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Value Chain Strategies for Stabilization of Tomato Prices in India -A Case Study

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ABSTRACT

Tomato (*Solanum lycopersicum*) is one of the most extensively cultivated and consumed vegetables in India. It is a highly demanded vegetable and consumed throughout the year due to its high nutrient content, which offers multiple health benefits. Tomatoes are highly perishable due to their high moisture content and have a short shelf life of 2-3 days at ambient conditions. Tomato faces significant post-harvest losses ranging from 15-25% in the value chain. Moreover, the tomato price in the Indian market is very unstable. During the season, wholesale prices normally range from Rs. 6-10; off-season wholesale prices exceeded Rs. 100 per kg, while the retail price crossed Rs 200 per kg. To minimize the post-harvest losses and also to stabilize the tomato prices in India, a study was conducted to identify different strategies that are essential to stabilize the prices of tomatoes in the tomato value chain in India. In this study, primary data were collected from farmers, traders, retailers, tomato processing industries, tomato seed suppliers, experts, and scientists. While secondary data were collected from several published research papers, reports, and documents of Govt policies, plans, and programs, etc. In this study, compiled views of farmers, input suppliers, traders, seed and tomato processing industries, experts and scientists. From the secondary data, probable solutions for tomato price fluctuations were identified, and several recommendations were drawn from this study. Among these recommendations, a few important ones are recorded as an urgent need for replacement of low-yielding varieties, promoting the formation of FPOs and cooperatives, and strengthening the infrastructure with government support in the tomato value chain.

KEYWORDS: Tomato, Varieties, Farmer, Shelf-life, Processing, SWOT, MSP

1. INTRODUCTION

Tomato (*Solanum lycopersicum*) is an important commercial vegetable crop of India and second most important crop of world after potato. India is the world's second-largest producer of tomatoes contributes approximately 11.04% to global tomato production. The country produces 21.54 million tons of tomatoes with productivity of 25.54 tons per hectare during the year 2024-25 after China with 70 million tons (Mukherjee, 2025). Studies estimate that about 30-35% of tomatoes are wasted every year at various stages in its value chain, including processed tomatoes (Mohan et al., 2023).

Tomatoes are a nutrient-rich fruit offering multiple health benefits due to their high content of potassium, vitamin C, fiber, and antioxidants like lycopene, lutein, and zeaxanthin. Besides lycopene and vitamin C, tomatoes provide other antioxidants, such as beta-carotene, and phenolic compounds, such as flavonoids, hydroxycinnamic acid, chlorogenic, homovanillic acid, and ferulic acid (Collins et al., 2022). Tomatoes packed with potassium, vitamin C, and antioxidants that support heart health and may help reduce cancer risk (Michelson, 2025).

The attractive red colour of tomatoes is the major dietary source of the antioxidant lycopene, which has been linked to many health benefits, including reduced risk of heart disease and cancer and yellow colour is due to carotenes (Vera-Guzman et al., 2025). Peculiar flavour of tomato is due to presence of ethanol, acetaldehyde and a number of volatile flavour components found in fruit (Kaur et al., 2023). Different forms of tomatine, a steroidal glycoalkaloid, are identified from various parts of plant. Tomato is a good appetizer, and its soup is a good remedy for preventing constipation (Dayal, 2022).

Postharvest loss is a major challenge hindering tomatoes production and tomatoes are highly perishable due to high moisture content and has short shelf life of about 2-3 days at ambient conditions. Post-harvest losses in the tomato value chain are driven by several factors, including inadequate infrastructure, poor handling practices, lack of storage and processing facilities, and environmental conditions. A huge loss of 30-50% was recorded in tomatoes between harvesting and consumption stages of the distribution chain. These losses occur during harvesting, transport, storage, and processing, impacting both producers and consumers (Wakene and Sharew, 2024).

Tomato value chain involves numerous stakeholders, including farmers, producers, processors, distributors, retailers, and consumers, each playing a crucial role in ensuring a steady flow of tomatoes from farm to table. Most of the farmers still sell their produce through the traditional channel i.e., wholesale market. Tomato is grown in most of Indian states, produced throughout the year and surpluses that get transferred to other states. Metropolitan cities are the major consumption centers for tomatoes (**Fig. 1**) and Delhi's Azadpur mandi is one of the largest consumption markets, tomatoes are supplied

from different parts of the country. Though India is the second largest producer in global tomato production but there are huge price fluctuations, crises in different markets of India. Tomato has high demand throughout year as it is considered as important vegetable. Moreover, in tomato value chain, about 30-35% of tomatoes are wasted every year at various stages in value chain. Therefore, to identify strategies for stabilizing price fluctuations in the tomato value chain, a case study was conducted during 2024-25.

