

# Supply Chain Efficiency: An Insight from Fruits and Vegetables Sector in India

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**ABSTRACT:** The purpose of this paper is to present the status of Supply chain efficiency in Fruits & Vegetables (F&V) sector in India and discusses the need and importance of efficient supply chain in this sector. Authors highlight the inefficiency of Fruits and Vegetables supply chain sector as one of the major business problem in the agriculture sector of India. This study will help decision makers and various stakeholders involved in the supply chain of Fruits and Vegetables like Farmers, Transporters, Local traders, Commission Agents, Cold storage provider to understand the current status, issues & need and importance of efficient supply chain for better planning and management in the field of Fruits and Vegetables sector.

Most of the prior literature are focused on the general supply chain of Fruits and Vegetables and ignore the perspective of supply chain efficiency. This review fills this gap in the literature of supply chain management of Fruits and Vegetables sector.

**Keywords:** *Agribusiness, Supply Chain Efficiency, Logistics, Fruits and Vegetables, Post-harvest losses.*

1. INTRODUCTION

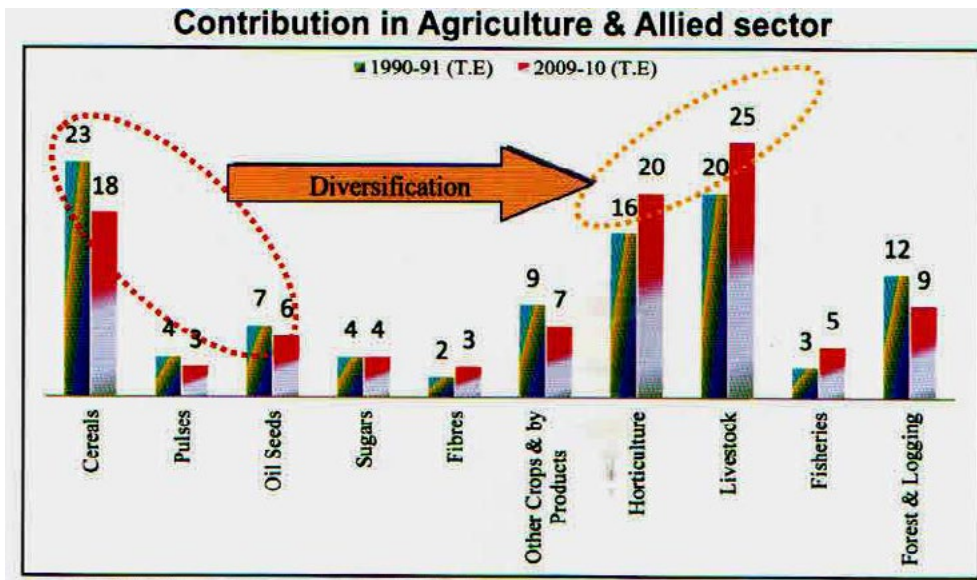
India is known as fruit and vegetable basket of the world. It is the second largest producer of overall fruits and vegetables production in the world, after China and one of the centers of origin of fruits and vegetables with the total production of 81.285 million metric tonnes of fruits and 162.187 million tonnes of vegetables till the year end 2013 (NHB, 2013). It has the potential to be the world’s largest food producer which is bestowed with one of the best natural resources in the world and several factors like Increasing urbanization, nuclear families, working women, disposable income and changing lifestyles are gearing up the Indian food supply chains for a better future. Organized retail and Private label penetration, demand for functional food, and increased spend on health food are major drivers for the growth of this sector (Viswanadham, 2007). As the population is increasing, the demand for such food is also increasing. To meet such demand and provide a food in proper quality and nutrition, Supply chain plays a very vital role in this sector and becomes even more important because of perishability and very short shelf life.

1.1 Significance of Fruits & Vegetables Sector

The Agriculture sector in India has undergone significant structural changes in the form of decrease in share of GDP from 30 percent in 1990-91 to 13.7 percent in 2013 indicating a shift from the traditional agrarian economy towards a service dominated one, but more than half of the total workforce (about 52 %) is still employed by the agriculture, and despite a steady decline of its share in the GDP, is still the largest economic sector and a significant piece of the overall socio-economic development of India (ASSOCHAM, 2013).

Structural change in the composition of agriculture and allied sector leading to a diversification of Indian agriculture sector into the horticulture, livestock and fisheries sector. The share of Horticulture in total output from the agriculture and allied sector has increased from 16 percent to 20 percent during the period of 1990-91 to 2009-10 as shown in Figure 1. The traditional crop likes cereals, Pulses and Oil Seeds share have been declined in the same period.

