

Study on
**Post - Harvest Losses
in Tomato Value Chain
in Madhya Pradesh**



Solidaridad



Kingdom of the Netherlands

Study on

Post - Harvest Losses in Tomato Value Chain in Madhya Pradesh

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ABBREVIATIONS / ACRONYMS

AGMARKNET	: Agricultural Marketing Information Network
APEDA	: Agricultural and Processed Food Products Export Development Authority
APMC	: Agriculture Produce Market Committee
CA	: Controlled Atmosphere
CAGR	: Compound Annual Growth Rate
CSO	: Civil Society Organisation
DAESI	: Diploma in Agricultural Extension Services for Input Dealers
FAO	: Food and Agriculture Organization
FGD	: Focus Group Discussion
FPO	: Farmer Producer Organizations
GHG	: Greenhouse Gas
GI wire	: Galvanized Iron wire
Gol	: Government of India
ICAR	: Indian Council of Agricultural Research
ICT	: Information and Communication Technology
KSA	: Kingdom of Saudi Arabia
KVK	: Krishi Vigyan Kendra
MIDH	: Mission on Integrated Development of Horticulture
MOFPI	: Ministry of Food Processing and Industries
MRL	: Maximum Residue Level
MT	: Metric Ton
NABARD	: National Bank for Agriculture and Rural Development
NGOs	: Non-governmental Organizations
NHB	: National Horticulture Board
PMFME	: Pradhan Mantri Formalisation of Micro food Processing Enterprises
PMKSY	: Pradhan Mantri Krishi Sinchai Yojna
PPP	: Public-Private Partnership
RKVY	: Rashtriya Krishi Vikas Yojna
SAARC	: South Asian Association for Regional Cooperation
SDG	: Sustainable Development Goals
SFAC	: Small Farmers Agribusiness Consortium
SHGs	: Self Help Groups
SWOT	: Strengths, Weaknesses, Opportunities and Threats
TSS	: Total Soluble Solids
UAE	: United Arab Emirates
USA	: United States of America
WBCIS	: Weather Based Crop Insurance Scheme

Dr. E. Ramesh Kumar
Commissioner
Horticulture and Food Processing
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FOREWORD

Tomato (*Solanum lycopersicum*) is the most widely cultivated vegetable in the world. The total global tomato production is around 180 million tons from around 5.03 million ha with productivity of 37 tons/ha (FAO, 2019). At the regional level, Asia accounted for almost 62% of production share, followed by the USA (13.2%), Europe (12.6%) and Africa (12%). India being the second largest producer of Tomatoes contributes around 10.5% (19-20 million tons) of total tomato production in the world.

Madhya Pradesh is the leader in terms of area and production of Tomatoes. The state is the second-largest producer of Tomatoes after Andhra Pradesh. However, area wise Madhya Pradesh ranks first in tomato cultivation among the major tomato producing states of India but the productivity is lower than these states. The area and production of tomatoes in the state is increasing continuously, which contributes significantly to the country's tomatoes production as leading tomato producers. This indicates the growing trend of farmers towards horticulture farming and specifically towards tomato production.

As a commercial vegetable, tomato holds a considerable prospect for securing the livelihood of the farmers and other value chain players viz; aggregators, traders and wholesalers in the state of Madhya Pradesh.

Given the growing demand, a robust value chain for tomatoes needs to be developed in the state.

The present study on "Post-Harvest Losses in Tomato Value Chain In Madhya Pradesh" highlights the issues and areas in tomato production, post-harvest management, marketing, processing as well. The report has provided detailed information regarding the current production trends, post-harvest practices, price volatility, seasonality, market functionalities, price build-up, and economics of stakeholders. Major gaps in value chain like; price volatility, absence of proper and developed market linkages, access to proper technical knowledge and extension support to the farmers, storage infrastructure and processing units have been identified in the report as well. Based on this, recommendations and possible implementation strategies for intervention have also been highlighted in the report.

I appreciate the efforts of Solidaridad and the Consulate General of the Kingdom of the Netherlands in India - Government of India for coming up with this interesting report. The study will provide an excellent framework for strengthening existing initiatives as well as designing of new strategies involving Government departments, organisations and private players, in coming days on the similar theme; for addressing the post-harvest losses in Tomato value chain in Madhya Pradesh and increasing the farmer's income and tomato production sustainably. I hope that this endeavor will help in strengthening the existing value chain of tomatoes in the state and prove beneficial to all the related stakeholders.

Best Wishes


Dr. E. Ramesh Kumar



Kingdom of the
Netherlands

Michiel Vanerker

Agricultural Counsellor for India and Sri Lanka,
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MESSAGE

While the whole world came to a stand-still in the last two years due to the pandemic, the global supply chain for agriculture products has worked more or less seamlessly so that there was no food scarcity or security issues across the world. All actors in the agriculture supply chain worked together to ensure that everyone had enough food. However the last two years has also shown us the vulnerability of the agriculture sector from the long term challenges.

Agriculture is getting impacted by climate change but activities of the agriculture sector also have their impact on the environment and contribute to climate change. While some of the challenges the agriculture sector faces due to climate change require long term investment and planning, some of the challenges can be dealt with imminently. Food Loss and Waste (FLW) is one such challenge. FLW leads to emission of greenhouse gases but also natural resources required to produce the food are wasted.

Hence Sustainable Development Goal (SDG) 12 seeks to “ensure sustainable consumption and production patterns.” The third target under this goal (Target 12.3) calls for cutting in half the per capita global food waste at the retail and the consumer level, and reducing food losses along production and supply chains (including post-harvest losses) by 2030.

SDGs are the main pillars of co-operation between India and the Netherlands. The Agriculture Department of the Embassy of Kingdom of the Netherlands actively seeks cooperation with Agriculture Ministry at the Central and State level, private sector and knowledge institutes to address the challenge of FLW that will help India achieving SDG 12.3.

Last year, my Department requested Solidaridad to explore possible ways to work with stakeholders to address losses in the tomato value chain. Solidaridad, an organization from the Netherlands, based in Bhopal, Madhya Pradesh, is already working with the local government agencies and private sector to implement Good Farming Good Food program. Good Food Good Farming program is funded by the Netherlands government under the Sustainable Development Goal Program. I am happy Solidaridad agreed to execute this baseline study on the post-harvest losses in tomato value chain.

The study helps to identify factors responsible for post-harvest losses and the study also gives recommendation on mitigating those losses. We are keen to co-operate with the Government of Madhya Pradesh and stakeholders in the tomato value chain in the next steps to be taken, to share knowledge, technology and starting materials from the Netherlands and support implementation of those recommendations.

This will not only benefit tomato growers in Madhya Pradesh but also help in mitigating climate change and reduce wastage of precious natural resources.

Best Wishes

Michiel Vanerker

Dr. Shatadru Chattopadhyay
Managing Director
Solidaridad Network Asia

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MESSAGE

It gives me great pleasure to share the study report on- “Post-Harvest Losses in Tomato Value Chain In Madhya Pradesh” with our distinguished stakeholders and readers. The report gives an insight about the existing tomato value chain in the state of Madhya Pradesh while highlighting the gaps related to production, productivity, pricing, marketing, infrastructure, technologies and post-harvest losses in the existing tomato value chain in the state.

