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RESEARCH PAPER

Supply chain of tomato : Linking Indian Farmers to International Consumers

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Abstract : The consumption pattern of Indian consumers is fast diversifying due to rapid internationalization of dietary patterns, rising double income families and ever-increasing health consciousness. As a result, consumers have shifted significantly from consuming merely food grains to vegetables and fruits. This change has accelerated the demand for more and more horticultural produce, both raw and processed. Tomato is one of the major horticulture crops consumed world widely. The consumption of tomato products increased over the past few years. According to the report of WPTC the increase in the consumption of processed tomato indicates a slow shift of consumers away from fresh products towards processed products. The demand for tomato is high in Europe, North America, Italy, U.S.A, Russia and Germany. The demand of the processed tomato is more most of the tomato is consumed as sauce for pizza and pasta. Tomato is one of the most widely grown vegetable crops in Uttarakhand and Tarai region of North India. In Uttarakhand 119742 metric tons of tomato is cultivated in an area of 9360.75 hectares (NHB, 2019). The farmers of Uttarakhand prefer tomato cultivation as the agro-climate condition is favourable. Moreover, wide spread use of tomatoes for different food preparations such as soups, salads, pickles, chutney, paste, puree, ketchups, junk and ready to eat food has increased demand for tomatoes. In Uttarakhand, the generated produce is not efficiently supported by the existing market infrastructure. The entire supply chain of tomato is laden with inefficiencies: poor transportation facilities, lack of cold chain facilities, lack of processing units, poor connectivity from farm to market, huge post-harvest losses and large no. intermediaries. The grower's still practice traditional cultivation methods remain unaware of consumer needs, preferences and prevailing market prices. This causes large fluctuation in consumer prices and low quality of non-standardized produce. This is a double whammy as farmers realize poor prices on the one hand whereas consumers pay exorbitant prices on the other hand. Horticulture crops being high value crops are important in enhancing income for the farmers besides creating on farm and off farm employment. It is important for India to leverage its diverse agro-climates and distinct seasons, which makes it possible for farmers to grow a wide variety of horticulture crops. The objective of this paper is to design an efficient supply chain model which can better price realization of farmers and also ensures timely, adequate, quality supplies to consumers at the right prices.

Key Words : Tomato, Demand, Supply chain management, Inefficiency, Uttarakhand, Post-harvest loss

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INTRODUCTION

The consumption pattern of Indian consumers is fast diversifying due to rapid internationalization of dietary patterns, rising double income families and ever-increasing health consciousness. As a result, consumers have shifted significantly from consuming merely food grains to vegetables and fruits (BCG, 2017). This change has accelerated the demand for more and more horticultural produce, both raw and processed. As a result, the growing demand for high-value food commodities is opening up opportunities for farmers. In order to cope with the demand, commodities have to be diversified that have strong potential for higher returns to land, labour and capital (Birthal *et al.,* 2007). However, there is doubt about the capability of small-scale farmers to participate effectively and meaningfully in the market-oriented production due to their limited access to markets, capital, inputs and technology and extension services.