Figure 1. Contribution of different agriculture segments in Agriculture & Allied Sector



Source: ASSOCHAM Report

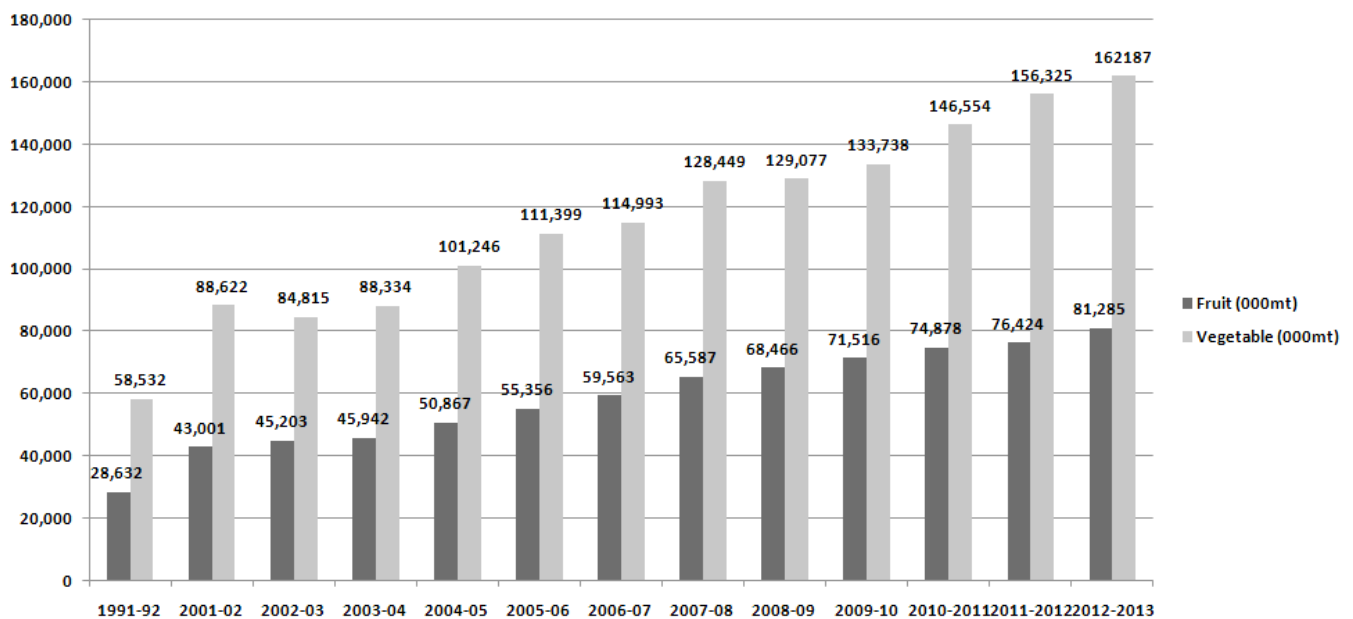
Government data shows that the consumption of wheat and rice has been declining around 1-2 percent in both urban and rural India, while the demand for fruits and vegetables has been rising by 2-3 percent annually (IFMR, 2012). The horticulture sector has been a driving force in stimulating a healthy growth trend in Indian agriculture. The increased shares of horticulture in the agriculture & allied implies that they have been growing at a much faster rate than the traditional crop sector. Given the rising share of high value commodities in the total value of agricultural output and their growth potential, this segment is likely to drive agricultural growth in the years to come. It plays a unique role in India's economy by improving the income of the rural people. Cultivation of these crops is labor intensive and as such they generate lot of employment opportunities for the rural population. Thus, cultivation of horticultural crops plays a vital role in the prosperity of a nation and is directly linked with the health and happiness of the people.

## 1.2 Trends in Fruits and Vegetables Production & Present Status

During 2012-13, India's contribution in the world production of F&V was 12.6 % and 14 % respectively. India is the second largest food producer in the world, after China and one of the centers of origin of F&V with the total production of 81.28 million metric tonnes of fruits and 162.87 million metric tonnes of vegetables till the year end 2013. India is the largest producer of many F&V with share in world production till the year end 2013 as follows: 44.1% of Mango & Guava, 25.6% of Banana, 42.6% of Papaya, 72.9% of okra (NHB, 2013).