India is a leading producer of tomatoes and the country ranks among the top tomato producing countries in the world. Due to its high market demand, tomato is cultivated as a commercial vegetable crop, in India. Tomato cultivation plays a major role in contributing to the livelihood of the farmers and many value chain players. Madhya Pradesh is the leader in Tomato area and production. The State holds immense untapped opportunities for farmers, businesses, processors, service providers and many other value chain functionaries.

The report is the outcome of painstaking survey, detailed data analysis, views and information received from relevant stakeholders, market players, producer and last but not the least, senior officials at State and district level from department of Horticulture and Agriculture.

I would like to extend my heartfelt gratitude to the Horticulture and Food Processing Department, Government of Madhya Pradesh and Consulate General of the Kingdom of the Netherlands in India as well as our distinguished stakeholders for the invaluable support and guidance during conduction of the study. I am glad for the excellent work done by the Solidaridad team in completion of the study.

I am hopeful that this report will work as a reliable reference material to everybody concerned with the Tomato value chain. This will be helpful in formulation of strategies and interventions to strengthen and enhance efficiency of Tomato value chain while promoting Madhya Pradesh as a tomato production and processing hub of India.

Best Wishes

Dr. Shatadru Chattopadhyay

Executive Summary

Scientifically, tomato is a fruit, but in culinary usages, it is considered as a vegetable. Tomato is widely grown and equally consumed in all parts of the world. India is the second-largest producer of tomatoes in the world and contributes nearly 14% of the world's tomato production. Indian tomato has a good demand in the international market namely in the countries; United Arab Emirates, Nepal, Qatar, Maldives, Oman, Bangladesh, and Singapore. Between the year 2006-07 and 2016-17, export of tomatoes and tomato products from India increased more than nine-fold in terms of export value (in US\$).

The tomato is an integral part of the Indian vegetable basket thus, changes in price and supply create a significant impact on producers, consumers as well as on our food security. Among the Indian states, Madhya Pradesh is the largest producer of tomatoes in India, followed by Andhra Pradesh, Karnataka and Gujarat. Out of the total 51 districts of Madhya Pradesh, the top 10 tomato-producing districts have produced more than 58% of Tomatoes of the state in the year 2020-21.

Although Madhya Pradesh is among the leading Tomato producing states in the country, it faces several challenges in terms of its production and marketing which hinders the state to realize its complete potential. With this backdrop, the tomato value chain study has been carried out in selected districts of Madhya Pradesh. The study intended to analyze the production trends, post-harvest practices, price volatility, market functionalities, price build-up, and economics of stakeholders of the Tomato value chain.

The study involved collection of relevant information from both primary and secondary sources. The secondary data on production, yield, market price, and export pattern of tomatoes and tomato products in India have been collected from pertinent literature, related Government Departments and authentic websites and other sources. The primary data was collected from different tomato value chain stakeholders and Government officials through personal interviews and focused group discussions in the districts of Shajapur, Ujjain, Dhar, Jhabua, Mandsaur, Dewas, Agar Malwa and Chhindwara.

Tomato is a profitable crop and a good number of farmers grow tomato in both Kharif and Rabi seasons. The average production of tomato in a hectare varied between 600 and 800 quintals. Depending on the price and quality of inputs and agriculture practices followed, the cost of tomato production in a hectare of land was around ₹ 1,29,000 (€ 1562,32). Out of the total cost of production, more than 40% was invested for inputs like seeds, fertilizers, pesticides, and other crop protection chemicals. The cost of production for a kg of tomatoes including post-harvest practices like; sorting, grading, packing, transportation to local Mandi and handling; was around ₹ 2.87 (€ 0.03). In case the produce was transported to distant Mandi the cost of production reached to ₹ 5.16 (€ 0.06) for a kg.

As was found during the survey, majority of the tomato farmers were smallholders who were primarily dependent on other fellow farmers and local agri-input dealers for relevant crop based advisory and technical extension support. The farmers mentioned of limited exposure to relevant Government

1 EUR = 82.5693 INR, on the Date : 9th April 2022

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advisory bodies like the Horticulture Department, Krishi Vigyan Kendra for knowledge and extension support. This noticeable gap in suitable agri-extension support and technical knowledge support, observed in the clusters, affected the tomato productivity and yield in those clusters. Tomato cultivation and production is a labor-intensive work and most of the workforce engaged in the process were either unskilled or semiskilled. A gap in skills required for proper pre-harvest, harvesting and post-harvest management techniques emerged due to the same. Along with this, unpredictable climatic patterns and extreme weather events (untimely and ill disturbed rainfall, flooding, hail storm, frost) and increased insect/pest/disease infestation also posed serious problems to tomato crops culminating in lower yield. All these factors led to considerable crop loss during production and post-harvest. Furthermore, a shortage of basic infrastructures like; cold storages, packhouses, processing units existed in the clusters. Tomato being a perishable fruit requires to be stored at appropriate temperature and atmospheric conditions. Lack of availability of such infrastructures compelled the farmers to sell the produce right away at nearby markets.

The tomato farmers in a village and cluster sold their produce through local aggregators. This was the main marketing channel identified for the area. A local aggregator is in general a big farmer who collected tomatoes from the farmers of the village/ cluster and transported the same to nearby APMC/ Mandi for selling. The farmers were charged separately for transportation and packaging which was deducted from their total sale cost. Few farmers also reported directly selling of their produce to the traders of distant APMC/ Mandis and sometimes directly to the consumers through roadside markets. Fewer farmers (1.8%) informed to have a pre-harvest marketing contract with agents and about 1.5% of farmers sold their produce directly to the processors.

Absence of exact market information and alternative marketing channels were observed to be a major gap in the existing tomato value chain in the identified clusters. Further, the presence or existence of farmers' collectives/ FPOs in horticulture commodities has not been found during the study. The registered FPOs handling horticulture commodities in the state are also in very nascent stage and struggling with basic management and business compliances.

Market volatility was also a prevalent issue faced by the tomato farmers. The price of tomatoes in Mandi varied from ₹ 2 (€ 0.02) to ₹ 60 (€ 0.72) depending on the season of harvesting. Tomatoes were least available between May and July months and during this period the price of tomatoes remained on higher side. Similarly, in the months of December to February, due to high availability of tomatoes in the region the price remained on lower side. Price of produce is mainly decided by the value chain intermediaries rather than producers, as the latter have hardly any access to direct market.

The gross income from tomato production and sell ranged between ₹ 4.87 lakhs (€ 5893,03) and ₹ 6.09 lakhs (€ 7375,57). However net earning did not show much difference among different marketing channels. This indicated that distant markets might have better prices but net returns did not differ much. Price gap in alternate markets had its own limitations.

It has been estimated that about 17.4% losses occurred during entire value chain of fresh tomatoes. At the farm level the losses were 6% which included harvesting, grading, packing and aggregation; local

trader and wholesaler level losses were 3.4 %, whereas, remaining losses occurred at retailer level which was about 8.0%. It was observed that the post-harvest losses in fresh tomato value chain were very high in comparison with the processed tomato value chain. The losses in the processed tomato value chain are around 3 % (sorting of diseased, insect affected and rotten tomatoes), this is because of the shorter supply chain in processed tomatoes.

The study has observed increasing price trend during the lean season and lower price trend during the peak season. The seasonality in production and irregular shocks are the two important components contributing to the variations in the prices of tomato. Seasonality in prices is a result of the varying pattern of production of tomato during different months of a year. On the other hand, shocks often originated from the uncertain weather conditions and other unpredictable events.

