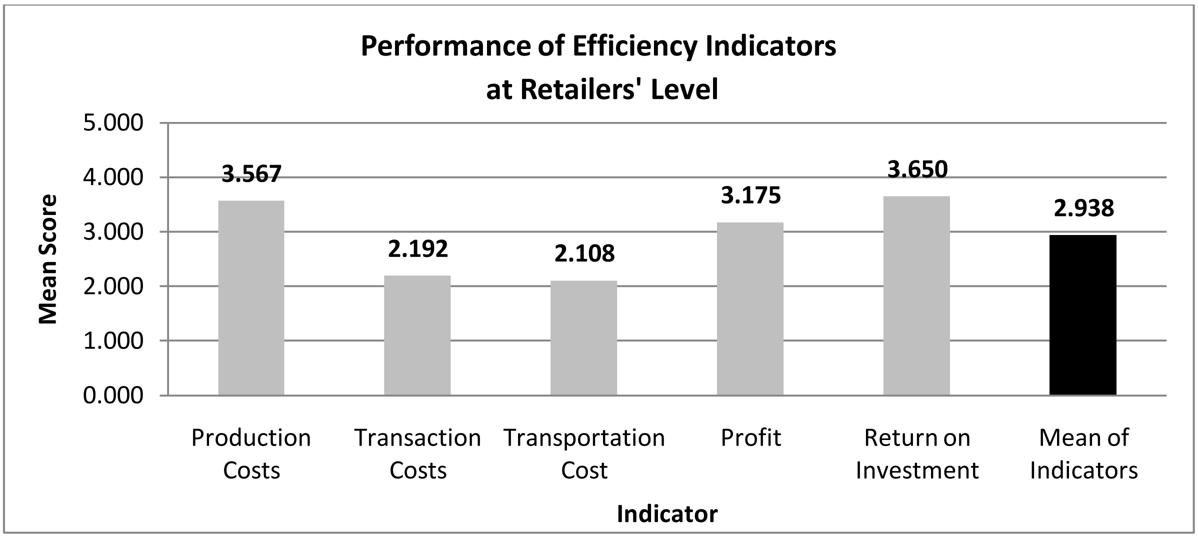

Figure 6.3: Performance of efficiency indicators at retailers' level

6.3.4 Transporters' Level

From the figure 6.4, it is examined that the performance of efficiency indicators at transporters level is 3.494 which show the performance is moderate. The indicator shows production cost, transaction cost and profits with scores 3.900, 3.985 and 3.745 respectively are considered to be higher performance indicators.

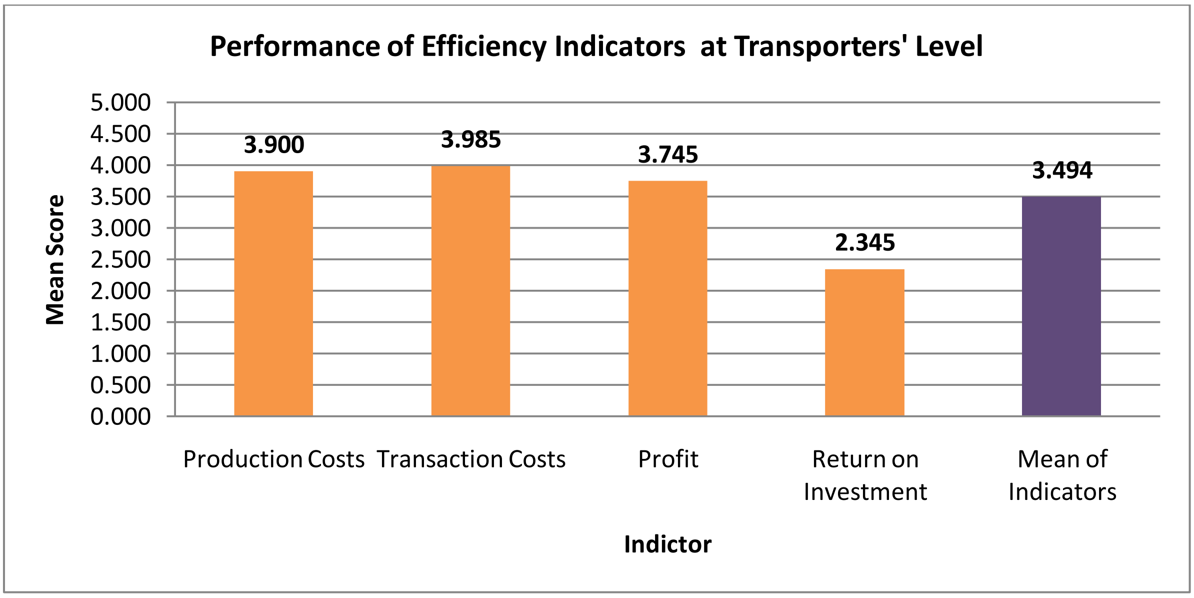

Figure 6.4: Performance of efficiency indicators at transporters' level

The profit margins are significantly high showing a score higher than the mean score at 3.745 whereas return on investment (2.345) as the time taking to return back investment is longer. Thus, the performance of efficiency indicators at the transporters level is moderate and there is scope for improvement in all indicators for better performance.

6.3.5 Production Cost

The figure 6.5 shows that production costs across the supply chain partners which show a mean score of 3.795. The farmers and retailers level have a score of 3.633 and 3.567 respectively, and lower than the mean. This indicates that the production costs are higher at the farmers' level and retailers' level when compared to the traders and transporters level.

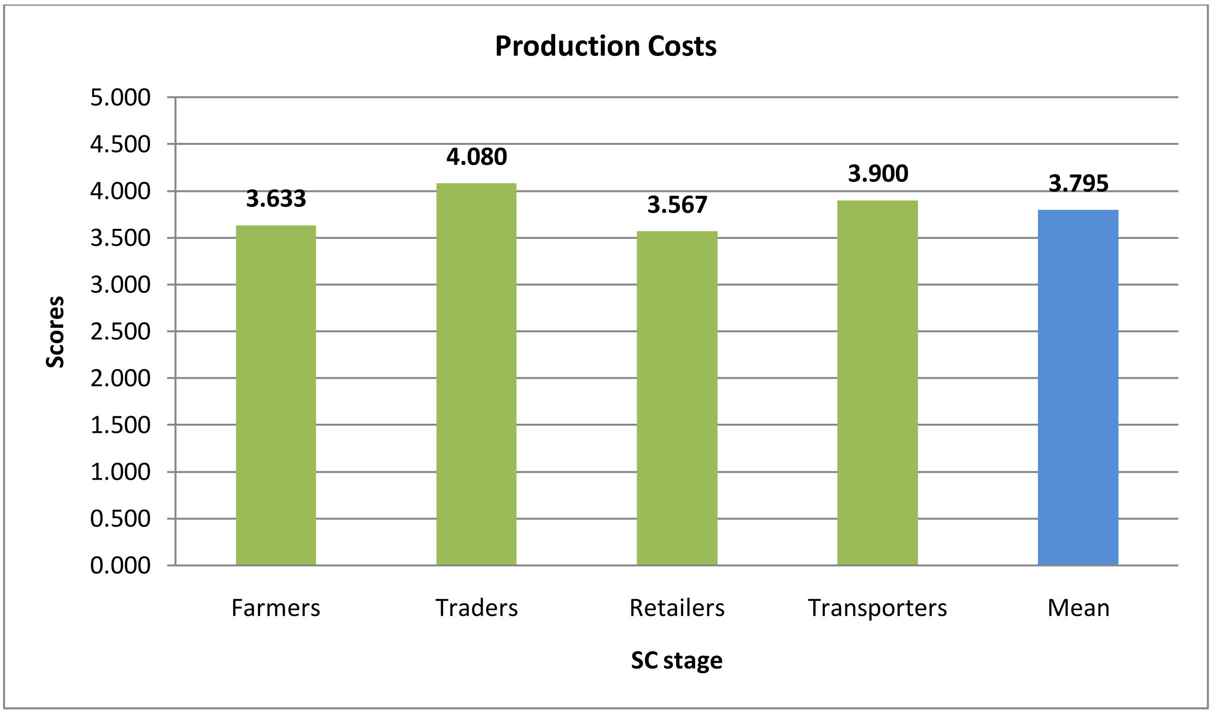

Figure 6.5: Performance of Production cost measure among supply chain partners

The traders' level shows a score of 4.080 indicating that the production cost is very minimal. At the transporters' level a score of 3.900 has been observed showing a minimum cost on production. The inference drawn from the scores that the cost of production is lowest at the traders' level followed by transporters, farmers' and traders' levels.

6.3.6 Transaction Cost

Figure 6.6 shows a mean score of 3.029 for transaction costs across the supply chain partners. The lowest transaction cost is observed at the retailers' level which shows a score of 2.192. This is followed by the traders' level which shows a score of 2.290. The farmers' level shows a score of 3.649 which is close to the mean score indicating that the transporters' costs are slightly higher at the retailers' level. The transaction costs are the highest at the transporters level at a score of 3.985.

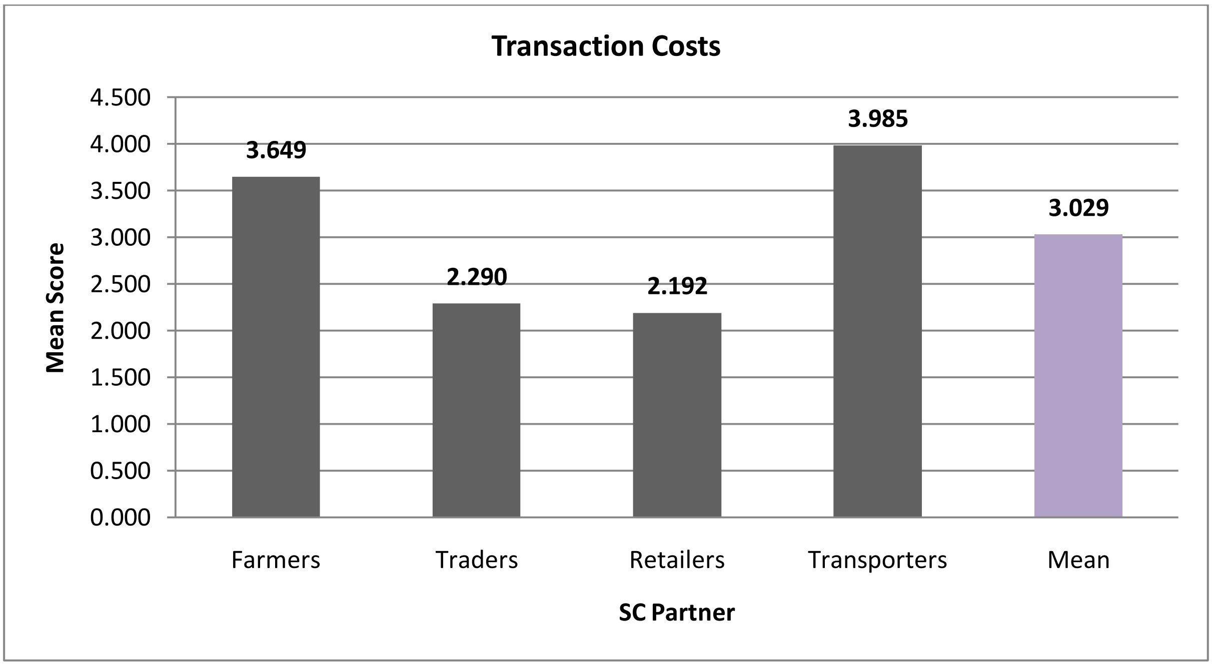

Figure 6.6: Performance of transaction cost measure among supply chain partners

Thus, we can say that the transaction cost is lowest at the farmers followed by traders, retailers and transporters in order of increasing transaction costs across the supply chain partners.

6.3.7 Transportation Cost

Figure 6.7 shows a mean score of 2.897 for transportation cost. The traders show transportation costs with a score of 3.629 that indicate the transportation costs are less. This is followed by the farmers' with a score of 2.954. The retailers' level incurs high costs on transportation costs at a score of 2.954.

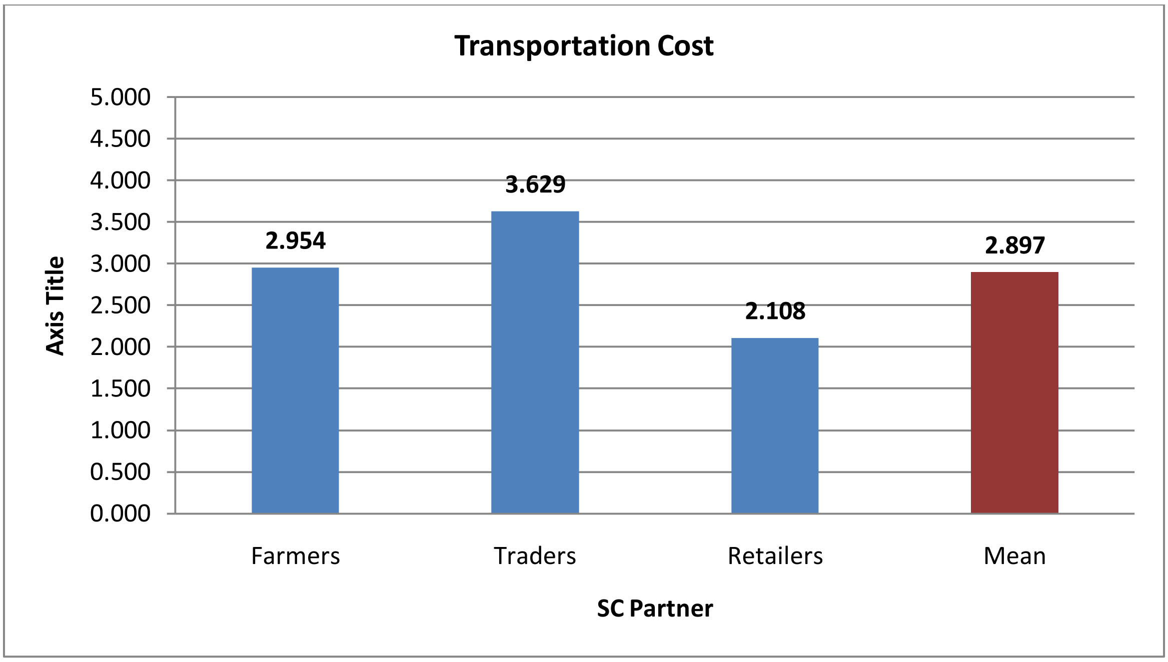

Figure 6.7: Performance of transportation cost measure among supply chain partners

Thus, it is concluded that the transportation cost is the highest at the retailers' level and lowest at the traders' level, moderate at the retailers' level and slightly high at the farmers' level.

6.3.8 Profit

Figure 6.8 shows a mean score of 3.036 on profits incurred by the supply chain partners. The highest profits indicator score is observed at 3.745 at the transporters level. This is followed by the retailers' level which shows high profits at a score of 3.175. Moderate profits are observed at the traders' level at a score of 2.984 while the lowest profits are observed at the farmers' level at a score of 2.239. This shows that the traders and retailers have greater profits when compared to the transporters and farmers.

Thus, in the decreasing order of profits gained in the supply chain, the transporters are in the lead followed by transporters, traders and retailers. This can be attributed to the fact that the margins at the farmers' level is low (despite high price of produce), and distribution loss due to wastage.

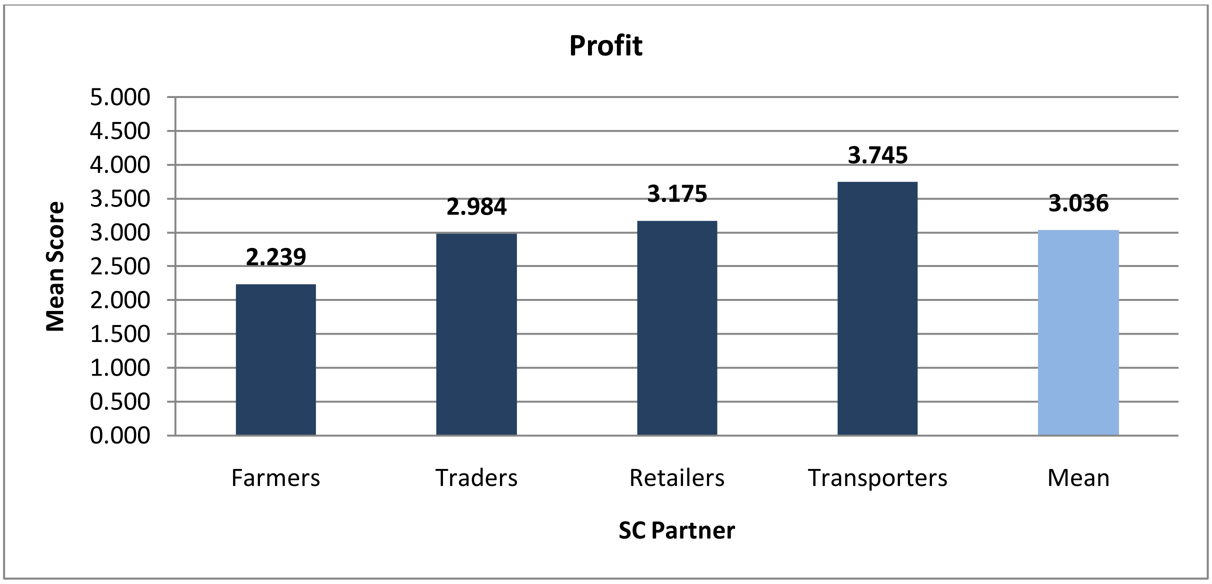

Figure 6.8: Performance of profit measure among supply chain partners

6.3.9 Return on Investment

Figure 6.9 shows a mean score of 3.733 for returns on investment across the supply chain partners. The farmers' level shows the highest return on investments at a score of 3.985 which show that the transporters are able to recover the investment in one to two years. This is followed by the farmers who show a return on investment score of 3.649 which is much above the mean score.

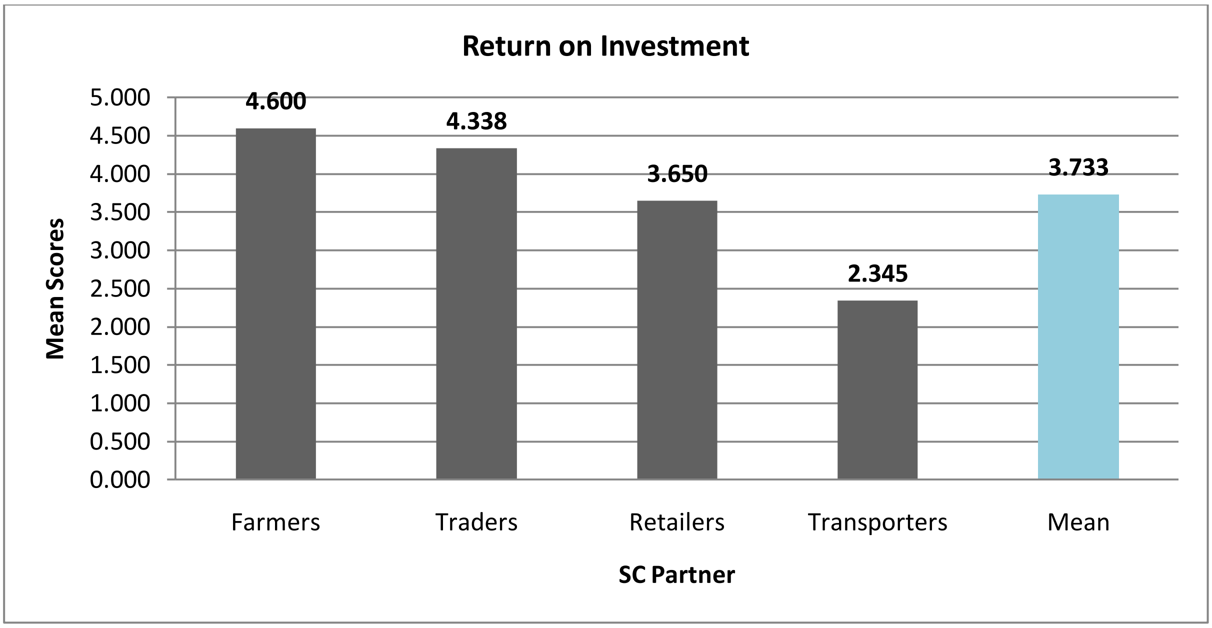

Figure 6.9: Performance of Return on investment indicator among supply chain partners

The traders and retailers are almost at the same level when considering the mean scores of 4.338 and 3.650 respectively. Thus, it can be concluded that the return on investment is repaid within two to four years across the supply chain.

6.4 PERFORMANCE OF FLEXIBILITY INDICATORS

Flexibility indicates the degree to which the supply chain can respond to a changing environment and extraordinary customer service requests. In this study, it includes several measures such as customer satisfaction, volume flexibility, and delivery flexibility. The flexibility indicator is analysed entity wise followed by the indicators in the following subsections.

6.4.1 Farmers' Level

Figure 6.10 indicates the mean on performance of flexibility at farmers level that shows a score of 2.488 which means that the overall flexibility is moderate at all the levels. The delivery flexibility is not measured at farmers' level due to reason that the farmers are bound to dispose their fresh produce crop immediately after the harvest.

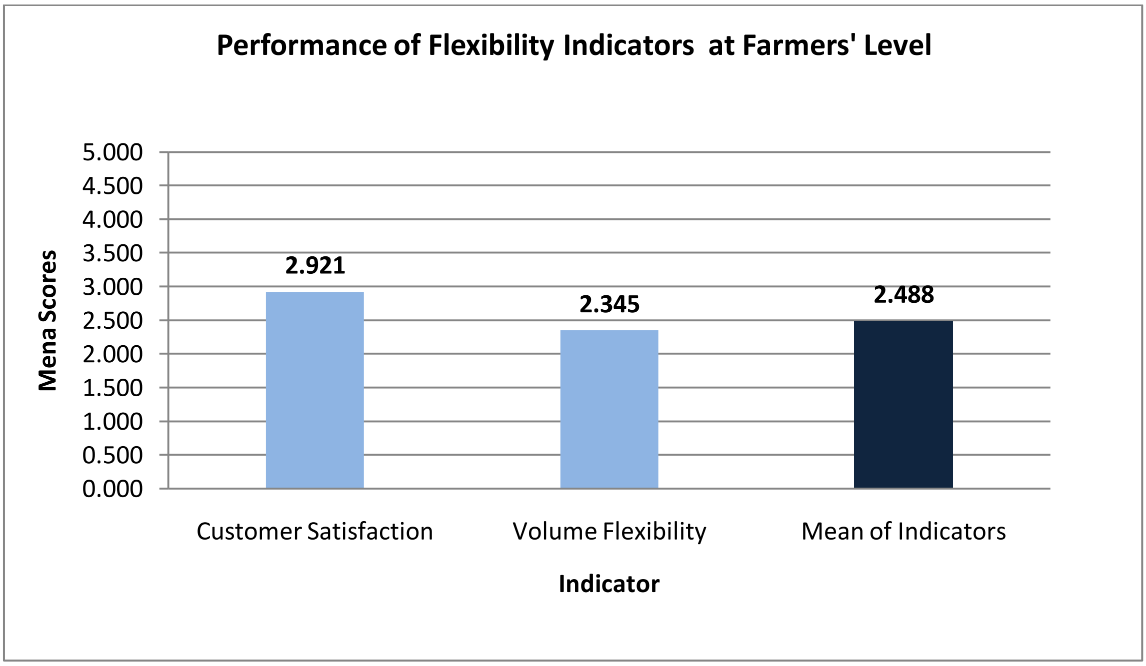

Figure 6.10: Performance of flexibility indicators at farmers' level

It has been observed that the customer satisfaction score is 2.921 which indicate that the customer satisfaction is relatively fair but has more scope for improvement. The volume flexibility scores show a value of 2.345 only which means the volume flexibility is low. This can be attributed to lack of grading and lack of opportunity for trading in small quantity by the farmer.

6.4.2 Traders' Level

The figure 6.11 shows a mean score of 2.795 at the traders' level on performance of flexibility indicators such as customer satisfaction (2.935), volume flexibility (2.698) and delivery flexibility (2.752). At the traders level it has been observed that all the indicators are performing reasonably low which needs to be improved to the maximum extent.

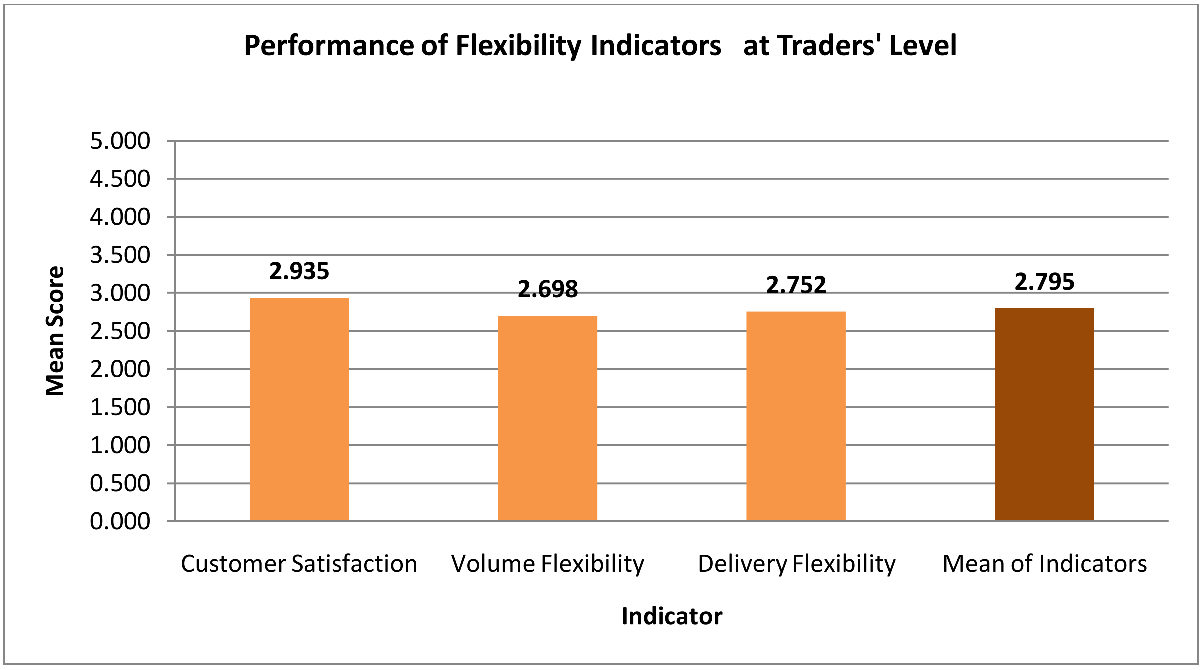

Figure 6.11: Performance of flexibility indicators at traders' level

The volume flexibility is defined as "*the ability of a firm to change the output levels of the products produced*". The volume flexibility indicator needs more attention for better results on performance of flexibility at the traders' level. The delivery flexibility can be improved by maintaining the appropriate coordination among the traders, retailers and customers. The customer satisfaction at traders' level can be enhanced by increasing the volume flexibility and delivery flexibility.

6.4.3 Retailers' Level

At the retailers level the mean on performance of flexibility shows a score of 3.693 in the figure 6.12. This means that at the retailers' level there is a significant performance of flexibility indicators. In the given scores volume flexibility shows a score of 4.0 indicating that there is high flexibility in the volume because the retailers supply the desired quantities which is ordered by the customers.

The delivery flexibility shows a score of 3.6, which measures the flexibility in produce, delivered at the customers' desired place and time. The customer satisfaction shows a score of 3.480 which means that there is scope for improving the satisfaction levels by implementing effective produce delivery systems. Thus, it can be concluded that the performance of flexibility indicators at the retailer level is reasonably good.

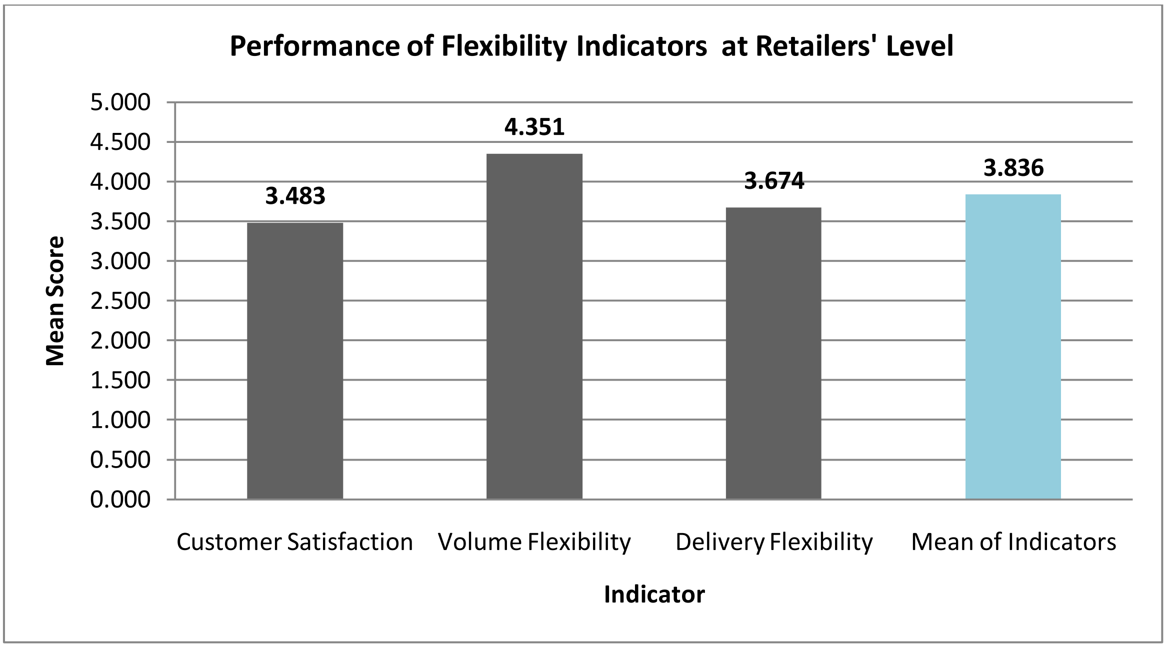

Figure 6.12: Performance of flexibility indicators at retailers' level

6.4.4 Transporters' Level

At the transporters' level the mean on performance of flexibility indicators shows a score of 3.018 in the figure 6.12A. This indicates that the performance of flexibility indicators is moderate. The scores of customer satisfaction volume flexibility and delivery flexibility are 3.283, 2.480, and 3.290 respectively. The indicator scores of customer satisfaction and delivery flexibility appear to be performing higher than the mean score of all indicators.

The volume flexibility in the context of transport services refer to ‘the ability of a transport firm to offer a volume of services that are needed by a consumer in given time’. This volume flexibility indicator needs to be improved by effective service delivery, proper trip planning and coordination among the transport stakeholders such as consignee, consigner, and service provider. These delivery flexibility and volume flexibility can together improve the customer satisfaction.

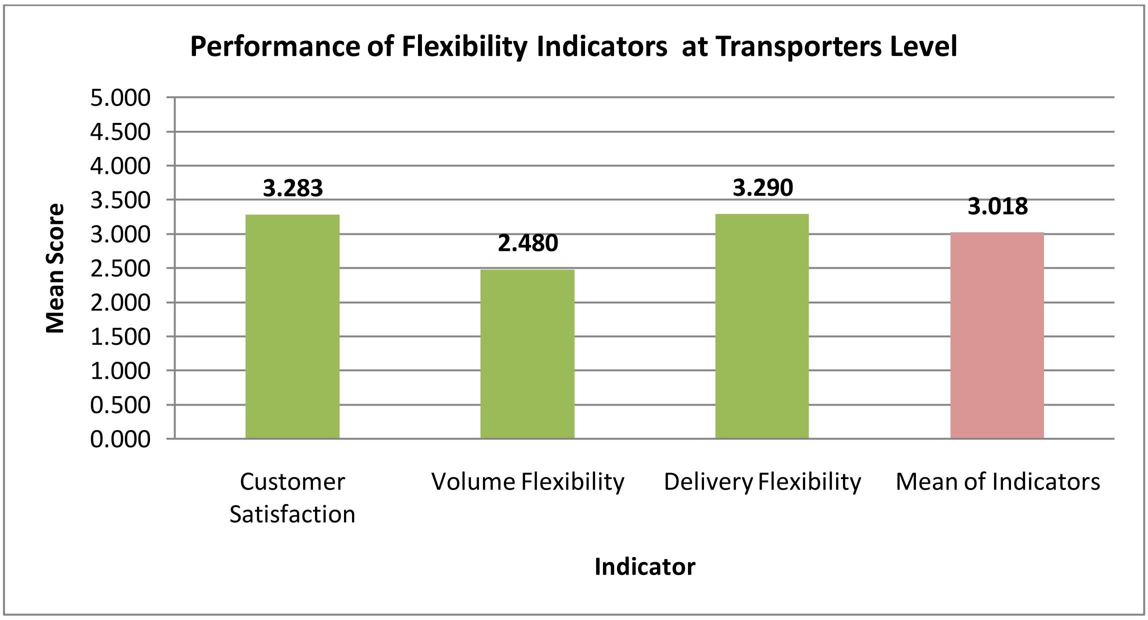

Figure 6.12A: Performance of flexibility indicators at retailers’ level

6.4.5 Customer Satisfaction

The graph shows a mean score of 3.156 for customer satisfaction across the fresh produce distribution chain. This means that the customer satisfaction is moderate at the farmers’ level and traders’ level with a score of 2.921 and 2.935 respectively when compared to the mean score. The score of retailers on customer satisfaction is 3.483, above the mean showing a moderate level of satisfaction. At the transporters level the score on customer satisfaction was found to be 3.283.