The production of F&V in India has been shown in **Figure 2** from the year 1991-2013 which has increased from 28.63 million metric tonnes to 81.28 million metric tonnes in fruits and 58.53 million metric tonnes to 162.18 million metric tonnes in vegetables from the year 1991-2013.

**Figure 2. Fruits and Vegetables Production in India**



Source: Indian Horticulture Database, NHB, 2013

With growing population and food accounting for a major share of the total private consumer expenditure, F&V sector has a high potential for growth. India's share in the global market is still nearly only 1% (APEDA, 2014) and the processing levels in F&V sectors at around 2 % only (Dharni & Sharma, 2008; Viswanadham, 2007; Rathore *et al.*, 2010) where it is 65%, 78%, and 23% in case of other countries like USA, Philippines, and China.

## 2. SUPPLY CHAIN: CONCEPTS

Supply chain is the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hand of the ultimate customer (Christopher, 1998). In other words, a supply chain consists of multiple parties/firms, both upstream (i.e., supply) and downstream (i.e., distribution), and the final consumer. It is the planning and control of the flow of total material from suppliers to manufacturers to distributors and finally to the end users (Jones & Riley, 1985). Ballou (2004) says that Supply chain refers to all those activities associated with the transformation and flow of goods and services, including their attendant information flows, from the sources of raw materials to end users. According to Simchi-Levi *et al.* (2008) Supply chain management (SCM) may be defined as a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system-wide costs while satisfying service level requirements. It involves many independent organizations and develops through intra- and inter-organizational integration and coordination encompassing the initial stage to the end user. It includes a two-way flow of materials, services and information, and the related managerial and operational tasks. It aims at providing high value to customers with appropriate resource utilization, and building competitive advantage (Cooper *et al.*, 1997). The key elements involved in a Supply chain are customer value, competitive advantage and integration and coordination.

Customer needs can be met efficiently with Efficient Customer Response (ECR) which is based on efficient assortment, replenishment, promotions and new product development. These all are dependent upon the range of products, its pricing, and management of space in the retail outlet.

Competitive advantages to any firms come through enhancement of productivity and value. Advantage of productivity accrues by achieving the better results with minimum resource utilization compare to others. Value emanates by providing customized products or services, reliability and responsiveness, which require innovation and resources (Christopher, 1998).

Integration and Coordination comes through partnership in the supply chain which requires healthy interactions among the partners over time, with sharing of information, risks and rewards (Ellram & Krause, 1994).

## 3. SUPPLY CHAIN IN FRUITS & VEGETABLES (F&V) SECTOR

Over the years, the definitions have changed and broadened the scope of SCM, but, these definitions are still limited to manufactured products and services with little attention being paid to agriculture. F&V constitutes a major part of the world economy and is the raw material for many industries. Among the agricultural produce, perishable food produce like F&V have got the least attention. The SCM of F&V constitutes the processes from production to delivery of the agro-fresh produce, i.e. from the farmer to the customer. SCM of F&V is complex as compared to other SCMs due to the perishable nature of the produce, high fluctuations in demand and prices, increasing consumer concerns for food safety & quality (Vorst & Beulens, 2002), and dependence on climate conditions (Salin, 1998).

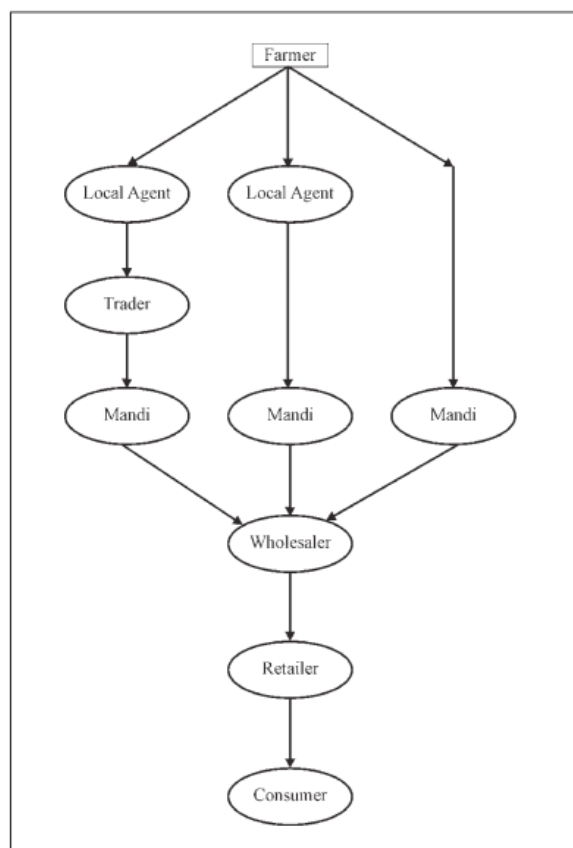
The existing supply chain in F&V sector involves many intermediaries (**Figure 3**) who eat up all the share of about 75 percent of the total net margin accruing to the entire supply chain (Modi *et al.*, 2009). From a farm gate to a consumer, a horticulture product passed through six-seven different distribution channels (Viswanadham, 2007). F&V produced in the farmer's field reaches the end consumer through a chain of intermediaries. These intermediaries carry out various functions, such as transfer of ownership of commodities, its movement, maintenance and preservation of quantity & quality, payment to the seller and commodity delivery to the buyer (Halder & Pati, 2011).