Based on the survey data analysis and the gaps identified, the study recommends proper extension and knowledge support to tomato farmers through conducting training programmes, setting up demonstration plots and capacity building of lead farmers. Timely crop advisory can also prove beneficial in minimization of crop losses. Awareness about cultivation of processable tomato varieties is also important for the farmers and the same must be ensured during training and extension support. It is crucial to introduce such varieties in extension system through consultations with ICAR research centres, State Agricultural Universities, Seed Companies and Processing Industries. Efforts should also be made at cluster level by the Government Departments and the CSOs/NGOs to sensitize the farmers about the existing Government schemes and ensure maximum extension of the schemes by the farmers.

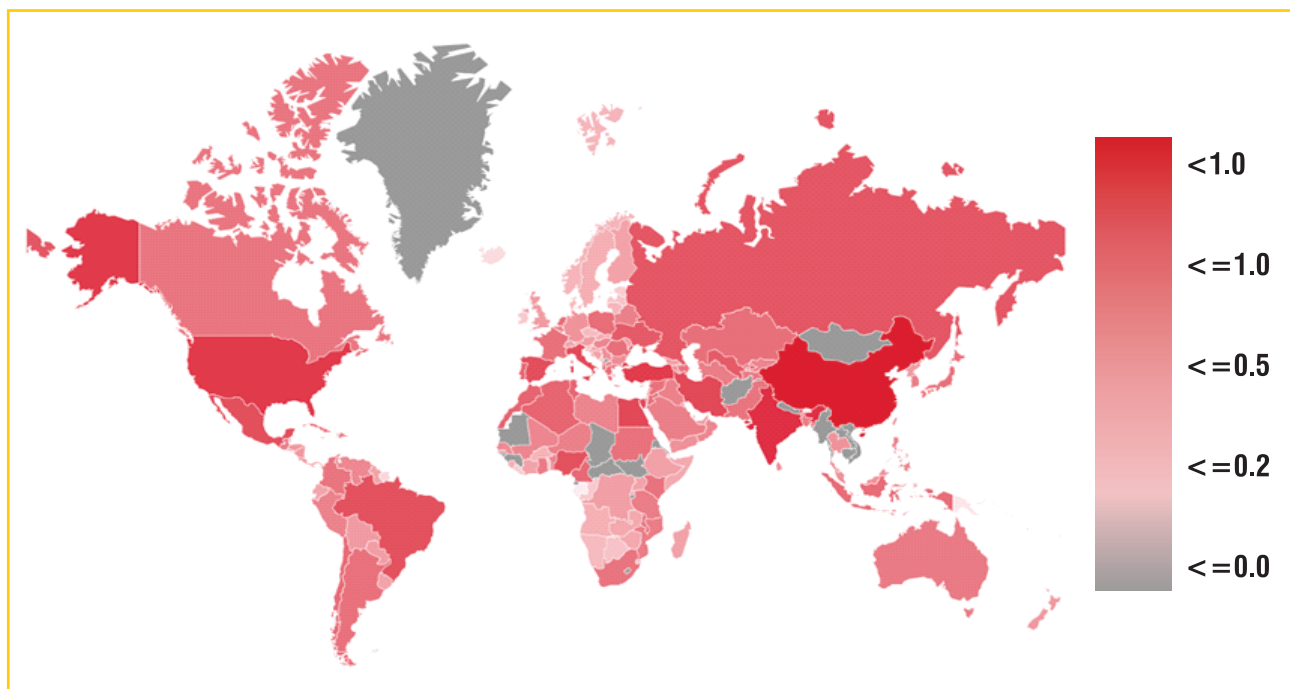
Furthermore, establishment of required infrastructure facilities namely; cold storage units, packhouses and processing units will help minimise post-harvest losses and enhance market potential of tomatoes. A proper marketing information system could be established for the farmers for obtaining information about market prices; location wise, to make informed decision. In this regard, app-based systems can also be thought of. The supply chain standards for sustainable tomato can also be developed. Support to existing FPOs and formation of FPOs in this regard is also pertinent.

The interventions proposed to address the food loss and food waste would potentially contribute towards increased availability of food, enhancing farmers' income, easing pressure on land and water resources and reducing green-house gas (GHG) emissions. The actions undertaken to address the causes of food losses in the tomato value chain would potentially contribute towards multiple UN Sustainable Development Goals (SDGs).

Global Scenario – Tomato Production

The tomato is the most widely cultivated vegetable in the world. The total global tomato production is around 180 million tons from around 5.03 million ha with productivity of 37 tons/ha (FAO, 2019). At the regional level, Asia accounted for almost 62% of production share, followed by America (13.2%), Europe (12.6%) and Africa (12%). More than half of the worldwide tomato production (58%) is concentrated in four countries. China is the leading tomato producer worldwide (34.72%) with nearly one third of worldwide production followed by India (10.5%), Turkey (7.1%) and the United States of America (6%).

The global market comprises of around 75% for the fresh produce and around 25% for the processing. Among the major countries producing this crop; China occupies premier position in area covered followed by India. However, the productivity harnessed in China is almost double than that of India. The USA ranked third in area coverage, but leads in productivity of tomato. Due to the lower yields of Indian tomatoes, it increases the cost of cultivation and makes India uncompetitive in processed tomato. On the other hand, China is able to produce tomato paste at much cheaper rate because of low cost of raw material and processing. Even Indian manufacturers prefer to import cheap Chinese tomato paste.



Top 10 Tomato Producing Countries

The top 10 producing countries account for around 75 % of global production of tomatoes (Chart 1 & 2). The per hectare yield of tomatoes in India is the lowest (24.34 ton/ha) among top ten producing countries. The USA has the highest yield : 98 ton/ha.