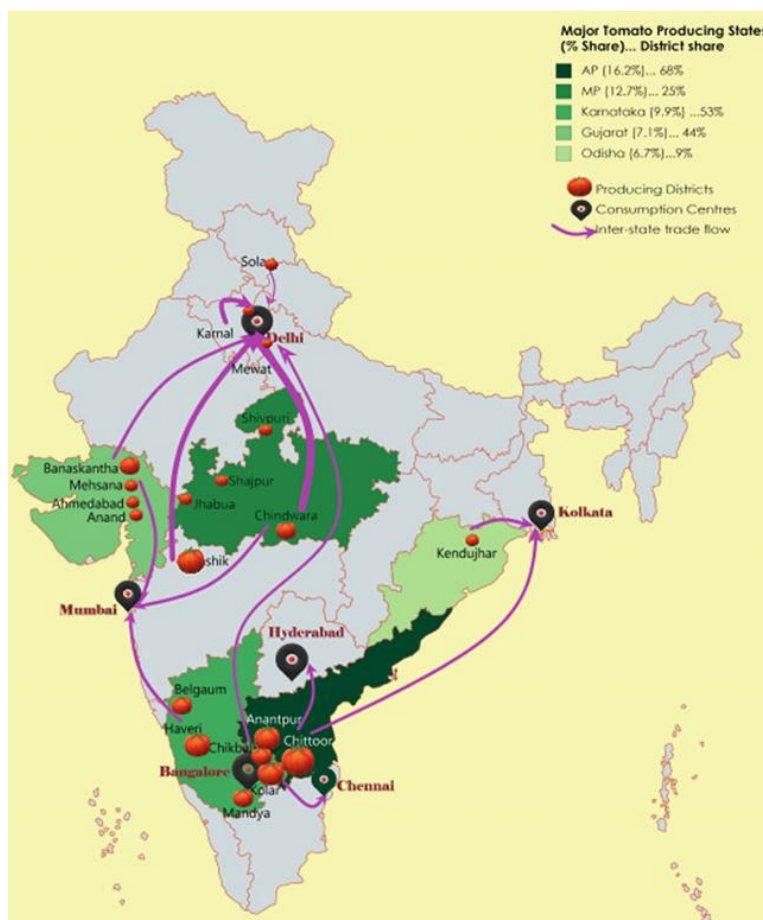


Fig. 1. Major production and consumption centres for tomatoes in India. (Source: Gulati et al., 2022)

2. MATERIALS AND METHODS

This study was undertaken to assess the problems in tomato trading, processing, issues of price fluctuations in India, hindering the upgrading and growth of the tomato value chain, and to highlight areas that could be considered for further examination and possible engagement under tomato processing.

In this study, the primary data were collected through interviewing farmers, mandi traders, APMC and APEDA officials, input suppliers, wholesalers, and retailers. For the collection of primary data, interacted with 45 nos. farmers of Fazilka district, Punjab. In case of traders and middleman, interacted with 15 nos. from Azadpur Vegetables Mandi, Delhi and 5 nos. from Ludhiana Vegetables Mandi. In case of seed suppliers, interacted with 25 Seed shops from Abohar, Ludhiana, and Delhi markets. However, to know the status of tomato processing industries, visited Punjab Agro Juices Ltd. (PAJL), Alamgarh, Punjab, India, while several retailers (95

nos.) were contacted and interviewed viz., Abohar (10 nos.), Ludhiana (10 nos.), Bhatinda (15 nos.), Meerut (15 nos.), Bangaluru (15 nos.), Hyderabad (10 nos.), Port Blair (5 nos.) and Delhi (15 nos.). Primary data were also collected through interactions with different experts working in tomato research using a survey schedule/questionnaire. Expert opinions were also included from different organizations, viz., ICAR-IIHR, ICAR-IARI, ICAR-IIVR, ICAR-RC for NEH Region, Umiam, NIFTEM Kundli (Haryana), APMC, New Delhi, APEDA officials at New Delhi and Seed Industries (ACSIN Agriscience Pvt Ltd. Gurugram, Haryana). For this study, secondary data were collected from several published research papers, reports, and documents of Govt policies, plans, and programs, etc., relevant to the country.

3. RESULTS AND DISCUSSION

In this study, to stabilize price fluctuations in tomato value chain, primary data were collected from farmers, traders,

retailers, tomato processing industries, tomato seed suppliers, experts, and scientists. Analyzed the data using suitable statistical tools and drew valuable remarks, which were presented in the following sections:

3.1 Farmers Views

During the study, to identify the tomato value chain problems, visited different farmers field and interacted with 45 nos. of farmers from Fazilka district, Punjab. Tomato farming faces several **challenges** that hinder productivity, profitability, and sustainability. As per survey, identified several problems and issues which are stated below:

- Tomato farming is very profitable if climatic condition is suitable, no glut in the mandi, less insect infestation etc.
- They are facing problems of good seed and planting materials availability, few farmers are raising their seedling in the poly houses at Punjab Agro Industries Corporation Limited, Abohar, Punjab @ Rs. 1.00/seedling.
- During the survey, it was observed that farmers of Punjab are growing several tomato varieties viz., Punjab Varkha Bahar-1, Punjab Varkha Bahar-2, Punjab Swarna, Punjab Sona, Kesari, Kesar Cherry, Punjab Gaurav, Punjab Sartaj, Punjab Varkha Bahar-4 and Rani variety of East West F1 hybrid but it depends on availability of seeds in the local market.
- Many of the farmers have reported that the variety which they are growing presently have poor yield potential and high yielding varieties seeds are not available in the local markets and they are forced to grow the varieties which are available in the market.
- They also reported that PAU Regional Station, Abohar and State government extension agencies promoting several tomato varieties in the Fazilka district viz., Punjab Gaurav, Pusa Gaurav, Pusa Hybrid, Varkha Bahar series, HS-101/102, Hisar Anmol, Hybrid-2, Cherry types (Sona, Kesari), Punjab Swarna etc. The ongoing support from Punjab Agro factories in Abohar (Fazilka) for processing also encourages farmers to grow high-yield types like Punjab Gaurav, Pusa Gaurav, and other hybrids. But due to non-availability of seeds in the market, farmers are not able to grow high yielding varieties suitable for processing. However, most of the large farmers of Fazilka district of Punjab are presently growing Rani variety of East West F1 hybrid tomato seed (East-West Seed India Pvt. Ltd.) due to availability of seeds. They prefer Rani variety because fruits are very attractive, firm, flat-round fruits, typically weighing fruits of 80-90 grams and seed rate of 60-70 gm per acre. It matures about 65-75 days after transplanting, bright red colour and tolerant to ToLCV, ToMCV and Fusarium Wilt. The variety is suitable for table purpose and has low TSS (4.0-4.5%) but Punjab Agro Juices Ltd. (PAJL), Alamgarh, Punjab, India used for processing purposes due non availability of other suitable varieties.
- Farmers reported, overproduction in peak seasons (especially during February-May) leads to price crashes, with farmgate prices sometimes dropping below ₹3/kg which does not meet the cost of harvesting due to shortage of labour and high labour cost. Lack of organized contract farming or MSP (Minimum Support Price) leaves farmers helpless to middlemen.
- During the survey, it was observed that tomato farmers are facing losses due to climate change, sudden increased in

humidity and erratic rains, several pest and disease incidence such as leaf curl virus, fruit borer, early/late blight, and whitefly during summer and rainy season are one of the major problems in tomato cultivation in Punjab.

- Farmers reported, 15-30% losses during glut season due to lack of storage or limited access to cold storage facilities and processing units, only limited quantities were procured by Punjab Agro (Punjab Agro Juices Ltd.) at Abohar.
- Tomato farmers of Fazilka has canal and tube well irrigation facilities but several vegetable farmers are facing waterlogging in low-lying areas and poor ground water quality which affects tomato yields, moreover, due to over-irrigation and poor drainage, tomato crops are affected with root rot and wilting.
- Several farmers (10-15%) of Fazilka have already started organic tomato farming but they are not getting any premium prices in the market as they do not have awareness on Good Agricultural Practices (GAP) and natural farming techniques, organic certification. Therefore, they are not interested to continue organic farming.

3.2 Views of Tomato hybrid seed production and processing industry

During the survey, visited one tomato hybrid seed production and processing industry viz. ACSEN Agriscience Pvt Ltd. Gurugram and collected information of new prominent hybrid variety (have more than 21 days shelf life) which is yet to commercialize in India. During discussion and interaction with the officials of ACSEN Agriscience Pvt Ltd. Gurugram who involved in breeding of tomato hybrids, several points were noted which are listed below:

- Limited numbers of industries are involved specifically in production of tomato hybrid seeds though there is high demand of tomato seeds, so there is urgent need to grant the permission of Private agencies for enhancement of seed production by Govt. agencies.
- The most of public sector research institutes developed tomato varieties are either not popular due to non-availability in the marketplaces or varieties have low yield as compared to private companies' seeds.
- Farmers are always looking for tomato seeds which have high yield, disease and pest resistant varieties to minimize the cost of tomato production. They are not bothering about the variety have more shelf life or not. Farmers are also looking for short duration tomato varieties having bright red colour fruits. Examples of Saaho variety, which was found very popular in farmers of Karnataka but not suitable for processing. Similarly, Rani variety, which is suitable for table purposes, found very popular among the farmers of Fazilka district of Punjab.
- Though private tomato seed industries are very much interested in production of tomato seeds having more shelf-life and suitable for processing, but specific market demand is not available. Moreover, R&D cost for development of tomato variety suitable for processing purposes is very high and there was limited or no support from Govt. agencies for development and production of tomato seeds suitable for processing.

3.3 Views of Tomato pulp processing industry

A survey was conducted in the Punjab Agro Juices Ltd. (PAJL), Alamgarh, Abohar-Ganganagar Road, Abohar, Punjab-152116, India on 24th May 2025. During the survey, interacted with the managers, supervisors and also quality control staffs of the company and collected different background information.