The commission agents and local traders perform the function of aggregators. On behalf of big traders they procure the fresh produce from the small

growers. Some big farmers used to sell their produce directly to the local Mandis (market place). Mandi (market) system has number of inefficiencies like non-transparent price setting where seller and buyer are often cheated, high losses due to non-scientific handling and storage. There exists inadequate infra-structural support leading to high losses, as high as 40 percent in case of fruits and vegetables. Usually,

farmers prefer to sell their produce to local agents or trader rather than selling directly in Mandi. Sidhu *et al.* (2010) in his study found that more than 90 percent of the produce dispose through commission agents/wholesalers and a small proportion sell through retailers and directly to consumers. All the links from farmers to end user of the commodity constitute supply chain of the F&V sector in India.

**Figure 3. Supply Chain for Fruits &Vegetables sector in India**



Source: Modi, P et al, 2009

The F&V sector supply chain consists of various players. Logistics acts as a thread which connects the different players and components of the supply chain. These aspects are discussed below:

### 3.1 Players in the Supply Chain of F&V Sector in India

There are several players involved in fulfilling the needs of the consumer in the supply chain management of F&V. Those are farmers, local traders, agents

(commission agents), transporter, auctioneers, wholesalers, processors, traditional retailer of all type of formats family run 'mom and pop' stores, roadside shops, pavement shops and cart vendors apart from farmers and customers. Farmers are the cultivators of produce and source of supply. They are small by land holding and yield volume of crop and are highly fragmented across geographical areas. Agents, auctioneers, and wholesalers are traders in this supply chain.

Agent and auctioneers are first level of middlemen in this supply chain and transfer commodity from

producers to wholesalers. Numbers of transfers of ownership as well as transshipments of fruits & vegetable depend upon the number of agents present in between farmers and wholesalers. An agent operates from shops of small space, works for one or more wholesalers and normally deals with a particular range of fruits & vegetables. The traditional retailers buy vegetables from wholesalers and sell directly to customers. The families-run ‘mom and pop’ type stores sell staple products including vegetables.

Farmers may sell the produce directly to the consumers or to traders or manufacturers, without or after storage of the fresh produce; cold storage units; food processing entities; packaging units; wholesalers or distributors; retail chains or other form of retailers; hotels, restaurants, caterers; and consumers. The consumers may get the fresh produce from the farmers directly or through a combination of the different players in the supply chain.

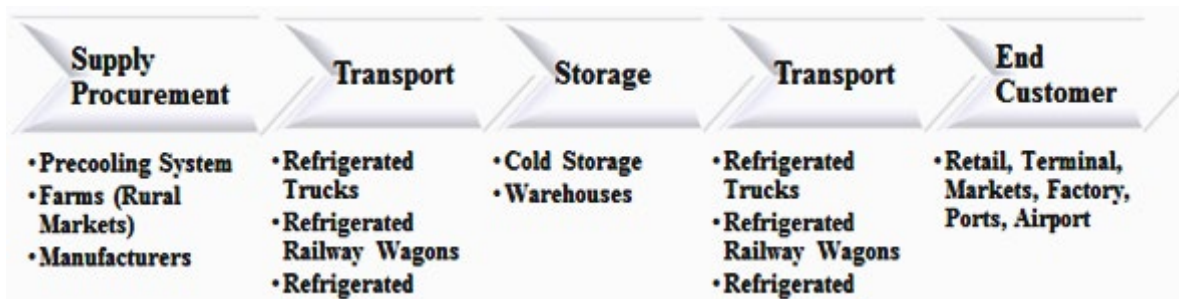
The supply chain may pass through all the stages referred above or only through some of them. Some farmers may sell their produce on the farm itself to the intermediaries. Some may sell to the trader through local commission agent. Some big farmers with large land size holding may sell directly to the mandi. Some may keep a small part of the produce for consumption and sell the rest. These approaches provide low return to the farmer. If the produced is

stored and sold according to the favorable marketing condition, then the return will be higher. But the farmers do not store any produce because of lack of storage facility. Processing of F&V will add value to it. Only primary processing is done by the farmers which include manual sorting and grading, packaging etc. Generally food items are processed by the firm who are involved in the business of export, processing units etc.