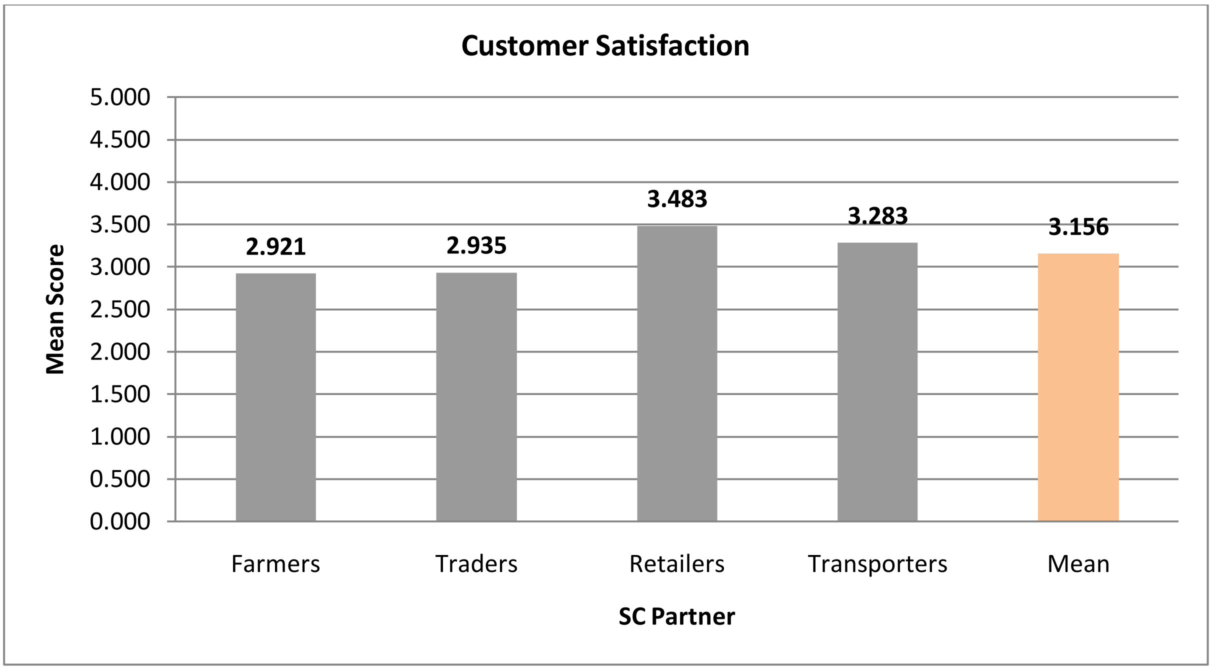

Figure 6.13: Performance of customer satisfaction measure among supply chain partners

Thus, on the whole the customer satisfaction needs improvement at the farmer's and trader's level and the same can be sustained at the retailers' level. The customer satisfaction at transporters level can be improved by effective delivery of the services at the right time and careful handling of produce to minimise the wastage.

6.4.6 Volume Flexibility

The mean score on volume flexibility shows 2.969 from figure 6.14. The retailers have a high level of volume flexibility at a score of 4.351 while the traders and farmers show a score of 2.698 and 2.345 respectively. This means that the farmers lack the opportunity to supply in small quantities as seen earlier.

Since the end user is not in direct contact with the farmer and trader the aspect of volume flexibility is found to be minimal. But, in the Rythu Bazar model it is found that the farmers are able to provide the produce in different volumes based on the customers' requirement as there is direct interaction with the end user. On the whole, the score of volume flexibility is highest at the retailers' level (4.351) where the produce is sold in varied quantities as per customer requirement.

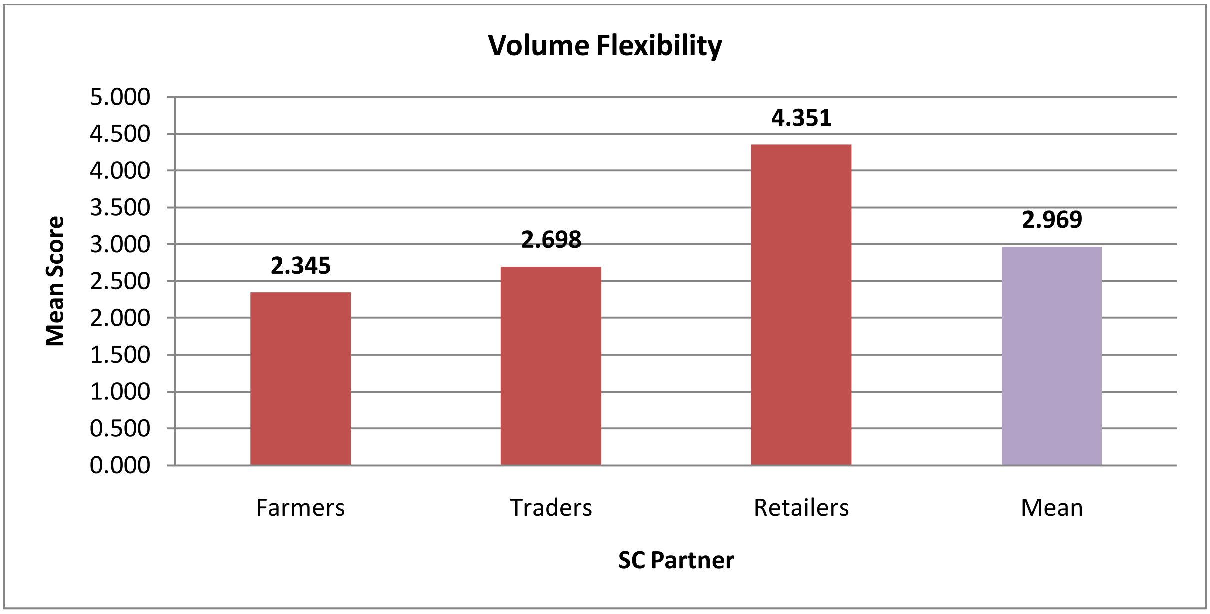

Figure 6.14: Performance of volume flexibility among supply chain partners

6.4.7 Delivery Flexibility

Figure 6.15 shows a mean score of 2.979 on delivery flexibility indicator while considering the traders, retailers and transporters. The retailers have a higher score of 3.674 when compared to the traders who show a score of 2.752 whereas transporters delivery indicators scored 3.290 which is higher than the mean score of all the chain partners. This means that delivery flexibility is at a moderate level and there is a need to improve on the same.

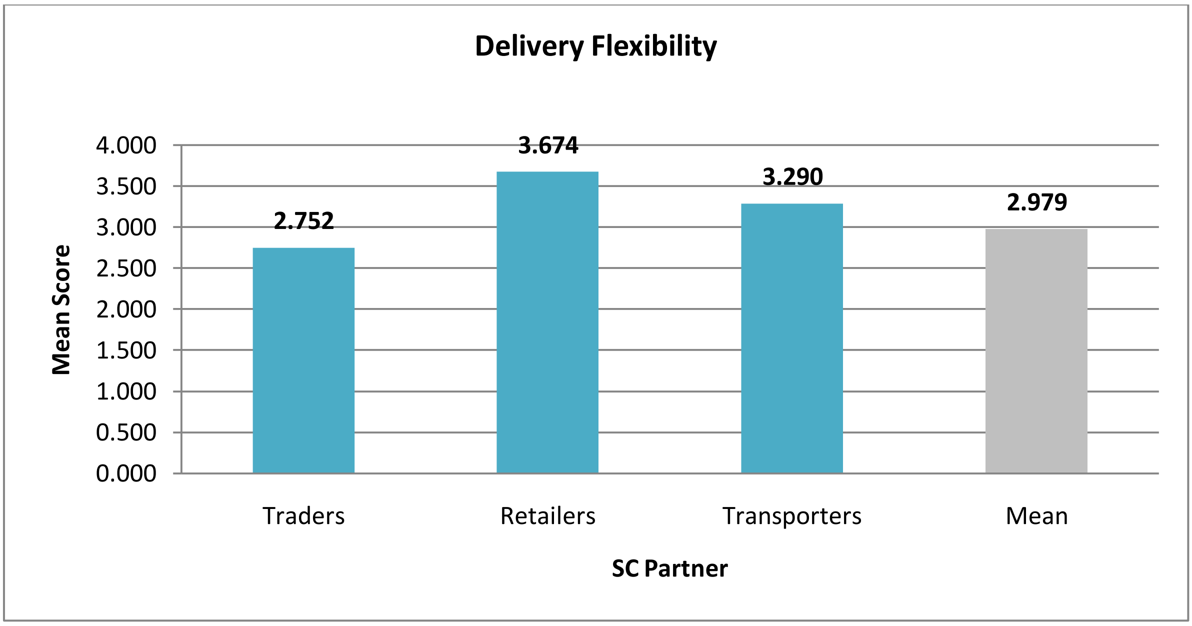

Figure 6.15: Performance of delivery flexibility measure among supply chain partners

Delivery flexibility does not apply to the farmers because the farmers are bound to sell the produce in AMCs during working hours only. On the whole the delivery flexibility seems to be performing below expectation and needs concentration at all the levels of the fresh produce distribution chain.

6.5 PERFORMANCE OF RESPONSIVENESS INDICATORS

Responsiveness aims at providing the requested products with a short lead-time. In this study, it includes several measures such as order fill rate, customer response time, lead times, and shipping errors. The responsiveness indicator is analysed entity-wise first and indicator-wise later in the subsections of responsiveness head.

6.5.1 Farmers' Level

Figure 6.16 shows a mean score of 2.847 on performance of responsiveness indicators at the farmers' level. The indicators include order fill rate (2.954), customer response time (2.807), customer complaints (2.921), lead time (2.957) and shipping errors (2.597).

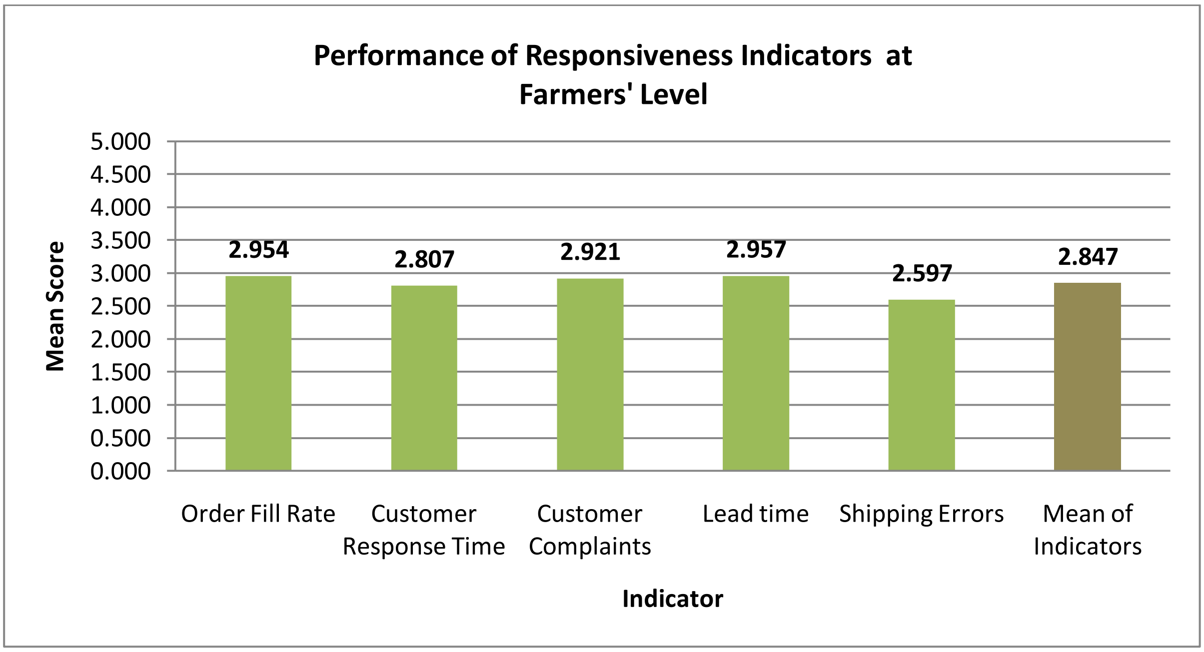

Figure 6.16: Performance of responsiveness indicators at farmers' level

Responsiveness needs improvement across the indicators considered at the farmers' level. Customer response time and shipping errors should be more focused to bring in improved responsiveness.

6.5.2 Traders' Level

Figure 6.17 shows a mean score of 2.755 for performance of responsiveness indicators at traders' level. The indicators considered are as follows order fill rate (2.645), customer response time (2.839), customer complaints (2.935), lead time (2.790) and shipping errors (2.565). This indicates that the responsiveness at the trader's level is low. The order fill rate is low because of the unplanned production and ineffective demand management. The customer response time is low due to the inability of the traders to handle the customer queries owing to the fact that there is heavy rush from customers who are required to wait for long hours at the counter.

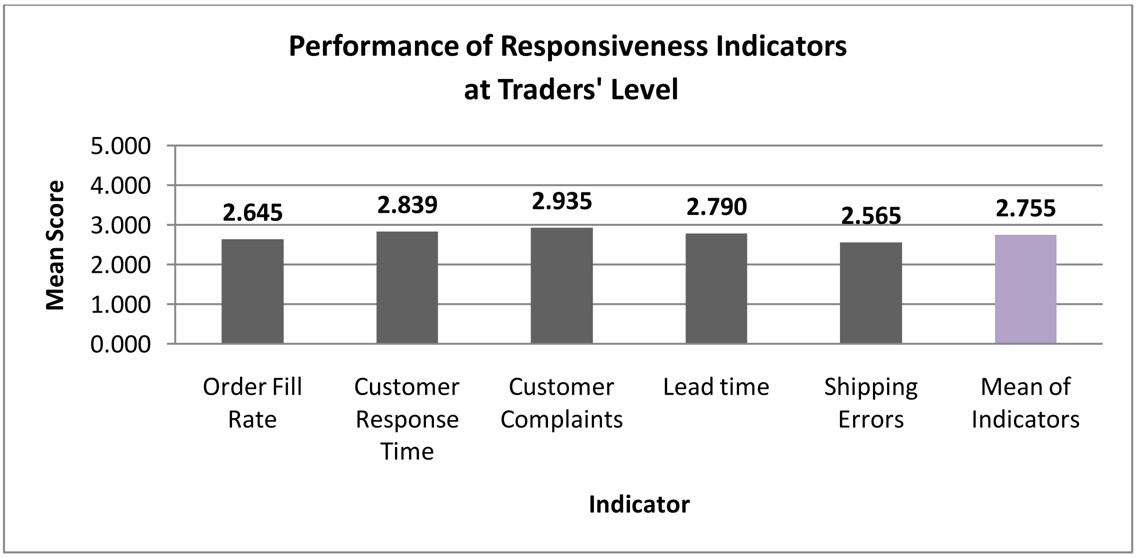

Figure 6.17: Performance of responsiveness indicators at traders' level

Traders are left with less time to attend to customer complaints leading to lowered responsiveness. Lead time is the time taken for actual delivery of order from the time of placement of order. The lead time score is low because traders require time to procure the produce and deliver to downstream customers and do not maintain buffer stock. Shipping errors occur due to variations in the quality of the produce ordered and the quality that is supplied. Thus, it can be concluded that there is need for extensive focus on these indicators at the traders' level to improve the performance. Therefore appropriate recommendations are given in the chapter on conclusion for improvement on performance of responsiveness indicators at traders' level.

6.5.3 Retailers' Level

Figure 6.18 shows a mean score of 3.218 for performance of responsiveness indicators at retailers' level. The order fill rate score of 3.342 indicates that the level of performance is fair and there is scope for improvement. The customer response time shows a score of 3.108 which means that the performance is rather moderate and there is need to reduce the waiting times and time to respond to queries.

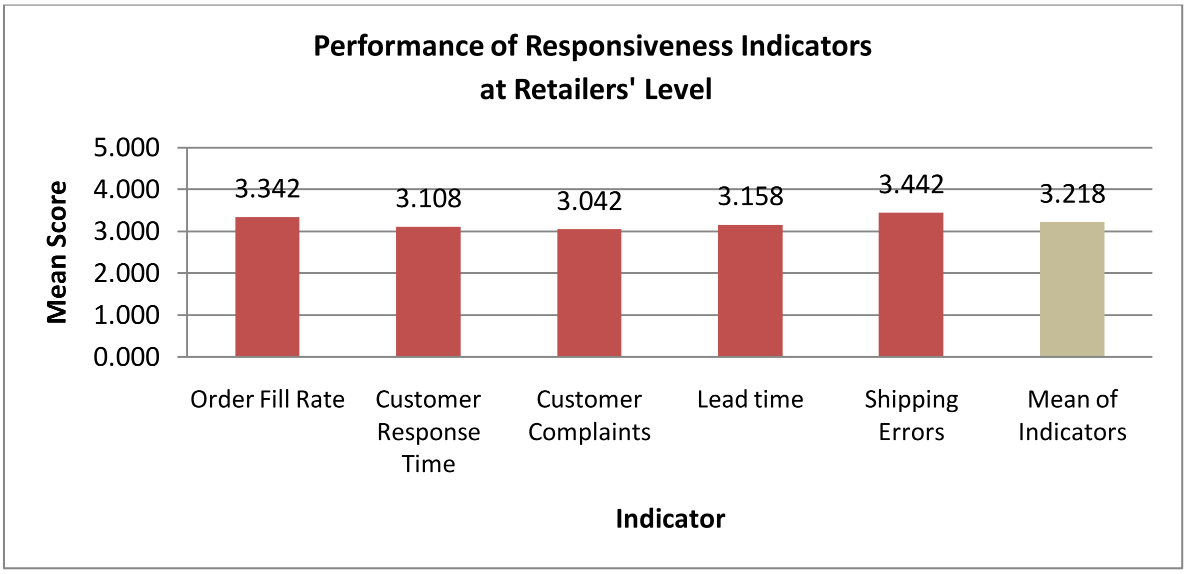

Figure 6.18: Performance of responsiveness indicators at retailers' level

A score of 3.042 on customer complaints shows that the retailer receives complaints mostly on quality aspects, on availability of the produce and rising prices. The lead time shows a score of 3.158 which means that the retailer takes approximately one day to deliver the produce which may be reduced to below 12 hours using appropriate communication system. The shipping errors shows a value of 3.442 indicating there is a low shipment error and this can be further reduced to minimise the shipment error.

6.5.4 Transporters' Level

Figure 6.19 shows a mean score of 3.580 for performance of responsiveness indicators at transporters' level. This includes indicators such as order fill rate (4.390), customer response time (3.984), lead time (3.490) customer complaints (3.645) and shipping errors (2.392) as indicators. The order fill rate, customer response time, customer complaints are observed to be significantly higher than the mean score of the chain partners which means that the transport operators are responding to customer service requests and customer queries spontaneously.

The indicators such as lead time and shipping error scores low at the transporters level and most of the times, due to the procedural delays at AMC markets and check-posts, the time is consumed much high hence it is effecting the lead time indicator score. The shipping error is found to be high due to the lack of effective tracking mechanism, improper guidance to the driver. Thus, the performance on responsiveness at the transporters level is said to be reasonable.

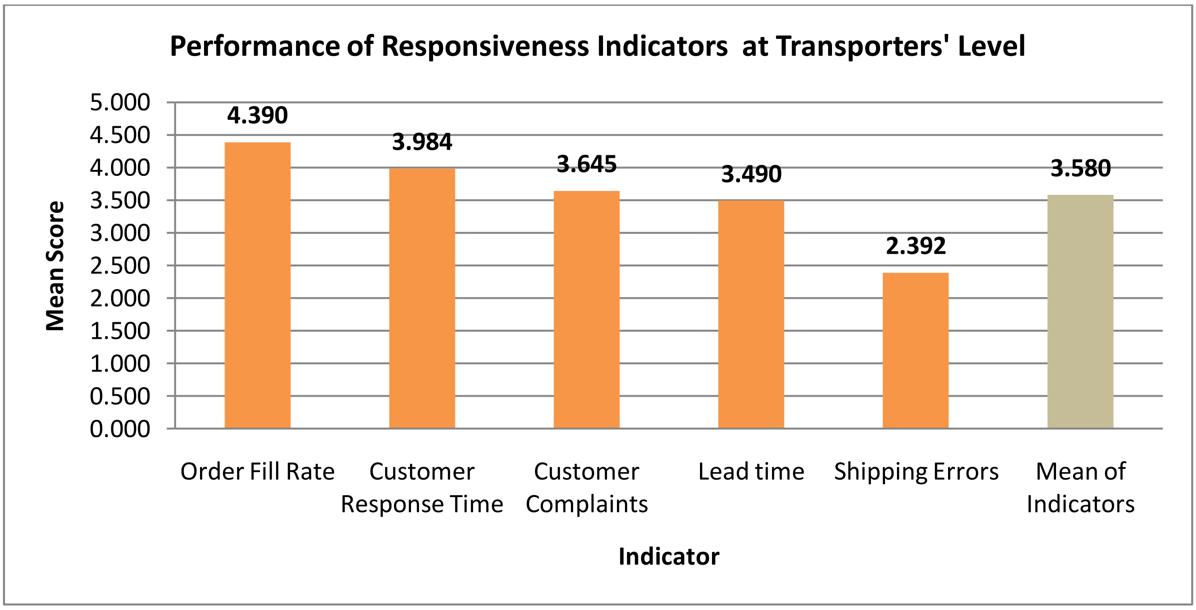

Figure 6.19: Performance of responsiveness indicators at transporters' level

6.5.5 Order Fill Rate

From Figure 6.20, it is seen that the mean score for order fill rate indicator shows a value of 3.333. The performance of order fill rate is high at transporters and its score is 4.390 reveal that the performance score of order fill rate is very high among responsiveness indicators. At the retailers level the score show 3.342 which means that the order fill rate is fair and falls between 80-90 percent. But, while considering the farmers' level which shows a score of 2.954 it has been observed that the order fill rate has fallen to 70-80 percent.

Traders level shows a score of 2.645 which is much lower than the farmers level on order fill rate and needs to be addressed using better coordination and information systems for effective communications. Thus, on the whole it can be said that the order fill rate can be improved at the farmer and trader levels in the supply chain.

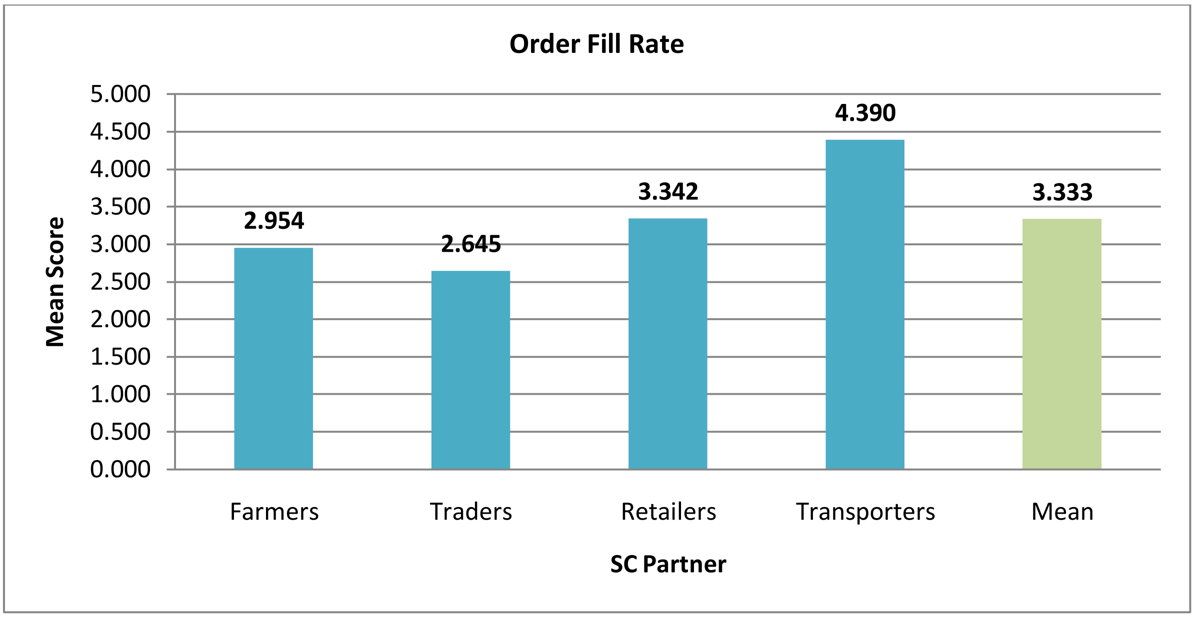

Figure 6.20: Performance of order fill rate measure among supply chain partners

6.5.6 Customer Response Time

Figure 6.21 shows a mean score of 3.185 on customer response time. The study revealed highest customer response at the transporters level with a score of 3.984, followed by the retailers at 3.108. The traders show a customer response time at 2.839, while the farmers show a score of 2.807 which is the lowest.

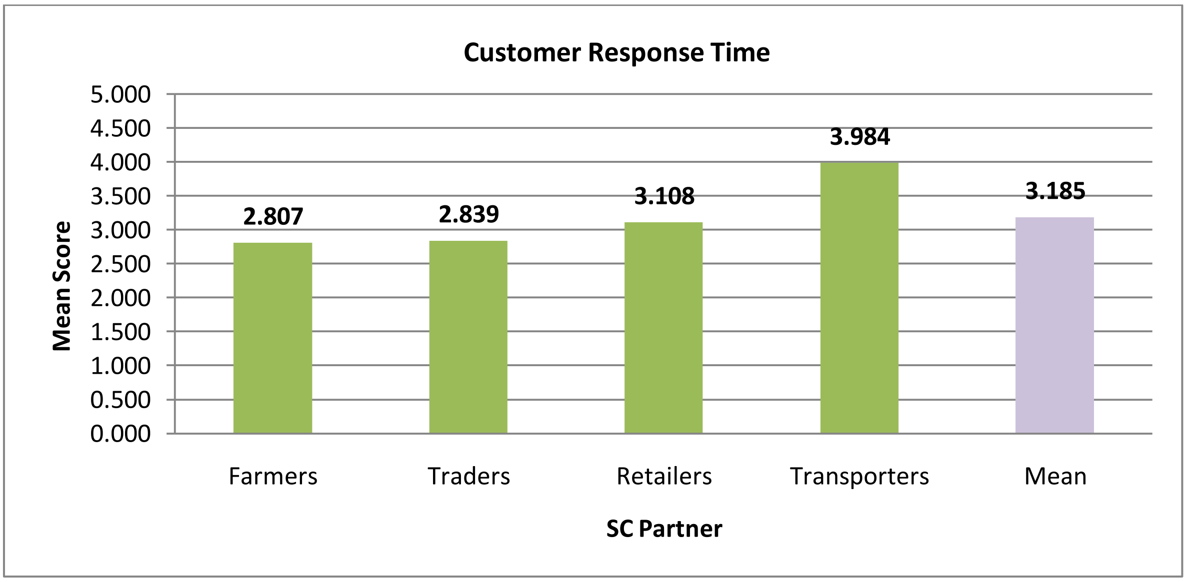

Figure 6.21: Performance of customer response time measure among supply chain partners

Transporters are performing well as they are able to meet the service requirements of the customer in time. The retailers show a reasonably fair performance while the traders and farmers have a lower performance on customer response time because farmers have minimal choice to respond.

6.5.7 Customer Complaints

Figure 6.22 illustrates the mean score for customer complaints shows 3.136 while considering the partners in the supply chain. The complaints at farmers' level (2.921) and traders level (2.935) are somewhat high when compared to transporters (3.645). The reasons for slightly high complaints at the farmers' level are mainly on issues of quality of produce.

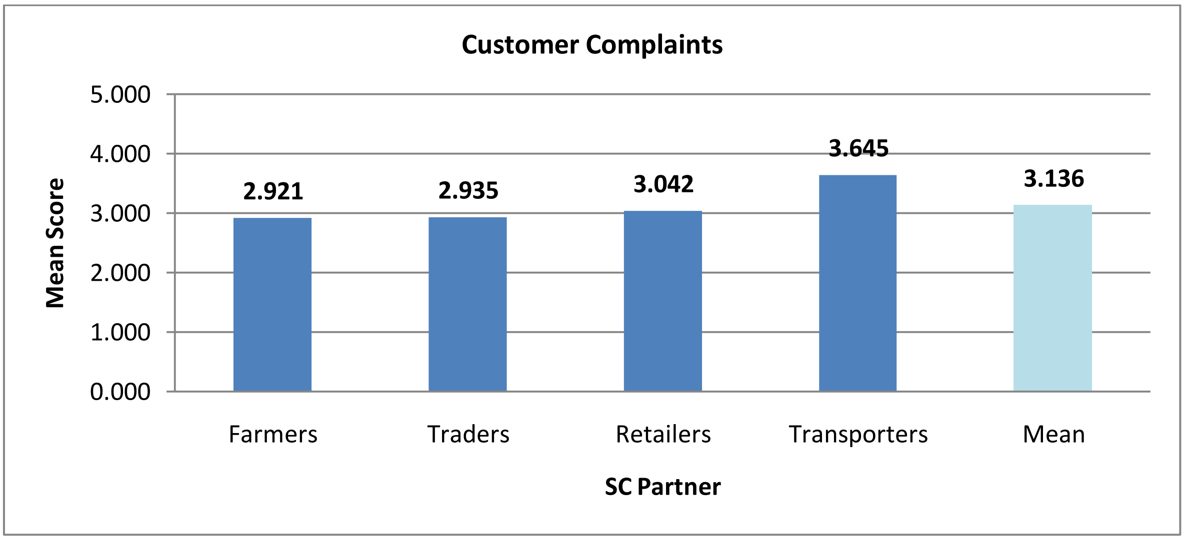

Figure 6.22: Performance of customer complaints measure among supply chain partners

At the traders level the customer complaints are comparable to that of the farmer. The retailers' level (3.042) also shows complaints related to quality issues. On the whole it can be said that the complaints are on quality issues which may be attributed to the bargaining for better price across the supply chain.

6.5.8 Lead Times

The mean score on lead time across supply chain partners is found to be 3.099 as per Figure 6.23. The transporters show a slightly high value on lead time of 3.158 when compared to farmers and traders who show a lead time score of 2.957 and 2.790 respectively.

The retailer score on lead times is 3.158 which states for further improvement in this indicators.

There is scope for reduced lead times by addressing the issues of problems related to coordination and information flow across the supply chain partners. Another important contributing factor for higher lead times is procedural delays, and activities that consumers more time (See section 5.4 of Chapter-V) due to road blockages. Hence, it can be concluded that the lead times can be considerably reduced by efficient coordination and information sharing among the chain partners.

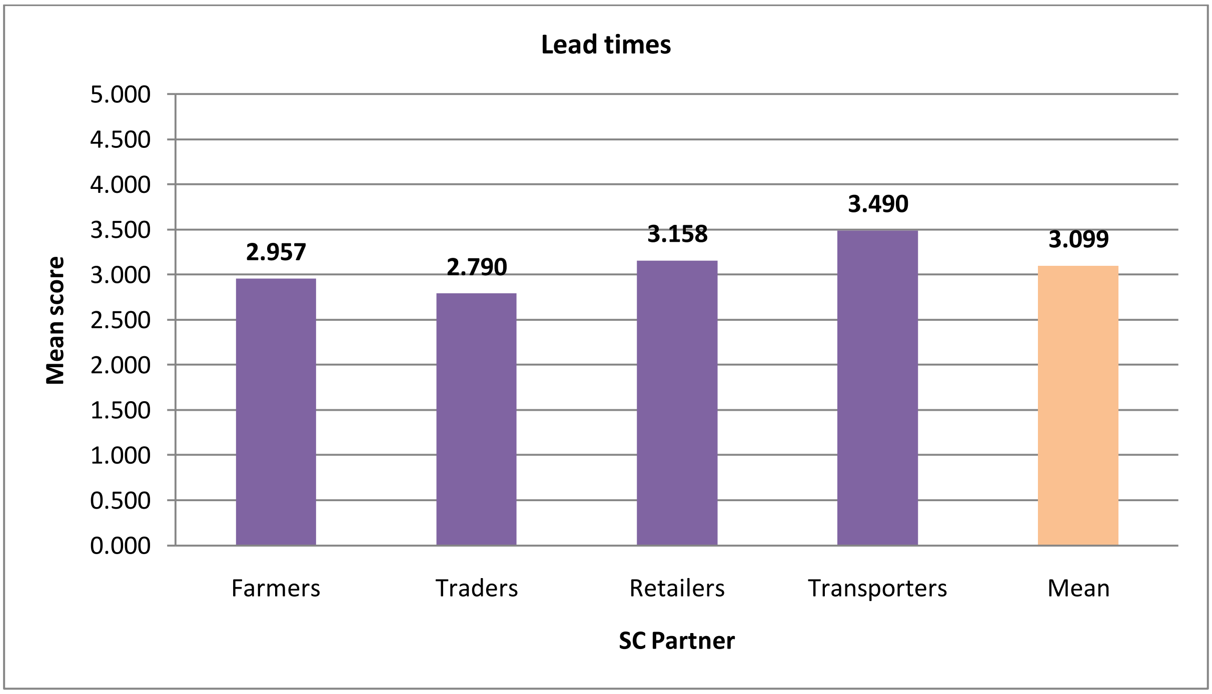

Figure 6.23: Performance of lead time measure among supply chain partners

6.5.9 Shipping Errors

Figure 6.24 indicates that the mean score value for shipping errors is at 2.749 across supply chain partners. The retailers show a score of 3.442 on shipping errors, while the farmers and traders show a score of 2.597 and 2.565 respectively. At the transporters level the score on shipping errors is 2.392.

Shipping errors are thus high among traders followed by farmers and retailers. The shipping errors can be due to variations in quality of produce and variety of produce. Thus, it may be concluded that shipping errors are avoidable by proper grading, sorting, and careful handling of produce across the supply chain.

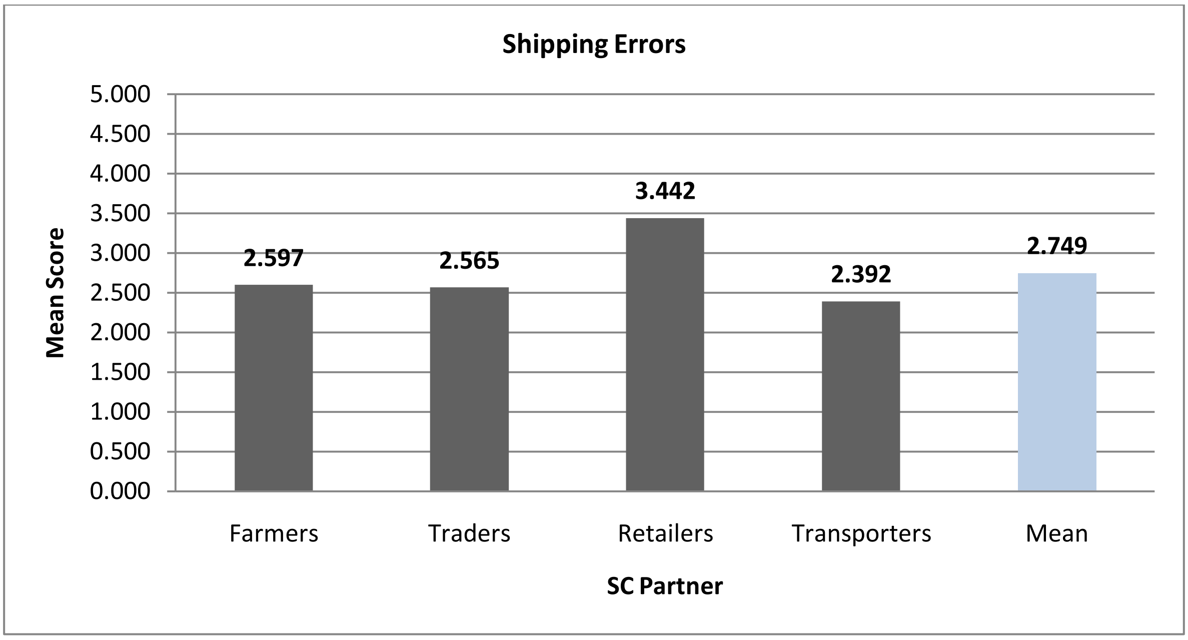

Figure 6.24: Performance of shipping errors measure among supply chain partners

6.6 PERFORMANCE OF PRODUCT QUALITY INDICATORS

Product quality consists of wide number of product physical features. For this study, it includes several measures such as appearance, taste, shelf life, salubrity/nutrition, and food safety. The product quality indicator is analysed entity-wise first and indicator-wise later in the subsections of this heading.