Chart 1 : Country-wise Area and Share in the Tomatoes Production

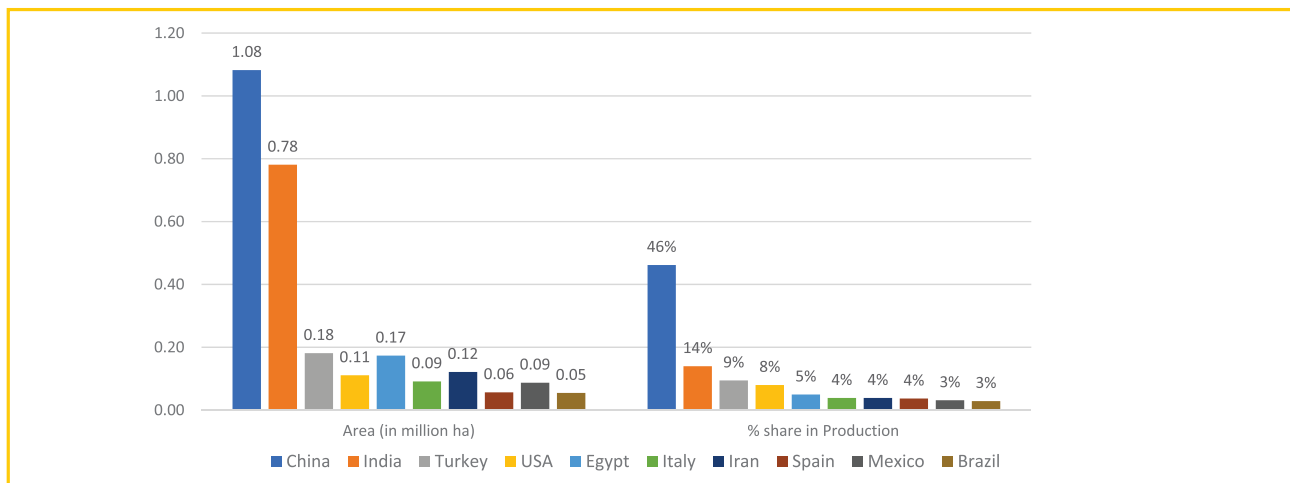
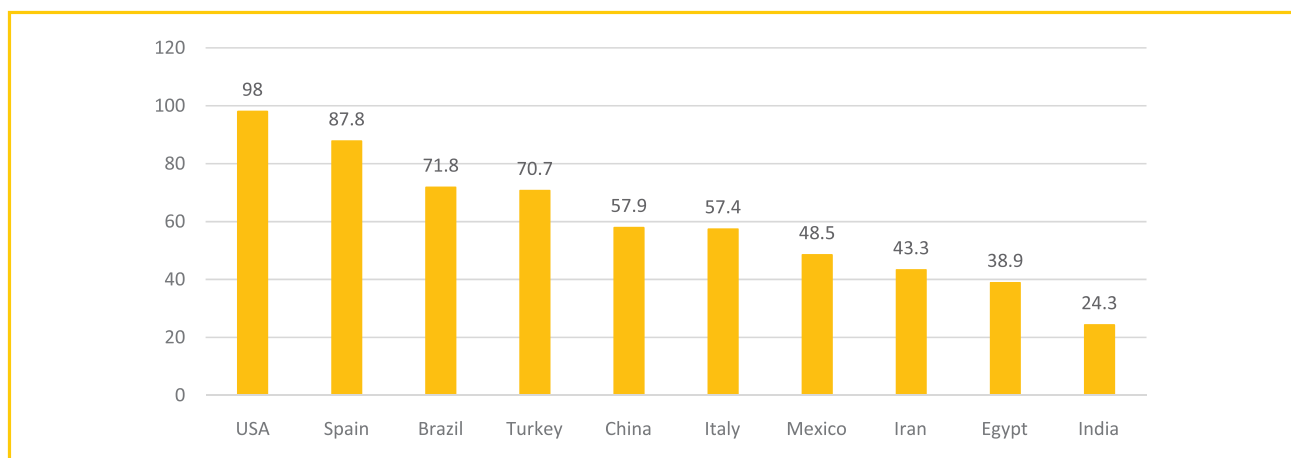


Chart 2 : Country wise Tomato Productivity (in MT/ha)



ROLE OF THE NETHERLANDS IN TOMATO SECTOR IN INDIA

The Netherlands has basically reinvented the tomato. Drawing on a centuries-old tradition of horticultural innovation, the Netherlands pioneered growing techniques that allowed them to breed varieties that travel well and burst with flavor. The key to success in this arena is a long horticultural tradition, and decades of developing high-level knowledge and techniques. World-class research, along with an insatiable appetite for innovation, makes the Netherlands a prime environment for the tomato sector.

However, when it comes to co-operation with India, Netherlands organisations are more interested to share knowledge and technology across the value chain. Food safety issues, shift in diet pattern of consumers and increase risk of pest and disease attacks are challenges that tomato growers face in India. Netherlands based seed companies like Rijk Zwaan, Enza Zaden, Bejo Zaden, Nunhems (now part of BASF) and East West Seed are working with farmers in India to offer better planting materials that can help growers to grow different varieties of tomato, minimize usage of agro-chemicals and double yield while growing in greenhouses.

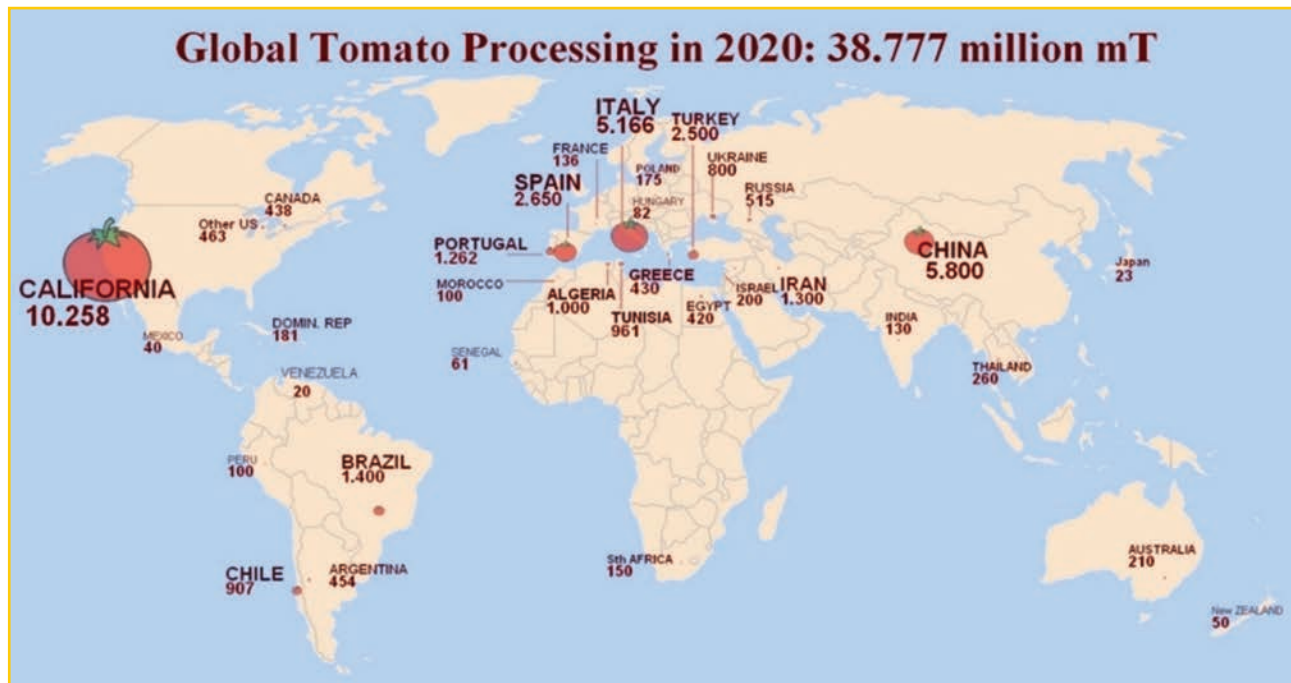


Bayer Crop Science is working with Wageningen University & Research, the top agriculture university of the world based in the Netherlands, on dealing with food loss and waste and had some studies around Seminis tomato variety Ansal for India.

Holland Door, a co-operative in the Netherlands which specializes in training and education implemented train the trainer program along with KVK Baramati in the Indo – Dutch Center of Excellence for Vegetables on topics like dealing with post-harvest losses in vegetable supply chain in India. And of course, the hardware is state of the art, from design of efficient greenhouses to drip irrigation and climate control systems, from germination rooms to cold storage.

Global Tomato Processing

The 13 main production and exchange countries¹ (7 in the EU, China, the USA, Turkey, Iran, Chile and Ukraine) exported approximately 6.8 million tons of finished products in the three leading tomato categories i.e., paste (3.4 million tons), canned tomatoes (whole or pieced, peeled or unpeeled – 1.9 million tons) and tomato sauce and ketchup (1.5 million tons). Paste is the main tomato product, both in production volume and in commercial value.