- The company has modern infrastructure facilities equipped with machinery from CFT SPA Italy to process large quantities of fruits and vegetables (Capacity up to 10 MT/hour).
- The company has another plant at Jahankhelan, Hoshiarpur with cold storage and a deep freezer capacity of 1000 MT at each plant. Both the plants have an in-built capacity of handling and processing a variety of fruits and vegetables with the quick changeover from one fruit/vegetable to another, like tomato, mango, kinnow, guava, pear, amla, aloe vera, bitter gourd, carrot, chilies, jamun etc. the plants have aseptic packaging facilities for fruits and vegetable extracts. The processed products are preservatives free and have a shelf life of up to 24 months. With a legacy in the business of processing, they turn processed products into final processed food like juices, paste, sauce, ketchup, soup concentrate, jams, marmalades that packed and sold by B2C companies.
- All products are packed in 200-liter aseptic bags in MS drums with a shelf-life up to 24 months. It was noted that in Punjab, the tomato season begins from the end of April and continues up to June.
- For production of tomato paste and other tomato products, the company purchases tomatoes from the selected villages of Fazilka and surrounding districts of Punjab where they supplied the seedling which were produced in their polyhouse, but variety is selected by the farmers themselves.
- The tomato procurement prices are generally decided by bargaining with farmers depends on Mandi rates during the period. If mandi prices are Rs. 5.0/kg then the company provides at least Rs.1.0-Rs. 1.5/kg more than mandi price to either middleman or to the farmers directly if they agree to supply in bulk with maintaining their quality as specified by the Punjab Agro Juices Ltd.
- In general farmers prefers to grow dual purpose F1 Hybrid Rani tomato seed (*East-West Seed India Pvt. Ltd.*) for tomato production due to its firm, flat-round fruits, typically weighing 80-90 grams. It matures relatively quickly, about 65-75 days after transplanting, and is valued for its succulent red colour and easy cultivation. Though the variety has low TSS (4.0-4.5%) and low juice content which is not highly recommended for processing, but the company do not have any other options.
- The company is getting huge domestic as well as export demand for their tomato products but due to limited period of availability of tomatoes, the plant is running with other crops throughout the year.
- They suggested that Govt. should initiate some scheme for production of tomatoes under polyhouse which will benefit the processor as well as the farmers for stabilizing the tomato prices round the year. Farmers will be interested to take risk, if Govt. give subsidies to tomato farmers who are willing to start production of tomatoes under poly houses. Moreover, if tomatoes are available throughout the year, several stakeholders will be willing to start on tomato value addition activities.

3.4 Views of Mandi vendors, traders, suppliers and commission agents

To access the present status of post-harvest management practices, a survey was conducted in the Azadpur Mandi, New Delhi, during January-February 2025, and interacted with tomato vendors, traders, suppliers, commission agents, and also visited the APMC office. Flowing points were recorded as listed below:

- Azadpur Mandi received huge quantities of tomatoes during mid of January 2025 to the 1st week of February 2025, from nearby states viz., Haryana, Madhya Pradesh, and Uttar Pradesh.
- There were tomato price crashes in Azadpur Mandi due to the non-availability of sufficient numbers of buyers.
- As per discussion with traders, a huge loss of fresh tomatoes (15-20%) was recorded due to lack of cold storage infrastructure in the nearby areas (**Fig. 2**).
- There was lack of sufficient shade places to accommodate the quantities tomatoes received during the peak season. Traders are forced to keep their tomatoes under the sun for long period before being sold to the customers. They reported a loss of 2-5% was occurred due to non-availability of sufficient shade place in the mandi.
- Due to lack of awareness and spaces in the mandi, improper handling as well as sorting and grading was carried out under the Sun in open condition which ultimately caused rapid wastage (2-3%) during storage & before marketing (**Fig. 3**).
- Poor handling practices during loading and unloading of tomatoes in the mandi causes another loss of 2-3%, which the traders must recover from the buyers.
- In the mandi, major quantities of tomatoes (95-97%) are transported and stored in HDPE plastic crates (20-25 kg capacity) and rest quantities (3-5%) are either kept CFB boxes or open condition.
- During the glut season, traders reported that they are not able to store their tomatoes in cold storage because of uncertainty of buyers as well as non-availability of cold storage facilities in nearby mandi.

3.5 Views of Tomato Retailers

- As per retailers, tomatoes are highly perishable, so they cannot store the tomatoes for more than 2 days in the store.
- In general, they face weight losses (7-10%) due to delay in sale, grading loss (5-10%), spoilage & decay loss (10-12%).
- During the season, they procure tomatoes @ Rs. 7.00 to Rs. 10.00 & sale@ Rs. 10.00 to Rs. 15.00, while during the lean period they procure tomatoes @ Rs. 25.00 to Rs. 30.00 & sale@ Rs. 40.00 to Rs. 60.00
- During the lean season, they get more profits (40-50%) while, during the glut season, profits are less (20-30%).
- Retailers generally prefers hybrids tomatoes, having more shelf-life than local varieties.
- Most of the retailers (90%) kept their tomatoes in plastic crates in open conditions; however, only 10% retailers reported using refrigerated storage for retaining better quality.

For this study, secondary data were collected from several published research papers, reports and documents of Govt policies, plans, and programs, etc., relevant to the country.

Analyzed the published documents for valuable remarks that were presented in the following sections:



Fig. 2. Tomatoes at Azadpur Mandi, New Delhi during January-February 2025. (Source: Survey photographs)



Fig. 3. Common practices for handling, sorting, and grading of Tomatoes. (Source: Lamba et al., 2024)

In Tomato farming, small and marginal farmers play a significant role in overall production; they also risk high economic losses (Lamba et al., 2024). Due to adverse weather conditions like excessive rains or sudden heat spells, etc., impact productions and availability, resulting in extreme price fluctuations. These challenges directly affect farmers' incomes, disrupt supply chains, and lead to significant wastage.