6.6.1 Farmers' Level

The figure 6.25 shows the performance of product quality indicators at farmers' level with a mean score of 3.892 considering appearance, taste, shelf-life, salubrity/nutrition and product safety. The appearance indicator shows a score of 4.475 which indicates that the overall quality of the produce is said to be high. The same trend is seen in terms of quality with respect to shelf life which shows a score of 4.357.

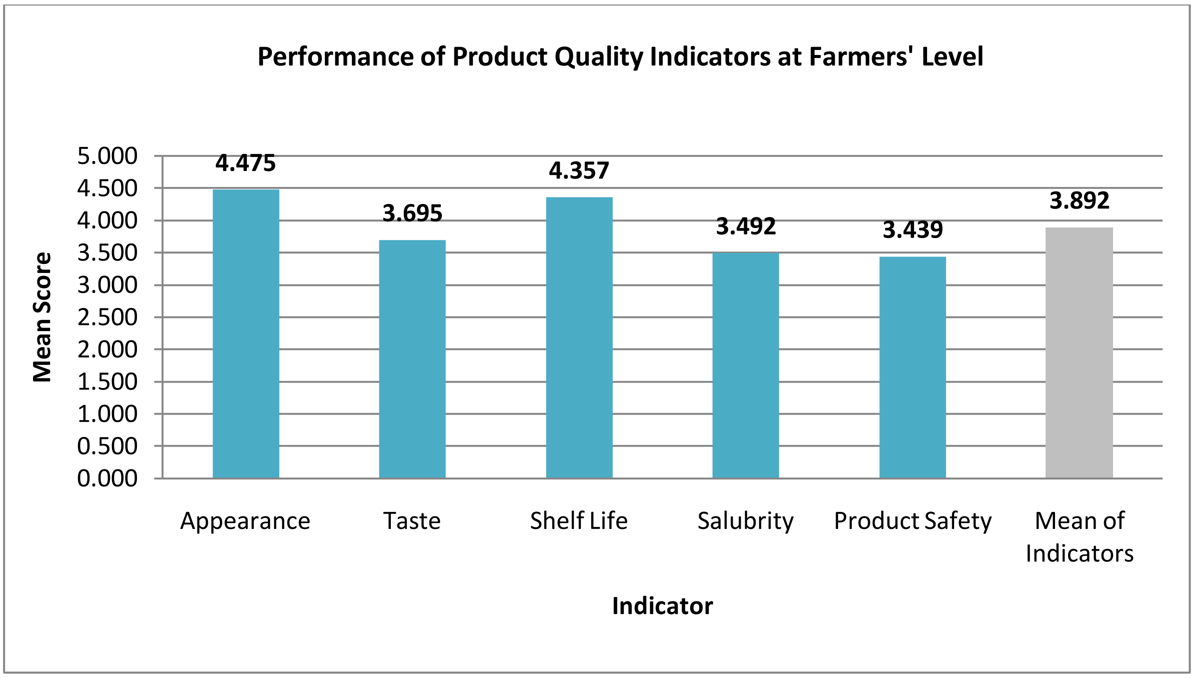

Figure 6.25: Performance of product quality indicators at farmers' level

The taste is found to be 3.695 showing that there is scope for improvement in this aspect of quality. The salubrity indicator is fair at a score of 3.492. The score on product safety is lower than the mean at 3.439. This clearly shows that the product quality indicators at the farmer level are in the reasonable high range. There is scope for improvement in the quality parameters across the indicators, and a special focus should be made on salubrity.

6.6.2 Traders' Level

Figure 6.26 shows a mean score of 3.813 while considering the performance of product quality indicators at traders' level such as appearance, taste, shelf life, and salubrity /nutrition and product safety. This means that the overall performance of product quality at traders' level seems to be high and more or less uniform among all the product quality performance indicators.

The score on appearance shows a value of 3.905 which means that the appearance is moderate while the taste and shelf life shows a value of 3.726. The shelf life is an important indicator and needs to be improved. The salubrity and product safety show a value of 3.855 and 3.903 respectively indicating that there is a decrease in the levels of taste affecting the quality of the produce. Overall it can be said that the performance of product quality indicators at traders' level is relatively high.

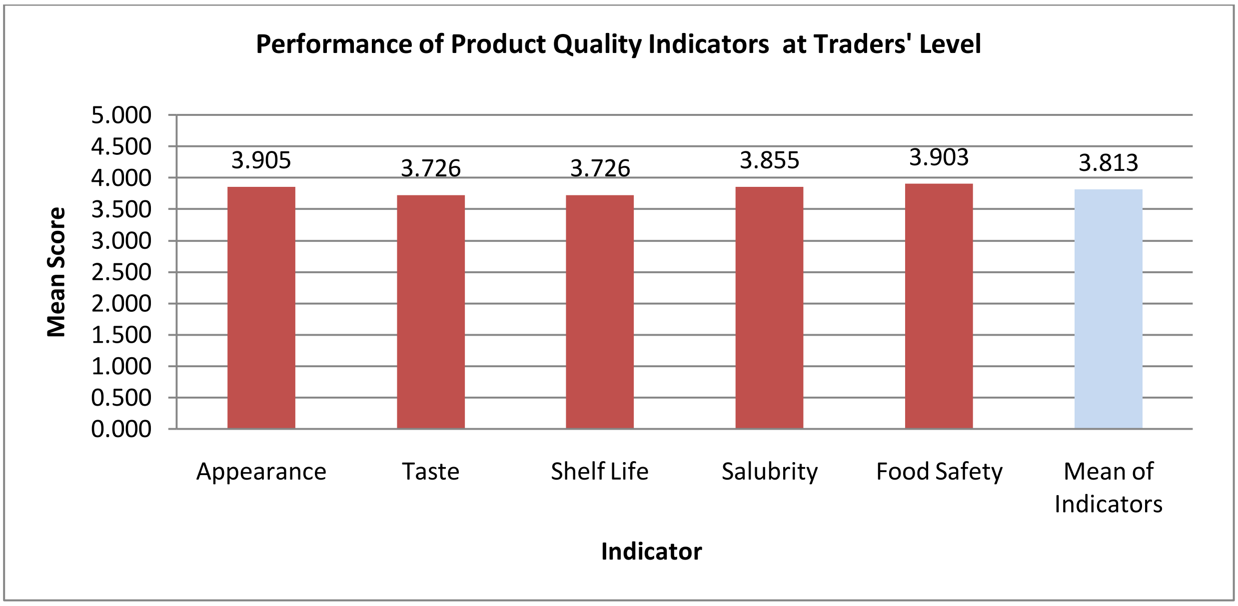

Figure 6.26: Performance of product quality indicators at traders’ level

6.6.3 Retailers’ Level

Figure 6.27 shows a mean score of 3.188 on performance of product quality indicators at the retailers’ level. The appearance indicator shows a score of 3.125 which is almost equal to the mean score value of the all indicators on product quality showing that the appearance is moderate.

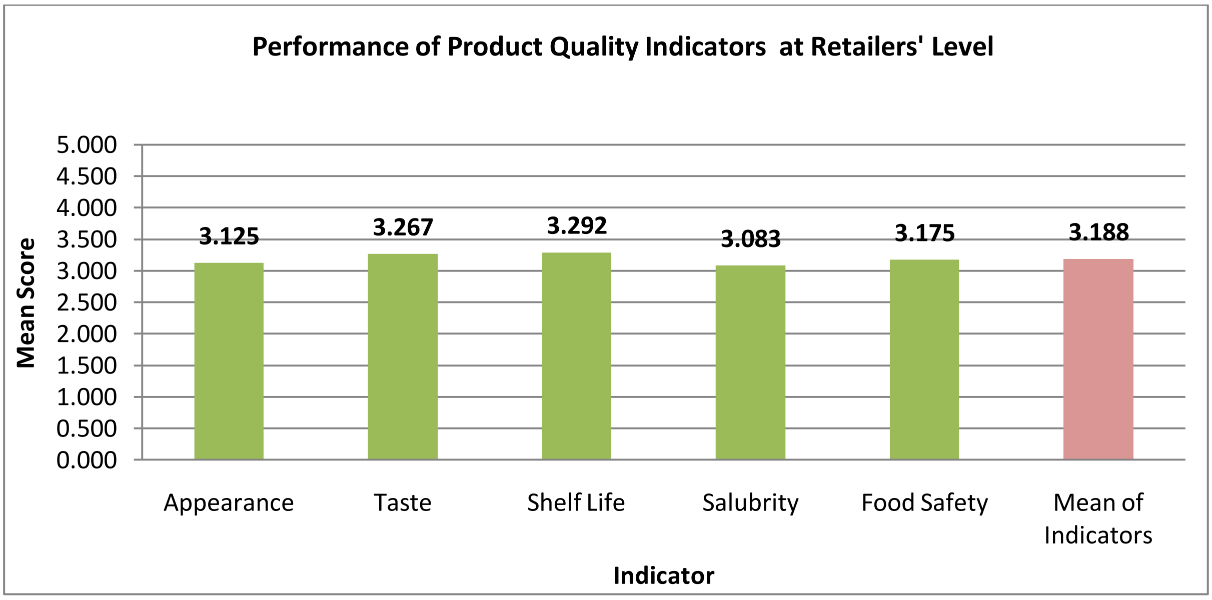

Figure 6.27: Performance of product quality indicators at retailers’ level

The taste indicator shows a score of 3.267 and is relatively better than the appearance indicator. The shelf life shows a score of 3.292 which is also moderate while the salubrity and food safety score are 3.083 and 3.175 respectively. Thus, it has been observed that the performance of product quality indicators at the retailers' level is moderate in all and leaving a scope for further improvement of these parameters.

6.6.4 Appearance

Figure 6.28 shows a mean score of 3.818 for appearance across the supply chain. The scores at the farmers' level show a value of 4.475 which is much higher than the mean scores. At the retailers' level it is found that the score is low at 3.125 while at the traders' level the score shows 3.818 which are moderately high.

Overall it has been found that the appearance across the supply chain is moderate and there is scope for better performance especially the retailers' need to take appropriate steps to preserve the freshness so as to appearance indicator score may improve.

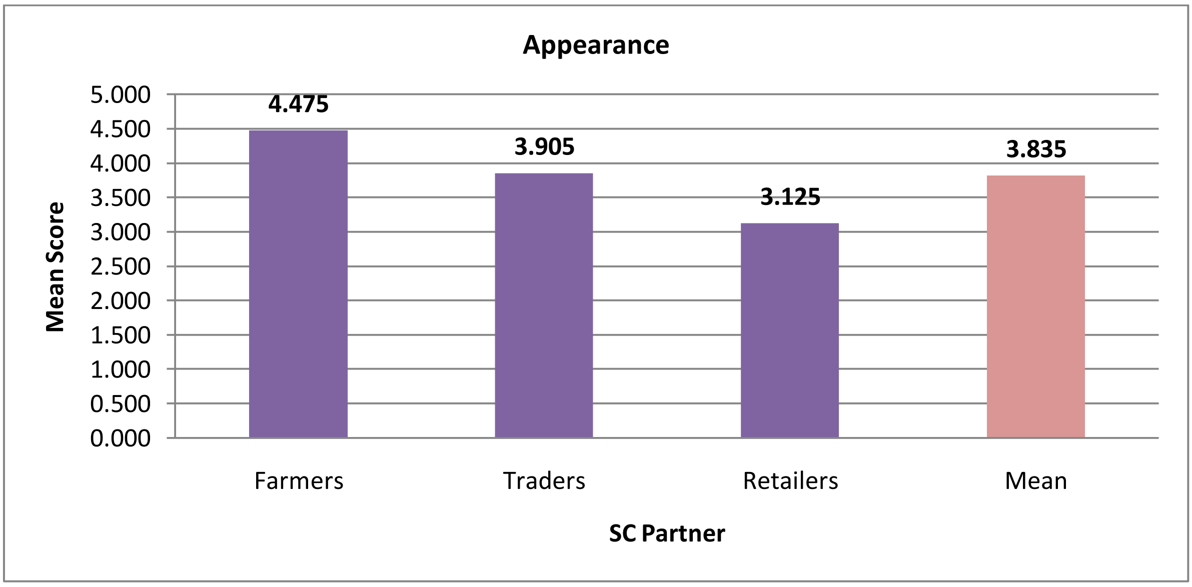

Figure 6.28: Performance of appearance measure among supply chain partners

6.6.5 Shelf Life

Figure 6.29 shows a mean score of 3.792 for shelf life indicator. At the farmers level the shelf life score stands at 4.357 indicating a high performance in shelf life indicator. The retailers' level shows a low score of 3.292, while the traders' level shows a score of 3.726 higher than the mean score of supply chain partners.

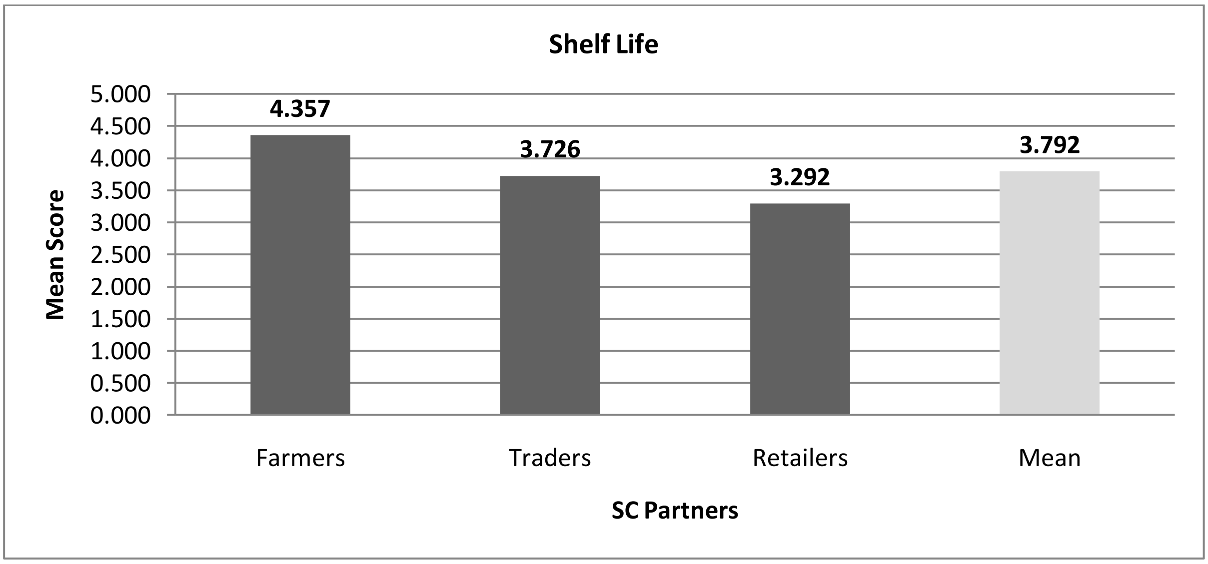

Figure 6.29: Performance of shelf life measure among supply chain partners

Thus, it has been observed that the shelf life varies among the partners of the supply chain and there is need for improvement of shelf life for better quality of produce. The retailers need to adopt post-harvest measures to improve the shelf-life indicator score.

6.6.6 Salubrity

Figure 6.30 indicates a mean score of 3.477 on salubrity or nutrition of the produce across the supply chain. This indicates that the salubrity or nutrition indicator performs moderately and there is scope for further improvement. At the farmers level the salubrity is 3.492 showing that the salubrity is the best at this level when compared to other partners in the supply chain.

The traders' level shows a score of 3.855 which is high and leaves scope for betterment. The retailers' level shows a value of 3.083 for salubrity indicating that there is a moderately low salubrity at this level. Salubrity is not being studied at the transporters level. Thus, it can be said that the overall salubrity is moderate across the supply chain with space for better performance.

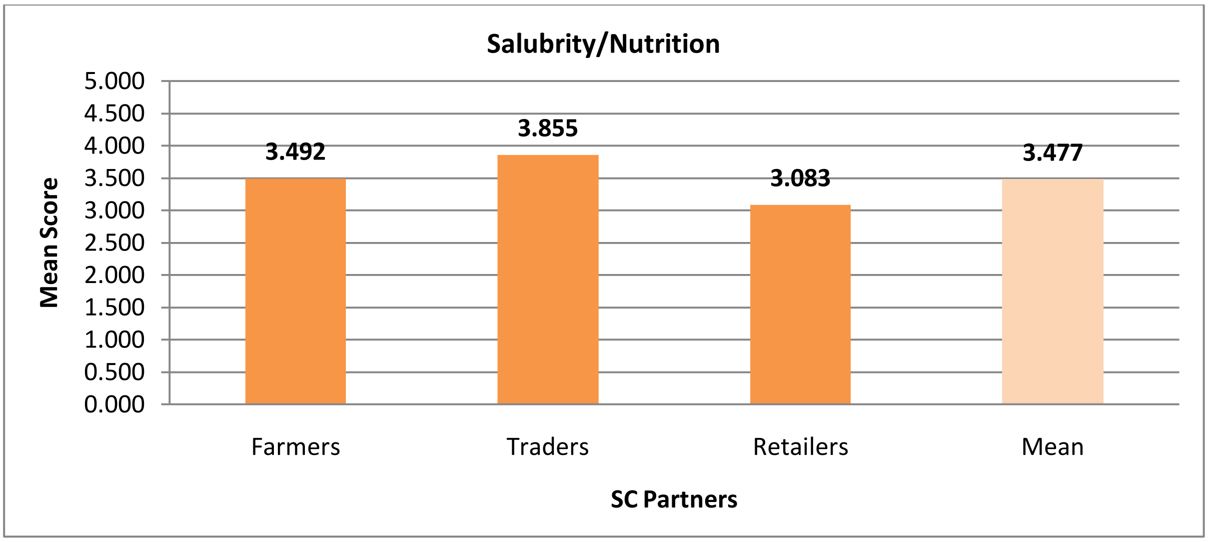

Figure 6.30: Performance of salubrity /nutrition measure among supply chain partners

6.6.7 Food Safety

Figure 6.31 shows a mean score of 3.506 on product safety across the supply chain partners. At the farmers' level the score on food safety is 3.439 indicating that the produce is relatively safe. At the retailers' level the score is low at 3.175 indicating a lower level of safety.

Figure 6.31: Performance of product safety measure among supply chain partners

The traders' level shows a score of 3.903 indicate a moderately high food safety among all the chain partners. Thus, it can be concluded that there is variation in product safety across the supply chain and there is need for improvement of product safety at all levels especially at the retailers' level.

6.7 PERFORMANCE OF PROCESS QUALITY INDICATORS

Process quality refers to production system characteristics that deal with the way a food product is made for public consumption. For this study, it includes several measures such as traceability, storage and transport conditions, pesticide and chemical use. The process quality indicator is analysed entity-wise first and indicator-wise later in the subsections of this heading.

6.7.1 Farmers' Level

Figure 6.32 shows a mean score of 2.343 on performance of process quality indicators at the farmers' level while considering traceability, storage and transport condition, pesticide/chemical use and promotion. The aspect of traceability score is 2.948; while the score on storage and transport condition is 2.767 and the score on pesticide and chemical use is 2.423 which is higher than the mean of process quality and treated to be of low performance.

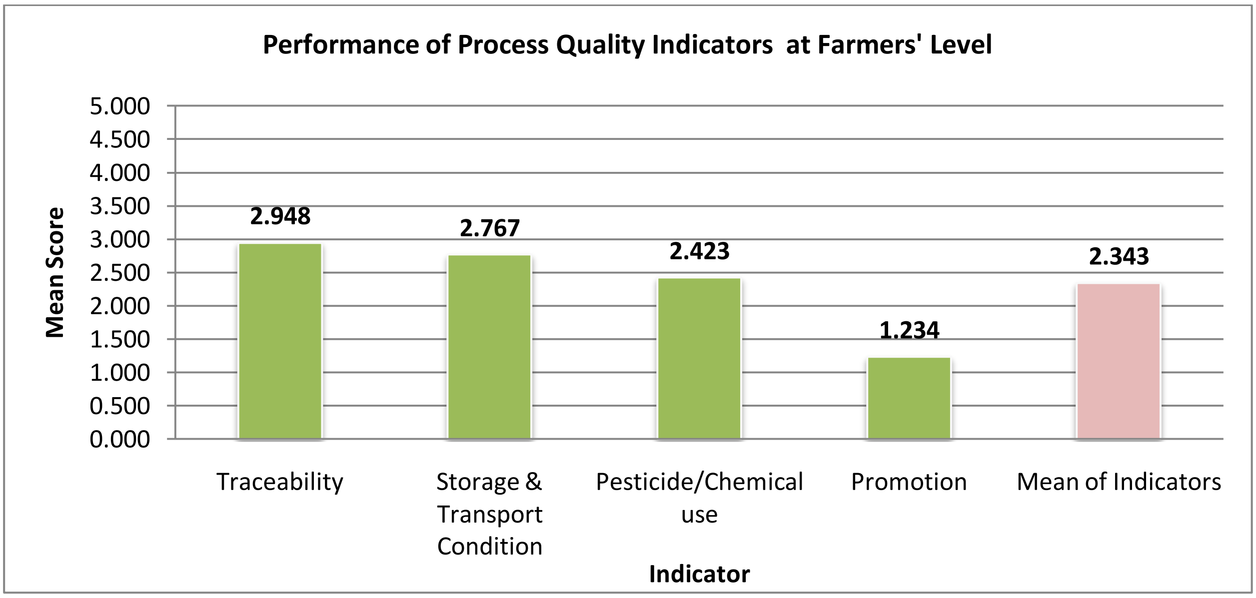

Figure 6.32: Performance of process quality indicators at farmers' level

It is observed that the promotion initiatives of fresh produce score are showing very poor. There is scope for improvement on traceability and storage and transport condition while the use of pesticide and chemical use needs to be further reduced. Thus, on the whole it is concluded that the performance of process quality indicators at farmers' level seems to be poor and need to be further improved.

6.7.2 Traders' Level

Figure 6.33 indicates a mean score of 2.820 for performance of process quality indicators at traders' level which includes traceability, storage and transport condition, pesticide and chemical use and promotion. The score on traceability is found to be 2.123 which mean that the score is considered to be low and needs improvement. The score on storage and transport condition is 2.794 and requires further improvement.

The score on pesticide and chemical use is 3.125 indicates that there is need to reduce the use of pesticides and chemicals and improve storage and transport conditions for better performance at the traders' level. The indicators such as pesticide use and promotion are above the mean score of process quality indicator.

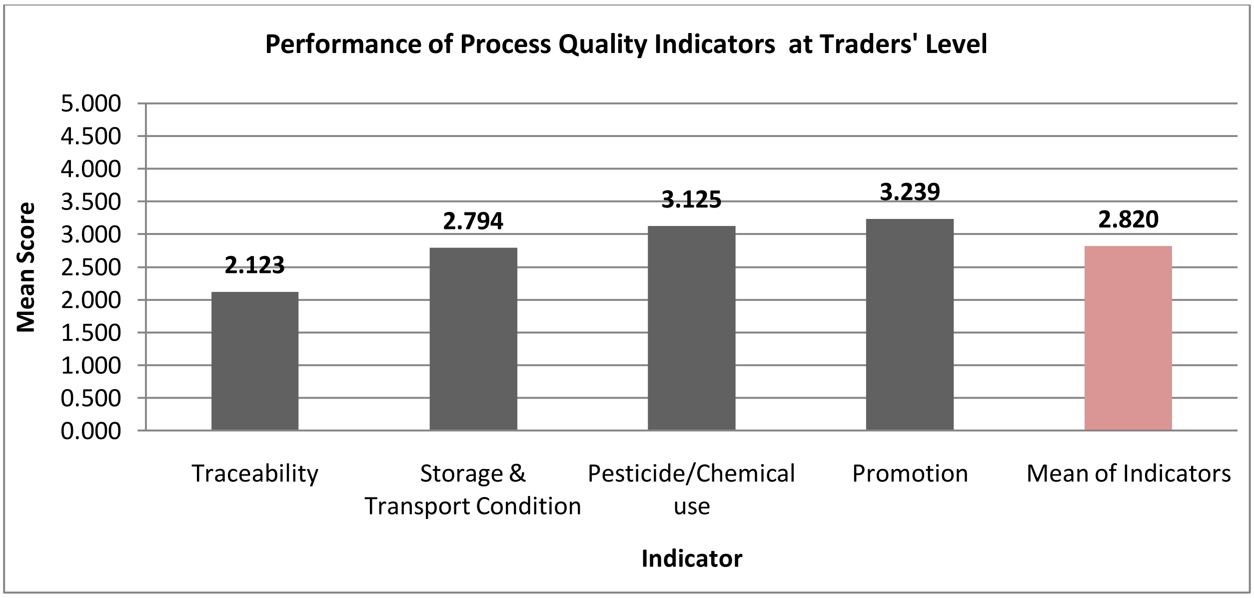

Figure 6.33: Performance of process quality indicators at traders' level

6.7.3 Retailers' Level

Figure 6.34 shows a mean of 3.127 for performance of process quality indicators at the retailers' level. The promotion indicator shows a score of 2.456 which are low and necessitates marketing interventions. The storage and transport condition shows a value of 3.193 indicating that the storage & transport conditions are moderate.

There are high values for pesticide and chemical use at the retailers' level and the value on promotion is found to be 4.093 and which is high among the process quality indicators as the retailers do not use much of pesticides. Thus, overall it may be concluded that there is scope for improvement in performance of process quality indicators at the retailers' level.

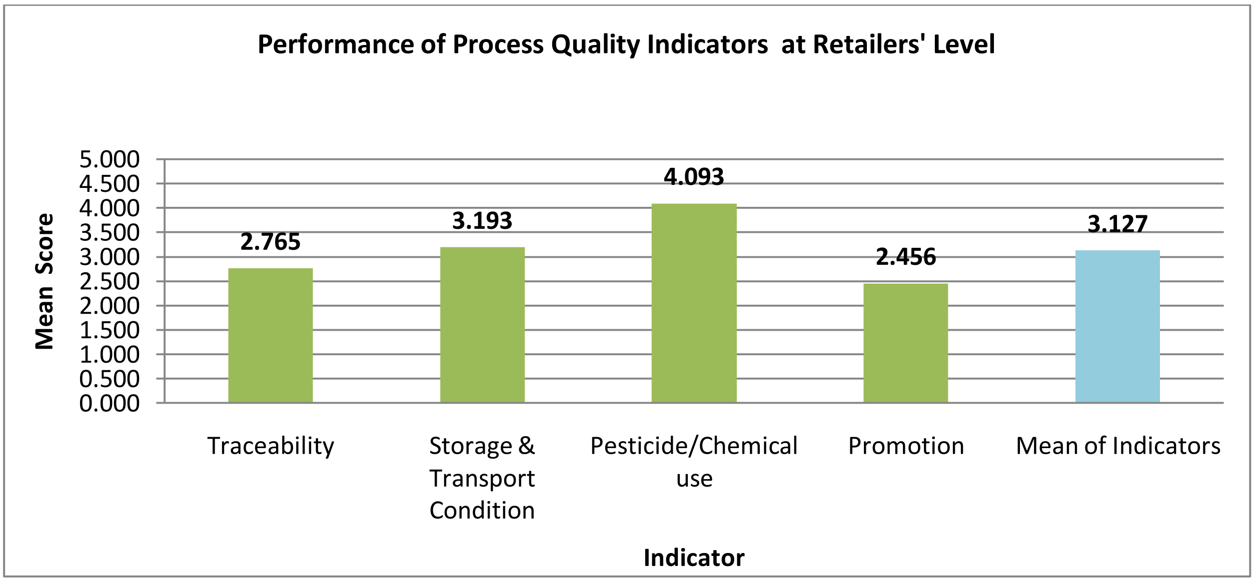

Figure 6.34: Performance of process quality indicators at retailers' level

6.7.4 Traceability

Figure 6.35 shows a mean score of 2.612 on traceability across the supply chain partners including farmers, traders, retailers and transporters. Traceability indicates the origin, location and life history of product and helps in crisis management in the event of safety and quality violation. Traceability is critical element in exporting fresh produce to overseas customer and it is great source of visibility in fresh produce supply chains even in domestic markets.

At the farmers level the traceability scores show 2.948 which is low. Similarly, at the traders' level the score on traceability is found to be 2.123. The retailers' level shows a score of 2.765 indicating very low traceability levels. Thus, it can be stated that traceability across the supply chain is low and need to be improved to a great extent.

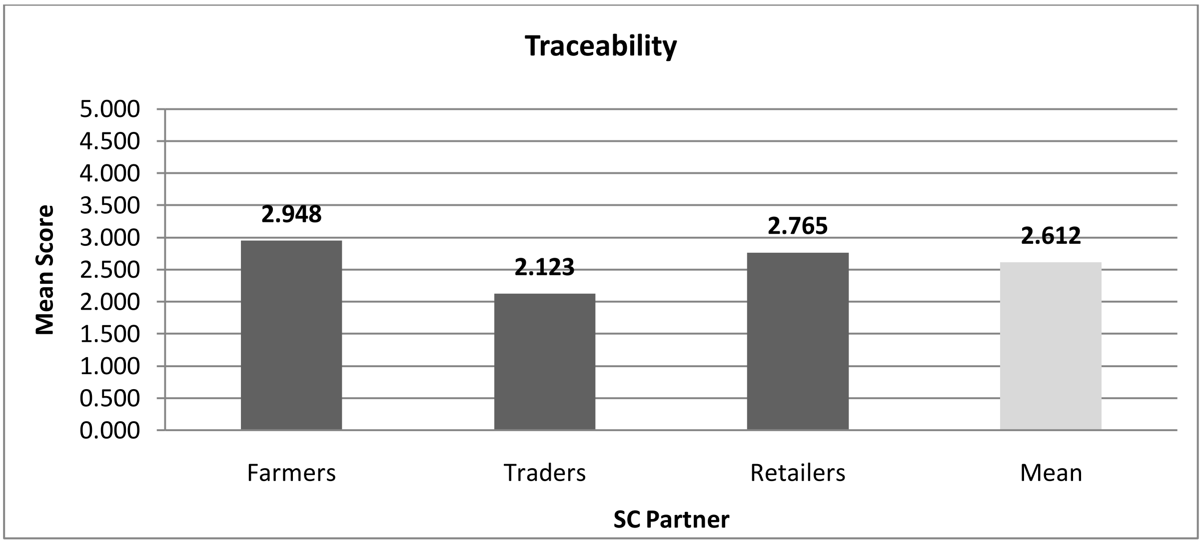

Figure 6.35: Performance of traceability measure among supply chain partners

6.7.5 Storage and Transport Conditions

Figure 6.36 shows a mean score of 2.934 on storage and transport conditions across the supply chain. The farmers' level shows a score of 2.767 which are low and needs improvement. The traders' level shows a score of 2.794 which are comparable to that of the farmers and requires improvement of facilities of storage and transport.

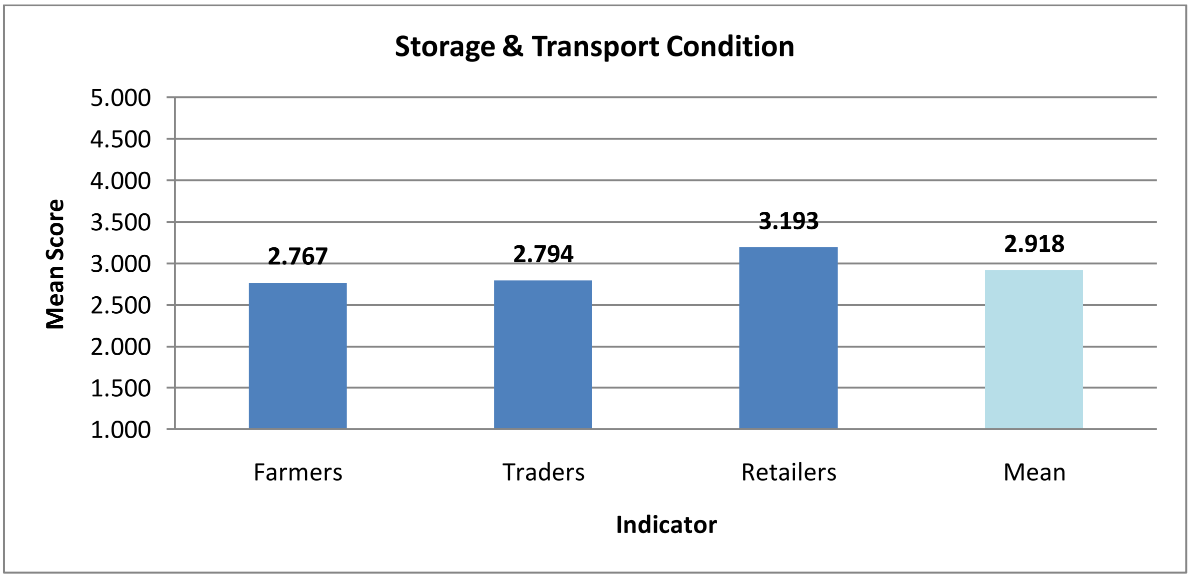

Figure 6.36: Performance of storage and transport condition measure among supply chain partners

The retailers' level shows a score of 3.193 which are somewhat higher than that of the farmers and traders and can be rated as moderate with scope for improvement. Thus, overall one can say that the storage and transport condition needs improvement at all levels in the supply chain.

6.7.6 Pesticide and Chemical use

Figure 6.37 shows a mean score of 2.774 on use of pesticides and chemicals while considering farmers and traders in the supply chain. This indicates a moderate use and there is need for further reducing the use of pesticides and chemicals. The traders' levels have a higher level of pesticide and chemical use at 3.125 when compared to the farmers at 2.423 which is relatively low.

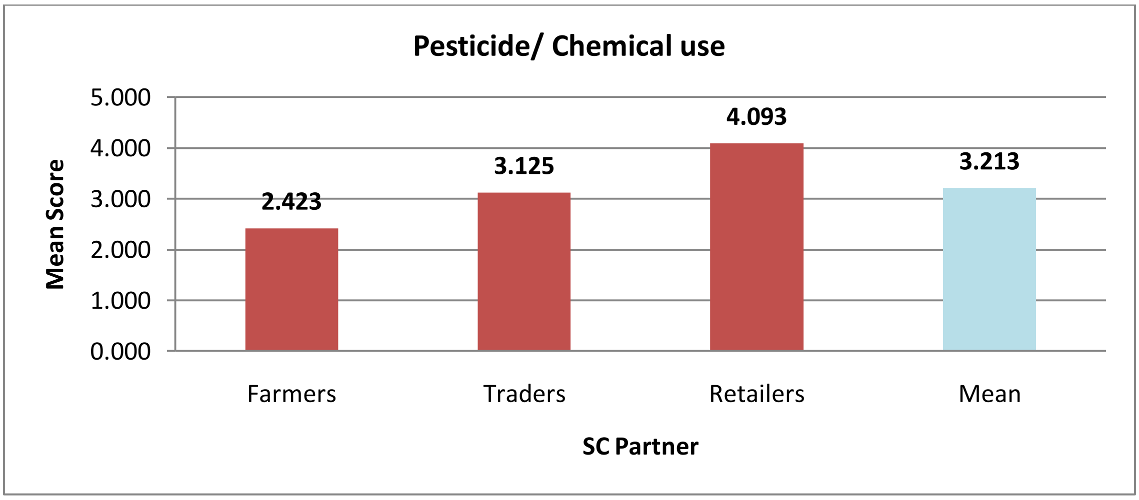

Figure 6.37: Performance of pesticide/ chemicals use measure among supply chain partners

Thus, it can be said that the use of pesticides and chemicals is high at the traders and needs to be reduced drastically while at the farmers level there is further scope for decreasing the use of pesticides and chemicals. Overall there is need to reduce the use of pesticides and chemicals across the supply chain.