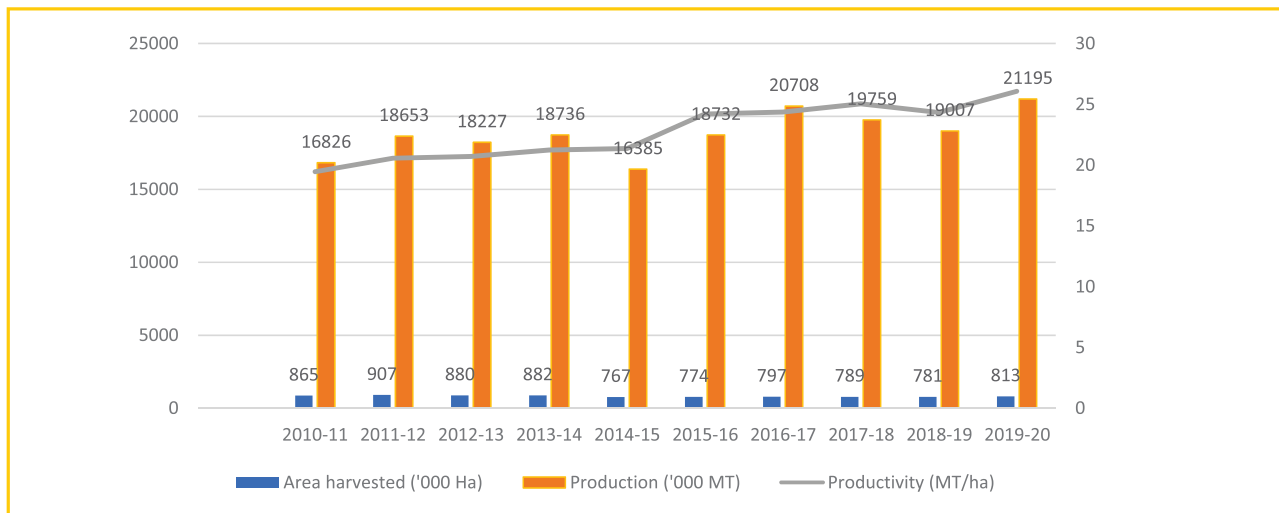
Indian Scenario

The tomato is one of the most important vegetables in India. It is interesting to note that tomato is cultivated in almost all the Indian states indicating its demand, popularity, its use in culinary and food consumption. This also shows that this crop can be cultivated in diverse agro-ecological regions of India.

India being the second largest producer of tomatoes contributes around 14 % (19-20 million tons) of total tomato production in the world. The total production and productivity has showed an increasing trend whereas the area under cultivation has dropped between 2015 and 2019 (Chart 3). During this period, the CAGR for production (2.34) and productivity (2.97) was positive, while for area (-0.62) it was negative. The productivity was hovering around 20-25 MT per hectares during this period.

¹https://www.tomatonews.com/en/background_47.html

Chart 3 : Area, Production and Productivity of Tomatoes in India

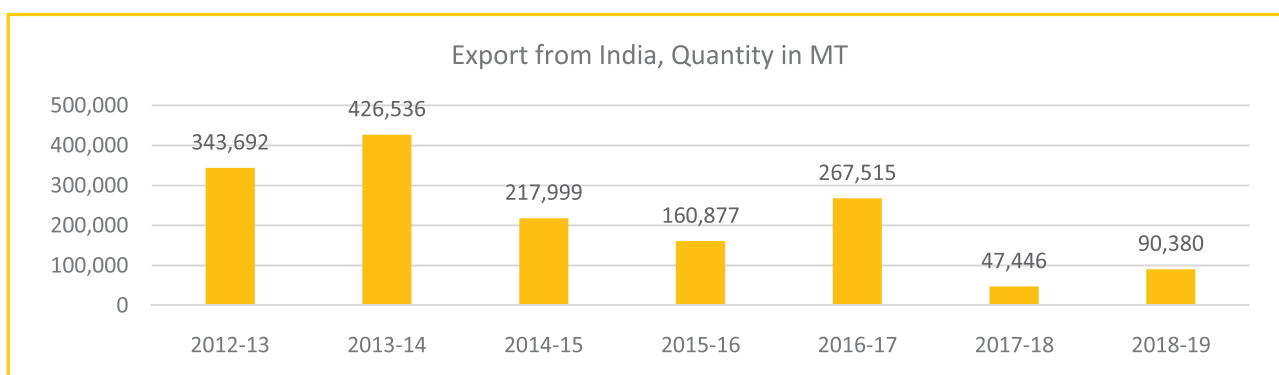


Export of Tomatoes from India

India mainly supplies tomato to Gulf countries: United Arab Emirates and nearby countries like Pakistan, Bangladesh and Nepal. Export quantity varies from 47,000 tons to 2,17,999 tons, depending upon the availability and demand from other countries (Chart 4). Recently exports to Pakistan have halted due to tensions between the two countries.

The export of tomatoes from Madhya Pradesh is not reported yet. The main reasons observed were non-availabilities of Integrated Pack Houses, MRL (Maximum Residue Level) testing facilities, lack of cold chain infrastructures etc. The exporters from other states procure tomatoes from Madhya Pradesh through wholesalers or Mandi Agents.

Chart 4 : Export of Tomatoes from India (2012-13 to 2018-19)



(Source: DGCI&S)

The chart shows that the export of tomatoes from India has decreased over the years. The major volume was exported to Pakistan which is now halted. In the year 2018-19, India exported 0.17 million tonnes of tomatoes (fresh and fresh equivalent to paste), which is less than 1% of 20 million tonnes of tomatoes produced in the year 2018-19 (Gulati et al., 2022).

Tomato Processing in India

India contributes to around 14% of the world's total tomato production and the second largest producer of tomatoes in the world. However, India processes only around 1% of the total tomatoes produced annually. This impacts farmers by way of high-post harvest losses and low returns during the periods of market glut. However, the demand for the processed tomato products is growing at an annual rate of about 40% for the last 4 years.

Challenges for the tomato processors in India

- Mostly the varieties cultivated by farmers are suitable only for table purposes and not for the tomato processing industry. The tomatoes cultivated in India are acidic with large locules and thin wall, thus it requires more fruit to produce per unit of tomato paste.
- Large proportion of physical losses during transportation and storage affects the product quality.
- Lack of availability of viable/low-cost raw material for processing due to the low productivity of tomatoes.

Madhya Pradesh – The Food Hub of India

Madhya Pradesh is popularly known as the food hub of India. A million of farmers in the state are dependent on agriculture for their livelihood. The agricultural sector is largely dominated by small and marginal farmers. The state is ranked number 1 in the production of oranges and coriander production, 2nd in tomato, onion, green pea and guava production; and 3rd in lemon and chilli production.