As per the latest estimates by NABCONS (NABARD Consultancy Services) 2022, tomato incurs the second-highest postharvest losses (11.61%) in India, second only to guava (15%). The highest quantitative tomato food loss and food waste (FLFW) was found at the farm level (15%), directly impacting the farmers, at the retail level (12%), which is also quite high (Lamba et al., 2024).

However, tomato prices tripled in the month of July 2023 from around ₹30 per kg in the month of June 2023 to ₹109 per kg in the retail market by the end of July 2023 (NABARD, 2023). On the other side, it has been noticed that during peak season, the prices of tomatoes crash in some months, causing distress to farmers, even forcing some farmers to dump their tomato produce in the fields (Kumar, 2024 and Anon., 2025 a, b, and c). Yadav et al. (2025) reported that different factors that influenced the price fluctuations in tomato marketing are variations in yield, mismatches of demand and supply, farmers and middlemen seasonal supply preferences for urban markets over processors because of low farm gate prices, and the socioeconomic profiles of marketers along their supply chains.

The current varieties/hybrids, which cover over 90% of area, are not specifically bred for processing qualities. In major Mandi in

India, the price of tomato is normally ranges from Rs. 6-10 for crop harvested during January-May. However, it will skew to Rs 0.50 to Rs. 2.0 per kg during market glut condition and sometimes do not even meet the cost of production which is currently estimated between Rs 2.00 to 2.50 per kg on average. Hence, farmers are forced to sell their produce at the prevailing low price or leave them on the plant without harvesting as the prevailing market price will not even meet harvesting and transport expenses.

It was noticed that during the month of February 2025, tomato farmers faced major price dip in the market and many tomato farmers in Siddipet and Medak districts of Telangana abandoned their crop as traders offered just Rs 2.5 per kg which was not even sufficient to get the labour wages spent on harvesting (Anon., 2025a). Again, similar case was notice during the month of February 2025 from Jamshedpur, Jharkhand, India where farmers in the region were forced to discard their crops on roads and in fields due to unprofitable rates and farmers reported that Traders in Jamshedpur were offering only Rs. 2-3 per kg for tomatoes, which doesn't even cover the

transportation costs (Anon., 2025b). During June 2025, Anon. (2025c) reported a sharp crash in tomato prices in and around Mysuru, Karnata distressed, forcing many farmers to dump the produce on roadsides and at the APMC Yard though farmers were prepared to sell it at as low as ₹8 per kg in bulk or wholesale while, the cost of cultivation ranges between ₹60,000 and ₹1 lakh per acre.

However, the price shows an upward trend during off season of July-December, ranging from Rs 30-40/kg because of the short supply during these months. Recently during 2023-24, Kumar (2024) reported that the price of tomatoes has increased by 19 per cent particularly over the past two months, from January to the first week of March 2024. Prices have reached Rs 50 per kg at retail, exacerbated by weather disruptions. Before this, record-high tomato prices were observed in July and August 2023, when wholesale prices exceeded Rs 100 per kg in some regions, while the retail price crossed Rs 200 per kg. Kumar (2024) reported that in India, tomato prices were found to be very unstable, and it fluctuates with respect to time as well as region/area specific (Fig. 4).

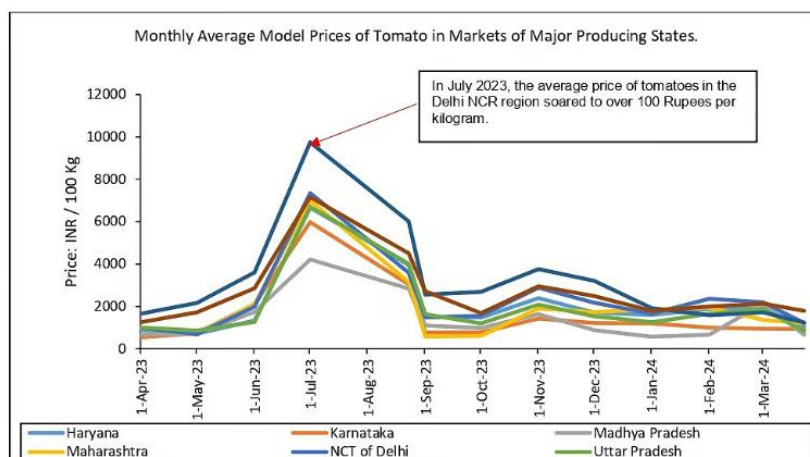


Fig. 4. Monthly average model prices of tomato in markets of major producing states (Kumar, 2024)

A significant increase in tomato prices (Kumar, 2024 and Gajanana et al., 2025), particularly in Madhya Pradesh, the National Capital Territory of Delhi, Maharashtra, Haryana, Karnataka, West Bengal and Uttar Pradesh were due to an abrupt decline in tomato supply, attributed to adverse weather conditions and the shifting of crops towards other higher-return-giving crops, which caused modal prices to skyrocket from a modest Rs 20 per kg to a staggering Rs 200 per kg in retail by July end and August 2023 (Kumar, 2024).