### 3.2 Cold Chain

A cold chain protects a wide variety of F&V produce to get deteriorate in the whole supply chain by providing temperature controlled facility. It is a logistic system that provides a series of controlled temperature storage and transport conditions from the point of origin to the point of consumption, i.e. from farm to fork. It saves fresh produce from degradation, humidity, improper expose to temperature and keeps them frozen, fresh and chilled (Bishara, 2006). Any disorder in temperature or time-distance in the cold chain could hamper the net present value and their added value (Bogataj *et al.*, 2005). The cold chain starts at farm level and covers up to the consumer level in a temperature controlled practices and behavior. Cold chain infrastructure generally consists of grading, sorting, packing, storage, processing and transportation facilities. A typical cold chain is shown in **Figure 4**.

**Figure 4. The Cold Supply Chain Infrastructure**



Source: Sapra & Joshi (2011)

The Cold chain industry in India is estimated to be presently worth over Rs.13,000 crores (US\$2.6 Billion) per annum (Narula, 2011) with various opportunities in the F&V segment in terms of trade and value addition. Despite the huge opportunities, the cold chain industry is at a nascent stage with various bottlenecks discussed below. A lot is yet to hap-

pen in the industry with respect to development of technology, Government plans, and strategy before it can transform the lives of farmers and the growth of Indian economy.

In 2010, the cold storage gap was of about 370 lakh MT as shown in **Table 1** on the basis of peak season

production and highest arrival/ harvesting of storable F&V in a month (NCCD, 2012). The existing cold storage facilities are available only in the wholesale market or nearer to that market. The local market or regional market does not have the cold storage facility where the major fresh produce is sold by the farmer.

**Table 1. Gap in Cold storage capacity in various states in India**

State	Cold Storage Requirement in lakh MT	Present Capacity in lakh MT	Gap in lakh MT
Andhra Pradesh	23.24	9.01	14.23
Assam	9.19	0.88	8.31
Bihar	42.41	11.47	30.94
Chhattisgarh	5.43	3.42	2.01
Gujarat	27.48	12.67	14.81
Haryana	8.04	3.93	4.11
Himachal Pradesh	4.87	0.20	4.67
Jammu & Kashmir	7.37	0.43	6.94
Jharkhand	7.96	1.70	6.26
Karnataka	24.04	4.07	19.97
Kerala	27.71	0.58	27.13
Maharashtra	62.73	5.47	57.26
Manipur	0.80	0.00	0.80
Meghalaya	2.39	0.03	2.36
Mizoram	0.74	0.00	0.74
Madhya Pradesh	12.13	8.08	4.05
Nagaland	0.70	0.06	0.64
Orissa	18.35	2.91	15.44
Punjab	13.18	13.45	0.00
Rajasthan	3.91	3.24	0.67
Tamil Nadu	79.06	2.39	76.67
Tripura	1.63	0.30	1.33
UP & Uttaranchal	122.28	101.87	20.41
West Bengal	105.66	56.82	48.84
<b>Total</b>	<b>611.30</b>	<b>242.98</b>	<b>368.32</b>

Source: NCCD (2012)

Supply chain of perishable food requires proper controlled temperature to maintain and sustain the quality as well as increases the shelf life of the produce and makes them easily available to the customer in a quality manner but the weak and ill equipped cold chain infrastructure (Rathore *et al.*, 2010), improper marketing systems and facilities (Gauraha & Thakur, 2008; Singh *et al.*, 2008) of the country has become the major impediments in the growth of the sector.

#### 4. SUPPLY CHAIN EFFICIENCY

Efficiency is according to Beamon (1998) is the measurement of how well the resources expended are utilized. In general, it describes the extent to which time, effort or cost is well used for the intended task or purpose. It is often used with the specific purpose of relaying the capability of a specific application of effort to produce a specific outcome effectively with

a minimum amount or quantity of waste, expense, or unnecessary effort. Supply chain efficiency is how well the resources are utilized in the Supply chain. The most efficient Supply chain has the lowest possible cost and at the same time meets the customer’s expectations on service like delivery precision and lead-time (Pettersson, 2008). Various authors discuss

and define supply chain efficiency as shown in **Table 2** and it can be inferred from their viewpoint that high customer service, less lead-time, low cost, less wastage, high value, quality, resource utilization, and profitability are the main factors that define supply chain efficiency.