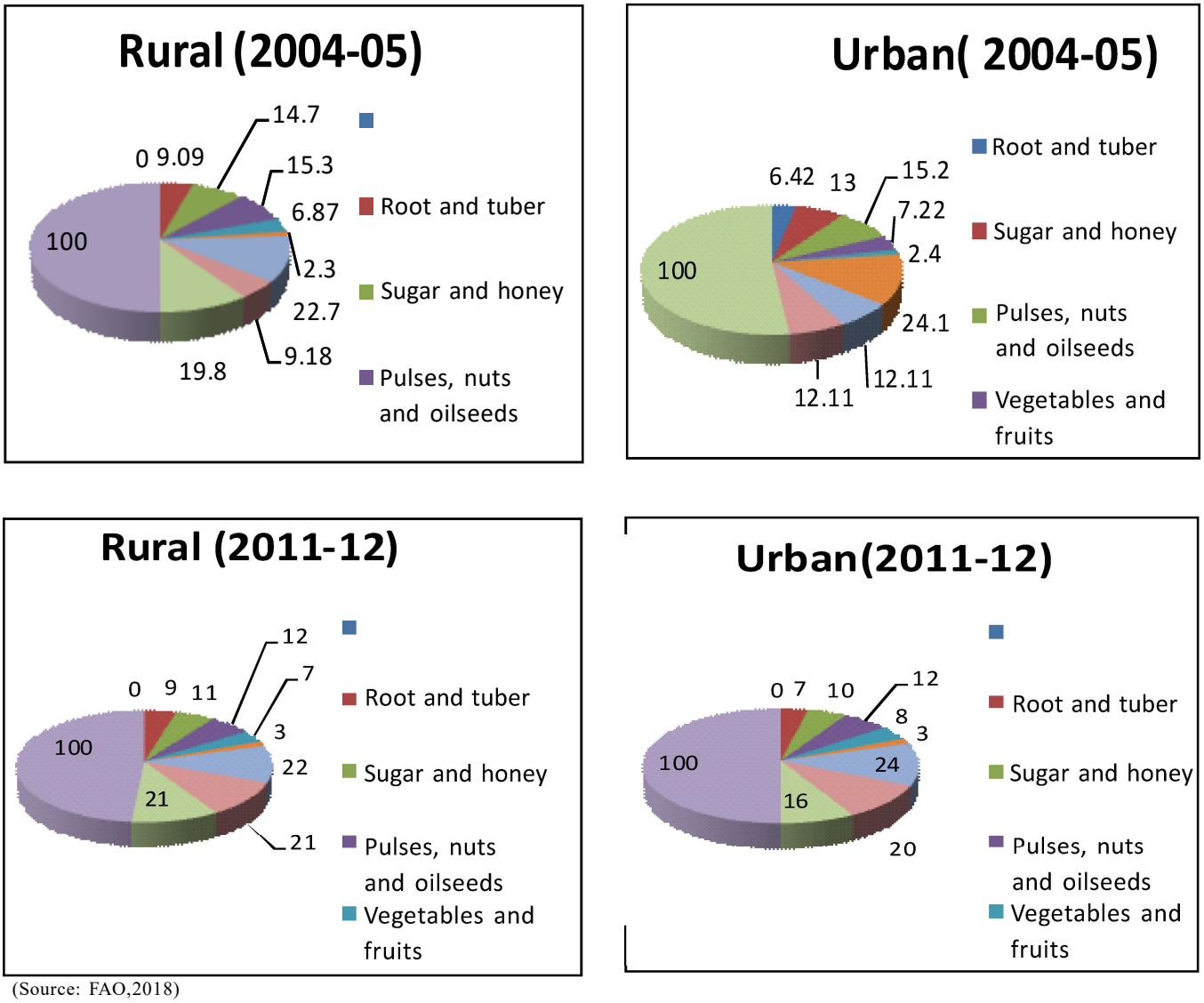
Objective of the study:

The study has been conducted mainly to:

Understand the present status of supply chain of tomato in Uttarakhand and challenges faced by supply chain members and strategies to overcome with the challenges.

MATERIAL AND METHODS

The research paper is an attempt of exploratory



(Source: FAO,2018)

Fig. 1: Percentage share of calorie intake from non-cereals food groups

research, based on the secondary data sourced from govt. reports, journals, magazines, articles and media reports. The data has been retrieved from various sources such as Scopus, Elsevier, FAO annual reports, NSS report, National horticulture board report, Directorate of Horticulture and Food processing, Uttarakhand, NCEAR report etc.

Present scenario of fresh produce consumption in India:

There is a consensus that the Indian agricultural and agro-food market landscape is changing in line with changes occurring internationally as a result of globalization and market liberalization. The food basket of the average Indian household is fast evolving toward high-value food commodities such as vegetables, fruits, egg, meat and milk. It is postulated that the agricultural production portfolio is diversifying and moving toward producing these high-value products in response to the changing tastes and preferences of the consumers. Concurrently, food procurement and distribution systems are also evolving accordingly (T. Mkhabela).