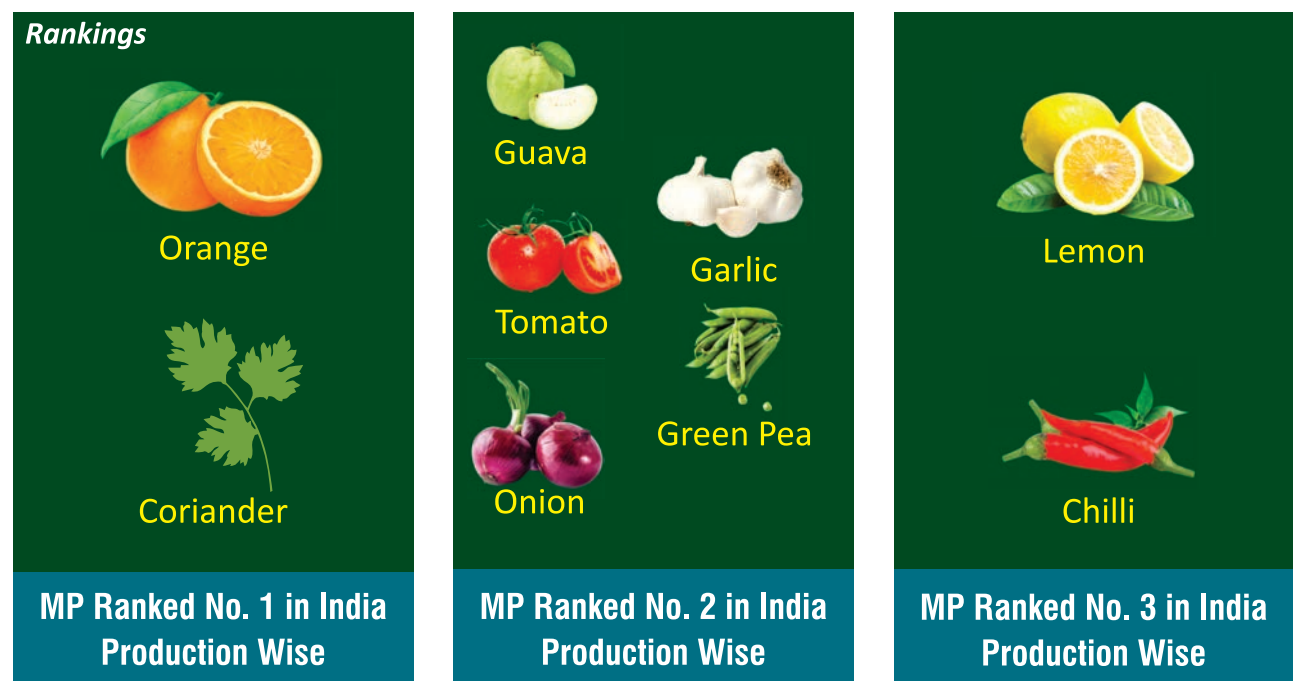


Fig 1 : Ranking of Madhya Pradesh in Horticulture Segment

The horticulture segment has become the sunrise sector for the Madhya Pradesh state (Fig 1). The state is the third largest producer of vegetables. According to the latest figures, Madhya Pradesh is leading in the production of Tomato and the state has similar share as of Andhra Pradesh which is the largest Tomato producing state in the country (Table 1).

Table 1: Area and Production of Horticultural Crops in Madhya Pradesh

S. No.	Crop	Year 2019-20		MP Rank
		Area	Production	
1	Fruits	3,87,000.00	79,47,000.00	7 th
2	Vegetables	9,60,000.00	1,90,43,000.00	3 rd
3	Spices	7,56,000.00	42,60,000.00	2 nd
4	Flowers	33,000.00	3,86,000.00	3 rd
5	Medicinal and Aromatic Crops	39,000.00	99,000.00	1 st
Total		21,75,000.00	3,17,35,000.00	

Madhya Pradesh Tomato Scenario

Madhya Pradesh is leader in terms of area and production of tomato. The state is the second-largest producer of tomatoes in India after Andhra Pradesh. Whereas, Karnataka is in third position (2019-20). All the three states contribute approximately one-third (32.25%) of the country's total production of tomatoes. Area wise, Madhya Pradesh is the first in tomato cultivation among the major three tomato producing states of India.

The area and production for tomatoes in Madhya Pradesh is increasing continuously and is contributing significantly to country's tomatoes production as leading tomato producers. This indicates the growing trend of farmers towards Horticulture Farming and specifically towards tomato production.

Between the years 2015-16 and 2019-20, Madhya Pradesh showcased incredible growth in tomato production (Table 2), and during this period production grew by 3.56 % CAGR.

Table 2: Area, Production and Productivity of Tomato in Madhya Pradesh

Year	Cultivated Area(000 ha)	Production('000 MT)	Productivity (MT/ha)
2010-11	28	347	12.50
2011-12	55	1350	24.40
2012-13	63	1845	29.50
2013-14	66	1937	29.50
2014-15	70	2177	31.00
2015-16	75	1923	25.71
2016-17	95	2723	28.54
2017-18	84	2419	28.62
2018-19	85	2516	29.46
2019-20	93	2723	29.30
CAGR	12.75%	22.88%	8.89%

(Area in ha, Production in MT, Productivity in MT/ha)

Table 3 : Area (in 000 ha), Production (in 000 MT) and Productivity (in MT/ha) in Major Three Tomatoes Producing States of India

		Andhra Pradesh	Madhya Pradesh	Karnataka
2015-16	Area	59.08	73.7	60.98
	Production	2236.56	2285.9	2046.14
	Productivity	37.86	31.02	33.55
2016-17	Area	55.5	95.4	60.45
	Production	2100.95	2719.57	1916.86
	Productivity	37.85	28.51	31.71
2017-18	Area	61.67	84.53	64.25
	Production	2744.32	2419.28	2081.59
	Productivity	44.5	28.62	32.4
2018-19	Area	69.54	85.41	62.01
	Production	2503	2516	2030
	Productivity	37.85	28.51	32.74
2019-20	Area	78.1	92.9	69.2
	Production	2815	2723	2540
	Productivity	36.04	29.31	36.71

The production of tomatoes has increased tremendously which has been reflected in the CAGR from 2010-11 to 2019-20. However, there is huge gap between the actual and potential productivity per hectare. The current productivity levels of the Madhya Pradesh state (29.3 t/ha) are 23% lower than the average yields in the state of Andhra Pradesh (36.04 t/ha) (Table 3).

Tomato Clusters of Madhya Pradesh

Out of the total 51 districts of Madhya Pradesh; top 10 tomato producing districts, produce about 58% of tomatoes of the state (Table 4). The historical data highlights the drastic ups and downs in the production. This is because of the high sensitivity of the tomato cultivation and production against the climate and environmental factors.