6.8 CONCLUSION

This study measured the performance of fresh produce supply chain using key performance indicators. The each key performance indicator is analysed separately along with their sub-indicator. The KPI used for the study are efficiency, flexibility, responsiveness, product quality and process quality and their respective scores measures at 3.328, 3.034, 3.100, 3.564, and 2.763. The scores revealed that there is much scope for the improvement in almost all the performance indicators. The overall fresh produce supply chain performance scores at farmer, trader, retailer and transporter levels are 2.997, 3.129, 3.261, and 3.363 respectively. These scores indicate that there is no much difference among the supply chain entities and performance seems to be moderate and relatively similar.

In the next chapter, the various supply chain models are being followed in Indian agriculture and their working phenomenon has been discussed. The models are analysed in view to develop a conceptual model.

CHAPTER – VII
SUPPLY CHAIN MANAGEMENT MODELS IN AGRI-PRODUCE DISTRIBUTION SYSTEM

The present chapter discusses different models of fresh produce supply chains used in agri produce distribution system in India and a due focus is given on Andhra Pradesh models. In this chapter, the various constraints of agri-produce supply chain are discussed initially which are necessitating for development of alternative models in the sector. The later sections of this chapter will explain the ICT (Information and Communication Technology) enabled supply chain models and non-ICT supply chain models discussed with a view to develop an appropriate model that fit into the fresh produce supply chain environment.

7.1 CONSTRAINTS IN EXISTING AGRI-SUPPLY CHAIN

The study has discussed the constraints relating to road infrastructure, storage and marketing, market awareness, capital constraints and risk taking ability. They are discussed in detail in sub-sections of this heading.

7.1.1 Road infrastructure

The main roads between the major cities are often in good condition when compared to the rural networks. The ongoing market prices for transportation are often higher than the official estimates which are based exclusively on the distance. The total transport charge depends on the distance, condition of the road, and possibility of getting something to ship back. The increase in fuel price adds to the transportation cost. Poor infrastructures also restrict the size of the market and obstruct inter-regional trade.

7.1.2 Storage and market infrastructure

Access to a reliable and fast transportation network is vital for marketing of perishable goods especially in the absence of appropriate storage facilities. Cold chains for perishable products are scarce. In tropical climate most products get easily rotten, and delays in transport and marketing present a considerable risk for the traders, which they are often unable to bear due to limited working capital. Not only traders but also the producers are constrained by lack of storage facilities and thus products are often sold directly from the field as the producer postpones harvesting until the buyer is known. Even the main markets in the State are not provided with adequate supply of water, toilet facilities, or electricity despite the commitment of the government to provide such services.

7.1.3 Market Orientation and Business Skills along the Supply Chain

Despite the fact that most of the traders interviewed for this study had been in business for years, the level of knowledge in basic business skills is very low and the business was rarely growing. Especially in rural areas the traders are unable to distinguish between revenue and profit, and thus sometimes end up eating their own working capital while thinking that they are running a profitable business. Lack of entrepreneurial skills is also a constraint for the farmer, who has traditionally been producing the same crops and starts finding the markets for them only at the time of harvest. Better understanding of the roles of the government and market would help to avoid large dissatisfaction among the producers. Training in business skills could facilitate the farmers in becoming more market-oriented.

7.1.4 Capital constraint

Formal credit institutions are limited in rural areas. Lack of capital and access to credit is not only a constraint for the small-scale producers and traders but also the large market players. Lack of business skills can also act as a barrier for expanding the business especially when it comes to managing and obtaining loans, which is used to increase the working capital. Liquidity constraint affects farmers' production adversely as they rarely have money or are able to borrow money to purchase the necessary farming inputs, such as seeds and pesticides on time.

7.1.5 Risk aversion

Producers' and traders' inability to borrow against future earnings leads also to low risk and often low return strategies being selected. The markets are often poorly integrated and supply is unreliable. The fluctuation of prices and availability of goods was highlighted as a major constraint for trade by all stakeholders in the supply chain. It was found that adoption of new crops has been slow in many villages as the farmers cannot be sure of the potential market, and are unwilling to face the risk of not being able to sell the products.

Due to the above constraints, the new initiatives have come up from the private and government in order to effectively address them. The following sections discuss the various new models used in agri-supply chain.

7.2 RECENT SUPPLY CHAIN MODELS IN INDIAN AGRICULTURE

The vertically coordinated supply chains are expected to eliminate the inefficiencies in traditional agricultural marketing which arises as a result of the multi-layer intermediaries and also characterised by poor infrastructure and technology (Rao, 2007). The vertical coordination supply chain models are necessary for Indian agriculture distribution system. In India several attempts are also made by corporate companies which altered the traditional supply chain models using ICT (Information and Communication Technology) as tool for vertical coordination and other models have been altered the only distribution system through which the intermediaries between farmer and customer work. There are several successful examples of linking farmers to these modern value chains with effort from corporate, government agencies, NGOs and development agencies. The following sub sections describe the initiatives of PepsiCo, ITC e-choupal, Safal and infosys as given below.

7.2.1 PepsiCo contract farming

The PepsiCo with its international research experience and marketing skills had ventured with Punjab Agro Industries Corporation who provided the extension support. This resulted in improved R&D activities, Technology transfer and commercialisation of agriculture. PepsiCo provided the full-time services of overseas consultants who have expertise on growing of tomato and potato. The extension personnel are selected from the farmers themselves who are responsible for the contact with the farmers; this lead to the diffusion of technology from lab to field using various means of communication to disseminate knowledge and monitor crops.

PepsiCo assisted the farmers in land preparation, crop monitoring, post-harvesting, transportation and logistics during crop growing and produce marketing periods. The farmers are paid promptly on the agreed price and found that the net impact of the model was remarkable. Under this model tomato yields increased dramatically from 16 to 52 MT per hectares. The prices of the crop declined due to the increased production in the State but farm income increased by more than 2.5 times and the same continued for three years. During the agreement period the contract farming transformed the economy of Sangrur and exposed them to world class farming, as well as remunerative and assured market.

PepsiCo gained profits by receiving uninterrupted and quality raw materials and fluctuations in market pricing reduced due to plans in the long run. However, the study detected various operational problems in the functioning of contract-farming practices. The farmer reported problems like poor technical assistance, delayed payments and outright cheating in dealing and manipulation of norms by the firms. Farmers had little bargaining power with the company hence firm posed risk to farmers. Since the contract farming is not allowed in India, the legal protection was not available to the farmers in the event of company not meeting its fulfilment. As the acreage under tomato crop increased and production too increases the open market prices is going to fall and then company bases its contract price on the basis of this open-market price. PepsiCo also shared its benefits to create the right kind of trust with the farmers.

7.2.2 ITC e-choupal

ITC started e-choupal project with an intention to enhance the global competitiveness of Indian agriculture and raising the standard of living in Indian villages. It intends to leverage information technology to reduce aggregate cost of its supply chain and to extract value through a near dis-intermediation of the supply chain. ITC has a belief that intermediaries who yield substantial economic power cannot be totally eliminated. Hence ITC considered disassociating intermediaries from the information flows which is a basis for structure of e-choupal initiative.

ITC’s e-choupal's holding Internet-enabled kiosks in-charged by a lead farmer of the village, called the Sanchalak across various villages of interior Madhya Pradesh, Karnataka, Uttar Pradesh and Andhra Pradesh. The Sanchalak is trained to operate the computer. These Sanchalaks, with the help of Internet kiosks are supposed to perform three distinct activities; (1) Information and knowledge dissemination: These kiosks display real-time data on market price prevailing in the Mandis across States. They also carry information on weather and have a knowledge bank of best scientific practices. (2) Virtual aggregation of demand and supply: By aggregating both buyers and sellers ITC intends to reduce the aggregate cost by providing a kind of commodity exchange which disassociates intermediaries from intermediation of information flow making the chain more competitive. (3) Allowing retailing of agri-inputs as well as other products and services. The e-Chaupals provide ITC with the opportunity to directly purchase soya, rice and other crop from the farmers. This provided the farmers an alternative route to Mandi through online access and transaction across remote locations.

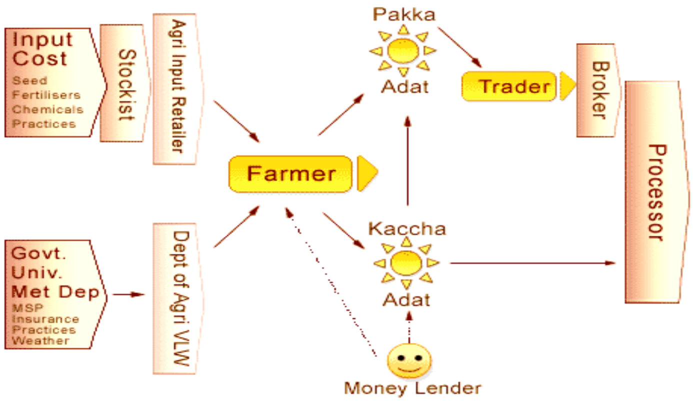

Figure 7.1: ITC e-choupal model of fresh produce supply chain

Source: www.itcibd.com

This has reduced transaction cost through pre and post e-choupal experiment. Farmers incur transaction cost, which arose due to trolley freight to Mandi, cost of labour, khadi, karnai and handling cost. Process cost incurs towards commission to agents, cost of gunny bags, and loading cost of labour freight and transit loss. Both farmer and process transaction cost works against the interest of farmers and the company. With the help of e-choupal, ITC has been able to reduce this transaction cost drastically claiming a win–win situation for both farmers as well as itself. The coverage of e-choupal is currently around 3.5 lakhs farmers growing soya bean, coffee, wheat, rice, pulses and shrimp in around 3,50,000 villages through 650 kiosks across four States.

ITC has done a commendable job of connecting the remote villages with the help of Internet kiosks. But this initiative has doubts as they do not provide any other information for the farmers who expect weather information, which they get by collaborating with the IMD. As far as Mandi prices in nearby Mandi are concerned, it is quite useful and farmers know much before moving out of his village what price is he is going to get and which Mandi should he sell in and the Sanchalaks do the grading for the farmers.

Most farmers did not agree with ITC claim that farmers have been getting better prices for their produce. It is also countered by other farmers who believe except for minor benefits like de-bagging expenses etc. Farmers also said that the company does not pay the price agreed by the Sanchalaks. Sometimes, grading is downgraded and hence the net farmers realisation. The significant advantage which farmer has gained is right weight, which was a major worry in traditional Mandi.

7.2.3 SAFAL Exchange

The National Dairy Development Board (NDDB) has started the Fruit and Vegetable Unit of SAFAL at Delhi, which is one of the first fruit and vegetable retail chains set up as a part of the Mother Dairy Foods Processing Ltd. The retail unit provided a direct link between fruit and vegetable growers and consumers. The other initiative was a fruit processing Plant of SAFAL at Mumbai, a 100 percent export-oriented unit, which capitalises NDDB's food processing strength. NDDB has set up an alternate system of wholesale markets in Bangalore as a pilot project.

The initiative is named as SAFAL Market and is initiated to fine-tune horticultural growth in India, by a shift in their earlier retail chain model to a wholesale market concept. This market is a move to introduce a transparent and efficient platform for sale and purchase of horticultural produce by connecting growers through Growers’ Associations with farmers and wholesale buyers in various markets across the country (SAFAL website). The model involves establishment of an alternate marketing structure that provides incentive for quality and productivity thereby improving farmers’ income. Through this approach there is an expected increased integration between growers, wholesalers and retailers into the market system.

The SAFAL Market is an establishment of an auction market through clock auction, backward linkage through farmer associations and a forward linkage in the form of cash and carry semi-wholesale and retail stores. SAFAL Market comprises of a terminal market capable of handling approximately 1,600 tons per day of fresh fruits and vegetables at full capacity catering to an estimate of 30 percent of Bangalore's demand. The market infrastructure also has the facility of cold storage, grading, sorting and distribution. The business practices at the SAFAL Markets are transparent and competitive, thus the wholesalers are a bit hesitant and need more time to orient them to the new system while, on the other hand, growers have rapidly linked themselves with the new model.

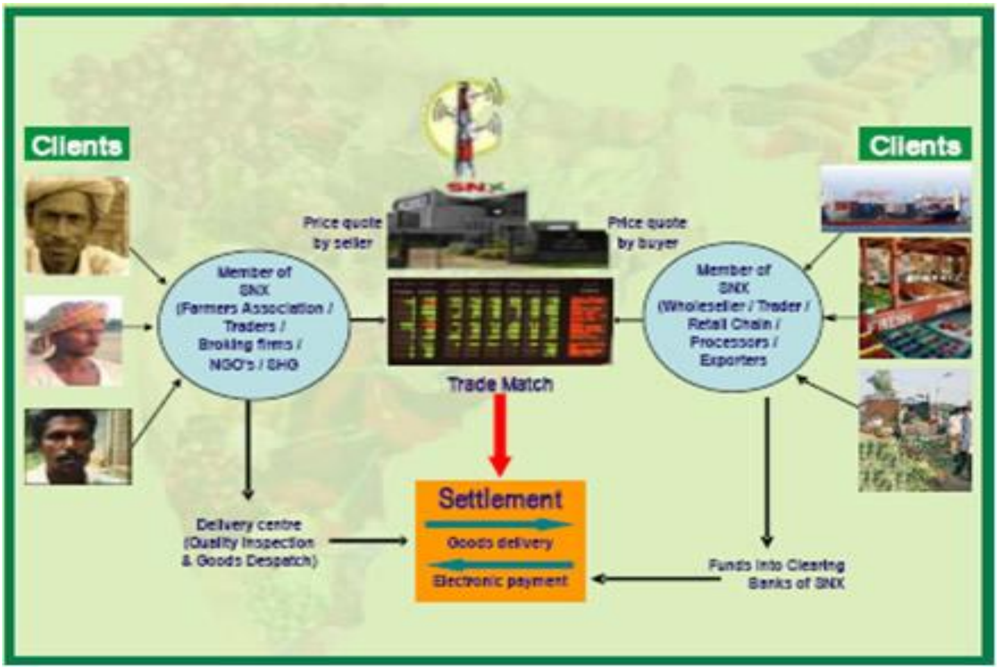

Figure 7.2: Mother Diary's SAFAL model of fresh produce supply chain

Source: www.freshplaza.com

The market is supported by 250 Horticultural Farmers' Associations organised throughout India with more than 20,000 members. The farmers' associations are linked to 40 collection centres that are equipped to meet the specific or special requirements of buyers, in terms of quality, packaging and weight. Individual growers are being trained in quality management aspects and provided extension services for production enhancement, by introducing improved varieties, agronomic and plant protection practices, pre- and post-harvest management. Logistics support in terms of packaging and transportation of produces is also arranged on behalf of the growers on a pre-fixed charge. More than 200 types and quality of fresh fruits and vegetables are sourced in SAFAL Market through standard quality, grade, weight and packaging and is handled by the auction market.

Farmers or the wholesale purchasers have to register themselves with SAFAL Market on a very nominal charge and become its member, in order to involve themselves with the daily transactions. This is necessary to enable the SAFAL authorities to have consistent suppliers and takers and plan their future demand. Farmers are provided payment for their produce on weekly basis in the form of account payee cheque. Farmers selling their produce to SAFAL realise 10 to 15 percent higher profit as compared with traditional channel (Chengappa and Nagaraj, 2005). They gain through proper weighing of produce, low transaction cost, less input cost, efficient transportation, less wastage, right price and extension services. Farmers are ready to supply more than the indent given by SAFAL. Farmers have appreciated the technical service rendered by SAFAL.

Wholesalers participate in auctions at Auction Market Complex or can even bid using Remote Electronic System. The auction takes place in two parallels set up of clock auction halls. Wholesalers find it an added advantage to come at SAFAL terminal market where all the produce is auctioned at the same place rather than fragmented four product specific wholesale markets in Bangalore. Forward linkage is carried out through 10 to 12 cash and carry stores, owned by the auction market constructed at strategic locations in the city to cater to the requirements of the local retailers. Cold storage facility is also available for the wholesalers or other market users available on payment basis. Incentives to the wholesalers are assured in terms of availability of quantity and quality of fresh fruit and vegetables, graded and quality checked in wholesaler/retailer friendly packs for easy handling and transport. The state-of-the-art fruit ripening facility, assured quick and efficient despatch of produce per auction, online wholesale price information of all items in major markets is also made available at SAFAL market to help buyers and suppliers in their decision making.

SAFAL Market by and large has been operating successfully in overcoming the constraints that the fresh fruits and vegetables marketing is facing in India. It has been able to establish an efficient supply chain both in backward and forward linkages. An experiment of backward and forward integration provided by NDDB-SAFAL has benefited the farmers immensely (Chengappa, 2006). The up scaling of such models involving the private players and the government playing the role of a facilitator is crucial to make the farmers economically sustainable in the long run.

7.2.4 Infosys supply chain

Infosys developed an ICT for agro supply chain aimed at improving efficiency in the agro supply chain. The solution successfully minimises inventory requirements, reduces waste and allows retailers and farmers to be better integrated. This application falls under Growth-oriented Microenterprise Development Program (GMED), which is a 6.3 million dollar USAID-funded Initiative. GMED is an innovative program that develops sustainable and scalable approaches to job creation by fostering the growth of micro and small enterprises. Maintaining on-time, programmed delivery of fresh produce from a large and scattered production base is a complex and critical operation. This solution gives the organised retail sector access to a reliable small holder production base. It thereby decreases farm-to-market losses, currently estimated at 30-40 percent on certain products.

The application tackles supply chain management from profiling of farmer clusters to crop planning, scheduling, tracking and forecasting. It allows farmers to access technical information including database searches for data and images, access to region-specific weather updates and market information, i.e., daily sales volumes and average prices, the statement added. There are 1,700 small holder farmers currently integrated into organised retail supply chains through this application, thereby bridging the urban-rural agricultural divide, it added. The orders received from the retailer will be split into smaller quantities and distributed among the farmers, who will then produce and supply directly to the retailer at predetermined price.

Infosys has built the solution consisting of wireless software applications that are accessible on handheld devices, enabling agents to address information gaps constraining vegetable and fruit farmers and enabling other supply chain participants to monitor and control the back-end and front-end supply chain functions. The application also enables wholesaler/retailer or other intermediaries to optimise cost by allowing large procurement, efficient transportation management and enabling intelligent crop production management. The solution allows for peer-to-peer (p2p) synchronisation between field agents without connecting to a central server.

7.2.5 Rythu Bazar model

Andhra Pradesh is the second largest producer of fruits, vegetables and flowers in the Country. The predominantly grown fruit crops are mango, banana, cashew nut, sapota, guava and pomegranate. Brinjal, lady's finger, onions, tomatoes, beans and gourds are the major vegetables produced in the State. Regulated Market Yards for fruits and vegetables are functioning only at few centres in the State. The Marketing system for fruits and vegetables is in the hands of middlemen. Middlemen exist at various levels between the farmer and the consumer and exploit through malpractices in weighing, handling and payments. The farmer's share in the consumer's rupee is estimated to be just 40 paisa. In addition the estimated losses in handling vegetables in the traditional channel of marketing are about 30 to 35%.

Large numbers of small farmers are unable to effectively bargain for a better price in the wholesale markets. Inefficiencies in wholesale markets result in a long chain of intermediaries, multiple handling, and loss in quality and increase the gap between producer and consumer prices. Intermediaries and system inefficiencies consume a disproportionate share of consumer prices. Large number of small retailers, each handling small quantities, create high overheads leading to high margins on produce. Rythu Bazars will operate outside the purview of Agricultural Market Committees to be managed by Estate Officers and under the control of Joint Collectors. It was therefore thought necessary to evolve an alternate marketing strategy where both growers and consumers are benefited through Rythu Bazars. Rythu Bazars are thus planned for direct interface between the farmers and the consumers eliminating middlemen.

The objectives is to ensure remunerative prices to the farmers and provide fresh vegetables to consumers at reasonable rates fixed every day, facilitate prompt realisation of sale proceeds to farmers without any deductions, to curb malpractices in weighing/measurements provide vegetables with correct weighing to consumers and to provide direct interface between farmers and consumers eliminating intermediaries in trade. These Rythu Bazars are located on Government lands identified by the District Collectors.

Infrastructure is provided to Rythu Bazars from Agricultural Market Committees funds. The temporary structures in Rythu Bazars are replaced by semi permanent structures to provide adequate protection against sun/rain to the producers and the users alike. The

Rythu Bazars shall have to ensure the adequate number of sheds for farmers to sell their produce. Adequate arrangements for supply of drinking water, Toilet facilities with proper sanitation, proper arrangements for parking of vehicles, arrangements for removal of garbage and cleaning the market by local body, facilities for storage of unsold produce like Zero Energy Cool chambers. Weighing scales are provided to all the farmers with proper arrangements for issue and collection.

The successful functioning of a Rythu Bazar is due to proper identification of a cluster of villages and genuine farmers and their marketing linkage to Rythu Bazars. It is desirable to identify the farmers from a cluster of 10-15 predominantly vegetable growing villages to enable provision of horticulture services, inputs and transportation arrangements to the Rythu Bazars effectively. Horticulture Department may identify such clusters immediately for all the Rythu Bazars. Only the farmers/groups with valid photo identity cards should be allowed to sell in Rythu Bazar. The Daily allotment of shops shall be on first-come-first-serve basis on rotation. No one shall be allowed to occupy the same shop continuously. Farmers shall not be allowed to reserve the shop by keeping vegetables in the night.

The vegetables grown within the district are to be sold only by the farmers. Rythu Bazars have to ensure availability of all vegetables whether grown locally or not. The import and sale of vegetables not grown locally or not grown in that season may be organised through self help groups. Self help groups shall not be allowed to sell the vegetables grown within the district. District administration should assist the self help groups in procuring vegetables through proper tie ups. The daily return of transactions at all Rythu Bazars are made available through computer net work to aid decision making in the transport of vegetables from the low price areas.

The premises is maintained clean by removal of garbage, cleaning the market, maintenance of toilets may be entrusted to the local body, private agency, or Self-help Groups. The funds required for the cleaning is met from the income generated through auction of parking space, canteen, etc. Farmers and Self-help groups clean the space allotted to them and put the garbage at the places specified. The Funds allotted to Rythu Bazars wherever necessary may be utilised for proper sanitation in the market and other amenities like Telephone, Fax and Computers are installed in all Rythu Bazars. The Estate Officers shall use the above for prompt submission of returns and receipt of information for better management. Networking of all Rythu Bazars enable Estate Officers in realistic price fixation and helps the farmers, Self Help Groups in taking advantage of the prevailing prices in different markets.

Adequate participation of farmers is the best way to prevent the entry of middlemen. The entry of middlemen (retailers / wholesalers) defeats the purpose of setting of Rythu Bazars. No seller shall be allowed to enter into Rythu Bazar without valid photo identity card. Self-help Groups to sell only those vegetables which are not grown in the District and other essential commodities supplied by the government agencies. Estate Officer will be held responsible for allowing persons without proper identity cards. The Joint Collector and others conduct frequent surprise inspections and they should leave their remarks in the inspection register without fail.

The price fixation in Rythu Bazars shall be through a committee of farmers and the Estate Officer. Adequate care should be taken to fix the prices realistically. If the prices in Rythu Bazars are higher than the local market rate, there is no incentive to consumers. And if the prices fixed are lower than the wholesale market rates there is no incentives to farmers. The prices generally in Rythu Bazars shall have to be 25% above the wholesale rates and 25% less than the local retail price. Marketing Department shall provide the wholesale prices to Estate Officer for realistic price fixation. Estate Officer should also make his efforts to obtain the wholesale and retail prices. Whenever Marketing Department is not able to provide wholesale prices by 6.00 A.M in the morning, previous day's wholesale price may be used. For the different varieties (clearly distinguishable) of the same vegetable, different sale price may be fixed.

7.2.6 Apni Mandi / Kissan Mandi

An innovative concept of 'Apni Mandi' has been introduced in some States. Apni Mandi is also called 'Kissan Mandi', as it is different from the traditional mandi or market yard, where the produce moves to the buyer through either a commission agent or trader. In Apni Mandi there is a direct contact between the farmer producer and the buyer who is generally the consumer. This system does away with the middlemen. In Apni Mandi, farmers sell their produce directly to the consumers without involvement of the middlemen. The price spread in Apni Mandi is considerably low. These are working satisfactorily in the case of fruits and vegetables. These, 'Apni Mandi' are similar to the Saturday markets of UK and USA.

The main objectives of popularising the concept of Apni Mandi are

i. Better marketing of agricultural produce especially of fruits and vegetables.
ii. Ensuring direct contact of the producer-farmers and the consumers and thereby enhancing the distributional efficiency of the marketing system.
iii. Increasing the profitability of agricultural crops for the producers by minimisation of marketing costs and the margin of the middlemen.
iv. Ensuring the availability of fresh fruits and vegetables and other farm produce at reasonable prices to the consumers.
v. Removing social inhibitions among the farmers for retail sale of their produce.
vi. Encouraging additional employment to the producers and thereby enhancing their incomes.
vii. Promoting national integration by inviting the farmers of other States to sell the produce grown by them directly to the consumers in Apni Mandis of other States and
viii. Providing business techniques to the farmers so that in the long-run they may adopt this practice for other crops and enterprises too.

The first Apni Mandi was started in Punjab by the Punjab Mandi Board at Chandigarh in February, 1987. Punjab Mandi Board took the initiative with a view to providing small farmers around cities a direct access to consumers. Similarly, in Haryana, the first Apni Mandi was started at Kamal in 1988. In Rajasthan also, this scheme has been introduced in several districts and towns. The initiative is worth emulating.

The market committee of the area where Apni Mandi is located provides space, water, sheds counters, balances and other facilities to the farmers in Apni Mandis. The Market Committee Staff need to work hard with dedication for the success of Apni Mandis. The State Marketing Boards provide financial assistance to the Market Committees for these services rendered by them to the Apni Mandi. This scheme is being implemented with certain resistance from middlemen. Some farmers also have reservations about the success of the scheme as it assumes adequate skills of retailing on the part of farmers. However, farmers as well as consumers would benefit from the Apni Mandi Scheme and its popularity may pick up after sometime.

7.2.7 Hadapsar Vegetable Market

Hadapsar vegetable market is a model market for direct marketing of vegetables in Pune city. This sub-market yard is situated nine kilo metres away from Pune city. This belongs to the Pune Municipal Corporation and the fee for using the space in the market is collected by the Municipal Corporation from the farmers. This is one of the ideal markets in the country for marketing vegetables. In this market there are no commission agents/middlemen. The market has modern weighing machines for weighing the produce. Buyers purchase vegetables in lots of 100 kg or 100 numbers. The produce is weighed in the presence of licensed weigh men of the market committee and sale bill is prepared. The purchasers make payment of the value of produce directly to the farmer. The purchaser is allowed to leave the market place along with the produce after showing the sales bill at the gate of the market. Disputes, if any, arising between buyers and sellers are settled by the supervisor of the market committee after calling the concerned parties. The market committee collects one percent sale proceeds as market fee for the services and facilities provided by the committee to the farmers and buyers.

7.2.8 Uzhavar Shandies

Uzhavar Shandies (Farmers' Market) were established in selected Municipal and Panchayat areas of the Tamil Nadu by the State government. In these markets, farmers enjoy better marketing infrastructure free of cost and also receive considerably high prices for the products than what they use to receive from middlemen at village or primary markets of towns. Farmers are additionally benefited in the form of interaction with other farmers and with departmental personnel. Farmers also get good quality seeds and other inputs in the market yard itself. The consumers in these markets are benefited by getting fresh vegetables at relatively lower prices. Farmer’s market / Uzhavar Shandy are an innovative scheme introduced by the Government of Tamil Nadu, to help the farmers at large. It is the first of its kind in India started in Madurai in1999 first time and the State Government proposes to establish totally 100 such farmers’ markets in the important centres covering the whole State.

The farmer’s market provides the place for the growers of vegetables and fruits to sell their produce directly to the people without recourse to the middlemen. These markets are mainly started to establish a direct link between the farmers and the consumers. There will be no place for the middlemen to the consumers. When the goods are routed through middlemen, the farmers are not getting remunerative prices for their produce. Likewise, as the middlemen at wholesale and retail levels add their respective margins in the sale prices, the goods are sold at higher prices to the consumers. By eliminating the middlemen, this scheme aims at benefiting both the farmers as well as the consumers.

The market place is established in the important centres to help the farmers living in and around that centre. Every market has 80 to 100 small shops or sheds. Each farmer is allotted a shop to sell his produce. The State Government appoints the marketing Committee to regulate the marketing Centre. The committee will also have farmers as its representatives. This Committee identifies the farmers and gives them a permit card. Such farmers alone are allotted the shops to market their produce. The farmers need not pay any rent or commission for selling their goods at the market. Farmers can transport their produce to the marketing centres free of cost using State Transport Corporation Buses. The market is open for the public from 7.00 AM to 7.00 PM. daily. As and when the farmers bring their produce to the market, the committee will fix the prices for the same. The same price will be ruling for that particular commodity for the whole day. The prices are fixed for different commodities on the basis of previous day prices of that commodity in the wholesale market.

In a short period of one month, since farmers’ market came into existence, it was found that the income of the farmers, who are using the farmers market, has doubled. This is made possible, as the farmers need not spend any amount towards handling and marketing their produce. The rise in the farm income of the farmers is also due to the direct marketing of their produce to the consumers. Wherever middlemen play their role in distributing the farm produce, the farmers do not get remunerative prices. The middlemen of a particular area usually form a cartel and accordingly fix low prices for the agricultural goods. But, the scheme of farmers market enables them to realise just prices for their produce by eliminating all types of middlemen. As the sale at the farmers market is only for cash, the farmers are getting money immediately. This is absent when they sell their produce to the middlemen. Most of the traders make delayed payments to the farmers.

7.2.9 Shetkari Bazar

On the lines of farmers' markets in other States viz., Apni Mandi in Punjab, Haryana and Rajasthan since 1988, Rythu Bazar in Andhra Pradesh since January 26, 1999 and Uzhavar Shandies in Tamil Nadu, the Shetkari Bazars were established in the State of Maharashtra for the marketing of fruits and vegetables. The Shetkari Bazar, by eliminating intermediaries, links producers direct to the consumers, reduces price-spread (marketing margin of intermediaries) and enhances producer's share in consumer's rupee. Thus, these markets increase the farm income, well being of the farmers and bring stability in prices of horticultural and plantation crops.

7.2.10 Krushak Bazars

On the lines of Rythu Bazars in Andhra Pradesh and Uzhavar Shandies in Tamil Nadu, Government of Orissa has taken a programme of establishing Krushak Bazars in the State of Orissa in the year 2000-01 with the purpose to empower farmer-producer to compete effectively in the open market to get a remunerative price for his produce and to ensure products at affordable prices to the consumers. The government provides following incentives for opening Krushak Bazars in the State.

a) Provides 1 to 2 acres of land at suitable place, free of cost, for establishing the Bazar.
b) A cluster/group of villages within the proximity of the market area and farmers growing vegetable are identified having the surplus produce for sale.
c) The identified farmers are allowed to use marketing facilities so that there is no intervention of middlemen and farmers to get better prices for their produce.
d) Public utility facilities viz., drinking water, electricity, toilet, canteen and rest house are provided to farmers by the Krushak Bazars.
e) Identified farmers are provided inputs like seeds and fertiliser at reasonable prices in the Krushak Bazars, and
f) Storage facilities in the market area are also provided to the farmers in Krushak Bazars.

7.2.11 Co-operative Marketing Society

When producers of agricultural commodities or any other product form a society with an objective of carrying out marketing of their produce, such society is called as Co-operative Marketing Society. The need for co-operative marketing arose due to many defects observed and experienced in the private and open marketing system. Those are several malpractices prevail in the marketing of agricultural produce. For example, arbitrary deductions from the produce, manipulation of weights and measures and cheating the farmers, collusion between the broker and the buyer while fixing the prices, delay in payment of amounts due to farmers, etc. The result is the farmers are indebted to trader - moneylender. In such circumstances co-operative marketing society can largely help the farmers reduce the malpractices and offer honest and correct services.

There exists a chain of intermediaries between the producer and the final consumer. They include village merchant, itinerant trader, wholesaler, commission agent, pre-harvest contractor and retailer. They take their own margins for the services, they render. But these margins are generally exorbitant, making the commodities costly for the consumers and reducing the producer's share in the consumer's price. A co-operative marketing society can eliminate some or all of the intermediaries and can reach to the consumers and establish direct trade relations with them. This will make commodities cheaper to the consumers and also ensure good quality of produce to them because much of the handling is avoided.

There are some services such as transport, storage, financing, grading, packaging, loading/unloading, which are, carried out by some private functionaries who charge high rates for these services. A co-operative marketing society performs these services efficiently and at cheaper rates. A co-operative marketing society provides market finance to farmers and ensures better returns to their produce. Besides marketing society can act as an agent of credit co-operative society and help to recover loans advanced by credit societies. At present, most of the financial needs of the farmers are fulfilled by trader - moneylenders at very high rates of interest and with the condition that they will sell their produce through them. This can be avoided, if there is a co-operative marketing society.

Under the system of co-operative marketing whole responsibility of marketing is taken up by the farmers themselves, organised on co-operative basis. The area of operation of marketing society is usually fixed with reference to local conditions - area based or commodity based. The commodity-based societies related to grapes, oranges, banana, pomegranate, etc. have wider jurisdiction covering the major areas growing each crop. There are societies at the producer's level and they federate at State or national level to deal with bigger markets including foreign markets for export of their produce. Membership of a co-operative marketing society is open to individual farmers who produce the crop for which the society is formed. Other co-operative societies in the area can also become institutional members.

The functions of co-operative marketing societies are:

1. To arrange for the sale of members’ produce to the best possible advantage.
2. To undertake activities in connection with grading, pooling and procurement of produce of the members.
3. To provide storage facilitates to their members by renting or owning the go downs and thereby facilitate to grant advances against pledge of produce.
4. To protect members from all types of malpractices eliminates the middleman in the chain of marketing.
5. Co-operative marketing society ensures grading, etc. and supply of good quality material to consumers.
6. It teaches business methods to farmers and serves them as agency for supply market information.
7. The society is able to stabilise prices over a long period by adjusting the supply with the demand.
8. Marketing societies are also encouraged to undertake export trade so that they can give better prices to their members.