As per the report of Food and Agriculture Organization of the United Nations (FAOSTAT), 2018 the eating habits of the average Indian have undergone some changes over the past 50 years. The report analyzed the average person's consumption in the non-cereals food groups: dairy and eggs (milk, animal fats), plant produce (vegetables, fruits, starchy roots), meat (beef, pork, poultry, seafood, other meat), sugar and fat (sugar and sweeteners, vegetable oils, oil crops, sugar crops) and others (pulses). The Fig. 1 shows the change in average daily food consumption of Indians in 2004-05 and 2011-12.

The above statistics shows that the average Indian from rural and urban is consuming more calories than they did 50 years ago. India's consumption of eggs, dairy and plant produce has increased. Whilst the average Indian diet remains primarily vegetarian, the consumption of meat and animal-based products has also increased. But due to change in the dietary pattern and health related consciousness among each age group in India the consumption of vegetables has been raised in a significant manner from past few years. Furthermore, the consumption of pulses, sugar, honey and roots tuber has decreased whilst the average daily oil and fat intake has increased.

Due to the evolving working dietary patterns, double income families, urbanization of the consumers and increasing women and health consciousness, the consumption pattern of consumers has diversified over the years. Hence, the diet diversification results shift in consumption of consumers from food grains and cereals to high value food products such as milk, egg, meat, fruits and vegetables. As a result, the horticulture sector has emerged as a major driver of growth in the agricultural sector. According to an estimate, 40% of Indian population will be living in urban areas by 2025 and these city dwellers will account for more than 60 % of consumption. Most of the families living in the cities are nuclear and the proportion of nuclear families is projected to increase from 70% to 74% by 2025 (BCG, 2017). As a result, the changing consumption pattern will accelerate the demand for more horticultural produce. Apart from the health consciousness and other mentioned factors, the shifting of farmers to high value crops *i.e.* fruits and vegetables due to higher income and employment is also an important factor for growth in the horticulture sector in India. It is to be also noted that in India the contribution of vegetables is highest (59–61%) in horticulture crop productions over the last five years.

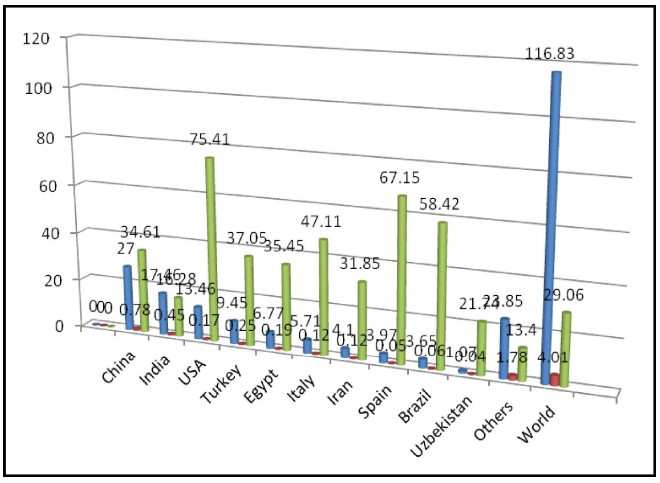
The above statistic shows that the annual demand and production has been raised from last few years. This would be due to change in the lifestyle and eating habits

Table 1 : Total annual production and demand of onion, potato and tomato during 2012-13 to 2017-18

Production in 000' tones
Annual demand in 000' tones

Years	Onion		Potato		Tomato	
	Production	Annual demand	Production	Annual demand	Production	Annual demand
2012-13	16813	18252	45344	42203	18227	16766
2013-14	19402	18503	41555	41502	18736	17182
2014-15	18927	18488	42174	42151	18305	16961
2015-16	20333	19002	43417	43169	18732	17259
2016-17	21718	20770	48237	45739	19542	17871
2017-18	23262	20531	51310	47463	19759	18366

Source: NSS report No. 558, House hold consumption of various goods and services in India, 2011-12