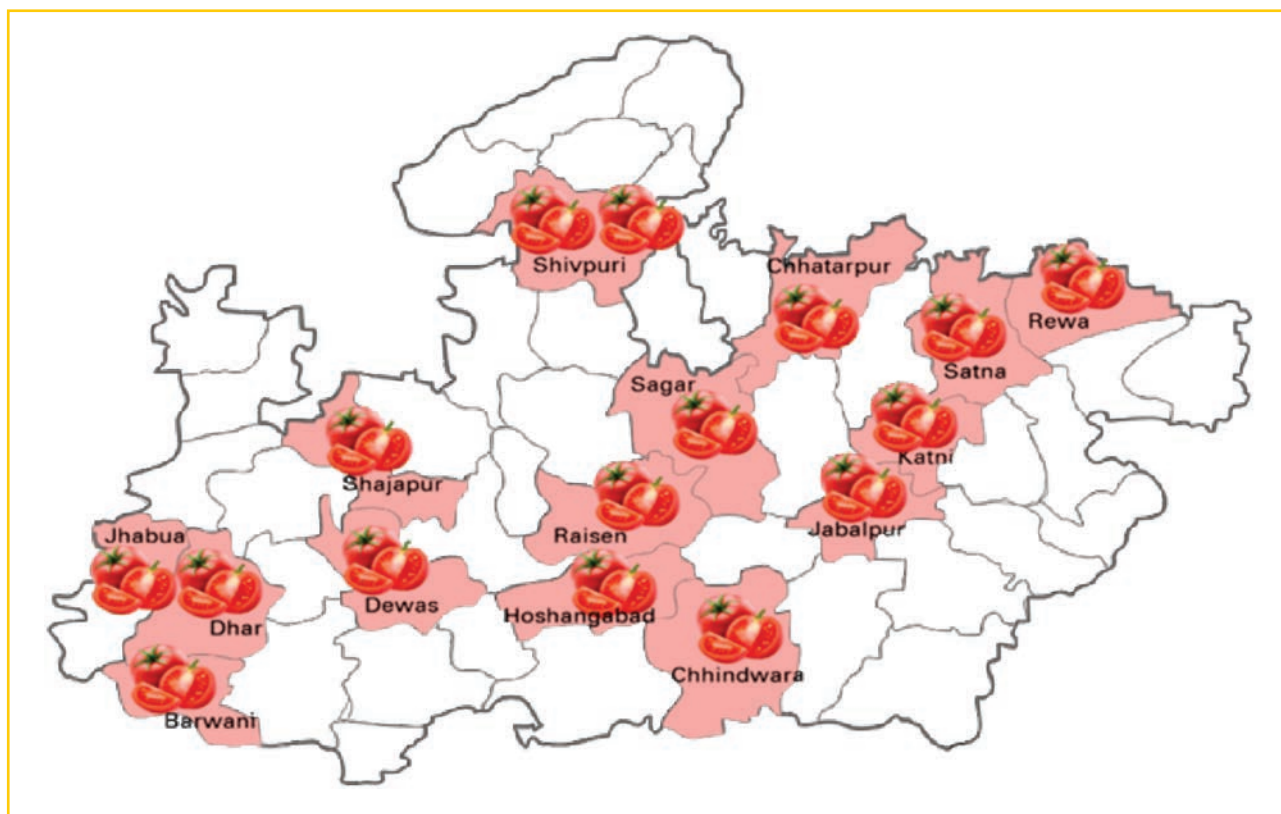


Table 4 : District wise Production of Tomatoes (MT) (Year 2016-20)

District	2016	2017	2018	2019	2020
Shivpuri	383315.00	253642.00	296143.00	315720.91	342210.00
Chhindwara	236830.00	250054.00	274470.00	274470.00	308075.00
Sagar	185000.00	172420.00	170247.00	196631.00	229793.00
Raisen	113432.00	129076.00	131325.00	131325.00	151750.00
Barwani	50468.00	67176.00	65376.00	73728.00	131976.00
Jhabua	171430.00	134400.00	129205.00	130800.00	130800.00
Satna	63555.40	57716.00	69139.70	80489.00	124353.00
Dhar	107625.00	108247.00	119479.80	118554.00	118554.00
Dewas	57764.00	72217.00	96993.00	98244.52	107787.37
Anuppur	40462.50	48463.80	53384.38	83297.85	98910.81
Others	1312801.10	1125865.00	1110315.00	1220247.00	1254960.00
Total	2722682.98	2419276.37	2516078.26	2723506.95	2999169.57

Study Background

Baseline Study on Post-Harvest Losses in Tomato Value Chain in Madhya Pradesh

Madhya Pradesh has significant contribution in production of TOP (Tomato, Onion and Potato) crops and there appears to be ample opportunity to promote and strengthen the TOP value chain. All the three crops offer the opportunity of value addition by creating needed infrastructure and motivating entrepreneurs for processing the produce and this will further provide immense help to enhance the income of the farmers in the state. Poor productivity, high post-harvest losses and lack of infrastructure for storage, processing and pack houses etc. are the key challenges that restrain the efficient value chain in the state.

In this context, a baseline study was designed and conducted on “Post-Harvest Losses in Tomato Value Chain in Madhya Pradesh”. The study aimed to map the tomato value chain, identify the root causes of post-harvest losses as well as technical, institutional and policy level issues and gaps in the selected potential clusters of the state. The study was organised in India by Solidaridad with the support from the Consulate General of the Kingdom of the Netherlands, under the guidance of the Horticulture and Food Processing Department, Government of Madhya Pradesh. The findings of study would provide an overview to formulate strategies and interventions to strengthen and enhance efficiency of value chain and to minimize the post-harvest losses.

Study Objectives

- To map the tomato value chain, identify key players and issues, and gaps within the value chain specifically related to post-harvest losses.
- To determine the relations between value chain players and their role in the tomato value chain.
- To identify the existing infrastructure and logistics facilities and related gaps in the context of tomatoes.
- To analyze the existing production system, quality, seasonality, and related challenges as well as potential scope for improvement.
- To assess the existing engagement of the public and private sector and available support mechanisms.
- To suggest possible implementation strategies for intervention points.

Approach and Methodology

The scope of the study was to have an in-depth understanding of the gaps in the tomato value chain and assessment of the post-harvesting losses in the tomatoes value chain in the selected districts. A combination of research tools including secondary and primary research followed by the quantitative and qualitative assessment is adopted for the comprehensive analysis and to achieve the desired results and objectives of the study.

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Study Area

The seven districts of Madhya Pradesh namely Chhindwara (Jabalpur division), Ujjain, Shajapur, Dewas and Mandsaur (Ujjain division) and, Dhar and Jhabua (Indore division) of Madhya Pradesh were selected for the aforementioned study.



Methodology

The methodology is designed with the objectives to involve all the relevant value chain players and stakeholders. The research is mainly based on the primary information collected from the field and this was supported and validated with appropriate secondary data and information.

Step 1. Primary Research and Qualitative Assessment

As an initial step, a set of comprehensive questionnaires were prepared for the collection of primary information and to gather the information on the situation of tomato crops across the value chain. The following stakeholders' group across the value chain of tomato crop were interviewed in the identified clusters:

- Farmers
- Farmer Producer Organizations (FPOs)/ Co-operatives
- Self-Help- Groups (SHGs)

- Intermediaries
- Commission agents, wholesalers and retailers
- Service providers (logistics, storage, packhouses)
- State Government Officials
- Govt. officials at the district level including the Horticulture Department, KVKs, APMCs, academic institutes, etc.

The digital Kobo tool was used for the primary data collection, which has ensured the credibility and efficiency in the data collection from field. In addition to this, meetings were organized with the line departments of the State Government and other concerned agencies involved directly or indirectly in the tomato value chain.

Sample Size

The random sampling technique was followed to select villages, markets, market functionaries, processors and farmers. Within each selected district, approximately 80 farmers and 10 other stakeholders were selected for the study. A total of 669 farmers were surveyed in 7 Districts.

Focus Group Discussions (FGDs)

The FGDs were conducted in each district. The discussion helped in understanding the causes of post-harvest losses in the value chain – production practices, technology adoption, cultivation costs, movement of product and price markup from farm gate to the local and distant markets and other value chain gaps and issues etc.

Step 2. Secondary Research

The secondary information helped in understanding of the crop profile of selected areas, existing levels of production, marketing infrastructure as well as infrastructure facilities for logistics, storage, and marketing. The secondary data was collected from the State Horticulture Department, National Horticulture Board, FAO and AGMARKNET.

Limitations of the Study

As the primary data were collected using the questionnaires based primary survey and focused group discussion, the main limitation of the study was that most of the stakeholders and intermediaries such as commission agents and traders were not willing to share their purchases and sale-related information.