However, in response to the recent surge in tomato prices across the country, the central government has directed its agencies, including the National Agricultural Cooperative Marketing Federation of India Limited and the National Cooperative Consumers, Federation of India Limited, to swiftly procure tomatoes from marketplaces in major tomato-growing states such as Andhra Pradesh, Karnataka, and Maharashtra. Kumar (2024) reported that tomatoes come from multiple states throughout India in differing quantities. The southern and western regions collectively account for approximately 56-58 per cent of the nation's total tomato yield. In the Delhi-National Capital Region, the primary source of tomato arrivals is Himachal Pradesh, Haryana and Western UP, with a smaller portion sourced from Kolar in Karnataka (Kumar, 2024).

The processors consulted seek tomato at or under Rs 4.50 per kg to maintain commercially viable operations (though some indicated a willingness to go beyond Rs 5 per kg, particularly during the off-season). As a result, a large number of smaller tomato processing plants in India are reported to have suspended operations due to the unviability of processing in view of fluctuations in tomato prices and supply bottlenecks. This is because of high perishability nature of this crop, short duration crop and inability to store the crop for long, and production concentration in few states. Such nature renders tomato crop to higher price volatility compared to any other vegetable crop.

3.6 Strategies for stabilization of tomato prices

Reasons for the sudden upsurge in tomato prices is mismatch of "supply and demand", but there could be additional underlying factors, such as tomato viral diseases, heat waves, and delayed monsoons during April and May, which resulted in pest infestations on tomato crops, adversely impacting their quality and commercial viability (Tiwari et al., 2023a).

During the period from December 2022 to April 2023, numerous farmers experienced prices as low as ₹6 to 11 per kg for their tomato crop. Therefore, farmers were compelled to sell their

harvests at unprofitable rates or even abandon their produce, leading to a scarcity of supply. The transition in agricultural practices led to a decline in tomato production, exacerbating the shortage in supply and fuelling the increase in prices. Tamil Nadu, Gujarat, and Chhattisgarh experienced around 20% reduction in tomato production, further intensifying the scarcity of supply. Cities like Ahmadabad and Delhi witnessed a surge of 264 % and 186 %, respectively (Tiwari et al., 2023a).

The Consumer Affairs Ministry is planning to initiate a “Tomato Grand Challenge”, which aims to invite creative solutions for enhancing tomato production, processing, and storage. In parallel, the Tamil Nadu government has made the decision to sell tomato at a price equivalent to the cost of production in government operated Farm Fresh Outlets (FFOs). The primary objective of the Tomato Grand Challenge is to devise a comprehensive and strategic approach to minimize losses while incorporating value addition. This initiative seeks to introduce innovative, modular, and economically viable solutions for the development of technologies related to preproduction, primary processing, post-harvest practices, storage, and the utilization of tomato (Tiwari et al., 2023a). These solutions are intended to be applicable at various levels, including farms, rural areas, and urban settings:

- The aim of the Tomato Grand Challenge is to advance and promote the adoption of enhanced tomato cultivars, production techniques, and practices that are well suited for diverse weather conditions such as rainy seasons, dry heat, and humid climates. Additionally, the focus is on refining tomato processing methods, extending fruit shelf life, and implementing mechanized harvesting approaches. These scientific endeavours seek to improve the overall quality and efficiency of tomato production and utilization.
- Development and distribution of information systems related to crop planning, market intelligence for farmers, and interface platforms for various stakeholders such as farmers, nurseries, traders, and customers. These systems aim to provide valuable insights and facilitate efficient communication channels regarding production practices and other relevant aspects of tomato cultivation.
- Focus on the development of inventive post-harvest treatments and packaging solutions to effectively reduce losses that occur during the harvesting, handling, and transportation stages. These scientific advancements aim to mitigate postharvest losses and enhance the overall quality and shelf life of the tomato.
- Aims to explore ground-breaking storage technologies and solutions that enable extended preservation of tomato. These scientific advancements are crucial in reducing panic selling caused by the perishability of tomatoes, ensuring their availability for a longer duration.

3.7 Probable Solutions for Tomato Price Fluctuations

Several measures are suggested to prevent huge price fluctuation in tomatoes during the season and off-season, as well as in different regions of India, as listed below:

- **Establishment of real-time advisory services in tomato growing areas**, such as providing market, weather, and

logistics insights through digital platforms (like AgriTimes, Fyllo) to optimize harvest timing, storage use, and transportation.