Source: National Horticulture Board Report, 2018

Fig. 2: Major tomato producing countries in the world

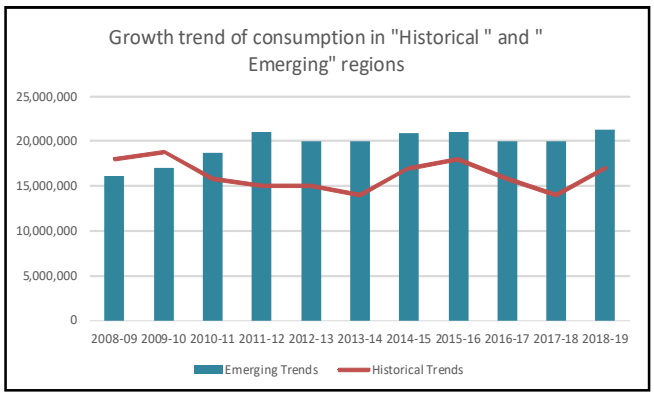
of people. It has been also noticed that the people prefer to consume raw vegetables rather than processed or cooked form. Tomato is one of the major horticulture crop consumed world widely. Also, the consumption of tomato products has increased over the past few years. According to the report of WPTC, the increase in the consumption of processed tomato indicates a slow shift of consumers away from fresh products. The demand for tomato is high in Europe, North America, Italy, U.S.A, Russia and Germany. The demand of the processed tomato is more in these countries and most of the tomato is consumed as sauce for pizza and pasta.

As per the report of FAO China and India is biggest tomato producing countries in the world. In the above Fig. 2 it is identified that despite of largest producer in the word the gap in the productivity between China and India is very huge. This may be due to various reasons along with this the yield capacity of USA is higher than India. These figures need to be considered because tomato is one of the major crops produced in India and due to low productivity, our farmers are suffering in the domestic as well as international markets. The reasons for low productivity are many such as poor infrastructure, improper market, unawareness of farmers regarding new techniques and cultivation practices, lack of availability of cold storage, poor weather conditions etc.

The below Fig. 3 for consumption supplied by the FAO includes tomatoes consumed fresh and industrially processed (paste, canned, ketchup and other sauces, juice, etc.). with the help of this figure, it can be said that total tomato consumption has increased from past few years. The emerging trends shows the expected rise in the consumption of tomatoes in the upcoming years. According to the current available data the expected global average consumption for 2018-19 stands at about 22 million MT. This shows that the global consumption has slowed in its progression over the past six or seven years, compared to the beginning of the 2000s.

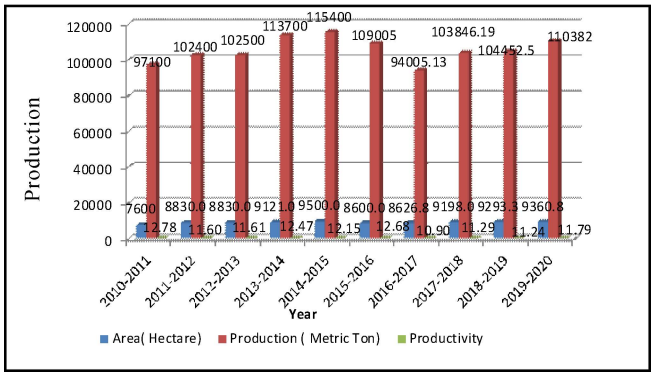
Despite of having changes in the consumption pattern of tomato, whether it is eaten in raw or processed form, tomatoes feature among the world's most frequent crops. According to figures published by the FAO, in 2013, tomatoes were the ninth biggest crop worldwide, with some 164 million tones harvested, far behind sugarcane, potatoes or even cassava. According to available data, total production should reach slightly more than 175 million tones this year, out of which approximately 38 million are destined for industrial processing.

The foregoing changes present opportunities as well



Source: FAO, 2018

Fig. 3: Growth trend of consumption in "Historical" and " Emerging" regions



Source: Directorate of Horticulture and Food processing, Uttarakhand (Chaubatiya)

Fig. 4: Area, production and productivity of tomato in Uttarakhand

as challenges for farmers. It is envisaged that farmers would benefit from diversification into high-value commodities that have a strong potential for higher returns to land, labor and capital. Institutional innovations in marketing would enhance farmers' access to markets, quality inputs, technology, information, and services which eventually would lead to improvement in productivity and reduction in marketing and transaction costs as well as increased wealth.