Although, many advantages are envisaged in the co-operative marketing the structure has remained relatively weak as compared to credit co-operatives. There are only about 1000 marketing societies as against 20,000 credit societies in Maharashtra. The marketing is more difficult involving many technical and commercial aspects. Marketing of perishables is still more different. Arranging quick transport, arranging storage to avoid losses, to keep watch on demand-supply position to ensure good prices to members are all matters needed for good marketing. Several marketing surveys/studies at farmer's levels have revealed that among several marketing channels, co-operative channel has offered greater share of consumer's prices to the producers. Whichever, marketing is un-organised, farmer-producers have expressed that marketing co-operative societies should be formed. This was particularly reported in the cases of marketing of perishables.

The table 7.1 describes the summary of models involved in fresh produce distribution system which are discussed elaborated in the previous section of this chapter.

Table 7.1: Summary of modified agri-supply chain models in India

Sl. No	**Supply chain model**	**Features**
1	PepsiCo contract farming	This model enables the farmers to join corporate farming with PepsiCo which result in improved farming practices by adopting modern technologies of agriculture. This model increased the incomes of farmers and also reduced the procurement costs by reducing post-harvest losses for PepsiCo. This model confined to potato and tomato commodities as the technology providers are specialized in these areas only. This model also suffer from initial problems like poor technical assistance, delayed payments and outright cheating in dealing and manipulation of norms by the firms
2	ITC E-choupal	The e-choupal model built on the Information and Communication Technologies (ICT) and helped to shrink the supply chain of agricultural commodities. In this model the handling and transportation costs are shared between the ITC and farmers involved in e-choupal project. This model benefits farmers by improving transparency in pricing and by eliminating malpractices of weighing. This model works as an instrument for obtaining agri-input for lower prices as compared to outside market as the farmers directly negotiate directly with input companies by off-tracking dealers. The ITC procured the produce for lower cost compared to conventional models. This model needs ICT infrastructure which is a bottleneck for expanding this project.
3	Safal Exchange	Safal establishes direct linkage between farmers and retailers through its markets. The cold storages, grading, sorting and distribution facilities around setup in the nearest proximity of Safal markets. It also setup fruit processing units in different places of country for which the fruits are procured from Safal markets exclusively. This model offers lower price and high value to the consumer as the value chain partners available in the markets. Due to this high level integration within the chain results in minimisation of distribution losses. This model provides benefits only to those farmers who enrol for Safal markets. Another limitation for this model is that it needs huge investment to setup and develop market infrastructure for expansion.

4	Infosys Supply Chain model	The Infosys supply chain is an ICT based model that allows an access to organised retailers to reach small farmers. The ICT application provides information about the farmer clusters, crop planning and supply trends to the retail companies. This information makes retail companies to minimise their excess inventories up to 40 percent which also reduces the loss due to the perishability. The application provides information on daily sales volumes and price movements to farmers which help in realizing reasonable prices. Since this is a new initiative and thus enough awareness is needed to pull the more farmers into this model.
5	Rythu Bazar / Apni Mandi / Kissan Mandi/ Krushak Bazars/ Shetkari Bazar/ Hadapsar Market Models	These models are more concern with eliminating intermediaries from the fresh produce supply chains hence reduces the manipulations in the distribution. These are proven to be successful models in realizing remunerative prices for small farmers and high value to the consumers. The Rythu Bazar model is replicated in many other States after successful results in Andhra Pradesh with different names. This model is highly useful to those farmers produce in lower quantities of fresh produce. This model does not guarantee all the small farmers to sell their produce as the availability of space is a constraint. The road connectivity and timely availability of transportation is critical for this model. The another limitation of this model is that the assortment of fresh produce commodities are slightly lower and the arrivals comes every day are much lower than the traditional distribution system
6	Uzhavar Shandies	These markets are mainly started to establish a direct link between the farmers and the consumers. The scheme of farmers' market enables farmers to realise remunerative prices for their produce by eliminating all middlemen. Farmers will have the benefit of better marketing infrastructure at free of cost and also receive Farmers are additionally benefited in the form of interaction with other farmers and with departmental personnel. Farmers also get good quality seeds and other inputs in the market yard itself. The consumers in these markets are benefited by getting fresh vegetables at relatively lower prices.
7	Co-operative Marketing Society	The objective of setting up Co-operative marketing societies is to eliminate the intermediaries and to establish direct trade relations with the consumers. This will make commodities cheaper to the consumers and also ensure good quality of produce as multiple handling is avoided. This model of marketing performs transportation, storage, financing, grading, packaging, loading and unloading services efficiently at cheaper rates. The societies are able to stabilise prices over a long period by adjusting the supply with the demand and also encouraged to export for better prices to their members. The main drawbacks of these societies are the more involvement of political leadership, lack of proper understanding among the member and lack of professionalism to carryout day to day affairs.

7.3 CONCLUSION

Vertical coordination has emerged as a feasible model for food processing industry as well as agri-commodity markets in India. The distribution system of agriculture uses traditional model which is governed by agri- marketing committees. It is a well-known fact that the complete number of intermediaries in food and agricultural supply chain are also many making chain uncompetitive as well as these intermediaries block market information making transaction cost unfavourable to the Indian farmer.

The study concluded that experience of corporate firms and non-corporate initiatives describe that there is a need for systematic approach to organise farmers' groups and assembling various technologies which could prove to be successful. The study also recommends that there is a need for extension professionals that help farmers with all the necessary information, regarding timely inputs, marketing, and their entitlement to various governmental programs and benefits. The staff should also have hands-on experience in dealing with field problems such as enhancing production from the farm, value-addition to the farm produce, post-harvest technology and marketing facilities.

On the whole it is concluded that the commitment of corporate towards the new model/initiatives are resulted in success implementation of models where as lack of proper awareness among the stake holders may be the reason for the failure of the new initiatives. It is also observed that information sharing, methods of farming, reduction of losses and coordination are the instrumental for the new era initiatives in Indian agri-distribution.

The next chapter will describe the summary of findings that include the Agri-SCM practices, results of hypotheses and performance of fresh produce supply chain followed by the recommendations and proposal of an alternative model for fresh produce distribution system.

CHAPTER - VIII
OBSERVATIONS AND RECOMMENDATIONS

This chapter summarises the observations of the research study on measuring the supply chain performance of fresh produce distribution system in Andhra Pradesh. The observations are discussed under three key headings namely, supply chain practices, statistical inferences and supply chain performance. This is followed by a detailed list of recommendations that evolved from the findings of the study.

8.1 GAPS IN FRESH PRODUCE SUPPLY CHAIN PRACTICES

Grading: The findings of the study revealed that fresh produce is transported for sale even before grading, immediately after harvest from the farmers' level to the traders' level in the supply chain. Grading determines the prices of produce at the trader's level. But, the farmer is compelled to trade his produce due to various genuine reasons. Some of the reasons for trading of produce without grading may be attributed to the following:

- Post-harvest technology is unknown to the farmer coupled with lack of proper mechanisms to transfer such technology.
- Farmers exchange their produce for money at the earliest because of their commitments to repay loans or short term credit availed for cultivation activities.
- Besides fresh produce is prone to early ripening which shortens the shelf life and can lead to heavy losses.

Cleaning and washing: It was observed that cleaning and washing are seldom carried out at the farmers' level before sale of produce to the next level in the supply chain due to the belief that washing will hasten the ripening process. The retailers' undertake cleaning activities limited to freeing of dust and plant debris without any kind of chemical treatment. The prime reason for washing was to give a fresher appearance in order to gain customer attention.

Cold logistics: The study showed that cold chain facilities and related logistics for storage are not being used by the supply chain partners for fresh produce. Cold storage facilities are available at a minimal level but not used for tomato and banana. However, in the case of chilly, tamarind and other vegetables storage facilities are being used at the field level. The organised retailers are equipped with very few facilities for storage and movement of fresh produce in cold logistic containers.

Traceability: The study on the cultivation methods and information management across supply chain shows that the use of pesticides, fertilisers and post-harvest management information are not being shared with the next supply chain partner. Information on source of procurement, date of harvest, instruments used in cultivation, residue level, etc. are not at all furnished to the customer by any of the supply chain partners namely the farmer, trader and retailer.

Use of pesticides: The study revealed lack of awareness at farmers' level on usage of pesticides and government established standards on the same. This adversely affects the quality of produce because of diseases that affect the crops or high and harmful levels of residue in the produce. Farmers take precautionary measures in case of fresh produce transport and storage system by effective packaging of produce with plastic crates and banana leaves which are traditionally followed and serve the purpose to some extent. Traders give greater importance for packaging of fresh produce while transporting to distant destinations, to prolong the shelf -life.

Buffer stocks: The study revealed that a limited number of farmers hold buffer stock for a day or two in order to realise better prices because of the short shelf life of fresh produce leading to increased losses. Besides there is lack of adequate and appropriate storage facilities to maintain buffer stocks. However, retailers hold buffer stocks for a relatively longer duration that is 2 to 5 days for obtaining a better price.

Transportation: Auto rickshaws and two wheelers form the major means of transportation of fresh produce from the fields to the market because of reliability and cost effectiveness. In larger AMC markets – the transport modes like trucks, lorries, tractors, auto-rickshaws are locally and easily available.

Damage during transit: The study revealed that, in majority of cases the fresh produce is damaged during transit as a result of long waiting time for loading and unloading. Fresh produce is damaged due to poor road conditions in rural areas, traffic jams in cities, long distances, adverse temperatures, which acts as contributing factors towards perishability during transit. However, there is a general satisfaction with the services offered by the transport operators.

Fill rate: The study on fill rate at each level clearly indicates that there is 90 percent fulfilment of the basic demands at each level of the supply chain and leaving a scope for reducing the unfulfilled demand about 10 percent. Majority of the retailers are able to supply the fresh produce within 12 to 24 hours. But, better coordination and information sharing can result in reducing the demand fulfilment time. The reasons for delays more than a day are due to harvesting delays, transport delays, weather conditions and market work hours that are fixed.

Delays in delivery: The study found that a huge time gap between promised time and the actual time of delivery which is the delay in delivery time, an important determinant of the quality of supply chain and the extent of delay between the supply chain partners. Lack of coordination exists in the entire supply chain but sufficient levels of coordination exist between immediate supply chain partners. There is need to reduce the delay in delivery time of fresh produce at the respective supply chain partner levels. The lost demand is one of the adverse effects of delay in delivery time of fresh produce. This can be addressed by establishing coordination and communication with transport operators and supply chain partners.

Price realization: The study revealed that the fresh produce prices are highly volatile and are determined by the demand and supply forces. Prices are usually stabilised during the full harvest season and rise when the crop reaches end season. Prices are established by an auction system. When the supply of produce is high, the prices generally are determined by the agent itself. The role of farmers in fixing prices is very limited. Thus, the price of fresh produce is realised in different ways.

The farmers are well aware that the prices in their markets do not compare to other markets. There is no information mechanism that is provided by the government on surrounding markets to compare the prices. As of now, cordial relationships are maintained between individual partners in the supply chain, especially immediate entities, thus, enabling them to share information on prices of produce in different markets.

Information on on-going prices: The study also explored the knowledge sources for ongoing prices of fresh produce. On a regular basis newspapers are a common media that provides information on prices. The study revealed that a majority of the respondents are not having any information about the prices in surrounding markets. The farmers dispose off their produce for a lesser price due to emergency situations that force them to exchange their produce for money. The reasons for emergency are mostly immediate household needs or timely preparation for the next crop or in majority of cases due to short term credit/loan repayment commitments. This also indicates that the farmer depends solely on the sale of produce to meet his day to day expenditures.

Lost sales: The study observed that at the traders' level, the stocks are handled appropriately to meet the customer demand and refilled within 24 hours. The 'Lost sales' are not applicable to farmers but is an important quality indicator for traders and retailers in a supply chain. The percentage of lost sales is significantly high among traders and retailers. The stake is higher for retailers when compared with traders on lost sales in supply chain of fresh produce.

Relationships with organised retailers: The study observed that the organised retail firms approach a limited number of farmers who can meet the demand of their nearest retail shops. The retail farms like Reliance Fresh and Heritage have contact with farmers. 44.9 percent of the farmers have contacts with retailers, but the actual agreement for procurement is limited to a very small number. The advantage derived by a retail company out of this kind of arrangement is freshness of produce, stable prices, low market taxes and perfect weight measurement. It is observed that un-organised format of supply chain has more potential in distribution of produce rather than organised sector. This situation is due to lower expansion rate of organised retailing and their inability to work in rural areas due to high operating cost.

Procurement of vital inputs: The study also observed that in fresh produce supply chain, the procurement of vital inputs like seeds, fertilisers and pesticides play a vital role. When the input cost is more it results in higher cost to the customer. The dealers charge much above the mark-up price that is determined by the government. They also reported that the formal co-operative set-up failed to function when there is a huge need for agricultural inputs. The private dealers, who are into agri- input trading, take maximum advantage out of the scarcity situation that prevails in the market. The farmers report that most of the dealers, sell their inputs on credit, hence, the farmer cannot raise any objection to the higher price charged by dealers. This situation is a result of minimum or negligible working capital that the farmers usually possess. On the whole every farmer is finding difficulty in procuring desired agri inputs.

Consolidation agents: Consolidation agents collect a fixed amount from farmers or traders and work more or less as a trader but they will not have trader registration with AMC. The traders whose level of business is very high generally prefer to take the assistance of consolidation agents.

Packaging: Packaging plays a key role in protecting the produce from adverse environment and unhygienic conditions that can damage the produce. About 75.5 percent of traders reported that packaging facilities are available in rural AMC and spot markets. These facilities are made available to farmers and consolidated agents by traders alone, for which the farmer pays a nominal charge. Thus, the packaging facilities are not available uniformly in all the AMC markets. It is observed that most of the AMC markets are lacking in infrastructures like auction platforms, road transportation and lighting facilities. Also, the traders store the produce in a safe place for few hours/day before the produce is sold to the retailer.

Procurement of stocks by retailers: Retailers procure their fresh produce from different sources depending on the distance and quantity. Retailers find more varieties in AMC markets and they buy in bulk quantities due to which the price options available are widened. These merchants buy bulk quantities from traders and sell their produce to retailers. Usually retailers get fresh qualitative produce at an affordable price. Sometimes the retailers crowd the market and are seen waiting for their turns in long queues to weighing their fresh produce and for counting cash. The longer waiting time at the counter creates inconveniences to the customers.

8.2 INFERENCES FROM STATISTICAL ANALYSIS

The following inferences have been drawn from the statistical analysis like mean, regression, Chi-square and ANOVA techniques.

Causal Study on Transport Performance:

The present study identified the various independent variables contributing to transport performance using regression analysis. It is found that reliability in delivery, information sharing among consignee, consigner and transporter, time to load and unload and capacity of the transport vehicle variables are statistically significant. Transport performance (performance) is more when the time taken for load and unload (Load-unload) is short.

Causal Study on Perishability:

The study showed damage during the harvest by the farm men, lack of effective packaging, living organism like Bacteria, Fungus, insects etc., lack of plastic crates during the transportation, and lack of cleaning and washing variables are significantly affecting the perishability of the fresh produce. It is also found that the other variables such as the road conditions, non-removal of foreign bodies, lack of enough care while the loading and unloading and lack of effective care during road transport are showing insignificant effect on the perishability.

Most Prevalent Waste

The study conducted an analysis on wastages in fresh produce distribution. The mean was taken by calculating the transport waste, re-handling waste, harvesting wastage, waiting time wastage, over production wastage and excess inventory waste. It was found that the transport waste takes the first position as it shows the highest wastage. Second, in the order of wastage ranking is the category under “unnecessary handling of produce” which is totally avoidable. Wastage during harvesting is relatively high and ranks three in the analysis on wastage. The waiting time wastage and overproduction wastage are almost in the same place in the order of wastage and the excess inventory wastage is the least and ranks sixth in the order of ranking. Hence, wastage can be minimised at various stages by taking appropriate steps to minimise avoidable wastage specific to handling, transportation and harvesting.

Calculation of Activities Mean Time

The study attempted to calculate the mean time taken for fresh produce distribution at the farmers' level to the traders' level. On the whole, the time taken to reach the produce from the field to the trader is approximately 5 hours and 8 minutes which excludes two factors namely harvesting time and transit time that are case specific and cannot be standardised.

The study conducted an analysis on wastages in fresh produce distribution taking the mean of wastes incurred on transport, re-handling, harvesting, waiting time, over production and excess inventory waste. Wastage during transport is very high and in general it can be stated that there is scope for minimising avoidable wastage at various stages.

Customers Satisfaction in Fresh Produce Supply Chain

Customer satisfaction was included in the study taking parameters like timely availability, damage and spoilage, colour and fragrance, mealness and sweetness, cleanliness of fresh produce and relationships with retailer. The customers are fairly satisfied with the timely availability of produce whereas customers are dissatisfied on damage and spoilage which need improvement. The cleanliness of fresh produce is at a low satisfaction level, which may be attributed to lack of adequate facilities for cleaning and washing of fresh produce. The customers are not satisfied with the relationships with retailer showing that there is scope for improvement on customer satisfaction in fresh produce supply chain.

Results of Hypotheses

Chi-square test was conducted to test the research hypothesis framed for the current study, out of which the following were proved significant.

1. Hypothesis (H1): The condition of roads will influence the damage level of fresh produce during the transit;
2. Hypothesis (H2): The amount of care taken while loading and unloading will have an effect on the damage of fresh produce;
3. Hypothesis (H3): Spoilage of fresh produce will affect the overall performance of fresh produce supply chain;

Analysis of variance (ANOVA) test was conducted to substantiate the hypothesis framed for the study. The following hypotheses are said to be statistically significant.

1. Hypothesis (H4): There is a no significant gap between the promised delivery time and actual delivery time within the levels of supply chain;
2. Hypothesis (H5): The fill-rate is not uniform among the fresh produce supply chain partners such as farmers, traders and retailers;
3. Hypothesis (H6): There is a significant difference in customer response times in fresh produce supply chain entities i.e., farmers, traders and retailers; and
4. Hypothesis (H7): There is difference in level of trust within supply chain partners in fresh produce negotiations.

8.3 PERFORMANCE OF FRESH PRODUCE SUPPLY CHAIN

The overall score of fresh produce supply chain calculation as 3.158 and the score represent all the entities of the supply chain and which included most of the indicators of the performance measurement. The indicators considered are as follows order Efficiency (3.328), Flexibility (3.034), Responsiveness (3.10), Product Quality (3.564) and Process Quality (2.763). On the whole, the score of fresh produce supply chain performance is 3.158 which indicate the performance is said to be moderate.

The following indicator scores that contribute positively to the score are Production costs (3.795), Return on investment (3.733), Appearance/freshness (3.835), Shelf life (3.792), Food safety (3.506), Salubrity (3.477) and Order fill rate (3.333). Whereas the indicators that have contributed low to the supply chain performance are transportation cost (2.897), Volume flexibility (2.969), Delivery flexibility (2.979), Shipping errors (2.749), traceability (2.612), storage and transport condition (2.918) and Promotion of fresh produce (2.309) and these indicators are needed to be taken-up for the improvement.

Performance of Efficiency Indicators

All measures of efficiency indicators such as production cost, transaction cost, transportation cost, profit and return on investment was considered and it was found that the performance is efficient at the farmers’ level with high transportation costs and moderate profits. At the traders level though the production cost, transaction cost and transportation costs are low, the profits and return on investment, seems to be much lower than mean scores. Though the production cost, transaction cost and transportation costs are moderate, the profits and return on investment seems to be much lower than the mean with low profit margins at the retailer's level. The efficiency at the transporters level is high and has the highest return on investment.

The production costs are higher at the farmers' level and retailers' level when compared to the traders and transporters level i.e. the cost of production is lowest at the traders' level followed by transporters level, farmers' level and retailers' level. The transaction cost is lowest at the farmers followed by traders, retailers and transporters in order of increasing transaction costs across the supply chain partners. The transportation cost is the highest at the transporters level and lowest at the traders' level, moderate at the retailers' level and slightly high at the farmers' level.

The decreasing order of profits gained in the supply chain shows that the transporters are in the lead, followed by traders and retailers. This can be attributed to the fact that the margins at the retailers level are low (despite high price of produce), due to wastage and distribution loss. The traders and retailers are almost at the same level when considering the return on investment and repaid within two to four years across the supply chain.

Performance of Flexibility Indicators

The study showed that performance of flexibility and the volume flexibility are low at the farmers' level due to lack of grading and lack of opportunity for trading in small quantity by the farmer. At the traders' level, customer satisfaction can be enhanced by increasing the volume flexibility and delivery flexibility. The performance of flexibility indicators at the retailer level is reasonably good.

The customer satisfaction needs improvement at the farmer's and trader's level and the same can be sustained at the retailers' level. The customer satisfaction at transporters level can be improved by effective delivery of the services at the right time and careful handling of produce to minimise the wastage. Since the end user is not in direct contact with the farmer and the trader the aspect of volume flexibility is found to be minimal. The volume flexibility is highest at the retailers' level where the produce is sold in varied quantities as per customer requirement and ease of retailing.

Delivery flexibility does not apply to the farmers and transporters because the farmers are bound to sell the produce in AMCs during the working hours only. In case of transporters they are required to deliver the produce as per their customers' specifications leaving no scope for flexibility.

Performance of Responsiveness Indicators

The responsiveness requires improvement across the indicators considered at the farmers' level, with focus on customer response time and shipping errors. Traders are left with less time to attend to customer complaints leading to lowered responsiveness. There is need for extensive focus on these indicators at the traders' level to improve the performance. The retailer receives complaints mostly on quality aspects, availability of the produce and rising prices. It takes approximately one day to deliver the produce and this can be reduced using appropriate communication systems. The performance on responsiveness at the transporters level is said to be reasonable.

Transporters are performing well as they are able to meet the service requirements of the customer in time. The retailers show a reasonably fair performance while the traders and farmers have a lower performance on customer response time, because farmers have minimal choice to respond. The order fill rate can be improved at the farmer and trader levels of the supply chain. The complaints are on quality issues which may be attributed to the bargaining for better price across the supply chain. The lead times can be considerably reduced by efficient transportation. Shipping errors are high among traders followed by farmers and retailers. The shipping errors can be avoided by proper grading, sorting, and careful handling of produce across the supply chain.

Performance of Product Quality Indicators

The product quality indicators at the farmer level are in the moderate range. There is scope for improvement in the quality parameters across the indicators, and special focus should be made on shelf life. The overall performance of product quality is low and needs improvement across indicators at the traders' level and moderate at the retailers' level. The appearance across the supply chain is moderate and there is scope for better performance.

The shelf life varies among the partners of the supply chain and there is need for improvement of shelf life for better quality of produce. The overall salubrity is moderate across the supply chain with room for better performance. There is variation in product safety across the supply chain and there is need for improvement of product safety at all levels, especially at the traders' level.

Performance of Process Quality Indicators

The study found that performance of process quality indicators at farmers' level needs to be further improved. There is scope for improvement on traceability, storage and transport condition, while the use of pesticide and chemical use needs to be further reduced. At the traders' level there is need to reduce the use of pesticides and chemicals and improve storage and transport conditions for better performance as this is not applicable for retailers. Traceability across the supply chain is low and need to be improved to a great extent. The storage and transport conditions needs improvement at all levels in the supply chain. The use of pesticides and chemicals is high at the traders' level and needs to be reduced drastically. The use of chemicals and pesticides need to be used appropriately at the farmers' level.

8.4 RECOMMANDATIONS

The supply chains in order to run on their efficiency level need to build a long-term relation between the retailers and farmers for procurement and to provide extension services regarding the use of inputs, production technology, information on harvesting, prices, pre-cooling, grading, sorting, packaging and on-farm sorting. The government must initiate strong measures to remove constraints in infrastructure such as setting up of distribution centres, cold chains and link roads to the markets. Ensuring quality and quantity of the produce to the stores is another essential requirement for smooth functioning of the supply chain.

Handling and Storage during Transportation

Dropping of packages during loading and unloading is a frequent cause of damage to the produce and to the package, but can be minimised by using pack weights and designs which are well-suited with the handling method.

- Correct supervision and management of loading and unloading to prevent careless handling and to ensure workers are strong enough and tall enough for the job.
- Providing shelter from sun and rain at loading and unloading areas.
- Loads should be stacked in a manner which will prevent either the movement of individual containers or the collapse of the stack during transport. Riders should not

be permitted on top of the load, especially when it consists of produce in bulk or in sacks. Vehicles need cover to protect the load from the direct heat of the sun, but it should not restrict ventilation.

Avoid Injuries

The fragile nature of most fruit and vegetables products makes them very susceptible to injury, and the complete avoidance of such injury is not possible. However, damage may be reduced to a minimum by giving attention to:

a. Care should be taken to ensure that at the time of harvest, the produce are not wet, because citrus fruits in wet condition during harvest are more easily damaged.
b. The avoidance of over packaging or under packaging of containers. It should be filled to an extent that will exert adequate pressure for safe transport when the contents are closed. This will prevent movement of produce within the container.
c. Careful handling of produce at all stages, especially when in containers, which must not be rolled, dropped or thrown.

Avoid Post-Harvest Losses at Traders/Wholesalers

Wholesalers handle produce which may or may not be freshly harvested and packaged in various types of container. Depending on how well the farmer and transporter have done their job, the wholesaler must decide on the most appropriate sale and distribution system so that the produce can reach the consumer in the best possible condition. The general principle of keeping produce cool by stacking it in well shaded and ventilated locations and avoiding exposure to sun and rain at all times are the most important. If the produce is purchased from the farmer in bulk, then suitable packaging should be ensured so that multiple handling steps can be avoided and the produce is protected from compression and other injuries.

Avoid Post-Harvest Losses at Retailers' Level

1. In the first place, the retailer must be aware of the importance of post-harvest losses and their effect on profits, as well as understanding the basic causes of post-harvest losses and what can and cannot be done to prevent them.

2. All retailers must be selective when they buy produce. Produce with the first signs of wilting, physical damage, or decay should be avoided. Over-ripe fruit should never be considered unless they can be sold immediately (i.e. on the same day) to consumers who are prepared to buy them.
3. Retailers should try not to mix attractive and unattractive produce together. Grading of produce by quality and maturity helps add value to the produce and for the small volumes sold.

8.5 A PROPOSED ALTERNATIVE MODEL - I.C.T. ENABLED SUPPLY CHAIN FOR FRESH PRODUCE DISTRIBUTION SYSTEM

The study necessitates developing a new model based on the weaknesses that has been highlighted from the fresh produce supply chain performance measurement. The study reveals the following inefficiencies in the fresh produce supply chain: (1) high transportation and transaction cost, (2) low profits, (3) low level of volume and delivery flexibility (4) High customer complaints, (5) Higher lead times, (6) high level of pesticide residue (7) poor quality of produce and (8) low marketing capabilities. In addition to supply chain inefficiencies, the production inefficiencies are also raising a need for development of an alternative fresh produce supply chain model to tackle it effectively.

The study also revealed the facts that the farmers do not get the remunerative price for their produce as they grow fresh produce crop on credit and are forced to sell their produce immediately for liquidation. There is need for interventions that will benefit the farmer and the supply chain partners to maximise profits and minimise the expenditure. In this context farmers need to be introduced to a system that is user-friendly in making decisions and they need benefit from IT enabled systems that can be used across the supply chain.

Every farmer has a right to get the remunerative price for the investment made in producing fresh farm produce. The marketability of the produce is at stake because of severe losses that are incurred by the farmer due to a series of losses at various stages. There is need to ensure that the gaps that are observed in the marketing of fresh produce are bridged in order to gain maximum profit especially at the farmers level. The farmer receives only 60 percent of the potential price and ends up in losses, when there is no market for the fresh produce, simply because of lack of information. There is need to establish a systematic method of keeping the farmer enrolled and informed about the prices of various commodities. Hence, the following model (See figure 8.1) is suggested which is represented diagrammatically for complete understanding.

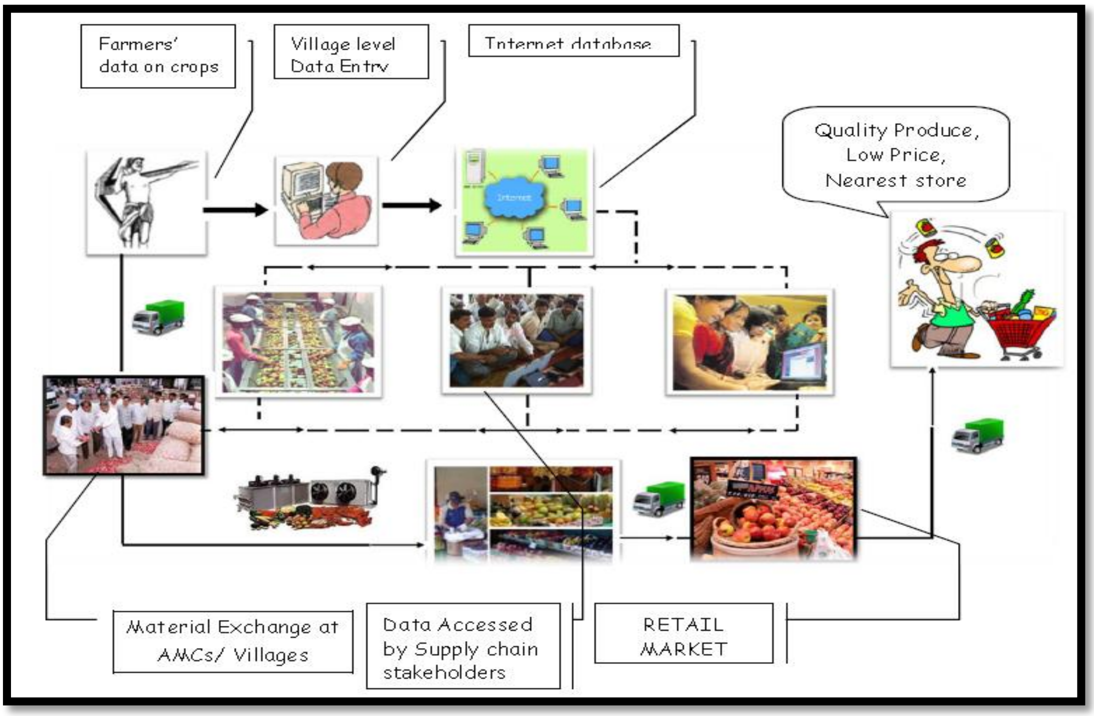

Figure 8.1: Diagram indicating process flow of proposed fresh produce distribution system.

Inputs required:

The following resources are needed to install and run the model successfully in selected places to reap the advantages of ICT based applications.

1. Manpower: For implementation of proposed model needs a Data Entry Operator be dedicated for feeding of data pertaining to the farmers and crops they are growing.
2. Material: Every village that needs Fresh Produce Distribution System needs an office with a computer and internet connection and supported by minimal quantity of stationary.
3. Money: It can be social investment and whole responsibilities are transferred to Panchayat so that the monitoring can be possible.

4. Time: The time required to launch this model is based on the time required for development of Fresh Produce Distribution System applications and time taken to install network facilities in villages.

Process:

The proposed model has a series of steps to run efficiently starts from the entering of data at village level to sales negotiations and final settlement.

1. Steps1: The farmers register his/her profile at the nearest gram Panchayat office (The details of data provided to village level data entry office is given in Annexure-V)
2. Step 2: The data base is updated to include all the details in the fields provided. (See Annexure-V)
3. Step 3: The information is uploaded to the website by the designated person at village Panchayat office who work for salary.
4. Step 4: Web generates the details of the farmers with the crops negotiations are made available as an option by providing contact details of farmers by produce required.
5. Step 5: Farmers receive all information on prices and traders details of which are made available to the farmer.
6. Step 6: Farmer makes informed decisions while selling his produce to make better profits and minimise loss due to transportation or based on his convenience he/she can choose the vendor.

Output/Outcome:

The proposed fresh produce distribution system model can be created to generate the following results:

1. The proposed model will generate the contact details of the farmers and allow the information to share among the chain partners such as farmers, traders, retailers, processors, bulk purchasers, exporters, households and interest groups.
2. The model will have two-way information which flows in one direction the data is flown from farmer to the downstream and in reverse direction the stake holders who can exchange the information through common means of communication.

3. In the traditional model, farmers do not know that who will be the best buyer for their produce but the proposed model enable the farmers to know about potential buyers and their technical specification.
4. Maintaining the freshness of produce is possible in this proposed model by reducing delay in delivery, transportation, auction time and by means of effective post-harvest management. Moreover the cost of transportation may drastically reduce as the buyers can directly contact the farmers and share the cost of transport.

Benefits of model:

Advantages of the proposed fresh produce distribution model across supply chain are as follows:

1. Information flow is two way and the linkages are strengthened across supply chain. Effective communication networks can result in high profits across supply chain and will transform the existing traditional un-organised market to a highly dynamic and systematised marketing of fresh produce.
2. To project the supply of fresh produce the supply is aggregated at State level, is possible as every farmer provides the details of crop growing and land holding. This will enable the decision makers to allow the surplus produce to export to other States in order to bring equilibrium in the market.
3. This model is built on the platform of traditional system. The model creates virtual market in which all the market stakeholders can freely exchange the information and break barrier that prevails such as price manipulation, cartelisation, loss of produce, higher transport costs in the traditional system. Prices are comparable with traditional AMC system.
4. The bottom line of the model is that it enables the traders, retailers, processors and farmers to interact with one another and realise price by negotiations over any means of telecommunication system. Farmers get higher price for their produce which is fair and is equal or more than the market value.
5. This model will avoid order delivery times and reduce time wastages by eliminating un-necessary transportation and handling in multiple markets to facilitate exchange process.
6. The farmers who are growing same crop can be formed into a cluster or an association at village, mandal and district level for every season. Product clusters are found at mandal level or at district level that can negotiate with direct customer include

processors, exporters and bulk users. For this the necessary data on farmers is provided by the proposed agri-distribution model. Farmers who are like-minded can meet periodically for cross learning. The product cluster can acquire their common amenities or infrastructures for value addition to the produce.

7. The product clusters may have similar type of plant input to grow. Hence they can negotiate directly with agri-input dealers, firms and companies for fair price as they purchase in bulk quantity. Government schemes also explored due to unity.
8. Agri marketing taxes are collected at village level from the customer. Policy makers can standardise the quality of produce.

The proposed model is a conceptual model that need to be pilot tested in a selected Mandal and the lessons learned may be used to replicate the same to wider area network coverage. Thus, it can be concluded that there is scope for high profits, provided certain modifications are made in the traditional system. To harvest the benefits, careful planning is essential that ensures reduced loss of time, at various stages in the supply chain. The solution to the existing problems in the supply chain of fresh produce should include a facility or platform that will enable the supply chain partners to make informed decisions. This will enable the process of improving the quality of service delivered and enable better prices at all levels, especially fulfilling the dreams of every farmer. Government can also provide loans that can facilitate the agribusiness based on recorded information available at the gram Panchayat office. This will solve other social and economic problems of the farmer who plays a crucial role in the health of the family, community and the society at large.

8.6 DIRECTION FOR FUTURE RESEARCH

The present study has contributed theory and empirical analysis to the field of supply chain performance measurement in traditional fresh produce distribution system. The present study proposed a conceptual model for fresh produce supply chain using ICT interventions. The proposed model need to be implemented by developing software application and tested in a selected Mandals of Andhra Pradesh. The results monitored in the pilot study can be helpful to further strengthen the application and implementation modalities for launching the same to wider area coverage. Hence, a further research is advised to look into development and implementation of the proposed model.