- Proper implementation of e-NAM for early warning systems and market intelligence apps to provide real-time market price information by a price forecasting system & mobile-based SMS facilities to spread real-time market information for the tomato growers (NHRDF, 2018a, b and Gulati et al., 2022a).
- Encourage deployment of cutting-edge traceability, digital solutions, IoT-enabled monitoring, and blockchain to track temperature, quality, and provenance throughout the supply chain, and such transparency builds trust, reduces spoilage, and helps comply with quality/regulatory standards, critical for domestic and export markets (Jadhav, 2023, Anon., 2024b and Sizan et al., 2025).
- Increasing awareness regarding grading and standardization of tomato in India, therefore, there is urgent need to establish an integrated pack house in the Rural haat/weekly market so that farmer could get better price of their produce (NHRDF, 2018a and NHRDF, 2018b).
- Establishment of an alternate marketing system (co-operative marketing system/private market sangh) for small and marginal farmers to get a good return for their produce, which could help to avoid the malpractices and exploitation by the commission agents and local traders (NHRDF, 2018a and b).
- Encourage FPOs and cooperatives to directly sell to retailers and processors at fix MSP for tomato so that farmers receive price at least equal to the cost of production. Promote formation of farmer producers' groups and priority should be given to securing tomato supply for processors at a fixed price through contract farming (NHRDF, 2018 a and b and, Ramappa and Manjunatha, 2016, NHRDF, 2018 a and b, NAAS, 2022 and Mohan et al., 2023).
- Empower farmers & aggregators by collective capacity building via smallholders into FPOs to access shared storage, pooling, logistics, and improve farm-to-market coordination (Lamba et al., 2024).
- Creation of a favorable environment & friendly food processing policies to attract the investors by encouraging small-scale tomato processing enterprises and competitive for establishment of tomato processing units (Ramappa and Manjunatha, 2016, NHRDF, 2018 a and b; Gulati et al., 2022a and NABARD, 2023).
- Establishment of tomato processing industries near major production centers. Though India produces a huge quantity of tomatoes (during the year 2024-25), tomato farmers are facing several problems during production, transportation, storage, processing, and marketing.

3.8 Policy Issues on Tomato Varieties and Hybrids

Due to several policy issues and constraints in tomato value chain which are essential for making availability of varieties and hybrids for farmers, are summarized below:

3.8.1 Non-availability of high-yielding varieties: In India, more

than 1000 varieties of tomatoes are presently cultivated (Sriram, 2025a). These varieties (both open-pollinated and hybrid varieties) were bred by several private seed companies, national institutes, and state agricultural universities. But most of the tomatoes cultivated in India have a yield potential of 25-30 tons/ha, while tomatoes cultivated in developed countries have an average yield potential of 100-120 tons/ha (Anon., 2020; Tiwari et al., 2022; NAAS, 2022; Sampathkumar, 2023 and FAOSTAT, 2023).



Fig. 5. New tomato processing varieties (Arka Apeksha and Arka Vishesh) developed by ICAR-IIHR, Bengaluru (Source: NAAS, 2022; Tiwari et al., 2022; Tiwari et al., 2023).

3.8.3 Intellectual property rights (IPR): Non-availability of a strong intellectual property rights (IPR) regime in India to protect private companies, to motivate further investment in seed research (NABARD, 2023; Gulati et al., 2022a).

3.9 Climate Change Issues

3.9.1 Agro-techniques to combat Climate Change

To mitigate the impact of climate change on tomato production, several agrotechniques can be implemented across the tomato value chain. These include adopting climate-resilient varieties, optimizing water management through techniques like drip irrigation and water harvesting, and utilizing integrated pest and disease management strategies. Additionally, enhancing soil health through practices like no-till farming and cover cropping, and promoting precision agriculture with sensor technologies can also help build resilience (Benitez-Alfonso et al., 2023).

3.9.2 Real-time Advisory Services- Non-availability of proper real-time advisory services to provide weather forecast, logistics, and market to optimize harvest timing, storage use, and transportation for small and marginal tomato farmers (Jadhav, 2023 and Sizan et al., 2025). In India, due to adverse weather conditions like excessive rains or sudden heat spells, etc., production and availability are impacted, resulting in extreme price fluctuations. Tomato production faces various agronomic challenges, including pest and disease infestations, unpredictable weather patterns, and soil degradation (Gatahi, 2020 & Anon., 2024b). Limited access to large-scale production of tomatoes in greenhouses and poly houses to enhance yield and prolong season (NABARD, 2023; NAAS, 2022; Gulati et al., 2022a; NHRDF, 2018b; and Ramappa & Manjunatha, 2016).

3.9.3 High Cost of Production- The major problems faced by tomato growers are high prices of hybrid seeds, fertilizers, and chemicals (Kumar et al., 2020). Moreover, the cost of

3.8.2 Limited access to high-yielding F1 tomato hybrids:

Though ICAR-IIHR released two high-yielding F1 hybrids, viz, Arka Apeksha and Arka Vishesh (Fig. 5), that are suitable for processing and have a yield potential of 75-80 t/ha. But limited extension services were undertaken by Govt agencies to popularize among farmers. Moreover, seeds of these two varieties are not commercially available for large-scale production & adoption.

production is very high due to a lack of precision farming, farm mechanization, climate-smart technologies, organic/natural farming (NHRDF, 2018b; NAAS, 2022; Gulati et al., 2022a & NABARD, 2023).

3.10 Marketing Issues

- The small and marginal tomato farmers are facing malpractices and exploitation by the commission agents and local traders in weekly markets and mandis during tomato marketing (NHRDF, 2018a & b).
- Limited access/awareness on e-NAM for price forecasting system & mobile-based SMS facilities to spread real-time market information for the tomato growers (NHRDF, 2018a, b & Gulati et al., 2022a).
- No MSP for tomato, so farmers are forced to accept low prices during marketing, which does not even meet the cost of production. (NHRDF, 2018 a & b; Ramappa & Manjunatha, 2016; NHRDF, 2018 a & b; NAAS, 2022, and Mohan et al., 2023).
- Tomatoes are highly perishable in nature, hence quick means of transportation are very necessary; however, the major tomatoes produce at villages are transported to the nearby towns and city markets only by road (Gajanana et al., 2025).