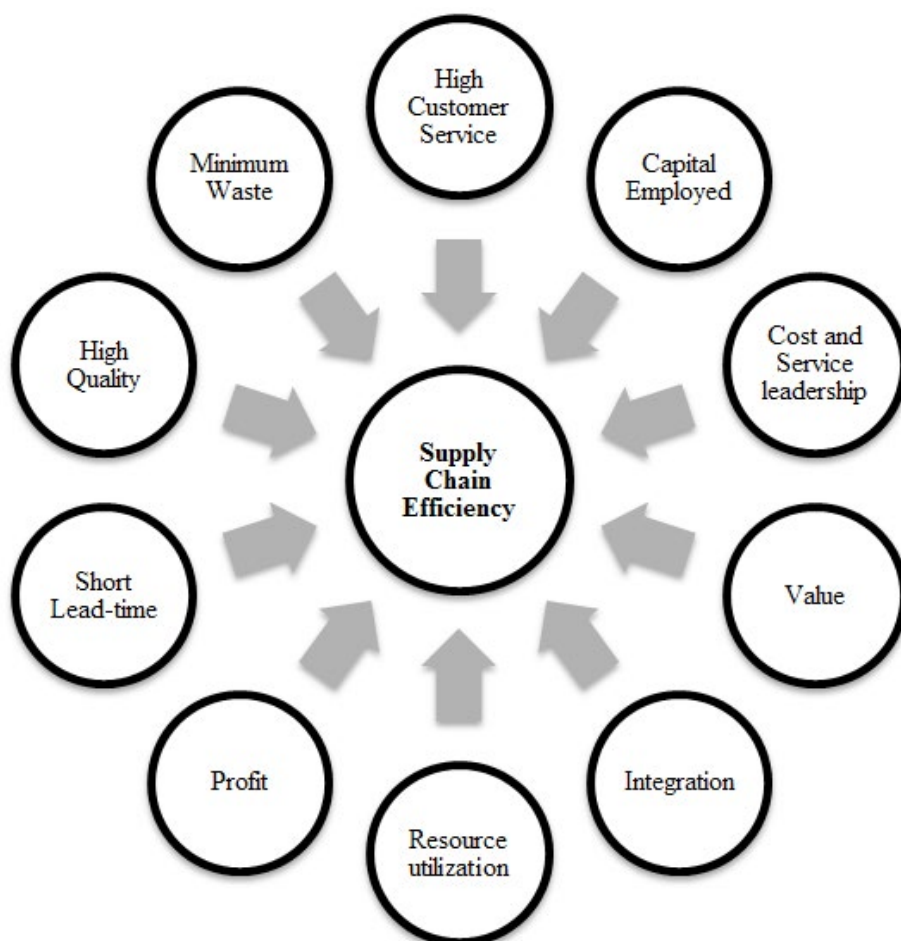
**Table 2. Defining Supply Chain Efficiency**

<b>Authors (Years)</b>	<b>Inference</b>
Collin (2003)	Success of Supply chains is composed of <b>Customer service, Capital employed, Total cost.</b>
Hoover et al. (2001)	Excellent Supply chain when a company provides requested <b>customer support.</b>
Bowersox et al. (2000)	Three perspectives to <b>create value</b> for customers are economic, market and relevancy value.
Simchi-Levy et al. (2000)	Efficient Supply chain strategies must take in account the <b>interactions at the various levels.</b>
Beamon (1999)	Efficiency is the measure of how well the <b>resources are utilized.</b>
Christopher (1998)	The future market leaders will be the ones that have achieved <b>cost and service leadership</b>
Dornier (1998)	The overall objective of any logistics system is to maximize <b>profitability.</b>
Bowersox & Closs (1996)	Relationship between <b>customer services level and cost</b> is important.
Haug (1985)	Excellent Supply chain when a company provides products with <b>short lead-time.</b>
Mentzer & Konrad (1991)	Effectiveness is defined as the extent to which goals are accomplished.
Goonatilake (1990)	Excellent Supply chain when a company provides products at <b>low cost.</b>
De Meyer et al. (1989)	Excellent Supply chain when a company provides products with <b>high quality.</b>



Further the identified factors defining the supply chain efficiency may be graphically represented in **Figure 5** below.