Since the present study conducted only for the two fresh produce commodities i.e. tomato and banana, the supply chain performance measurement study can be conducted for Aqua-chain, Meat chain, and other perishable commodities using SCOR performance indicators. In the future, similar type of research can be conducted in other States by focusing on the other commodities after careful consideration of local conditions. Even there is scope for conducting a performance measurement study for organised fresh produce supply chains including processed food chains.

ANNEXURE – I (A)

DETAILS OF AREA AND PRODUCTION OF BANANA CROP DISTRICT-WISE IN ANDHRA PRADESH DURING 1999-2000 TO 2007-2008

District	1999-2000		2000-2001		2001-2002		2002-2003		2003-2004		2004-2005		2005-2006		2006-2007		2007-2008	
	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production
Srikakulam	1569	39225	776	17335	1132	24904	943	22094	1005	23115	1021	23483	1037	25925	1041	31230	2228	77980
VijayaNagaram	4193	104825	3369	59183	6173	135806	6213	145571	6927	159321	6240	143520	6600	165000	7430	222900	7430	260050
Vishakhapatnam	3082	77050	1741	50705	2431	53482	1154	27038	2036	46828	1850	42550	1800	45000	2000	60000	1575	55125
East Godawari	11736	293400	7111	124386	10258	225676	9692	227084	11800	271400	9326	214498	15432	385800	15462	463860	15482	541870
West Godawari	6151	153775	4753	116102	8264	181808	8405	196929	8633	198559	8872	204056	12830	320750	12744	382320	13744	481040
Krishna	1382	34550	832	26208	1556	34232	1969	46134	1953	44919	1547	35581	3277	81925	3307	99210	1530	53550
Guntur	8192	204800	5864	141059	7967	175274	6240	146203	7068	162564	5895	135585	4600	115000	6213	186390	5695	199325
Prakasam	1077	26925	541	12085	511	11242	421	9864	345	7935	0	0	580	14500	1960	58800	632	22120
Nellore	1237	30925	365	8154	479	10538	780	18275	676	15548	1158	26634	933	23318.75	976	29280	1322	46270
Total	**38619**	**965475**	**25358**	**555217**	**38771**	**852962**	**35817**	**839192.3**	**40443**	**930189**	**35909**	**825907**	**47089**	**1177219**	**51133**	**1533990**	**49638**	**1737330**
Chittoor	529	13225	459	19033	1005	22110	775	18158	1027	23621	1100	25300	1181	29525	1212	36360	1212	42420
Cuddapa	4646	116150	3617	161828	4074	89628	3626	84957	3781	86963	3706	85238	3706	92650	3491	104730	4282	149870
Anatapuram	194	4850	282	11693	1582	34804	673	15768	604	13892	2000	46000	1418	35450	3732	111960	6261	219135
Karnool	2253	56325	1339	32282	2704	59488	3237	75843	3627	83421	4765	109595	4765	119125	5165	154950	5165	180775
Total	**7622**	**190550**	**5697**	**224836**	**9365**	**206030**	**8311**	**194726.7**	**9039**	**207897**	**11571**	**266133**	**11070**	**276750**	**13600**	**408000**	**16920**	**592200**
Andhra Total	**46241**	**1156025**	**31055**	**780053**	**48136**	**1058992**	**44128**	**1033919**	**49482**	**1138086**	**47480**	**1092040**	**58159**	**1453969**	**64733**	**1941990**	**66558**	**2329530**
MehaboobNagar	2	50	5	128	12	264	14	328	12	276	28	644	28	700	28	840	28	980
RangaReddy	465	11625	236	6042	249	5478	297	6959	103	2369	103	2369	372	9300	335	10050	375	13125
Hyderabad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medak	158	3950	237	6068	527	11594	393	9208	811	18653	1795	41285	1916	47900	2116	63480	4329	151515
Nizamabad	411	10275	191	4890	398	8756	464	10872	500	11500	470	10810	183	4575	606	18180	367	12845
Adilabad	199	4975	2	51	225	4950	60	1406	111	2553	376	8648	239	5975	255	7650		0
KarimNagar	0	0	0	0	1	22	14	328	19	437	20	460		0	65	1950	139	4865
Warangal	130	3250	154	3943	277	6094	609	14269	436	10028	1168	26864	1135	28380	1021	30630	1021	35735
Khamam	877	21925	709	18152	673	14806	835	19564	1738	39974	2015	46345	3014	75350	3285	98550	2304	80640
Nalgonda	17	425	13	333	9	198	3	70	0	0	10	230		0	0	0	56	1960
Total	**2259**	**56475**	**1547**	**39607**	**2371**	**52162**	**2689**	**63003**	**3730**	**85790**	**5985**	**137655**	**6887**	**172180**	**7711**	**231330**	**8619**	**301665**
A.P Total	**48500**	**1212500**	**32602**	**819660**	**50507**	**1111154**	**46817**	**109622**	**53212**	**1223876**	**53465**	**1229695**	**65046**	**1626149**	**72444**	**2173320**	**75177**	**2631195**

ANNEXURE – I (B)

DETAILS OF AREA AND PRODUCTION OF TOMATO CROP DISTRICT-WISE IN ANDHRA PRADESH DURING 1999-2000 TO 2007-2008

District	1999-2000		2000-2001		2001-2002		2002-2003		2003-2004		2004-2005		2005-2006		2006-2007		2007-2008	
	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production
Srikakulam	433	4330	414	4140	421	4210	345	3450	526	6312	348	6264	435	8265	348	6612	791	15029
VijayaNagaram	657	6570	543	5430	694	6940	605	6050	643	7716	670	12060	670	12730	585	11115	503	9557
Vishakhapatnam	1569	15690	1843	18430	1594	15940	1294	12940	1461	17532	1515	27270	2608	49552	2408	45752	2204	41876
East Godawari	786	7860	917	9170	984	9840	681	6810	1423	17076	980	17640	893	16967	962	18278	1077	20463
West Godawari	646	6460	552	5520	422	4220	317	3170	681	8172	196	3528	430	8170	458	8702	494	9386
Krishna	1007	10070	1305	13050	1017	10170	1322	13220	1004	12048	536	9648	1684	31996	1707	32433	1707	32433
Guntur	1545	15450	1493	14930	1255	12550	1067	10670	315	3780	874	15732	718	13642	778	14782	1108	21052
Prakasam	4923	49230	5966	59660	4511	45110	4048	40480	4238	50856	3526	63468	0	0	16000	304000	4994	94886
Nellore	118	1180	140	1400	56	560	154	1540	44	528	41	738	145	2755	60	1140	45	855
Total	**11684**	**116840**	**13173**	**131730**	**10954**	**109540**	**9833**	**98330**	**10335**	**124020**	**8686**	**156348**	**7583**	**144077**	**23306**	**442814**	**12923**	**245537**
Chittoor	8198	81980	10447	104470	11319	113190	16838	168380	13296	159552	14588	262584	14678	278882	13529	257051	13385	254315
Cuddapa	2126	21260	3020	30200	3565	35650	2443	24430	2606	31272	4378	78804	4288	81472	1264	24016	2189	41591
Anatapuram	2744	27440	2576	25760	2659	26590	3356	33560	3295	39540		0	3906	74214	632	12008	2885	54815
Karnool	23933	239330	23992	239920	21991	219910	21469	214690	20638	247656	19686	354348	11050	209950	11050	209950	9515	180785
Total	**37001**	**370010**	**40035**	**400350**	**39534**	**395340**	**44106**	**441060**	**39835**	**478020**	**38652**	**695736**	**33922**	**644518**	**26475**	**503025**	**27974**	**531506**
Andhra Total	**48684**	**486850**	**53208**	**532080**	**50488**	**504880**	**53939**	**539390**	**50170**	**602040**	**47338**	**852084**	**41505**	**788595**	**49781**	**945839**	**40897**	**777043**
MehaboobNagar	5068	50680	5064	50640	4631	46310	5518	55180	4942	59304	3217	57906	3650	69350	3500	66500	4856	92264
RangaReddy	12295	122950	12476	124760	10614	106140	10468	104680	12155	145860	2864	51552	6990	132810	6877	130663	4578	86982
Hyderabad	7	70	6	60	0	0	0	0	0	0		0	0	0	0	0	0	0
Medak	2443	24430	2374	23740	2425	24250	2207	22070	2474	29688	3722	66996	4081	77539	3790	72010	5935	112765
Nizamabad	1090	10900	1374	13740	1053	10530	1065	10650	2331	27972	1316	23688	2469	46911	2469	46911	2069	39311
Adilabad	1350	13500	1072	10720	1118	11180	1851	18510	1347	16164	7962	143316	21905	416195	11231	213389	10862	206378
KarimNagar	1669	16690	1404	14040	1066	10660	813	8130	1100	13200	740	13320	1831	34789	1280	24320	1789	33991
Warangal	1238	12380	1262	12620	1402	14020	1688	16880	1085	13020	408	7344	175	3325	432	8208	1152	21888
Khamam	665	6650	662	6620	588	5880	823	8230	647	7764	1375	24750	1381	26239	1400	26600	645	12255
Nalgonda	682	6820	919	9190	1022	10220	1067	10670	823	9876	560	10080	300	5700	309	5871	1325	25175
Total	**26507**	**265070**	**26613**	**266130**	**23919**	**239190**	**25500**	**255000**	**26904**	**322848**	**22164**	**398952**	**42782**	**812858**	**31288**	**594472**	**33211**	**631009**
A.P Total	**75192**	**751920**	**79821**	**798210**	**74407**	**744070**	**79439**	**794390**	**77074**	**924888**	**69502**	**1251036**	**84287**	**1601453**	**81069**	**1540311**	**74108**	**1408052**

ANNEXURE – II (A)

ITEM TOTAL STATISTICS OF FARMERS, WHOLESALERS AND RETAILERS

Sl.No	Variable Name	Variable Label Name	Farmers	Traders	Retailers
			Cronbach's Alpha if Item Deleted	Cronbach's Alpha if Item Deleted	Cronbach's Alpha if Item Deleted
1	RES_orderfulfillment	There is a gap in the quantity of fresh produce ordered and order fulfilled (Fill Rate)	0.773	0.726	0.794
2	RES_Customer_ Response_time	There is a delay in the fresh produce order delivery as against the promised time (Customer Response Time)	0.769	0.709	0.785
3	RES_wrong_ shipments	I was supplied the wrong fresh produce shipments against what I ordered (Percentage)	0.772	0.705	0.78
4	RES_consumer_ complaints	The customers complain on the various issues of timely delivery of the fresh produce (Consumer complaints)	0.768	0.705	0.777
5	RLT_Long_term	I look at the long term business relations.	0.759	0.711	0.783
6	RLT_business_ transaction	Our relationships confined to the particular business transaction	0.758	0.712	0.785
7	RLT_future_needs	The relationships continues after transaction for the sake of future needs	0.763	0.71	0.783
8	RLT_new_supplier	Every time I will approach a new supplier/customer	0.765	0.716	0.787
9	RLT_trust_party	I always trust other party in the business negotiation	0.764	0.713	0.789

10	RLT_give_take	I adopt "give and take" policy in the negotiation of transaction	0.763	0.708	0.78
11	RLT_market_trends	I discuss the market trends with my customer/supplier in un-seasons also	0.762	0.713	0.78
12	ESC_increase_sales	Efficient supply chain will leads increase sales	0.761	0.71	0.781
13	ESC_low_waste	Efficient supply chain results lower levels waste	0.762	0.705	0.777
14	ESC_improve_quality	Efficient supply chain will improve quality fresh produce	0.759	0.711	0.783
15	ESC_reduce_delivery	Efficient supply chain will reduce delivery time to immediate chain partner	0.763	0.708	0.782
16	ESC_react_ marketchange	Efficient supply chain react to market changes	0.766	0.709	0.783
17	EIS_FP_supply	Effective information system forecast the fresh produce supply	0.768	0.709	0.784
18	EIS_transp_pricing	Effective information systems leads to transparency in pricing of fresh produce	0.768	0.716	0.786
19	EIS_markt_infor	Effective Information system provides general market related information	0.768	0.719	0.789
20	EIS_improv_ comm_cust	Effective information system improves communication among suppliers and downstream customers	0.77	0.732	0.798
21	TP_loading_capacity	Loading capacity is given priority in the selection	0.769	0.732	0.797
22	TP_road_condition	Produce delivery time is depends on road condition	0.767	0.738	0.81
23	TP_condition_ equipment	Condition equipment protects the produce from bad whether	0.769	0.735	0.796
24	TP_load_delivery_time	More loading time leads to more delivery time	0.771	0.738	0.794

25	TP_driver_awareness	Driver awareness on what he transporting will results in delivering the produce at destination early.	0.768	0.715	0.782
26	TP_comm_ontime	Communication during the transit will helps in deliver the produce on-time	0.769	0.723	0.782
27	PR_farm_men	Damage during the harvest by the farm men	0.759	0.723	0.787
28	PR_physical_damage	Road conditions causes the physical damage to the fresh produce	0.765	0.723	0.789
29	PR_lack_packaging	Lack of effective packaging	0.766	0.729	0.788
30	PR_living_organism	Living organism (Bacteria, Fungus, insects etc.)	0.764	0.725	0.789
31	PR_foreign_bodies	Non-removal of foreign bodies causes perishability	0.764	0.725	0.791
32	PR_plastic_crates	Lack of plastic crates during the transportation	0.764	0.722	0.783
33	PR_washing	Lack of cleaning and washing	0.769	0.721	0.783
34	PR_care_ load_unload	Lack of enough care is not taken while the loading and loading	0.772	0.718	0.783
35	PR_packing_ perishability	Lack of effective care during road transport	0.768	0.713	0.78
36	RT_delay_delivery	Frequency of delay in delivery time	0.769	0.702	0.782
37	RT_damage_FP	Frequency of damage to fresh Produce	0.778	0.709	0.785
38	RT_hygenic_carriers	Frequency of availability hygienic containers	0.771	0.714	0.785
39	RT_improper_handling	Frequency of improper handling of fresh produce	0.769	0.708	0.78
40	RT_transport_protection	Frequency of lack of transport protection	0.772	0.72	0.787

41	PQ_Loss_colour	Frequency of loss of colour	0.766	0.722	0.789
42	PQ_physical_damage	Frequency of physical damage	0.768	0.719	0.79
43	PQ_Loss_Freshness	Frequency of loss of freshness	0.769	0.712	0.788
44	PQ_sweetness_mealness	Frequency of loss of sweetness and mealness to banana and tomato respectively	0.766	0.71	0.792
45	PQ_Loss_fragrance	Frequency of loss of fragrance	0.767	0.724	0.792
46	Resposiveness	Opinion on overall responsiveness of fresh produce supply chain	0.767	0.705	0.78
47	Relationships	Opinion on overall relationships between the suppliers and downstream customer	0.756	0.701	0.781
48	Effective_SCM	Opinion on overall relationships between the suppliers and downstream customer	0.757	0.701	0.779
49	Effective_Information_System	Opinion on overall performance of information systems in fresh produce supply chains	0.767	0.719	0.788
50	Transport_ Performance	Opinion on overall performance of transportation in Fresh produce supply chain	0.764	0.725	0.788
51	Perishability	Opinion on the spoilage of fresh produce	0.76	0.717	0.782
52	Road_Logistics_ Performance	Opinion on overall road transportation performance	0.767	0.708	0.78
53	Product_Quality	Opinion on overall quality of fresh produce	0.764	0.708	0.787
54	Fresh_Produce_ SCM_Performance	Your overall Opinion on fresh produce supply chain	0.761	0.724	0.793

ANNEXURE – II (B)

ITEM TOTAL STATISTICS OF TRANSPORTERS

Sl.No	Variable Name	Variable Label Name	Cronbach's Alpha if Item Deleted
1	TP_road_condition	Produce delivery time depends on road condition	.741
2	TP_condition_ equipment	Condition equipment protects the produce from bad whether	.753
3	TP_load_ delivery_time	More loading time leads to more delivery time	.737
4	TP_driver_ awareness	Driver awareness on what he is transporting will result in delivering the produce at destination early	.741
5	TP_comm_ontime	Communication during the transit will helps in deliver the produce on-time	.733
6	RT_delay_ delivery	Frequency of delay in delivery time	.741
7	RT_damage_FP	Frequency of damage to fresh produce	.750
8	RT_hygenic_carriers	Frequency of non-availability hygienic containers	.758
9	RT_improper_ handling	Frequency of improper handling of fresh produce	.760
10	RT_transport_ protection	Frequency of lack of transport protection	.778
11	Transport_ Performance	Opinion on overall performance of transportation in fresh produce supply chain	.733
12	Road_Logistics_ Performance	Opinion on overall road transportation performance	.746
13	Transporters_ Performance	Opinion on overall transporters performance in fresh produce supply chain	.718

ANNEXURE – II (C)

ITEM TOTAL STATISTICS OF CUSTOMERS

Sl.No	**Variable Name**	**Variable Label Name**	Cronbach's Alpha if Item Deleted
1	RES_Availability	How do you rate the availability of vegetable/fruits	.604
2	Damage_Spoilage	How frequently do you find damage/spoilage in tomato/banana	.620
3	PQ_Colour_ Fragrance	How do you satisfy with the colour and fragrance of tomato/banana	.563
4	PQ_Mealness_ Sweetness	How do you satisfy with the mealness or sweetness of tomato/banana	.589
5	PQ_Hygienic_ Cleanliness	How do you satisfy with the cleanliness of tomato/banana	.727
6	RLT_Retailer	Does the retailer maintain the relationships with you	.691
7	Overall_Produce_ Quality	Overall impression of customers on fresh produce supply chain	.551

ANNEXURE-III (A)

QUESTIONNAIRE FOR FARMERS

PART-A: DEMOGRAPHIC FACTORS:

a) Name of the Banana/Tomato Farmer:
b) Place:
c) Gender:
d) Age:
e) Social status:
f) Educational Qualification:
g) Size of family   No. of earners in family:
h) Type of soil:
i) Area of Land: Cultivating Area:
j) Quantity of production per Acre/crop:
k) No of crops in a Year:

PART-B: SUPPLY CHAIN PRACTICES

Please Answer the Following Questions with Yes or No

		YES	NO
1	Do you segregate the fresh produce at your level?		
2	Do you have fresh produce cleaning facilities in your farm fields?		
3	Are you using pesticides as per specified standards?		
4	Do you have information about the on going prices in surroundings markets?		
5	Do you have storage facilities in fresh produce distribution chain?		
6	Do you have cold logistics facilities in your area?		
7	Are you providing information on cultivation methods involved of fresh produce production?		

1. Do you have any contacts with organized retailer companies?
   ○ Yes   ○ No
   If your response is Yes, Which of the following organized retail companies have approached you?
   ○ Reliance Fresh ○ ITC ○ Heritage ○ Subhiksha ○ Others,Specify: ______

2. Do you keep the fresh produce stock in buffer?
   ○ Yes   ○ No
   If your response is Yes, What percent of stock you keep in buffer
   ○ 1-20 percent ○ 21 - 40 percent ○ 41 - 60 percent ○ More than 60 percent

3. What are the difficulties being faced you with respect to agri-inputs? (You can mark multiple choices)
   ☐ Shortage of Inputs ☐ Lack of timely supply ☐ High prices ☐ Low/No quality

4. Where do you sell your fresh produce stocks?
   ○Traditional Retail Shops ○APMC commission agents
   ○Direct customers ○Others, Please Specify: ______________________

5. How do you improve shelf life of your fresh produce? (You can mark multiple choices)
   ☐Refrigeration ☐Cold logistics ☐Effective packing ☐Washing & cleaning ☐Chemical treatment

6. How much is the distance between the farm fields and nearest APMC markets? _________
   ○ 0 to 10 Kms ○11 to 20 ◉21 to 30 Kms ○More than 30 kms

7. Which of the following is your regular preference for fresh produce road transportation?
   ○ Truck/Lorry ○Buses ○Four wheel carriers ○Auto rickshaw
   ○Two wheelers ○Bullock cart ○Push Cart/ Trolley

8. What is the time gap between the promised delivery time and the actual product delivery time? (Delay in product delivery) ___________
   ○Within a six ○6 to 12 hours ○12 to 24 hours ○More than one Day

9. What is the approximate percentage of perishability at your level? Specify: __________
   ○ 0 to 10 percent ○10 to 20 percent ○20 to 30 percen ○ 30 to 40 percent ○ More than 40 percent

10. Are you satisfied with the services offered by the transport operators?
   ○Completely satisfied ○ Somewhat satisfied ○Neither satisfied nor Dissatisfied
   ○Somewhat dissatisfied ○completely dissatisfied

11. Approximately, what percentage of quantity is perished in transit from farmer fields to APMC markets?
   ○Up to 10 percent ○10 to 20 percent
   ○20 to 30 percent ○More than 30 percent Specify: _____________

12. How is the price determined in fresh produce markets?
   ○Demand and Supply forces ○Cost of production ○Agents self decided
   ○Government decided MSP ○Combination of the above

13. If fresh produce is perished at your stage, how do you recover the loss? Specify _________________

ANNEXURE-III (B)

QUESTIONNAIRE FOR TRADERS

PART-A: DEMOGRAPHIC FACTORS:

Name of the Wholesaler/Trader:			
Name of the APMC			
Gender:	Age:	Social Status:	
Educational status:	Year of establishment:		
Annual Income:	Experience in trading:		
Firm Type:	Cooperative/Sole proprietary/Partnership/Others		
Turnover per month: Rs.			
Different Agriculture produce dealing with:			

PART-B: SUPPLY CHAIN PRACTICES
Please Answer the Following Questions with Yes or No

		YES	NO
1	Do you have any consolidation agents at farmer fields?		
2	Do you have grading and sorting facilities at APMC markets and Fresh spot markets?		
3	Do you have fresh produce washing and cleaning facilities in your farm fields?		
4	Do you have packaging facilities in APMC markets and Spot markets?		
5	Do you aware of Fresh product's quality specifications with respect to government regulations?		
6	Whether APMC markets have storage facilities?		
7	Are you providing information on cultivation methods involved of fresh produce production?		

1. Do you keep the fresh produce stock in buffer?
   ○ Yes ○ No
   If your response is Yes, What percent of stock you keep in buffer
   ○ 1-20 percent ○ 21 - 40 percent ○ 41 - 60 percent ○ More than 60 percent

2. How do you improve the shelf life to your fresh produce? (You can mark multiple choices)
   ☐Refrigeration ☐Cold logistics ☐Effective packing
   ☐Washing and cleaning ☐Chemical treatment ☐Any other, Please Specify:

3. Which of the following is your regular preference for fresh produce road transportation?
   ○ Truck/Lorry ○ Buses ○ Four wheel carriers ○ Auto rickshaw
   ○ Two wheelers ○ Bullock cart ○ Push Cart/Trolley ○ Any other, Please Specify:

4. What is the distance between the APMC to wholesale markets? __________
   ○ 0 to 10 Kms ○ 11 to 20 ○ 21 to 30 Kms ○ More than 30 kms

5. How much quantity you buy from farmers/Agents daily ______________ (1Ton = 1000 Kgs)
   ○ 0 to 2 MTs ○ 2 to 4 MTs ○ 4 to 6 MTs ○ More than 6 MTs

6. What is the approximate percentage of perishability at your level? Specify: ___________
   ○ 0 to 10 percent ○ 10 to 20 percent ○ 20 to 30 percent
   ○ 30 to 40 percent ○ More than 40 percent

7. What is the approximate quantity is perished during the transit? Specify: _____________
   a) Up to 10 percent b) 10 to 20 percent
   c) 20 to 30 percent d) More than 30 percent

8. What is the time gap between the promised fresh produce delivery time and the actual product delivery time? (Product delay)
   ○ Within a six ○ 6 to 12 hours ○ 12 to 24 hours ○ More than one Day

9. How much time is needed to refill the stock in case of complete stock outs at retailers?
   ○ Within a hour ○ 1 to 6 hours ○ 7 to 24 hours ○ More than one Day

10. What are the means of communications you follow to correspond with the suppliers?
    ○ Telecommunication ○ Internet ○ Postal ○ Any other
Specify:____________

11. How is the prices determined in fresh produce markets?
    ○ Demand and Supply forces ○ Cost of production ○ Agents self decided
    ○ Government decided MSP ○ Combination the above

12. What are the different problems you are facing in mandis? (You can tick multiple options)
    ☐Pricing Problems ☐ Storage Problems ☐Facilities Problems
    ☐ Information Problems ☐Any other Problems

13. Are you happy with the services offered by the transport operators?
    ○ Completely satisfied ○ Somewhat satisfied ○ Neither satisfied nor dissatisfied
    ○ Somewhat dissatisfied ○ completely dissatisfied

14. What is the lead time between the APMC points to retail point?
    ○ Less than 6 hours ○ 6 – 12 hours ○ 12 - 24 hours ○ More than one day

15. How much fresh produce inventory do you maintain in wholesale stores?
    Specify: Banana: _______________________ Tomato: ___________________________

16. What is the time difference between order placing and fresh produce delivery? ________

17. If fresh produce is perished at your stage, how do you recover loss? Specify ________
18. How frequently you face the stock outs in your wholesale point? Specify: ___________
19. How do you predict the fresh produce demand? Specify: _______________________
20. How frequently you face the stock out of tomato/Banana: _____________________

ANNEXURE-III (C)

QUESTIONNAIRE FOR RETAILERS

PART-A: DEMOGRAPHIC FACTORS

Name of the Retailer:		
Gender:	Age:	Social Status:
Educational status:	Year of establishment:	
Annual Income:	Experience in trading:	
Firm Type:	Sole proprietary/Partnership/Others	
Total Investment: Rs.	Location of Store: Rural/Town/Dist. HQ/City	
Turnover per month: Rs.	Fruits: (Banana:) Vegetables: (Tomato:)	

PART-B: SUPPLY CHAIN PRACTICES

Please Answer the Following Questions with Yes or No

		YES	NO
I	Do you have cold logistics/Refrigerated container facilities?		
Ii	Do you sort and grade the fresh produce at your level?		
Iii	Do you have fresh produce washing and cleaning facilities in your farm fields?		
Iv	Do you have storage facilities at your stage in the distribution chain?		
V	Do you have any back orders in fresh produce?		
Vi	Do you have information on production methods involved of fresh produce production?		

1. Do you keep the fresh produce stock in buffer?
   ○ Yes ○ No
   If your response is Yes, What percent of stock you keep in buffer
   ○ 1-20 percent ○ 21 - 40 percent ○ 41 - 60 percent ○ More than 60 percent

2. What is the source of procurement of fresh produce?
   ○ Rural Spot market ○ APMC market ○ Wholesalers
   ○ Direct Farmers ○ Others, Specify________________________

3. What is percentage of perishability at your level? Specify: __________
   ○ 0 to 10 percent ○ 10 to 20 percent ○ 20 to 30 percent
   ○ 30 to 40 percent ○ More than 40 percent

4. How do you improve the shelf life to your fresh produce? (Tick multiple Choice)
   ☐ Refrigeration ☐ Cold logistics ☐ Effective packing
   ☐ Washing and cleaning ☐ Chemical treatment

5. How much is the distance between the wholesale to retail markets? _________
   ○ 0 to 10 Kms ○ 11 to 20 ○ 21 to 30 Kms ○ More than 30 kms

6. What is the time gap between the promised fresh produce delivery time and the actual product delivery time? (Delay in delivery)
   Within a six   6 to 12 hours   12 to 24 hours   More than one Day
7. Which of the following factors determine the prices for your fresh produce?
   Demand and supply   Cost of production
   c) Minimum Support Prices   d) Other factors, please specify ___________________

8. What is the approximate time do you require to replenish the fresh produce stock?
   < 6 hours   6 - 12 hours
   12 - 24 hours   More than a day

9. Which of the following are your regular preferences for fresh produce road transportation?
   Truck/Lorry   Buses   Four wheel carriers   Auto rickshaw
   Two wheelers   Bullock cart   Push Cart/ Trolley

10. What is the approximate percentage of perishability at your level? Please Specify: ____
    0 to 10 percent   10 to 20 percent   20 to 30 percent
    30 to 40 percent   More than 40 percent

11. What is the approximate quantity that is perished during the transit? Specify: ________
    Up to 10 percent   10 to 20 percent   20 to 30 percent   More than 30 percent,

12. How do you know the on-going prices of fresh products in markets?
    Through TV media   Through news papers
    APMC information bulletins   Any other source, please specify: _______________

13. What is the customer response time for retail counter sale?
    Instantaneously   5 to 10 minutes   10-15 minutes
    15-20 minutes   More than 20 minutes

14. What is the time difference between order placing and fresh produce delivery? ______
    Less than a hour   2 - 6 hours   7 - 24 hours   More than one day

15. How is the customer satisfaction with reference to the sales transaction?
    Completely satisfied   Somewhat satisfied   Neither satisfied nor satisfied
    Somewhat dissatisfied   completely dissatisfied

16. Are you satisfied with the services offered by the transport operators?
    Completely satisfied   Somewhat satisfied   Neither satisfied nor satisfied
    Somewhat dissatisfied   Completely dissatisfied

17. How much cost do you incur to procure the fresh produce? Specify
    ____
18. If fresh produce is perished at your stage, how do you recover loss? Specify
    ____
19. How do you add value to fresh produce at your retail level? Specify
    ____

20. How much fresh produce inventory do you maintain in retail stores?
Specify: Banana: ______________________ Tomato: __________________________

21. How much quantity of fresh produce inventory you maintain in a day? ______________

(COMMON FOR FARMERS, TRADERS AND RETAILERS)

PART-C: SUPPLY CHAIN PERFORMANCE MEASUREMENT

A) Rank the Kinds of wastages that contribute to in Fresh Produce revenue losses.
Rank-5 for High contributor and Rank-1 for Low contributor

Type of waste	**Rank**
Harvesting wastage	
Over Production Wastage	
Waiting Time Wastage	
Transport Waste	
Excess Inventory Waste	
Unnecessary Re-handling Waste	

B) Efficiency

Variable (Average yield per Acre is 8.5 tonnes)	Amount in Rs.	Scale down the figures to 1Kg
Production Cost (Rent, seeds, Fertilizers, Manpower, Pesticides)		
Transaction Cost (Transport, Market taxes, Post-harvest Commissions Packaging, Handling, etc.)		
Revenue		
Profit		

C) Please answer the questions from 1-58 on a rating scale of 1-5 which described below

	1	2	3	4	5
Questions 1-41	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
Questions 42-52	Never	Seldom	Half of the occasions	Most of the occasions	Always
Questions 53-58	Completely satisfied	Somewhat satisfied	Neither satisfied nor dissatisfied	Somewhat dissatisfied	Completely dissatisfied

	Rate the following statements framed under different aspects of SCM	**1**	**2**	**3**	**4**	**5**
	RESPONSIVENESS IN SUPPLY					
1	There is a gap in the quantity of fresh produce ordered and order fulfilled (Fill Rate)	1	2	3	4	5
2	There is a delay in the fresh produce order delivery as against the promised time (Customer Response Time)	1	2	3	4	5
3	I was supplied the wrong fresh produce shipments against what I ordered	1	2	3	4	5
4	Total time period for production including harvesting (Lead time)	1	2	3	4	5

5	The customers complain on the various issues of timely delivery of the fresh produce (Consumer complaints)	1	2	3	4	5

RELATIONSHIP WITH SUPPLIERS AND CUSTOMERS

6	I look at the long term business relations.	1	2	3	4	5
7	Our relationships confined to the particular business transaction	1	2	3	4	5
8	Every time I will approach a new supplier/customer	1	2	3	4	5
9	The relationships continues after transaction for future needs sake	1	2	3	4	5
10	I always trust other party in the business negotiation.	1	2	3	4	5
11	I adopt “give and take” policy in the negotiation of transaction	1	2	3	4	5
12	I discuss the market trends with my customer/supplier in un-seasons also	1	2	3	4	5

EFFICIENT SUPPLY CHAIN COULD RESULTS IN

13	Increase Sales	1	2	3	4	5
14	Lower levels waste	1	2	3	4	5
15	Improve quality fresh produce	1	2	3	4	5
16	Reduce delivery time to immediate chain partner	1	2	3	4	5
17	React to market changes	1	2	3	4	5

EFFICTIVE INFORMATION SYSTEM LEAD TO

18	Fresh Produce supply forecast	1	2	3	4	5
19	Transparency in Pricing of fresh produce	1	2	3	4	5
20	Transparency in Grading of fresh produce	1	2	3	4	5
21	General Market related information	1	2	3	4	5
22	improve communication among Suppliers	1	2	3	4	5
23	Effective communication among Customers	1	2	3	4	5

TRANSPORT PERFORMANCE

24	Engine condition is given importance in the selection of truck	1	2	3	4	5
25	Loading capacity is given priority in the selection	1	2	3	4	5
26	Produce delivery time is depends on road condition	1	2	3	4	5
27	Condition equipment protects the produce from bad whether	1	2	3	4	5
28	More loading time leads to more delivery time	1	2	3	4	5
29	More unloading time leads to more delivery time	1	2	3	4	5
30	Skilled driver will ship the produce to the destination in time	1	2	3	4	5
31	Communication during the transit will helps in deliver the produce on-time	1	2	3	4	5

CAUSES TO PERISHABILITY IN FRESH PRODUCE

32	Vegetables are damaged during the harvest by the farm men	1	2	3	4	5

33	Road conditions causes the physical damage to the fresh produce	1	2	3	4	5
34	Lack of effective packaging is a major cause for damage	1	2	3	4	5
35	Living organism (Bacteria, Fungus, insects etc) will spoil the fresh produce	1	2	3	4	5
36	Foreign bodies are not removed after the harvest will causes perishability	1	2	3	4	5
37	Transporters provide the plastic crates to prevent damage and spoilage	1	2	3	4	5
38	Lack of temperature control leads to the faster ripening process	1	2	3	4	5
39	Washing with detergents or sanitizers remove the Fungicides and Pesticides residues from the produce	1	2	3	4	5
40	Enough care is not taken while the loading and loading the fresh produce in the market stages	1	2	3	4	5
41	Packing reduces the perishability by giving more protection to produce.	1	2	3	4	5

PROBLEMS IN ROAD TRANSPORTATION

42	How often there is a Delay in Delivery time	1	2	3	4	5
43	How often there is a damage to fresh Produce	1	2	3	4	5
44	How often hygienic containers available	1	2	3	4	5
45	How often there are delivery Errors (Wrong item shipments)	1	2	3	4	5
46	How often there is an Improper Handling of fresh produce	1	2	3	4	5
47	How often there is lack of transport Protection	1	2	3	4	5