Tomato production scenario in Uttarakhand:

Tomato is one of the most widely grown vegetable crops in Uttarakhand and Tarai region of North India. In Uttrakhand 104,452.49 tons of tomato is cultivated in an area of 9,293.25 hectare (NHB, 2018). The farmers of Uttarakhand prefer tomato cultivation as the Agro-climate condition is favorable. Moreover, wide spread use of tomatoes for different food preparations such as soups, salads, pickles, chutney, paste, puree, ketchups, junk and ready to eat food has increased demand for tomatoes. Fig. 4 shows the area, production and productivity of tomato crop in Uttarakhand.

In Uttarakhand the area under tomato crop, production and productivity has increased between 2010-11 and 2019-20 as per the Fig. 4. But in 2015-16, the area under tomato cultivation has decreased from (9.5'000 hectare to 8.6 '000 hectare). This has also resulted in reduced production. The primary reason for reduction in the area under tomato cultivation is low price realization by farmers. The agro-climate condition of Uttarakhand is favourable for the production of tomato but the generated produce is not efficiently supported by the market infrastructure. There is inefficiency in the supply chain of tomato that results post-harvest losses and low income generation. Recent data in tomato production from 2017 to 2020 past 4 years is still satisfactory. It has been observed the production level has been raised but the productivity has not shown any improvement. This has realized people are utilizing the same practice in cultivation and marketing due to this farmer are unable to receive adequate rewards from their efforts.

Uttrakhand has huge potential of seasonal and off seasonal tomato production. The agro climatic condition is favorable and supports the farmers in tomato cultivation. Tomatoes are quick growing and short duration crop. The short duration nature offers scope for raising three or more crops a year. Tomato crop is labor intensive and generate additional farm employment. However, vegetables especially fruity vegetables like tomato are highly perishable and are subject to lose after harvest. Tomato crop is extremely perishable in nature and, therefore, require efficient supply chain system. An inefficient supply chain system gives rise to several problems like high marketing cost, quantitative and qualitative losses at various stages, high level of price spread and unpredictable behavior of prices, low marketed surplus and low income for farmers (Shende and Meshram, 2015). For better price realization, it is not just enough to produce in large quantity but it should also be marketed successfully. It is necessary to improve the supply chain system to increase the availability of produce and to reduce post-harvest losses.

Supply chain of tomato :

Vegetables constitute a major part of the world's economy and are raw material for many industries. Among the vegetables, perishable produce like tomato has got the least attention. The supply chain management of perishable food produce constitutes the processes from production to delivery of the agri-fresh produce *i.e.* from the farmer to the customer. SCM of perishable food produce 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 and quality and dependence on climate conditions (Vorst and Beulens, 2002). Supply chain management encompasses the planning and management of all activities involved in sourcing procurement, conversion, and logistics management. It also includes coordination and collaboration with channel partners, which may be suppliers, intermediaries, third-party service providers, or customers (Salin, 1998).

In India 30-40 per cent of vegetable are wasted due to post harvest losses. The supply chain of tomatoes, which is one of the main vegetable crops of India, is laden with inefficiencies across the entire value chain leading to poor price realization of growers on one hand and exorbitant prices paid by consumers on the other hand. A major share of this consumer rupee goes to number of market intermediaries who exploit the farmers due to poor marketing linkages, non-existent of cold chain infrastructure and processing facilities. The growers still follow the age old cultivation practices and have no idea of consumer needs and preferences, market prices, various government schemes, scientific agronomical

practices especially agri-inputs, sources of timely and adequate credit availability and market linkages.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Challenges in the supply chain management of tomato:

Lack of farmer's knowledge and awareness :