**Figure5. Factors Defining Supply Chain Efficiency**



## 5. SUPPLY CHAIN EFFICIENCY IN FRUITS AND VEGETABLES (F&V) SECTOR

Supply chains in the case of F&V sector may vary from products to products in terms of number of players/parties involved and addition in the value of product at each stage. The value added depends upon the type of product/commodity and business. Some players are involve in export business and some are in food processing entities, so in this case value addition is higher and it is very low in domestic supply chain of F&V. Supply chain of F&V sector is influenced by the availability and quality of infrastructure such as roads, storage facilities, transport network and connectivity, and technology etc.

The present Supply chain in F&V sector that connects the farmers to both the organized, as well as

the unorganized retail, is still in a very pathetic state and highly inefficient with several intermediaries

and manual handling. The result is lots of wastage as much as nearly 30% and also less remuneration for the farmers (Viswanadham, 2007). Large share of a farmer's realizable value is lost as commission, supply chain mishandling and losses (Narula, 2011). Due to inefficient supply chain, price received by farmers is only about 24% to 58% of the consumer price. It is the inefficient Supply Chain that costs middlemen, consumers and more dearly the farmers (Veena *et al.*, 2011). Without an efficient supply chain, there is a high cost of wastage for the companies (Rathore *et al.*, 2010). Inefficiency in the supply chain of F&V sector leads to high losses and wastages which results in the availability of inferior qual-

ity commodity to the consumer and less prices to the farmers. Due to inefficient supply chain the extent of loss of F&V is about Rs. 10,000 crore to Rs. 12,000 crore per annum, and the loss of quantity ranges from 10% and 80 % in some of the most perishable F&V (Mittal, 2007). It is estimated that the food production in India is going to double in the next ten years; but post-harvest losses of about 35-40% of the total produce which amounts to Rs. 58,000 cr annually is a cause of concern. From various studies on post-harvest losses in India, it is evident that the amount of food wasted in a year in India is equivalent to annual food consumption in the UK (Rathore *et al.*, 2010). Estimates of Post-harvest losses in developing countries vary from 1 to 50% or even higher (Kader, 2005). According to the calculation of ASSOCHAM (2013) India, the producers have to forgo every year Rs. 2.13 lakh crore due to losses in the supply chain of fruits and vegetables.

Highly inefficient supply chain results in High wastage of fresh Produce, Instability in prices, farmers not getting remunerative prices as the differential between the farmer's realization and the final consumer price in India is the highest in the world even in the fresh produce (GOI, 2012), rural impoverishment resulting in farmers' frustrations and suicides (Rathore *et al.*, 2010), and increased additional costs in the supply chain which ultimately enforces the final consumers to pay high charges from his pocket.

Many researchers have found inefficiency in the supply chain as the major problem in the supply chain of F&V sector in India which leads to supply chain losses and wastages which finally results in higher

prices paid by final consumers and less income to the farmers and other stakeholders.

There is a comprehensive requirement of research in the area not only to fully understand the challenges in supply chains management but to identify the opportunities for improvement and also to reduce several inefficiencies in the supply chains (Bhardwaj & Palaparthi, 2008). F&V are highly perishable in nature; and because of the high level of wastage and inefficiency in this sector efficient supply chain after the farm gate to the final consumer has become an absolute necessity, hence there is an urgent need to develop intelligent supply chains to curb losses and increase the shelf life of F&V and ensure safety and desired quality (Rathore *et al.*, 2010). The extent of wastage can be reduced only by proper and efficient supply chain (Shukla & Jharkharia, 2013). So the efficient supply chain is a necessity for F& V sector and its importance in this sector has been discussed in the next section.