PRODUCT QUALITY

48	How often there is a Loss of colour	1	2	3	4	5
19	How often there is a physical damage	1	2	3	4	5
50	How often there is a loss of freshness	1	2	3	4	5
51	How often there is a Loss of sweetness and Mealness to Banana and Tomato respectively	1	2	3	4	5
52	How often there is a loss of fragrance	1	2	3	4	5
OVERALL OPINION						
53	How do you feel about the overall responsiveness of Fresh produce supply chain	1	2	3	4	5
54	How do you feel about the overall relationships between the suppliers and downstream customer	1	2	3	4	5
55	How do you feel about the overall information system in fresh produce supply chain	1	2	3	4	5
56	How do you feel about the overall road transportation performance	1	2	3	4	5
57	How do you feel about the overall causal factors contributing to perishability	1	2	3	4	5
58	How do you feel about the overall quality of fresh produce	1	2	3	4	5

ANNEXURE-III (D)

QUESTIONNAIRE FOR TRANSPORT OPERATORS

PART-A: DEMOGRAPHIC FACTORS

Name of the Transport operator:		
Gender:	Age:	Social Status:
Educational status:	Year of establishment:	
Annual Income:	Experience in transport field:	
Firm Type: Sole proprietary/Partnership/Others	No of trucks/vans:	
Total Investment: Rs.	Location of Store: Rural/Town/Dist. HQ/City	
Turnover per month: Rs.	Fruits: (Banana:) Vegetables: (Tomato:)	

TRANSPORT PERFORMANCE

24	Engine condition is given importance in the selection of truck	1	2	3	4	5
25	Loading capacity is given priority in the selection	1	2	3	4	5
26	Produce delivery time is depends on road condition	1	2	3	4	5
27	Condition equipment protects the produce from bad whether	1	2	3	4	5
28	More loading time leads to more delivery time	1	2	3	4	5
29	More unloading time leads to more delivery time	1	2	3	4	5
30	Skilled driver will ship the produce to the destination in time	1	2	3	4	5
31	Communication during the transit will helps in deliver the produce on-time	1	2	3	4	5

PROBLEMS IN ROAD TRANSPORTATION

42	How often there is a Delay in Delivery time	1	2	3	4	5
43	How often there is a damage to fresh Produce	1	2	3	4	5
44	How often hygienic containers available	1	2	3	4	5
45	How often there are delivery Errors (Wrong item shipments)	1	2	3	4	5
46	How often there is an Improper Handling of fresh produce	1	2	3	4	5
47	How often there is lack of transport Protection	1	2	3	4	5

ANNEXURE-III (E)

CHECK LIST FOR MARKETING OFFICERS

PART-A: DEMOGRAPHIC FACTORS

1. Name of the officer:
2. Designation:
3. Gender:
4. Age:
5. Experience in the field:
6. Name/Place of the Market:
7. Market Size: Small / Medium / Large

PART-B: FACILITIES AVAILABLE AT APMC MARKETS

VARIABLE	YES	NO
Grading and Sorting		
Post harvest treatment Irradiation		
Vaporization		
Water treatment		
Fungi Treatment		
Bacterial treatment		
Chemical treatment		
Any other		
Packaging Material		
Safety Measures to prevent from Physical Damages (cushion material)		
Chemical Contamination		
Fungi and Bacterial infections		
Produce Packaging		
Transportation Facilities (Village to APMC)		
Market Information on Ongoing price related		
Production related		
Exports related		
Any other		
Infrastructural facilities Auction Sheds		
Platforms		
Internal Roads		
Storage and Warehousing		
Intra-Transport		
Administrative Clearance for Lifting		

ANNEXURE-III (F)

QUESTIONNAIRE FOR CUSTOMERS

PART-A: DEMOGRAPHIC FACTORS

Name of the Customer:	Age:
Gender:	Social Status:
Educational status:	Name of the market area:
Annual Income:	

PART-B: SUPPLY CHAIN PRACTICES

22. How many times do you visit market??
Once in a fortnight Once in a week Twice a week Thrice a week Daily

23. How do you rate the availability of vegetables?
Always Most of the occasions Half of the occasions Seldom Never

24. How frequently do you find damage/spoilage in Tomato/Banana?
Always Most of the occasions Half of the occasions Seldom Never

25. How do you satisfied with the colour and fragrance of Tomato/Banana?
Completely satisfied Somewhat satisfied Neither satisfied nor satisfied
Somewhat dissatisfied Completely dissatisfied

26. How do you satisfied with the Mealness or Sweetness of Tomato/Banana?
Completely satisfied Somewhat satisfied Neither satisfied nor satisfied
Somewhat dissatisfied Completely dissatisfied

27. How do you satisfied with the cleanliness of Tomato/Banana?
Completely satisfied Somewhat satisfied Neither satisfied nor satisfied
Somewhat dissatisfied Completely dissatisfied

28. Does the retailer maintain the relationships with you
Always Most of the occasions Half of the occasions Seldom Never

29. What is your overall impression on Fresh produce supply chain?
Completely satisfied Somewhat satisfied Neither satisfied nor satisfied
Somewhat dissatisfied Completely dissatisfied

ANNEXURE-IV (A)

CALCULATION OF SCORES OF FRESH PRODUCE SUPPLY CHAIN PERFORMANCE AT FARMERS' LEVEL

Indicator	Mean/Range	5	4	3	2	1
Production Costs	Min-50000 Max-85000 Intrl-7000	Rs. 50000-57000	Rs. 57000-64000	Rs. 64000-71000	Rs. 71000-78000	Rs. 78000-85000
Transaction Costs	Min-1000 Max-4000 Intrl-1000	Up to Rs. 1000	Rs. 1000-2000	Rs. 2000-3000	Rs. 3000-4000	Above Rs.4000
Transportation Cost	Min-14000 Max-30000 Intrl-4000	Up to Rs. 14000	Rs. 14000-18000	Rs. 18000-22000	Rs. 22000-26000	Rs. 26000-30000
Profit	Min-95000 Max-180000 Intrl-17000	Up to Rs. 112000	Rs. 112000-129000	Rs. 129000-146000	Rs. 146000-163000	Rs.163000-180000
Return on Investment		More than 80%	60 to 80%	40 to 60%	20 to 40%	Up to 20%
Mean of Indicators						
Customer Satisfaction		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied
Volume Flexibility		Very high	Moderately high	Somewhat high	Slightly low	Very low
Delivery Flexibility		Very high	Moderately high	Somewhat high	Slightly low	Very low
Mean of Indicators						
Order Fill Rate		More than 90%	85 to 90%	80 to 85%	75 to 80%	Below 75%
Customer Response Time		Instantaneously	5 to 10 minutes	10-15 minutes	15-20 minutes	More than20 min
Customer Complaints		Less than 5	6-10	11-15	15-20	More than 20
Lead time		0 to 6 hours	6 to 12 hours	12 to 24 hours	1-2 Days	More than 2 days
Shipping Errors		0 to 5%	5 to 10%	10 to 15%	15 to 20%	More than 20%
Mean of Indicators						
Appearance		More than 90%	85 to 90%	80 to 85%	75 to 80%	Below 75%

Taste		More than 90%	85 to 90%	80 to 85%	75 to 80%	Below 75%
Shelf life (After harvest)		More than 8days	6-8 days	4-6 days	2-4 days	1-2 days
Salubrity/Nutrition		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied
Product safety		Highly safe	Somewhat safe	Slightly safe	Somewhat unsafe	Completely unsafe
Mean of Indicators						
Traceability		Completely informed	Partially informed	Slightly informed	Somewhat informed	Not informed
Storage & Transport condition		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied
Pesticide/Chemical use		No use	Somewhat use	Slightly use	Moderate use	Very High use
Promotion (% increase in customers)		Less than 5%	6-10%	11-15%	15-20%	More than 20%
Mean of Indicators						
Road condition		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied
Condition equipment		Extremely available	Frequently available	Somewhat available	Rarely available	Not available
Loading &Un-loading timings		Very low	Slightly low	Somewhat high	Moderately high	Very high
Driver awareness		Very high	Moderately high	Somewhat high	Slightly low	Very low
Communication during the transit		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied
Delay in delivery (Hours)		0 to 6 hours	6 to 12 hours	12 to 24 hours	1-2 Days	More than 2 days
Damage during transit (Percent)		0 to 10%	10 to 20%	20 to 30%	30 to 40%	More than 40%
Hygienic carriers (Frequency)		Always	Most of the occasions	Half of the occasions	Seldom	Never
Transport protection (Frequency)		Always	Most of the occasions	Half of the occasions	Seldom	Never
Mean of Indicators						

ANNEXURE-IV (B)

CALCULATION OF SCORES OF FRESH PRODUCE SUPPLY CHAIN PERFORMANCE AT TRADERS' LEVEL

Indicator	Mean/Range	5	4	3	2	1
Production costs	Min-50000 Max-360000 Intrl-62000	Rs. 50000-112000	Rs. 112000-174000	Rs. 174000-236000	Rs. 236000-298000	Rs. 298000-360000
Transaction costs	Min-1000 Max-7000 Intrl-6000	Up to Rs. 2200	Rs. 2200-3400	Rs. 3400-4600	Rs. 4600-5800	Above Rs.58000
Transportation cost	Min-800 Max-5000 Intrl-820	Up to Rs. 1620	Rs. 1620-2440	Rs. 2440-3260	Rs. 3260-4080	Rs. 4080-5000
Profit	Min-59000 Max-407000 Intrl-348000	Up to Rs. 128000	Rs. 128000-129000	Rs. 128000-198200	Rs. 198200-267800	Rs.267800-337400
Return on Investment		More than 80%	60 to 80%	40 to 60%	20 to 40%	Up to 20%
Mean of Indicators						
Customer Satisfaction		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied
Volume Flexibility		Highly Flexibility	Somewhat Flexibility	Slightly Flexibility	Low Flexibility	Very low Flexibility
Delivery Flexibility		Highly satisfied	Somewhat satisfied	Neither satisfied nor Dissatisfied	Somewhat dissatisfied	Completely Dissatisfied
Mean of Indicators						
Order Fill-rate		More than 90%	85 to 90%	80 to 85%	75 to 80%	Below 75%
Customer response time		Instantaneously	5 to 10 minutes	10-15 minutes	15-20 minutes	More than20 min
Customer complaints		Less than 5	6-10	11-15	15-20	More than 20
Lead time		0 to 6 hours	6 to 12 hours	12 to 24 hours	1-2 Days	More than 2 days
Shipping errors		0 to 5%	5 to 10%	10 to 15%	15 to 20%	More than 20%
Mean of Indicators						

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Appearance		More than 90%	85 to 90%	80 to 85%	75 to 80%	Below 75%
Taste		More than 90%	85 to 90%	80 to 85%	75 to 80%	Below 75%
Shelf life (After harvest)		More than 8days	6-8 days	4-6 days	2-4 days	1-2 days
Salubrity/Nutrition		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied
Product safety		Highly safe	Somewhat safe	Slightly safe	Somewhat unsafe	Completely unsafe
Mean of Indicators						
Traceability		Completely informed	Partially informed	Slightly informed	Somewhat informed	Not informed
Storage & Transport condition		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied
Pesticide/chemical use		No use	Somewhat use	Slightly use	Moderate use	Very High use
Promotion (% increase in customers)		Less than 5%	6-10%	11-15%	15-20%	More than 20%
Mean of Indicators						
Road condition		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied
Condition equipment		Extremely available	Frequently available	Somewhat available	Rarely available	Not available
Loading &Unloading timings		Very low	Slightly low	Somewhat high	Moderately high	Very high
Driver awareness		Very high	Moderately high	Somewhat high	Slightly low	Very low
Communication during the transit		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied
Delay in delivery (Hours)		0 to 6 hours	6 to 12 hours	12 to 24 hours	1-2 Days	More than 2 days
Damage during transit (Percent)		0 to 10%	10 to 20%	20 to 30%	30 to 40%	More than 40%
Hygienic carriers (Frequency)		Always	Most of the occasions	Half of the occasions	Seldom	Never
Transport protection (Frequency)		Always	Most of the occasions	Half of the occasions	Seldom	Never
Mean of Indicators						

ANNEXURE-IV (C)

CALCULATION OF SCORES OF FRESH PRODUCE SUPPLY CHAIN PERFORMANCE AT RETAILERS' LEVEL

Indicator	Mean/Range	5	4	3	2	1
Production costs	Min-16000 Max-72000 Intrl-11200	Rs. 16000-27200	Rs. 27200-38400	Rs. 38400-49600	Rs. 49600-60800	Rs. 60800-72000
Transaction costs	Min-5000 Max-30000 Intrl-25000	Up to Rs. 10000	Rs. 10000-15000	Rs. 15000-20000	Rs. 20000-25000	Rs. 25000-30000
Transportation cost	Min-5000 Max-28000 Intrl-4600	Up to Rs. 9600	Rs. 9600-14200	Rs. 14200-18800	Rs. 18800-23400	Rs. 23400-28000
Profit	Min-4000 Max-18400 Intrl-3600	Up to Rs. 7600	Rs. 7600-11200	Rs. 11200-14800	Rs. 14800-18400	Rs.18400-22000
Return on Investment		More than 80%	60 to 80%	40 to 60%	20 to 40%	Up to 20%
Mean of Indicators						
Customer satisfaction		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied
Volume flexibility		Highly Flexibility	Somewhat Flexibility	Slightly Flexibility	Low Flexibility	Very low Flexibility
Delivery flexibility		Highly satisfied	Somewhat satisfied	Neither satisfied nor Dissatisfied	Somewhat dissatisfied	Completely Dissatisfied
Mean of Indicators						
Order Fill Rate		More than 90%	85 to 90%	80 to 85%	75 to 80%	Below 75%
Customer Response Time		Instantaneously	5 to 10 minutes	10-15 minutes	15-20 minutes	More than20 min
Customer Complaints		Less than 5	6-10	11-15	15-20	More than 20
Lead time		0 to 6 hours	6 to 12 hours	12 to 24 hours	1-2 Days	More than 2 days
Shipping Errors		0 to 5%	5 to 10%	10 to 15%	15 to 20%	More than 20%

Mean of Indicators						
Appearance		More than 90%	85 to 90%	80 to 85%	75 to 80%	Below 75%
Taste		More than 90%	85 to 90%	80 to 85%	75 to 80%	Below 75%
Shelf life (After harvest)		More than 8days	6-8 days	4-6 days	2-4 days	1-2 days
Salubrity/nutrition		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied
Product safety		Highly safe	Somewhat safe	Slightly safe	Somewhat unsafe	Completely unsafe
Mean of Indicators						
Traceability		Completely informed	Partially informed	Slightly informed	Somewhat informed	Not informed
Storage & Transport Condition		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied
Pesticide/chemical use		No use	Somewhat use	Slightly use	Moderate use	Very High use
Promotion (% increase in customers)		Less than 5%	6-10%	11-15%	15-20%	More than 20%
Mean of Indicators						
Road condition		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied
Condition equipment		Extremely available	Frequently available	Somewhat available	Rarely available	Not available
Loading &Unloading timings		Very low	Slightly low	Somewhat high	Moderately high	Very high
Driver awareness		Very high	Moderately high	Somewhat high	Slightly low	Very low
Communication during the transit		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied
Delay in delivery (Hours)		0 to 6 hours	6 to 12 hours	12 to 24 hours	1-2 Days	More than 2 days
Damage during transit (Percent)		0 to 10%	10 to 20%	20 to 30%	30 to 40%	More than 40%
Hygienic carriers (Frequency)		Always	Most of the occasions	Half of the occasions	Seldom	Never
Transport protection (Frequency)		Always	Most of the occasions	Half of the occasions	Seldom	Never
Mean of Indicators						

ANNEXURE-IV (D)

CALCULATION OF FRESH PRODUCE SUPPLY CHAIN PERFORMANCE AT TRANSPORTERS' LEVEL

Indicator	Mean/Range	5	4	3	2	1
Production costs	Min-115000 Max-468000 Intrl-70600	Rs. 115000-185600	Rs. 185600-256200	Rs. 256200-326800	Rs. 326800-397400	Rs. 397400-468000
Transaction costs	Min-20000 Max-70000 Intrl-10000	Up to Rs. 30000	Rs. 30000-40000	Rs. 40000-50000	Rs. 50000-60000	Rs. 60000-70000
Transportation cost	Min-30000 Max-80000 Intrl-40000	Up to Rs. 40000	Rs. 40000-50000	Rs. 50000-60000	Rs. 60000-70000	Rs. 70000-80000
Profit (Per year)	Min-200000 Max-600000 Intrl-80000	Up to Rs. 280000	Rs. 280000-360000	Rs. 360000-440000	Rs. 440000-520000	Rs.520000-600000
Return on Investment (In a year)		More than 80%	60 to 80%	40 to 60%	20 to 40%	Up to 20%
Mean of Indicators						
Customer satisfaction		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied
Mean of Indicators						
Customer response time		Instantaneously	5 to 10 minutes	10-15 minutes	15-20 minutes	More than20 min
Customer complaints		Less than 5	6-10	11-15	15-20	More than 20
Shipping errors		0 to 5%	5 to 10%	10 to 15%	15 to 20%	More than 20%
Mean of Indicators						
Storage & Transport condition		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied

Mean of Indicators						
Road condition		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied
Condition equipment		Extremely available	Frequently available	Somewhat available	Rarely available	Not available
Loading &Unloading timings		Very low	Slightly low	Somewhat high	Moderately high	Very high
Driver awareness		Very high	Moderately high	Somewhat high	Slightly low	Very low
Communication during the transit		Highly satisfied	Somewhat satisfied	Slightly satisfied	Somewhat dissatisfied	Completely Dissatisfied
Delay in delivery (Hours)		0 to 6 hours	6 to 12 hours	12 to 24 hours	1-2 Days	More than 2 days
Damage during transit (Percent)		0 to 10%	10 to 20%	20 to 30%	30 to 40%	More than 40%
Hygienic carriers (Frequency)		Always	Most of the occasions	Half of the occasions	Seldom	Never
Transport protection (Frequency)		Always	Most of the occasions	Half of the occasions	Seldom	Never
Mean of Indicators						

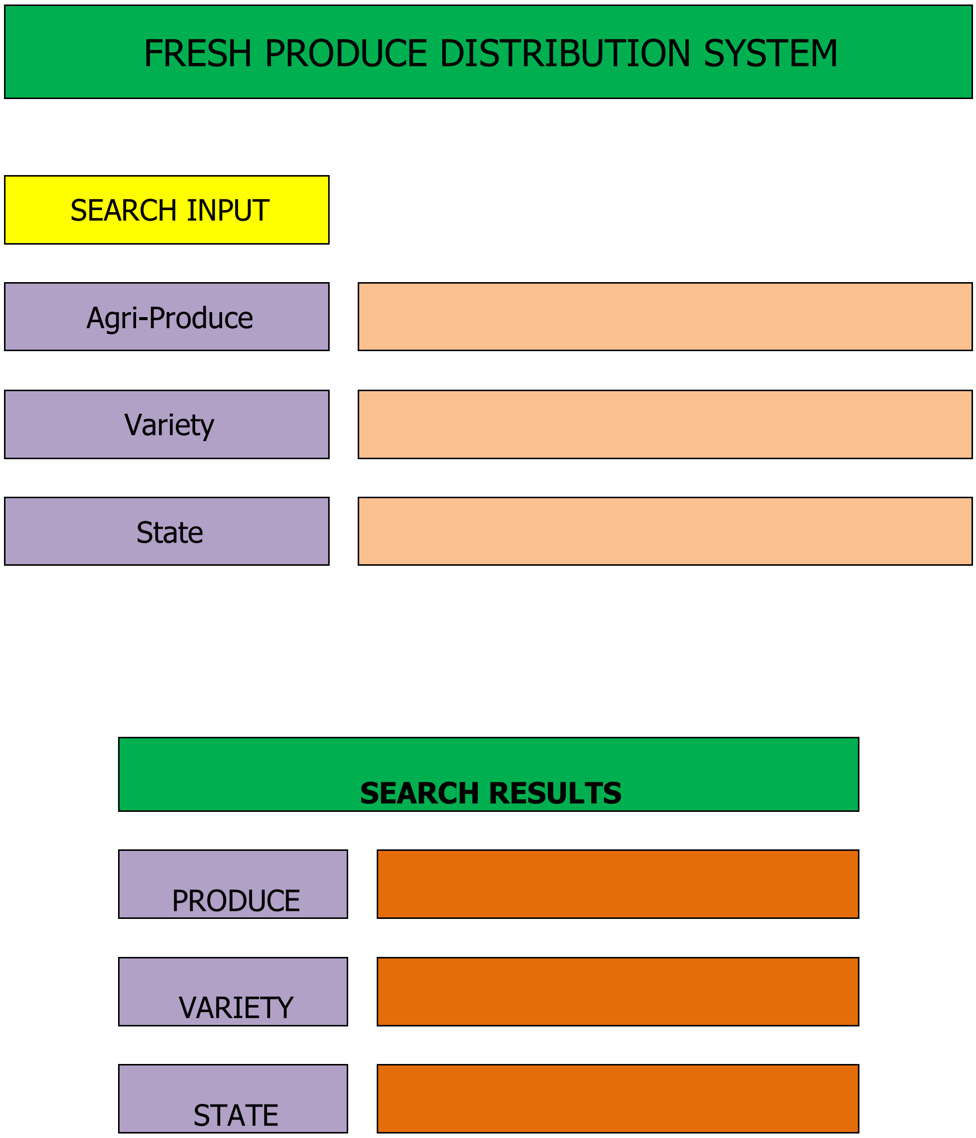
ANNEXURE – V

THE PROPOSED FORMAT OF FARMER & CROP RELATED DATA FEEDING SHEET THAT IS WILL BE ENTERED AT VILLAGE LEVEL

FRESH PRODUCE DISTRIBUTION SYSTEM
FARMER LEVEL DATA ENTRY

1	Farmer Identity Number	
2	UID Number	
3	Name of the farmer	
4	Land Survey Number	
5	Total Area of the Land	
6	Address	
7	Contact Number	
8	Village	
9	Mandal/Taluk	
10	District	
11	State	
12	Pin code	
13	Crop Cultivating	
14	Variety of crop	
15	Date of Sowing/Planting	
16	Period of crop	

THE PROPOSED FORMAT OF INTERNET SEARCHING TO ACCESS DATA FROM FRESH PRODUCE DISTRIBUTION SYSTEM DATABASE VIA INTERNET



THE PROPOSED FORMAT OF FARMER & CROP INFORMATION SHEET ACCESSED FROM INTERNET

FRESH PRODUCE DISTRIBUTION SYSTEM

SERIAL NUMBER	DISTRICT	MANDAL	FARMER NAME	CONTACT NUMBER	EXP. DATE OF HARVEST	TOTAL EXP. YEILD
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

ANNEXURES - VII

VITAE

Mr. Sudhakar Madhavedi has been pursuing full-time Ph.D program since July, 2007. He holds an MBA (Marketing Management) degree from Osmania University, Hyderabad and BBM from Andhra University (CMS-GITAM), Visakhapatnam. He has completed M.Phil (Management) program from Madurai Kamaraj University. Recently, he is visited Mahasarakham University, Thailand to pursue “International Research Internship program” for 10 weeks during 12-02-2010 to 23-04-2010.

He is having nearly four years of teaching experience in affiliated colleges of Osmania and JNT universities in around Hyderabad. He has several research publications in his credit in national and international refereed journals. He also presented several research papers in national and international conferences of which one paper is presented at IABE Annual conference at Las Vegas, USA. He has worked for UNO and World Bank impact assessment projects.

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MEASURING THE PERFORMANCE OF AGRI-SUPPLY CHAINS: A STUDY OF TRADITIONAL FRESH PRODUCE DISTRIBUTION SYSTEM IN ANDHRA PRADESH

A synopsis submitted to the University of Hyderabad in partial fulfillment for the award of the degree of

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1.0 INTRODUCTION

Supply Chain can be understood as a value-creation process, wherein all firms in a chain, link and align, to enhance the value of the chain as a whole (Porter, 1985). The process of value creation is achieved by firm operations, integration of processes, logistics and maintenance of products through quality control. Value creation throughout the chain is further improved by information flows, vertical integration and relationship management. Value creation occurs through operations, which include product transformation or processing, product enhancement i.e. cleaning, grading, packaging and presentation (Woods, 2004). As the product moves from one point in the chain to the other, value is created through the integration of processes along the chain, as a seamless interconnect of processes.

In logistics, where the product is being transported from one point in the chain to the next, value is added to the supply chain. There is further value addition where the quality preservation aspects such as grading, packing and cold chain procedures are involved. Thus, the value creation process in a supply chain requires clear information flows throughout the chain and links up the suppliers and intermediary customers with market demands and markets with supply.

2.0 SUPPLY CHAIN MANAGEMENT IN AGRICULTURE

Indian economy holds traditional supply chains as a powerful force in the agri food distribution system. Conventional understanding demonstrates that the fresh produce distribution system in India performs poorly (Birthal et.al, 2007) and there are different schools of thought which explain the reason for this poor performance. It has been observed that farmers receive a disproportionate share of the profits in the fresh produce supply chain when compared to traders and retailers (Narrod et.al, 2008). It is often claimed that there is lack of trust between buyers and suppliers which acts as an impediment in supply chain performance. The quality of fresh produce being distributed is poor and the supply is inconsistent (Pandey & Tewari, 2010). Besides, the post-harvest wastage rates are unacceptably high and market information flows are poor. Experts opine that prescriptions for improving the performance of such traditional supply chains should vary from chain to chain.

Two broad principal explanations can be advanced for the increasing interest in Agricultural Supply Chain Management (ASCM): the industrialisation of agriculture and the uncertainty associated with variations in product quality and safety (Henson and Loader, 2001).

Agriculture involves a wide range of distinct enterprises comprising farmers, processors, traders and retailers. Supply Chain Management (SCM) is an essential tool for integrating the activities of various suppliers within the distribution chain, in order to assure the consistent delivery of quality assured produce to the consumer (Ferentinos et.al, 2006). For the consumer and other stakeholders, SCM focuses on improving the performance of the supply chain through the delivery of guaranteed safe, desirable and good quality food in a cost effective manner (Fearne & Hughes, 2000). The increasing transaction costs of intensive agriculture and the need to reduce these costs, is the heart of agricultural SCM. The six fundamental requirements for an efficient supply chain between fresh produce growers and the major retail customers include: scale of operation, strategic alliances, production flexibility, and continuity of supply, quality control, and communication (Ziggers & Trienekens, 1999).

2.1 Issues in Fresh Produce Supply Chain Management

Fresh fruits, vegetables and root crops, collectively called fresh produce, are inherently perishable commodities and their physical distribution through the marketing system often leads to considerable losses. The Indian Fresh Produce supply chain is characterized by high cost, low quality, high perishability and increased lead times at all levels (Raghunath & Ashok 2004).

In India, it is reported that approximately 60 percent of quality is lost while produce transported from the farm to the final consumer in fresh produce supply chain. The efficient supply chain management of practices in fresh produce supply chain certainly benefits in terms of low price to customers and high revenues to producers (Mittal, 2007). The improved supply chain will reduce prices of fresh produce commodities by 35 percent due to the substantial reduction in wastage as well as multiple margins in the traditional supply structure. It is observed that the share of farmers in consumer price is about 30 percent whereas in developed countries it is as high as 70 percent (Raghunath et.al, 2005). Post-harvest losses vary significantly among commodities and varieties, in different regions and seasons. The wastage levels are as high as 24-40 percent in India but as low as 4 to 6 percent in developed countries (Deshingkar et.al, 2003). Hence it is apparent that India needs to emulate practices and expertise from the developed nations in supply chain management of fresh produce.

The major constraints related to distribution have been identified in several research studies which recommend for techno-managerial solutions are the supply chain of fresh produce are (i) lack of timely delivery; (ii) lack of uniform grading of harvested produce; (iii) improper packaging; (iv) poor quality of produce; (v) poor market infrastructure; (vi) improper pricing; and (vii) lack of standardized weights and measures. Besides these constraints, there is a poor dissemination of market information resulting in lowered productivity (Surendra et.al, 2009).

2.2 Post Harvest Losses in Fresh Produce Supply Chain

The supply of fresh produce consumption increase through the proper integration of post-harvest technology into distribution chain is critical. Effective post-harvest management requires adequate and appropriate cooling and packaging facilities, hygienic and speedy transportation, careful handling and adequate environment control. Improper post-harvest management in India's fresh produce supply chain has led to the wastage of 24 to 40 percent. The extent of losses of fruits and vegetables is estimated at about Rs. 10,000 crores to 12,000 crores per annum (Reddy et.al, 2010). The major causes of loss are improper handling, poor packaging, improper storage, uncontrolled temperature, etc.

Post-harvest management reduces wastage and maintains the quality of fresh produce. Poor handling of produce lowers market quality and can substantially reduce returns. India has around 1,300 cold storage facilities, of which 50 percent used for potatoes and the rest remain underutilized. In India, approximately 20 percent of fruits and vegetables go waste on account of the lack of cold chains (Viswanadham, 2006).

2.3 Demand and Supply Trends in Fresh Produce

There is a change in consumption pattern and diversification in production as Indian economy is moving towards a demand-driven economy. Total domestic demand for fruits is expected to increase from 17.43 million tons in 2010 to 25.47 million tons by 2020 in a scenario of economy growing at eight percent per annum. For vegetables, the demand is expected to increase from 103.16 million tons in 2010 to 137.25 million tons by 2020. Demand for both fruits and vegetables are expected to rise at the rate of 4 to 5 percent per annum in the next 10 years showing an increasing trend.

The increase in demand of fruits and vegetables for domestic consumption is a challenge to the country. The production of fruits and vegetables would increases from 66.9 million tons in 2010 to 131 million tons by 2015. The surplus margin of 20 to 25 percent of fruits and vegetables are moved from domestic market to export markets by reducing post-harvest losses. Much effort is thus required to minimise supply constraints and improve the growth rates of fruits and vegetables.

The reduction of post-harvest losses may increase the actual supply of produce for consumption. It is projected that production and actual supply are constantly growing from 83.8 million tons to 152 million tons in case of vegetables and 44.3 million tons to 74.9 million tons in for fruits. The actual supply of produce for consumption is increasing from 67.9 million tons to 123 million tons for vegetables and about 33.2 million tons to 56.2 million tons for fruits. It is also studied that the losses in distribution are increasing from 15.9 million tons to 29 million tons for vegetables and 11.1 million tons to 18.7 million tons for fruits. It can be understood that growing area of fruits and vegetables would reach to saturation level over a period of time. Hence it is necessary to reduce losses in fresh produce to meet the demand of growing population.

3.0 THE STUDY

The rationale and approaches to the study has been given in the following sections including objectives, hypothesis, scope of the study and others.

3.1 Need and Significance of the Study

The Agriculture sector in developed nations having adopted the supply chain approach effectively integrating the logistic operations consequently experienced a reduction in lead times, losses, cost and uncertainty. The SCM brings effective coordination among the distribution chain partners such as input suppliers and growers, cohesiveness among warehousing partners and retailers resulting in maximisation of customer satisfaction and high value creation to customers in the developed nations whereas in under-developed nations agri-supply chain management is being used for vertical coordination.

It is obvious that the existing fresh produce supply chains are disjointed which consists of many intermediaries adding cost rather than value. These chains meet the food requirement of crores of people and provide livelihood to lakhs of intermediaries. The consumer pays a high price for inferior quality owing to limited option. Indian fresh produce supply chain lags behind in respect of improved procurement, warehousing and competitive retailing. In recent years, there is an increased involvement of organised retail companies in fresh produce distribution creating a highly competitive environment in which the survival of traditional suppliers is critical to face the market challenges (Bart Mintena et.al, 2010).

In Indian fresh produce distribution system, the supply chain management decision areas like procurement, cold logistics, transportation and information systems are not given much attention. As a result several micro level supply chains have evolved without synchronizing in the downstream of supply chain. In this context, SCM becomes crucial for capacity building in the fresh produce distribution system. The present study is an attempt to address these issues and help understand SCM practices for performance improvement in fresh produce distribution system.

In the context of globalization, there is greater need to study the SCM practices and measure the performance of agri supply chains to sustain in the highly competitive environment to track the efficiency failures of fresh produce distribution system. The aim of implementing a performance measurement system is to improve the performance of the individual firms in the fresh produce chain which will have typical characteristics like high transport cost, inconsistent supply, high perishability, long throughput times, seasonality, and quality (Batt and Noonan, 2009).

3.2 Objectives of the Study

The main objective of the study is to measure the performance of supply chain in fresh produce distribution system in Andhra Pradesh for tracking failures and which may possibly leads to effective decision-making within the chain entities. In order to substantiate the main objective, the following secondary objectives of the study are framed:

1. To analyse the supply chain practices in fresh produce distribution system in Andhra Pradesh;
2. To measure the supply chain performance across distribution channels i.e., farmers, traders, retailers, consumers and transporters in traditional fresh produce supply chain;
3. To measure the performance of road transportation in fresh produce distribution logistics;
4. To identify the factors causing perishability in fresh produce distribution chain and to suggest preventive measures for maintain the quality of fresh produce; and
5. To develop an integrated supply chain model for fresh produce distribution chain based on the performance measurement.

3.3 Hypothesis of the Study:

Keeping in view of the importance and significance of the study, the following hypotheses are setup for the study based on the review of literature.

1. Hypothesis (H1): The condition of roads will influence the damage level of fresh produce during the transit;
2. Hypothesis (H2): The amount of care taken while loading and unloading will have an effect on the damage of fresh produce;
3. Hypothesis (H3): Spoilage of fresh produce will affect the overall performance of fresh produce supply chain;
4. Hypothesis (H4): There is a significant gap between the promised delivery time and actual delivery time within the levels of supply chain;
5. Hypothesis (H5): The fill-rate is not uniform among the fresh produce supply chain partners such as farmers, traders and retailers;
6. Hypothesis (H6): There is a significant difference in customer response times in fresh produce supply chain entities i.e., farmers, traders and retailers; and
7. Hypothesis (H7): There is difference in level of trust within supply chain partners in fresh produce negotiations.

3.4 Scope of the Study

This research work was conducted in the state of Andhra Pradesh covering three regions namely Costal Andhra, Rayalaseema and Telangana. The study considered the traditional fresh produce distribution system for the measurement of supply chain performance. The included the respondents such as farmers, traders, retailers, transporter and customers and the sample size of respondents are 305, 62, 120, 65 and 200 respectively. The study is confined to distribution side of the agri-supply chain.

The study considered only fresh produce supply chains taking two important commodities grown in Andhra Pradesh i.e., tomato and banana. The data collected AMC markets where all the fresh produce distribution chain stake holders involved in the process of exchange and value creation.

3.5 Chapterisation of Thesis

The research work is presented in eight chapters covering broad areas including introduction, review of literature, fresh produce supply chain practices, fresh produce transportation and perishability, fresh produce supply chain performance, agri-produce supply chain models and observations and recommendations.

The Chapter-I discusses the need for measuring the performance of agri-produce supply chain focusing on fresh produce sector explaining the objectives and hypothesis of the study. It also describes the research methodology which consists of data sources, research instruments used and their reliability. A detail description is given on the sampling method and criteria used for selection of sample along with the sample profile.

The Chapter-II focuses on review of literature which presents findings of the various researchers under the sub-headings: supply chain concept, supply chain flows, coordination and integration, third part logistics, performance measurement, supply chain costs, SCM in agriculture, quality management in fresh produce sector, post-harvest losses and marketing infrastructure.