Lack of knowledge about the quality seeds, fertilizers, pesticides and scientific technologies is one of the main reasons for low productivity. According to a Govt. report on an average, only 30-40 per cent of area is sown by using certified quality seeds in the country. In order to raise the productivity, there is a need to supply and promote use of quality seeds. Farmers are also unaware of the pesticides recommendations of CIBRC and the bio-pesticides that currently constitute 4.2% of the total pesticides market in India. It is estimated in a report that currently only 0.1% of the pesticides is being used in Indian farms. As per the report of NITI AYOG in India, use of fertilizer has steadily grown but it has been disproportionately tilted in favour of urea *i.e.* the source of nitrogen. In the early 1970s, the average proportions across N, P and K were 6:1.9:1/Gradually it shifted in favor of nitrogen over time reaching 10:2.9:1 in 1996. There was minor shift in the reverse direction subsequently but in 2012-13, the proportions still stood at 8.2:3.2:1. Also, the quantity of fertilizer use per hectare in India remains significantly low than in most countries in the world. The average consumption of fertilizers in India did rise from 105.5 kg per ha in 2005-06 to 128.34 kg per ha in 2012-13. However, the level remains well below what is observed in the neighboring Pakistan (205 kg per ha) and China (396 kg per ha) (NITI AYOG, 2015).

Glut of tomato in the market :

As per the study of NHB, 2016, 80% of the growers take their tomato production in the market only once in a year between June and October. It results into the problem of excess supply and low price realization of farmers.

Absence of knowledge of grading and standardization:

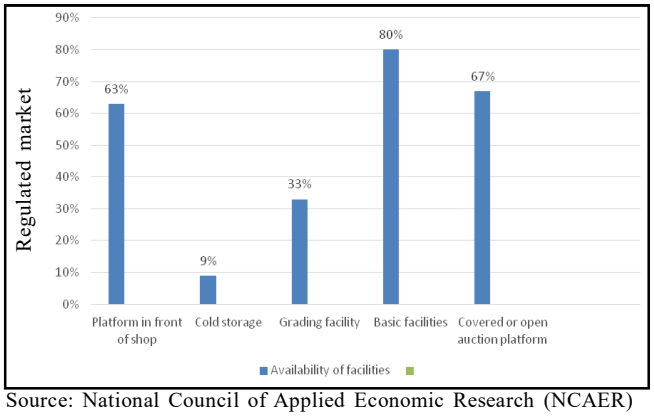
A large number of tomato farmers have little knowledge of the practice of the grading of the produce prior to its sale. They usually pick up superior and inferior quality products to make a single lot. As a result, they get a lower price for their produce.

Low level of value addition due to lack of processing units :

There are only few agro industries available in the study area that could manufacture various by-products of tomato. Hence, the tomato growers have to sell their tomato at whatever rate offered during the seasonal period. As per the report of Ministry of Agriculture In India only 2% vegetables grown goes for processing, while over 25% is spoiled due to improper handling and storage, and the rest is consumed in fresh form (Ministry of Agriculture 2016).

Lack of cold chain facility :

There are various issues related to cold chain in the region such as lack of cold chain facilities, inadequate capacity of cold chain and lack of cold chain network. A survey conducted by National Horticulture Board estimates that a total of 5367 cold stores of size 26.85 million tons remain in operation. Considering this, the total gap in cold storage space can be assessed to be a whopping 8.25 million tons (NHB, 2014).



Source: National Council of Applied Economic Research (NCAER)

Fig. 5: Status of facilities in regulated market

Poor connectivity of agricultural land from road head:

According to a study, around 92 per cent of the farmers have land holding away from an arterial road. The farmers collect their produce from the field that are scattered and bring it to the nearest road via local transport. Major portion of land that is away from the road is not connected to the main road via link road (Bisht,

2013). This increases the problem of the farmers and results waste of produce. According to the report of Assocham, Presently the average reach of a single regulated market is around 460 square kms, thus, farmers have to travel a long distance to sell their produce.

Inadequacy of transport facilities:

Tomato producers always faces the serious problem of transportation. The crop is entrusted to the local traders for transporting it to different areas. But in the harvest season the facility of transportation (vehicles like truck or tempo) is not easily available at required time. The crop does not reach the market instantly and it causes weight-loss of tomato and also in decrease in offered rates.

Weak Infrastructure :

There exist considerable gap in the essential facilities available in the market yards for the producers.