3.11 Infrastructure Issues

- Non availability of infrastructures such as collection centers, cold chain (packhouses, pre-cooling units, cold storage, and refrigerated transport facilities), mobile pre-cooling units and solar-powered cold storage in remote areas, primary processing unit (sorting, grading and packaging facilities) & secondary processing units, export facilities and storage facilities at production clusters to extend shelf life and reduce post-harvest losses of tomatoes to get better price in

the peak season or in glut situation (Ramappa & Manjunatha, 2016; NHRDF, 2018a; NHRDF, 2018b; NABARD, 2023 & Gulati et al., 2022a).

3.12 Processing Issues

- There are hundreds of cultivars released for commercial cultivation by the ICAR institutions, Agricultural Universities, and private seed companies, but only a few lines have suitable processing traits for future trials (Gulati et al., 2022a & Tiwari et al., 2022). Moreover, tomato processing requires a consistent and abundant supply of fresh tomatoes, and poor tomato yields in India significantly hinder the tomato processing industry (Gatahi, 2020).
- Due to the high cost of production, Indian ketchup manufacturers import processed tomatoes from China as it is cheaper to import Chinese tomato paste than to procure from India (Gulati et al., 2022).
- Non-availability of tomato processing industries near major production centers.
- Many smaller tomato processing plants in India are reported to have suspended operations due to the unviability of processing in view of fluctuations in tomato prices and supply bottlenecks (Kumar, 2024).
- There is no dedicated tomato processing industry in India, and tomato processing is an opportunistic activity when tomato APMC prices fall below Rs. 4 per kg (NAAS, 2022).
- Limited food processing incentives and policies which discourage small-scale tomato processing enterprises for the establishment of tomato processing units (Ramappa & Manjunatha, 2016; NHRDF, 2018 a & b, Gulati et al., 2022a & NABARD, 2023).
- Limited access to start-up incubation support programs for collective capacity building via smallholders into FPOs (Lamba et al., 2024).
- Limited R&D support programs for scale-up emerging technologies (TRL 3-6) to take lab/pilot-scale innovations to field trials.

Improving the tomato value chain in India involves addressing inefficiencies and challenges at each stage, from production to consumption. To strengthen the tomato value chain in India, a complete approach connecting farmers, policymakers, the private sector, and supply chain stakeholders is essential. Below are key recommendations and suggestions to address the major gaps:

1. Replacement of low-yielding varieties by advanced breeding & genetic engineering.
2. Implementation of strong intellectual property rights (IPR) to invest in seed research.
3. Promote production of tomatoes in greenhouses and poly houses to enhance yield and prolong the season.
4. Introduce varieties suitable for polyhouse cultivation that meet the quality requirements of the processing industry in India.
5. Strengthening of the tomato value chain infrastructure by Government support with involvement of individuals, FPOs & PPPs.

6. Enhancement of awareness on grading, post-harvest management practices, processing, and value addition for better price realization.

7. Encourage fair trading to control and monitor the real-time market price information through the Governmental implementation of e-NAM.

8. Promote formation of FPOs and cooperatives to access shared facilities, improve collective bargaining power, and directly sell to retailers and processors at fixed MSP through contract farming.

9. Promote implementation of real-time advisory, cutting-edge traceability, digital solutions, IoT-enabled monitoring, and blockchain to build trust, reduce spoilage, and help comply with quality/regulatory standards, critical for domestic and export markets.

10. Encourage enhancement of tomato processing via different government schemes, create a favorable environment & friendly food processing policies to attract the investors.

11. Motivate mechanized harvesting, subsidize transportation costs, support small-scale processing industries, and establish processing industries in major tomato-growing regions.

12. Encourage industry-collaborated R&D activities and start-up incubation support programs for upscaling (improve TRL) of advanced (non-thermal) processing technologies, etc.

13. Promote investment in green energy-efficient processing technologies in tomato processing.

4. CONCLUSIONS

The country produces 21.54 million tons of tomatoes during the year 2024-25 but a huge post-harvest losses occurred every year as well as price fluctuation in tomatoes during different period is a major challenge. The price fluctuations and reduction of post-harvest losses can be achieved by implementation of several measures such as - encourage to use improved varieties/ hybrid suitable for dual purpose with better shelf life, urgent need for replacement of low yielding varieties, implementation of strong intellectual property rights (IPR), mechanized harvesting, MSP, enhancement of tomato processing, collaborated R&D activities & e-NAM, production of tomatoes in greenhouses and poly houses. To stabilize tomato price fluctuations in tomato value chain, introduce Farmer Producer Organizations (FPOs) to avoid dependency on middlemen in tomato marketing, strengthening of tomato value chain infrastructure by Government support, needs investment in green energy-efficient processing technologies in tomato processing. Establishment of On-Farm Packhouses facilities, promote implementation of low-cost storage structures at village/FPO level, introduce improved crates instead of gunny bags and establish cold chain linkages for long-distance supply are advised to be effective in minimization of post-harvest losses. The SWOT analysis reviled the possibilities to improve in tomato value chain areas and where the country has to give more emphasis so that tomato price could be stabilized as well as minimize the post-harvest losses.

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