The Chapter-III chapter discusses the conceptual framework of fresh produce distribution system and supply chain performance measurement. This chapter also gives an overview on storage and transportation of fresh produce and also the various factors effect on fresh produce perishability. This chapter highlights the various parameters that can be used for the agri-supply chain performance measurement.

The Chapter-IV describe the fresh produce supply chain practices being followed at farmers, traders and retailers level focusing on grading, storage, packaging, maintenance of buffer stocks, traceability, use of pesticides etc. This chapter also describes performance measures such as shelf life, product lateness, delay in delivery, customer complaints, customer response time, produce quality etc.

The Chapter-V presents the regression analysis of: i) the factors that contribute to the road transport performance; ii) the factors that contribute to perishability fresh produce. The hypotheses framed for the study are tested using Chi-square and ANOVA techniques and presented in this chapter.

The Chapter-VI evaluates the performance of traditional fresh produce supply chain based on performance measures specially developed for agri-food supply chains includes efficiency, flexibility, responsiveness, product quality and process quality.

The Chapter-VII presents different models of agri produce distribution system in India. This chapter discuses constraints of agri-produce supply chain initially which necessitate for development of alternative models in the sector. In the later sections of this chapter will explain the various modified supply chain models (both ICT and non-ICT) discussed with a view to develop an appropriate model for fresh produce distribution.

The Chapter-VIII summarises the observations of the research under three key headings namely, supply chain practices, statistical inferences and supply chain performance. This is followed by a detailed list of recommendations that evolved from the findings. The different Annexure are presented at the end of the thesis.

4.0 RESEARCH METHODOLOGY

The study is descriptive in nature and relies on survey method. The information on the sample planning, data sources, commodities selected for the study and reliability of instruments are given as follows.

4.1 Data Collection

The study is based on both primary and secondary data. The primary data was collected from the farmers, traders, retailers, consumers and transporters by administering structured questionnaire and also by interviewing the officials of marketing department.

The secondary data on crop area, production and yield has been collected from the reports of Indian Horticulture Database, Directorate of Economics and Statistics, Ministry of Agriculture and FAO statistics. Most of the data is collected from National Horticultural Board for years 2000 to 2009. The data on wholesale prices, price index and market arrivals is obtained from 'Agmarknet' database and publication of the Directorate of Economics and Statistics. Apart from the data on agriculture and horticulture, the supply chain related literature is collected from the journals, online database and other web resources. During the research period, the data is also accessed from the various libraries of agricultural universities, State and Central universities and management institutes.

4.2 Criteria for the selection of fresh produce commodities for the study

It is a known fact that the consumption of bananas and tomatoes is high in India and the crops are grown throughout the year. Andhra Pradesh occupies first and fourth places in vegetable and fruit production respectively of which Banana and Tomato are the prime crops of production (Indian Horticulture Database, 2009). These commodities have highest level of post-harvest losses hence truly represents the family of fresh produce commodities. It is observed that the tomatoes and bananas highly damaged in handling and transporting activities and the total losses are estimated to 25 percent and 22 percent respectively (which are highest) indicating the low shelf life. Since these two commodities are produced and marketed throughout the year, the study can be conducted without any seasonal interruptions.

4.3 Multi-stage sampling

The study followed the Multi-Stage sampling which is a form of cluster sampling. This method is adopted when all the sample elements in all the selected clusters may be prohibitively expensive or not necessary (Durbin, 1967; Kuno, 1976). The technique is also used often when a complete list of all members of the population does not exist and is inappropriate. In the first stage State is selected, secondly the districts, in third stage AMC markets and in the fourth stage the sample respondents are chosen. The selection of sample at the different stages is discussed as follows.

4.4 Reliability of Instruments

For this study five instruments are designed. Initially 59 questions were framed for farmers, traders and retailers instruments. The target sample of 752 respondents including 305 farmers, 62 traders, 120 retailers, 65 transporters and 200 customers were analyzed. It is found that the Chronbach's alpha values of farmers' (0.769), traders'(0.720), retailers'(0.789), transporters(0.760) and customers' (0.655) shown are more significant as the value crosses 0.65 where as minimum acceptable value prescribed is 0.6

5.0 REVIEW OF LITERATURE

Several researchers discussed the supply chain performance in their works and a few are given under.

Caplice and Sheffi (1995) argued that traditional logistics approaches have focused on five types of performance i.e. Asset management, Cost, Customer service, Productivity and Quality.

Kaplan and Norton (1996) have identified four general categories performance measures which comprises of i) financial measures, ii) customer-related measures, iii) internal performance iv) learning.

Simchi Levy et.al (2000) suggested a model to improve supply-chain efficiency and effectiveness based on four criteria: profit, lead-time performance, delivery promptness and waste elimination. Their model analyses the supply-chain performance in two levels i.e. chain level and operational level.

Supply chain council (SCOR) model has 12 performance metrics. They are delivery performance, fill rate, order fulfillment, lead time, perfect order fulfillment, responsiveness, flexibility, total logistic cost, value-added employee productivity, cash to cash cycle time, inventory days of supply, and asset turns.

Sudha et.al (2005) concluded that post harvest losses occur to Tella Chakkera Keli (TCK) banana at various stages in the marketing network based on assessment by physical examination.

Kishore et.al (2006) conducted a study on economic analysis of post-harvest losses in vegetables in Karnataka. The storage loss at different stages added up to about 38 percent of the total loss while farm harvest operations accounted for about 17 percent of the total losses. Transit loss was another important component of post harvest loss contributing to about 25 percent of total loss. The study concluded that the post harvest losses occur due to faulty methods of harvesting, threshing, cleaning, drying, storage, transportation, processing and distribution of agricultural products.

Van der Vorst (2000) and Van der Spiegel (2004) have summarized the following specific aspects of agri-food supply chains: shelf-life constraints, long production throughput time, seasonality in production, conditioned transportation and storage required, storage-buffer capacity restrictions, product safety, physical and product quality features like sensory properties such as taste, odour, appearance, colour, size and image.

Lusine H. Aramyan et.al (2007) proposed the first conceptual framework for measuring performance of the agri-supply chain using financial and non-financial indicators combined with the specific characteristics of agri-food supply chains. Four main categories of performance measures (i.e. efficiency, flexibility, responsiveness, and food quality) have been identified as key performance components of the agri- supply chain performance measurement system.

Sanjay (2010) identified the major constraints in fruits and vegetables are non-availability of quality seeds, inadequate irrigation, lack of soil testing facilities and inadequate extension infrastructure, inefficient pest and decease management, low availability of credit, huge cost of production, lack of marketing information, huge post-harvest losses, lack of infrastructure like roads, cold storage, poor marketing intelligence, high transportation cost. He concluded that there is a strong need of government interventions in removing infrastructural constraints like setting up distribution centres, cold chains, roads to the markets.

6.0 DATA ANALYSIS

The study uses the regression analysis to identify the factors contributing to transport performance and the factors contributing to perishability of fresh produce. The study also presented several chi-square and ANOVA tests to substantiate the hypothesis framed for the study. The following are the indicative and precise description of analytical study conducted in this research.

6.1 Causal Study on Transport Performance

Transportation in a logistics system is usually an intermediary that facilitates the physical flows of goods from a point of origin (i.e., shipper) to a point of destination (i.e., consignee). Firms in transport logistics perform the physical distribution function to move goods from one place to another (Coyle et al., 1996). The Transport performance is a measure to evaluate the efficiency and effectiveness of service to meet the goals of all parties, i.e., shipper, service provider and consignee (Kleinsorge et al., 1991).

The dimensions of transport performance are service effectiveness (for shippers and consignees), and operational efficiency (for transport service providers). From these dimension of transport performance various attributes are identified to study the performance of road transport operation in the fresh produce supply chain. The independent variables have been cross checked with truck operators, farmers, traders and retailers to identify those variable that are important in their day to day transport operations. Transport Performance (y) is the major dependent variable which is influenced by the nine independent variables (x1 to x9) where x1 to x9 include Capacity of vehicle (Capacity), Loss or Damage during transit (Damage), Frequency of services (Frequency), Time taken to load and unload (Load_Unload), Information sharing (Information) , Reliability of delivery (Reliability), Availability special equipment (Equipment), Skills of drivers (Skills) and Condition of vehicle (Equipment).

In regression with multiple independent variables, the coefficient tells how much the dependent variable is expected to increase when that independent variable increases by one, holding all the other independent variables constant. The study includes the list all the coefficients of variables which indicate Reliability of delivery (Reliability), Information sharing (Information), Time to load and unload (Load_Unload) and Capacity of vehicle (Capacity) observed to be statistically significant.

The other independent variables such as Loss or damage during transit (Damage) and Time to load and unload (Load-unload) are having negative regression coefficients. The performance of the transport (Trans_performance) is high when the Loss or Damage during transit (Damage), Time to load and unload (Load-unload) is less in fresh produce transportation. The rest of the independent variables are having insignificant effect on the transport performance as the P-value is higher than 0.05.

6.2 Causal Study on Perishability

Fresh fruits and vegetable crops grown in the Andhra Pradesh offer the consumer a full assortment of commodities depending on the season. Most fresh produce crops are highly perishable and still alive after the harvest as they contain water and food materials which are essential for extend the shelf life. The fresh produce must reach the consumer in the right condition and marketed with an appropriate packaging and handling methods. If the any of supply chain firm fails to address these issues possibly lead to spoilage and losses. Hence the present study made an effort to identify the variable that causes the perishability of fresh produce using Regression model.

Perishability (y): Perishable products worse in quality over time, and become lesser in value. The common perishable goods include Fruits and vegetables, Dairy and Aquatic products which are examples of time and temperature-sensitive perishable products that can spoil easily.

Independent variables (x_1 to x_9): Perishability of the fresh produce will be influenced by many factors which fall under technical and non-technical categories. The technical category variables are concerned with the science of horticulture dealing with seeding/planting of fresh produce crop to the post-harvest management whereas, non-technical factors deal with marketing and logistics of fresh produce. In this study the independent variables which are highly contributing to the perishability (combination of technical and non-technical variables) are considered.

The independent variables (X1 to X9) include damaged during the harvest by the farm men (PR_farm_men), road conditions causes the physical damage to the fresh produce (PR_physical_damage), Lack of effective packaging (PR_lack_packaging), Living organism like Bacteria, Fungus, insects (PR_living_organism), Non-removal of foreign bodies causes perishability (PR_foreign_bodies), Lack of plastic crates during the transportation (PR_plastic_crates), Lack of cleaning and Washing (PR_washing), Lack of enough care while the loading and loading (PR_care_load_unload) and Lack of effective care during road transport (PR_packing_perishability).

The R-square of the regression model is the fraction of the variation in the dependent variable that is accounted for (or predicted by) independent variables. The model summary and coefficient of multiple determinations (R) have been studied and the variation in the dependent variable is explained by 65.9 percent through quadratic relationship with the predictor which appears to be significant for making predictions and coefficients.

It is clear that Road conditions causes the physical damage to the fresh produce (PR_physical_damage), Non-removal of foreign bodies causes perishability (PR_foreign_bodies), Lack of enough care while loading and loading (PR_care_load_unload) and Lack of effective care during road transport (PR_packing_perishability) are showing insignificant effect on the perishability of the fresh produce as their probability value are higher than the acceptable limit of 0.05. It is found the impact of the Damage during the harvest by the farm men (PR_farm_men), Lack of effective packaging (PR_lack_packaging), Living organism like Bacteria, Fungus, insects etc. (PR_living_organism), and Lack of plastic crates during the transportation (PR_plastic_crates), Lack of cleaning and Washing (PR_washing) variables have probability values of .001, .008, .001, .000 and .010 respectively.

6.3 Test of Hypotheses - Chi-Square & ANOVA

Chi-square test is performed to substantiate the research hypotheses (H1 to H3) framed for this study for which the level of significance is fixed at 5 percent (i.e. $\alpha = 0.05$). The tests are carried out using statistical software tool i.e., SPSS 17.

Analysis of Variance (ANOVA) test is conducted to test the hypothesis (H4-H7) framed for the study for which the level of significance is fixed at 5 percent (i.e. $\alpha = 0.05$). The tests are carried out using statistical software tool i.e., SPSS 17. The study on the hypothesis from H4 to H7 with their respective probability value, calculated value and their significance at 5 percent i.e. $\alpha = 0.05$.

7.0 PERFORMANCE OF FRESH PRODUCE SUPPLY CHAIN

The study has common set of indicators to evaluate the complete supply chain identified as key performance indicators. Efficiency measures how efficiently the resources are utilised (Lai et al., 2002). It includes several measures such as production costs, profit, return on investment and inventory. Flexibility indicates the degree to which the supply chain can respond to a changing environment and extraordinary customer service requests (Bowersox and Closs, 1996; Beamon, 1998). It may include customer satisfaction, volume flexibility, delivery flexibility, reduction in the number of backorders and lost sales.

Responsiveness aims at providing the requested products with a short lead-time (Persson and Olhager, 2002). It may include fill rate, product lateness, customer response time, lead-time, shipping errors, and customer complaints. The specific characteristics of agri-food supply chains are captured in the measurement framework in the category "food quality". Food quality is divided into product and process quality. Product quality consists of product safety and health, sensory properties and shelf-life; and product reliability and convenience. Process quality is divided into production system characteristics, environmental aspects and marketing.

The following Table 1 indicates the performance scores of fresh produce supply chain on Likert's five point rating scale. The higher score close to 5 indicates the performance of the indicator is favorable and score close to 1 specify the poor performance of the indicator.

Table 1: Performance of supply chain measures in fresh produce distribution chain

		MEAN SCORES OF SC PARTNERS				INDICATOR	
Category	Indicator	Farmers(X)	Traders(Y)	Retailers(Z)	Transporters (T)	Mean(I)	Std Deviation (D)
Efficiency	Production Costs	3.633	4.080	3.567	3.900	3.795	1.074
	Transaction Costs	3.649	2.290	2.192	3.985	3.029	0.955
	Transportation Costs	2.954	3.629	2.108	NA	2.897	0.814

	Profit	2.239	2.984	3.175	3.745	3.036	0.924
	Return on Investment	4.600	4.338	3.650	2.345	3.733	1.044
	Mean of Indicators (CE)	3.415	3.464	2.938	3.494	**3.328***	
Flexibility	Customer Satisfaction	2.921	2.935	3.483	3.283	3.156	1.082
	Volume Flexibility	2.345	2.698	4.351	2.480	2.969	0.901
	Delivery Flexibility	2.198	2.752	3.674	3.290	2.979	0.987
	Mean of Indicators (CF)	2.488	2.795	3.836	3.018	**3.034***	
Responsiveness	Order Fill Rate	2.954	2.645	3.342	4.390	3.333	1.021
	Customer Response Time	2.807	2.839	3.108	3.984	3.185	1.046
	Customer Complaints	2.921	2.935	3.042	3.645	3.136	1.022
	Lead time	2.957	2.790	3.158	3.490	3.099	1.008
	Shipping Errors	2.597	2.565	3.442	2.392	2.749	1.077
	Mean of Indicators (CR)	2.847	2.755	3.218	3.580	**3.100***	
Product Quality	Appearance	4.475	3.905	3.125	NA	3.835	1.007
	Taste	3.695	3.726	3.267	NA	3.229	1.045
	Shelf Life	4.357	3.726	3.292	NA	3.792	1.077
	Salubrity/Nutrition	3.492	3.855	3.083	NA	3.477	1.080
	Product Safety	3.439	3.903	3.175	NA	3.506	0.703
	Mean of Indicators (CP)	3.892	3.813	3.188	NA	**3.564***	
Process Quality	Traceability	2.948	2.123	2.765	NA	2.612	0.977
	Storage & Transport Condition	2.767	2.794	3.193	NA	2.918	0.977
	Pesticide/ Chemical use	2.423	3.125	4.093	NA	3.213	1.108
	Promotion	1.234	3.239	2.456	NA	2.309	0.894
Mean of Indicators(CQ)		2.343	2.820	3.126	NA	**2.763***	
OVERALL SC PERFORMANCE		2.997	3.129	3.261	3.363	**3.158***	

Note: * Scores may not tally due to rounding the numbers to nearest third unit from the decimal and fractions after the third unit is not shown but considered for calculation of scores.
NA- indicates that the given indicator is not measures for that particular supply chain entity.

7.1 PERFORMANCE OF KEY INDICATORS IN FRESH PRODUCE SUPPLY CHAIN

The overall score of fresh produce supply chain calculation as 3.158 and the score represent the all the entities of the supply chain and which include all indicators of the performance measurement. The indicators considered are as follows order Efficiency (3.328), Flexibility (3.034), Responsiveness (3.10), Product Quality (3.564) and Process Quality (2.763). The scores indicates that the performance of process quality is poor and also lower than overall score of the fresh produce supply chain performance. This can be attributed to poor performance of indicators such as traceability (2.612), storage and transport conditions

(2.918) and promotion (2.309). The responsiveness and flexibility indicators almost functioning with the similar pace but still there is a much scope for the improvement because the total supply chain performance is lies within these two indicators.

The product quality indicator is performing moderately good when compare to the rest of the key performance indicators. The product quality’s indicators such as Appearance, Shelf life and product safety are performing moderately high where as the other indicators in the same KPI is need to improve their performance by using appropriate post-harvest measures. The efficiency indicators also performing moderately but the indicators transportation costs (2.897) and transaction costs (3.029) show lower performance and which need to be addressed.

On the whole, the score of fresh produce supply chain performance is 3.158. It indicates the performance is said to be moderate. The following indicators scores that contribute positively to the score are Production costs (3.795), Return on investment (3.733), Appearance/freshness (3.835), Shelf life (3.792), Food safety (3.506), Salubrity (3.477) and Order fill rate (3.333).

Whereas the indicators that have contributed low to the supply chain performance are transportation cost (2.897), Volume flexibility (2.969), Delivery flexibility (2.979), Shipping errors (2.749), traceability (2.612), storage and transport condition (2.918) and Promotion of fresh produce (2.309) and these indicators are needed to be take-up for the improvement. The rest of the variables have moderate effect on the supply chain performance however, these need to be improved further enhancement of the score. The overall fresh produce supply chain performance score at farmers, traders, retailers and transporters level are 2.997, 3.129, 3.261, and 3.363 respectively. These scores indicates there is no much difference among the entities and performance is seems to moderate and more or less similar.

In coming sections, a complete performance analysis will be discussed key indicators-wise (KPI). The each KPI is analysed sub-indicator-wise and supply chain entity-wise. The analysis gives a true image of entire supply chain performance in fresh produce distribution system of Andhra Pradesh.

7.2 Performance of Efficiency Indicators

All measures of efficiency indicators such as production cost, transaction cost, transportation cost, profit and return on investment was considered and it was found that the performance is efficient at the farmers’ level with high transportation costs and moderate profits. At the traders level though the production cost, transaction cost and transportation costs are low, the profits and return on investment, seems to be much lower than mean scores. Though the production cost, transaction cost and transportation costs are moderate, the profits and return on investment seems to be much lower than the mean with low profit margins at the retailer's level. The efficiency at the transporters level is high and has the highest return on investment.

The production costs are higher at the farmers' level and retailers' level when compared to the traders and transporters level i.e. the cost of production is lowest at the traders' level followed by transporters level, farmers' level and retailers' level. The transaction cost is lowest at the farmers followed by traders, retailers and transporters in order of increasing transaction costs across the supply chain partners. The transportation cost is the highest at the transporters level and lowest at the traders' level, moderate at the retailers' level and slightly high at the farmers' level.

The decreasing order of profits gained in the supply chain shows that the transporters are in the lead, followed by traders and retailers. This can be attributed to the fact that the margins at the retailers are low (despite high price of produce), due to wastage and distribution loss. The traders and retailers are almost at the same level when considering the return on investment and repaid within two to four years across the supply chain.

7.3 Performance of flexibility indicators

The study showed that performance of flexibility and the volume flexibility are low at the farmers' level due to lack of grading and lack of opportunity for trading in small quantity by the farmer. At the traders' level, customer satisfaction can be enhanced by increasing the volume flexibility and delivery flexibility. The performance of flexibility indicators at the retailer level is reasonably good.

The customer satisfaction needs improvement at the farmer's and trader's level and the same can be sustained at the retailers' level. The customer satisfaction at transporters level can be improved by effective delivery of the services at the right time and careful handling of produce to minimize the wastage. Since the end user is not in direct contact with the farmer and trader the aspect of volume flexibility is found to be minimal. The volume flexibility is highest at the retailers' level where the produce is sold in varied quantities as per customer requirement and ease of retailing.

Delivery flexibility does not apply to the farmers and transporters because the farmers are bound to sell the produce in AMCs during the working hours only. In case of transporters they are required to deliver the produce as per their customers' specifications leaving no scope for flexibility.

7.4 Performance of Responsiveness Indicators

The responsiveness requires improvement across the indicators considered at the farmers' level, with focus on customer response time and shipping errors. Traders are left with less time to attend to customer complaints leading to lowered responsiveness. There is need for extensive focus on these indicators at the traders' level to improve the performance. The retailer receives complaints mostly on quality aspects, availability of the produce and rising prices. It takes approximately one day to deliver the produce and this can be reduced using appropriate communication systems. The performance on responsiveness at the transporters level is said to be reasonable.

Transporters are performing well as they are able to meet the service requirements of the customer in time. The retailers show a reasonably fair performance while the traders and farmers have a lower performance on customer response time, because farmers have minimal choice to respond. The order fill rate can be improved at the farmer and trader levels of the supply chain. The complaints are on quality issues which may be attributed to the bargaining for better price across the supply chain. The lead times can be considerably reduced by efficient transportation. Shipping errors are high among traders followed by farmers and retailers. The shipping errors can be avoided by proper grading, sorting, and careful handling of produce across the supply chain.

7.5 Performance of Product Quality Indicators

The product quality indicators at the farmer level are in the moderate range. There is scope for improvement in the quality parameters across the indicators, and special focus should be made on shelf life. The overall performance of product quality is low and needs improvement across indicators at the traders' level and moderate at the retailers' level. The appearance across the supply chain is moderate and there is scope for better performance.

The shelf life varies among the partners of the supply chain and there is need for improvement of shelf life for better quality of produce. The overall salubrity is moderate across the supply chain with room for better performance. There is variation in product safety across the supply chain and there is need for improvement of product safety at all levels, especially at the traders' level.

7.6 Performance of Process Quality Indicators

The study found that performance of process quality indicators at farmers' level needs to be further improved. There is scope for improvement on traceability, storage and transport condition, while the use of pesticide and chemical use needs to be further reduced. At the traders' level there is need to reduce the use of pesticides and chemicals and improve storage and transport conditions for better performance as this is not applicable for retailers. Traceability across the supply chain is low and need to be improved to a great extent. The storage and transport conditions needs improvement at all levels in the supply chain. The use of pesticides and chemical is high at the traders' level and needs to be reduced drastically. The use of chemicals and pesticides need to be used appropriately at the farmers' level.

8.0 OBSERVATIONS AND FINDINGS

Grading: The findings of the study revealed that fresh produce is transported for sale even before grading, immediately after harvest from the farmers' level to the traders' level in the supply chain. Grading determines the prices of produce at the trader's level. But, the farmer is compelled to trade his produce due to various genuine reasons. Some of the reasons for trading of produce without grading may be attributed to the following:

- Post-harvest technology is unknown to the farmer coupled with lack of proper mechanisms to transfer such technology.
- Farmers exchange their produce for money at the earliest because of their commitments to repay loans or short term credit availed for cultivation activities.
- Besides fresh produce is prone to early ripening which shortens the shelf life and can lead to heavy losses.

Cleaning and washing: It was observed that cleaning and washing are seldom carried out at the farmers' level before sale of produce to the next level in the supply chain due to the belief that washing will hasten the ripening process. The retailers' undertake cleaning activities limited to freeing of dust and plant debris without any kind of chemical treatment. The prime reason for washing was to give a fresher appearance in order to gain customer attention.

Cold logistics: The study showed that cold chain facilities and related logistics for storage are not being used by the supply chain partners for fresh produce. Cold storage facilities are available at a minimal level but not used for tomato and banana. However, in the case of chilly, tamarind and other vegetables storage facilities are being used at the field level.

The organised retailers are equipped with very few facilities for storage and movement of fresh produce in cold logistic containers.

Traceability: The study on the cultivation methods and information management across supply chain shows that the use of pesticides, fertilisers and post-harvest management information are not being shared with the next supply chain partner. Information on source of procurement, date of harvest, instruments used in cultivation, residue level, etc. are not at all furnished to the customer by any of the supply chain partners namely the farmer, trader and retailer.

Buffer stocks: The study revealed that a limited number of farmers hold buffer stock for a day or two in order to realise better prices because of the short shelf life of fresh produce leading to increased losses. Besides there is lack of adequate and appropriate storage facilities to maintain buffer stocks. However, retailers hold buffer stocks for a relatively longer duration that is 2 to 5 days for obtaining a better price.

Transportation: Auto rickshaws and two wheelers form the major means of transportation of fresh produce from the fields to the market because of reliability and cost effectiveness. In larger AMC markets – the transport modes like trucks, lorries, tractors, auto-rickshaws are locally and easily available.

Damage during transit: The study revealed that, in majority of cases the fresh produce is damaged during transit as a result of long waiting time for loading and unloading. Fresh produce is damaged due to poor road conditions in rural areas, traffic jams in cities, long distances, adverse temperatures, which acts as contributing factors towards perishability during transit. However, there is a general satisfaction with the services offered by the transport operators.

Fill rate: The study on fill rate at each level clearly indicates that there is 90 percent fulfilment of the basic demands at each level of the supply chain and leaving a scope for reducing the unfulfilled demand about 10 percent. Majority of the retailers are able to supply the fresh produce within 12 to 24 hours. But, better coordination and information sharing can result in reducing the demand fulfilment time. The reasons for delays more than a day are due to harvesting delays, transport delays, weather conditions and market work hours that are fixed.

Delays in delivery: The study found that a huge time gap between promised time and the actual time of delivery which is the delay in delivery time, an important determinant of the quality of supply chain and the extent of delay between the supply chain partners. Lack of coordination exists in the entire supply chain but sufficient levels of coordination exist between immediate supply chain partners. There is need to reduce the delay in delivery time of fresh produce at the respective supply chain partner levels. The lost demand is one of the adverse effects of delay in delivery time of fresh produce. This can be addressed by establishing coordination and communication with transport operators and supply chain partners.

Price realization: The study revealed that the fresh produce prices are highly volatile and are determined by the demand and supply forces. Prices are usually stabilised during the full harvest season and rise when the crop reaches end season. Prices are established by an auction system. When the supply of produce is high, the prices generally are determined by the agent itself. The role of farmers in fixing prices is very limited. Thus, the price of fresh produce is realised in different ways.

The farmers are well aware that the prices in their markets do not compare to other markets. There is no information mechanism that is provided by the government on surrounding markets to compare the prices. As of now, cordial relationships are maintained between individual partners in the supply chain, especially immediate entities, thus, enabling them to share information on prices of produce in different markets.

Information on on-going prices: The study also explored the knowledge sources for ongoing prices of fresh produce. On a regular basis newspapers are a common media that provides information on prices. The study revealed that a majority of the respondents are not having any information about the prices in surrounding markets. The farmers dispose off their produce for a lesser price due to emergency situations that force them to exchange their produce for money. The reasons for emergency are mostly immediate household needs or timely preparation for the next crop or in majority of cases due to short term credit/loan repayment commitments. This also indicates that the farmer depends solely on the sale of produce to meet his day to day expenditures.

Lost sales: The study observed that at the traders' level, the stocks are handled appropriately to meet the customer demand and refilled within 24 hours. The 'Lost sales' are not applicable to farmers but is an important quality indicator for traders and retailers in a supply chain. The percentage of lost sales is significantly high among traders and retailers. The stake is higher for retailers when compared with traders on lost sales in supply chain of fresh produce.

Relationships with organised retailers: The study observed that the organised retail firms approach a limited number of farmers who can meet the demand of their nearest retail shops. The retail farms like Reliance Fresh and Heritage have contact with farmers. 44.9 percent of the farmers have contacts with retailers, but the actual agreement for procurement is limited to a very small number. The advantage derived by a retail company out of this kind of arrangement is freshness of produce, stable prices, low market taxes and perfect weight measurement. It is observed that un-organised format of supply chain has more potential in distribution of produce rather than organised sector. This situation is due to lower expansion rate of organised retailing and their inability to work in rural areas due to high operating cost.

Procurement of vital inputs: The study also observed that in fresh produce supply chain, the procurement of vital inputs like seeds, fertilisers and pesticides play a vital role. When the input cost is more it results in higher cost to the customer. The dealers charge much above the mark-up price that is determined by the government. They also reported that the formal co-operative set-up failed to function when there is a huge need for agricultural inputs. The private dealers, who are into agri- input trading, take maximum advantage out of the scarcity situation that prevails in the market. The farmers report that most of the dealers, sell their inputs on credit, hence, the farmer cannot raise any objection to the higher price charged by dealers. This situation is a result of minimum or negligible working capital that the farmers usually possess. On the whole every farmer is finding difficulty in procuring desired agri inputs.

Consolidation agents: Consolidation agents collect a fixed amount from farmers or traders and work more or less as a trader but they will not have trader registration with AMC. The traders whose level of business is very high generally prefer to take the assistance of consolidation agents.

Packaging: Packaging plays a key role in protecting the produce from adverse environment and unhygienic conditions that can damage the produce. About 75.5 percent of traders reported that packaging facilities are available in rural AMC and spot markets. These facilities are made available to farmers and consolidated agents by traders alone, for which the farmer pays a nominal charge. Thus, the packaging facilities are not available uniformly in all the AMC markets. It is observed that most of the AMC markets are lacking in infrastructures like auction platforms, road transportation and lighting facilities. Also, the traders store the produce in a safe place for few hours/day before the produce is sold to the retailer.

Procurement of stocks by retailers: Retailers procure their fresh produce from different sources depending on the distance and quantity. Retailers find more varieties in AMC markets and they buy in bulk quantities due to which the price options available are widened. These merchants buy bulk quantities from traders and sell their produce to retailers. Usually retailers get fresh qualitative produce at an affordable price. Sometimes the retailers crowd the market and are seen waiting for their turns in long queues to weighing their fresh produce and for counting cash. The longer waiting time at the counter creates inconveniences to the customers.

9.0 A PROPOSED ALTERNATIVE MODEL – I.C.T. ENABLED SUPPLY CHAIN FOR FRESH PRODUCE DISTRIBUTION SYSTEM

Advantages of the proposed fresh produce distribution model across supply chain are as follows:

1. Information flow is two way and the linkages are strengthened across supply chain. Effective communication networks can result in high profits across supply chain and will transform the existing traditional un-organised market to a highly dynamic and systematised marketing of fresh produce.
2. To project the supply of fresh produce the supply is aggregated at State level, is possible as every farmer provides the details of crop growing and land holding. This will enable the decision makers to allow the surplus produce to export to other States in order to bring equilibrium in the market.
3. This model is built on the platform of traditional system. The model creates virtual market in which all the market stakeholders can freely exchange the information and break barrier that prevails such as price manipulation, cartelisation, loss of produce, higher transport costs in the traditional system. Prices are comparable with traditional AMC system.
4. The bottom line of the model is that it enables the traders, retailers, processors and farmers to interact with one another and realise price by negotiations over any means of telecommunication system. Farmers get higher price for their produce which is fair and is equal or more than the market value.
5. This model will avoid order delivery times and reduce time wastages by eliminating un-necessary transportation and handling in multiple markets to facilitate exchange process.

6. The farmers who are growing same crop can be formed into a cluster or an association at village, mandal and district level for every season. Product clusters are found at mandal level or at district level that can negotiate with direct customer include processors, exporters and bulk users. For this the necessary data on farmers is provided by the proposed agri-distribution model. Farmers who are like-minded can meet periodically for cross learning. The product cluster can acquire their common amenities or infrastructures for value addition to the produce.
7. The product clusters may have similar type of plant input to grow. Hence they can negotiate directly with agri-input dealers, firms and companies for fair price as they purchase in bulk quantity. Government schemes also explored due to unity.
8. Agri marketing taxes are collected at village level from the customer. Policy makers can standardise the quality of produce.

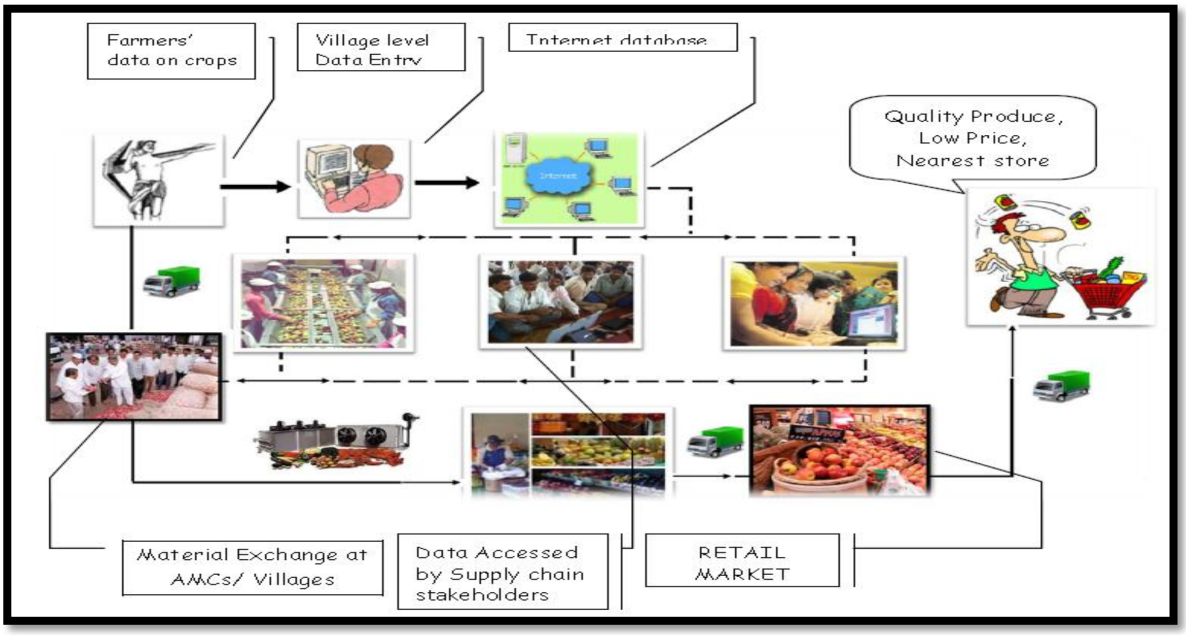

Figure 1: Diagram indicating process flow of proposed fresh produce distribution system.

The proposed model is a conceptual model that need to be pilot tested in a selected Mandal and the lessons learned may be used to replicate the same to wider area network coverage. Thus, it can be concluded that there is scope for high profits, provided certain modifications are made in the traditional system. To harvest the benefits, careful planning is essential that ensures reduced loss of time, at various stages in the supply chain. The solution to the existing problems in the supply chain of fresh produce should include a facility or platform that will enable the supply chain partners to make informed decisions. This will enable the process of improving the quality of service delivered and enable better prices at all levels, especially fulfilling the dreams of every farmer.

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