Large number of intermediaries :

According to a study conducted by (Singh, 2010) the marketing pattern varied considerably from farmer to farmer depending upon the nature of the vegetables and capacity of the farmers. In the entire marketing process, vegetables changed hands three to four times between producers and consumers. There are multiple intermediaries found to exist in the vegetable marketing system. The study further explain that most of the farmers with small and marginal land holdings sold their produce not in the agricultural market yard established under the State APMC Act, but in rural markets or *haats*. Farmers with large agricultural holdings on the other hand mostly sold their produce in the market yards.

As per the study conducted by Gandhi, 2002, it was found that for vegetables, 50 per cent of the commission agents purchases were made directly from farmers, whereas about 33 per cent were from traders, and 17 per cent from cold storage points. This indicates that many farmers part with their produce at the village level itself. The share of the farmer in the price paid by the consumer was frequently very low and varied in the range of about 30 to 70 per cent. The cost of marketing of agricultural produce frequently amounted only about to about 10 to 20 per cent of the price difference (*i.e.* the difference in prices paid by the consumer to retailer and the price paid by trader to farmer). Here the term 'cost' covers costs incurred in transportation of the produce and the commission charged by agents. And the 'commission' is not limited at 5-6% it is a random rate. This is an indicator of the poor level of marketing efficiency in these APMC markets.

Recommendations for action:

– There is a need to link higher educational and research institutes to KVK's and producers to scale up production and also provide guide line regarding quality seeds and advanced technologies. Government / institutions need to play a key role to ensure coordinated and well-focused training for farmers and agribusiness entrepreneurs and identifying, strengthening key institutions that can provide the requisite training for farmers and agribusinesses. For example the Department of Extension Services could be strengthened to provide quality services to the farmers. Support can be provided for the establishment of farmers' business schools to promote business-oriented farmers.

– There is a need to establish small cold storage near mandi to extent the shelf-life and maintain supply of tomato throughout the year. Govt. should set cold chain infrastructure in various districts to facilitate farmers for better procurement.

– In Uttarakhand most of the tomato is sold in raw form no value addition being done in any stage. Tomato is a perishable vegetable crop and producers have limited market options. Therefore, there is a need to increase the shelf-life through value addition process.

– Public private partnership is another strategic solution. Private players like Star Agri that provide integrated post harvest management solutions. Apart from providing warehousing services Star Agri also provide other value added services quality testing, agri insurance, Bulk procurement and rural retailing.

Integrated cold chain solutions :

There are few private players like cold star logistics that provides customized solutions for cold storage and refrigerated transportation across India for fresh and frozen commodities. Their services include refrigerated storage, warehousing, transportation, distribution and logistics. Govt. need to tie up with such private companies to enhance the supply of tomato and reduce post harvest losses.

– There is requirement to promote linkages between farmers and agri businesses, institutions/government should initiate promotional linkage strategies and

programmes through a network of public/private sector and non-governmental organizations. The services provided by this network should be publicized to create the awareness among farmers and agribusinesses on the specific type of assistance needed.

– For the benefit of the small farmers it is necessary to organize groups of farmers. Collective marketing is necessary to overcome with these constraints faced by small farmers in the market includes lack of financial and physical assets, lack of access to key information and services, lack of negotiating power and competitiveness due to the production of very small volumes of low-quality products, and a lack of self-confidence. Collective marketing can enable these farmers to supply the minimum volume required by buyers.

– Small size food parks can be developed at various centers points of district areas with the facility of packaging, semi processing units, grading, loading, unloading and machineries for value addition in vegetables.

– Alternate marketplaces to shorten the length of supply chain. Govt. should promote farmers to use such applications that reduce the distance between producer and buyer. There is one innovative company, eFarm, which is providing a way to bypass the long chain of intermediaries by directly connecting buyers and sellers of agricultural produce and allied services, via a web and mobile based information exchange platform. Another company working in this field to facilitate farmers TCS' "mKRISHI" platform offers personalized advisory services to farmers, via mobile phones (SMS and IVR), enabling them to access important information on pesticides, fertilizers, soil and water conservation, and improving access to markets for them.

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