### **5.1 Importance of Efficient Supply Chain in F&V sector**

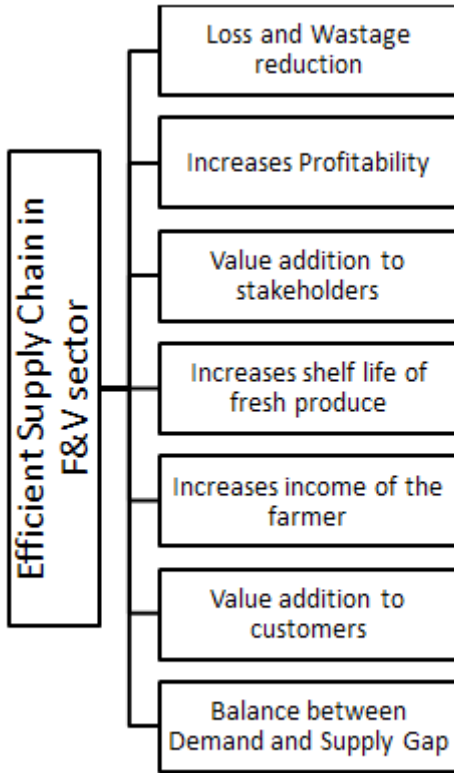
Efficient Supply chain is very important in F&V sector and it will lead to increase in the profit of the stakeholders involved in the chain and most importantly reduce the losses and wastages in this sector. It will also reduce the chances of deterioration in the quality of F&V produce and help to enhance the value and makes reliable delivery to the consumer at the right time with right quality and at the right prices. In Literature, various authors have discussed the importance of efficient supply chain in F&V sector in India which has been shown in chronological order in **Table 3**.

**Table3. Importance of Efficient Supply Chain in F&V Sector**

<b>Author (Year)</b>	<b>Importance</b>
Shukla and Jharkhar- ia (2013)	In future there will be several changes in the consumption pattern of the population in the developing countries such as India and China which will trigger the need for an efficient supply chain.
Halder & Pati, (2011)	As Indian economy is still based on agrarian economy, proper measures and efficient supply chain will play a crucial role in reducing the losses and wastages at various stages of the supply chain.
Veena et al, (2011)	Inadequate usage/improper management of cold supply chains are leading to loss in quality of the vegetables and fruits which in turn is leading to loss of profits and business opportunity.
Rathore at al, (2010)	Efficient supply chain not only increases the profitability and efficiency of retailers, but also adds value to different stakeholders like farmers, consolidators and consumers.
Reddy, G.P et al. (2010)	Establishing efficient and effective cold supply chain would not reduce post-harvest losses but also increase the shelf life of food.
Dharni and Sharma (2008)	Efficient value chain management will certainly add value and help in bringing the produce to the market.
Dharni and Sharma (2008)	An efficient supply chain and distribution structure is an important means for increasing income of farmers and increasing affordability.
Viswanadham, (2007)	By building an efficient and effective supply chain using state of the art techniques it is possible to serve the population with value added food while simultaneously ensuring remunerative prices to the farmers.

Improving the efficiency and the performance of the whole supply chain in F&V sector are expected to significantly reduce the perishable food waste and increase the income of farmers and other stakeholders. Further the importance of efficient supply chain may be graphically represented as in **Figure 6** below.

**Figure 6. Importance of Efficient Supply Chain in F&V Sector**



**6. CONCLUSION**

Fruits and Vegetables (F&V) sector in the case of agriculture and allied sector in India account for a significant share in the world production. This paper presents a status of F&V sector supply chain in India, supply chain efficiency, and highlights the need & importance of efficient supply chain to remove various bottlenecks and reducing the losses and wastage in this sector. The study and research conducted on the supply chain of F&V sector in India suggest that the supply chain is highly inefficient which is leading to huge losses and wastages and less income to the stakeholders. F&V sector in India is a very growing sector and presents a huge opportunity to the stakeholders and entrepreneurs through setting up the cold chain infrastructure and food processing units.

As Indian economy is based on agriculture and there are huge potential to serve domestic or global markets through various value addition, development of intelligent and efficient supply chain will

play a crucial role in reducing the losses and wastages, increase in farmer income, increase revenue from export, generate employments opportunities for the local peoples, and improve the livelihood of the farmers which leads to developing the economy and help India to emerge as a global leader in Food Sector.

**6.1 Contribution**

The paper examines the existing position of F&V sector in India. After giving a conceptual coverage of supply chain management, the supply chain relating to F&V sector is studied. Then, the efficiency of F&V supply chain is analyzed and the need & importance of the research for efficient supply chain in F&V sector has been discussed. It has been evident from the literature that the F&V's supply chain is highly inefficient. The present study undertakes a thorough review of basic and contemporary literature available and attempts to identify the business problem in the supply chain of F&V sector in India.

**6.2 Future Research directions**

To the best of our knowledge, the concept of efficient supply chain of F&V sector in India is still in a nascent stage and several possible future research directions can be defined. Addressing the problem of supply chain losses and wastage, transportation and storage can be the area of focus. Most significant logistics activity leading to supply chain inefficiency can be identified. Next, developing a framework to improve the supply chain efficiency of F&V sector can be a very interesting area of study.

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