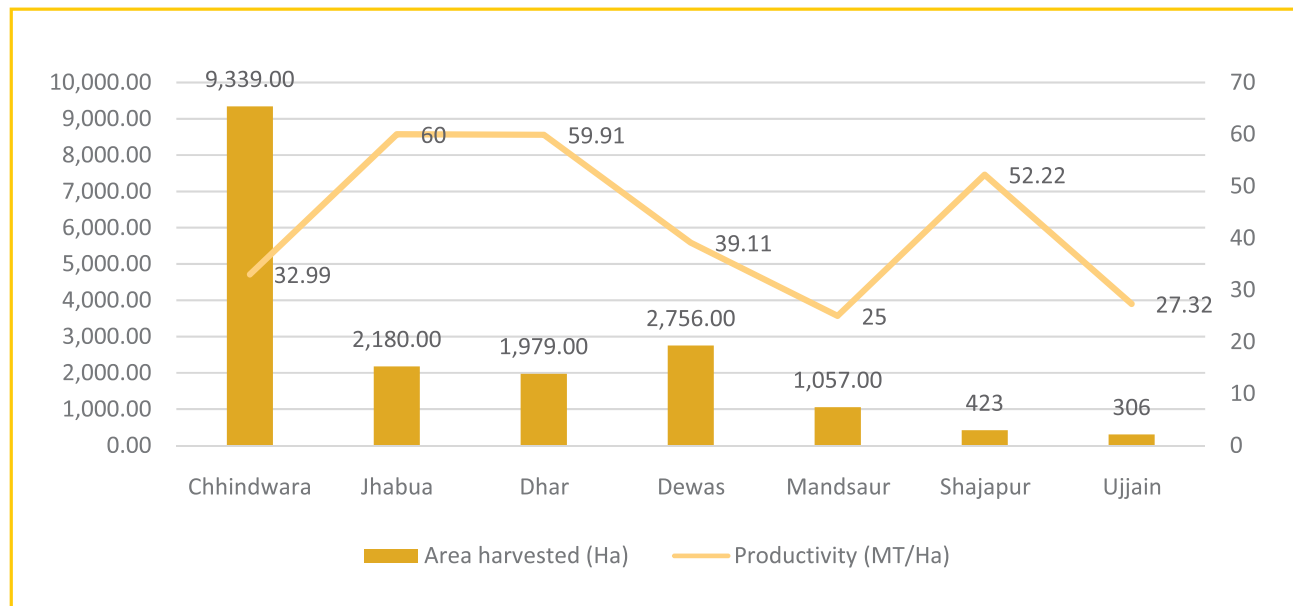
The selection of farmers and other players was based on the visit and the willingness of the particular person to answer the questions. The data collected from the farmers and market intermediaries was based on their memories and thus also had some limitations. The secondary data was collected based on historical records, and there might be some change in the present scenario thus also having some limitations. The stakeholder consultations in group could not be organized due to the Covid-19 situation.

Tomato Value Chain Analysis in Madhya Pradesh

Tomato Scenario in Study Area

The data showed that selected districts : Chhindwara, Ujjain, Shajapur, Dewas, Mandasaur, Dhar and Jhabua; contributed about 25% of total tomato production of the state (Chart 5).

Chart 5: Area and Productivity of tomato of selected districts of Madhya Pradesh (2020)



It is observed that there is huge variation in the productivity per ha. among the districts. The Mandasaur district is having lowest yield: 25 MT/ha, which is lower than the state average: 29.31 MT/ha. The total production of tomatoes in the study districts is 7,22,090.43 MT. With the interventions around productivity enhancement the farmers will be directly benefited in-terms of increased profit margins.

The potential markets for Madhya Pradesh tomato farmers are as given below:

- Local market
- Within state (to big cities of the state)
- Outside state (Major mandis like – Delhi, Ahmedabad, Pune, Kanpur)
- Export to other countries (Bangladesh & Gulf countries)
- Processors (Paste & Powder manufacturer)

This current chapter highlights the role played by the different value chain players and the associated gaps in the value chain.

Tomato Value Chain Players and Associated Gaps

The tomato value chain comprises of various intermediaries from farmers to consumers. The chain comprises mainly of input suppliers, producers, commission agents, wholesalers, collection centers, central warehouses, vendors, processors, retailers, distributors, exporters and consumers. The tomato value chain is very sensitive because of its short shelf life. Thus, the value chain stakeholders have an important role in reducing the losses in the value chain of tomato. The different players involved in the value chain have been further studied in detail to understand their role, associated issues and gaps specifically related to in-efficiency and post-harvest losses in the chain.

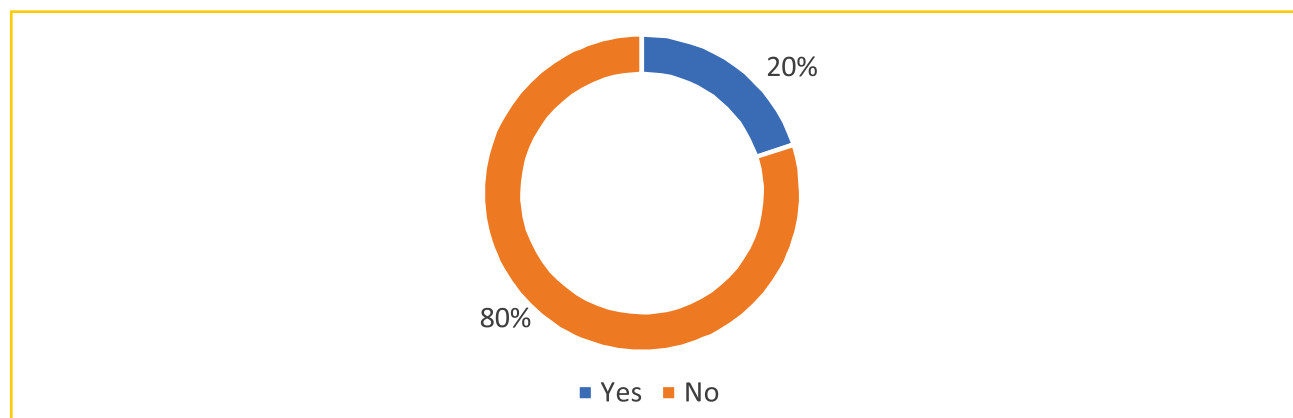
Input suppliers

The inputs suppliers are the retailers situated in the local markets and they provide agricultural inputs like seeds, pesticides, fertilizers and equipment etc. They also played a supportive role in providing crop advisories to farmers. They provided advice on buying of right seed varieties, fertilizers, doses of fertilizers and pesticides and methods of treatment. Most of the times, the advice provided by them were not at par the scientific advisory.

Although it is a pre-requisite to be an agriculture graduate to obtain the license for selling inputs, most of the agri-input shops were owned by a local trained person. This posed threats to receiving of reliable advisory sought by farmers. It often has led to crop productivity loss as the person providing the advisory is not competent enough to share such reliable and important crop advisory. It was also observed that the majority of inputs suppliers focus on maximizing their business profits and they promote products from which they can obtain maximum profit.

The recognized and authentic advisory bodies such as the Horticulture Department, the Agriculture Department and Krishi Vigyan Kendra (KVK) are present in the vicinity of the villages but due to limited reach, the farmers were unable to obtain extension support from these organizations. Timely availability of right crop advisory has been identified as a major challenge in the tomato value chain in the study area (Chart 6). Only 20% of the sampled farmers were able to get timely advisory.

Chart 6 : Access to Timely Advisories



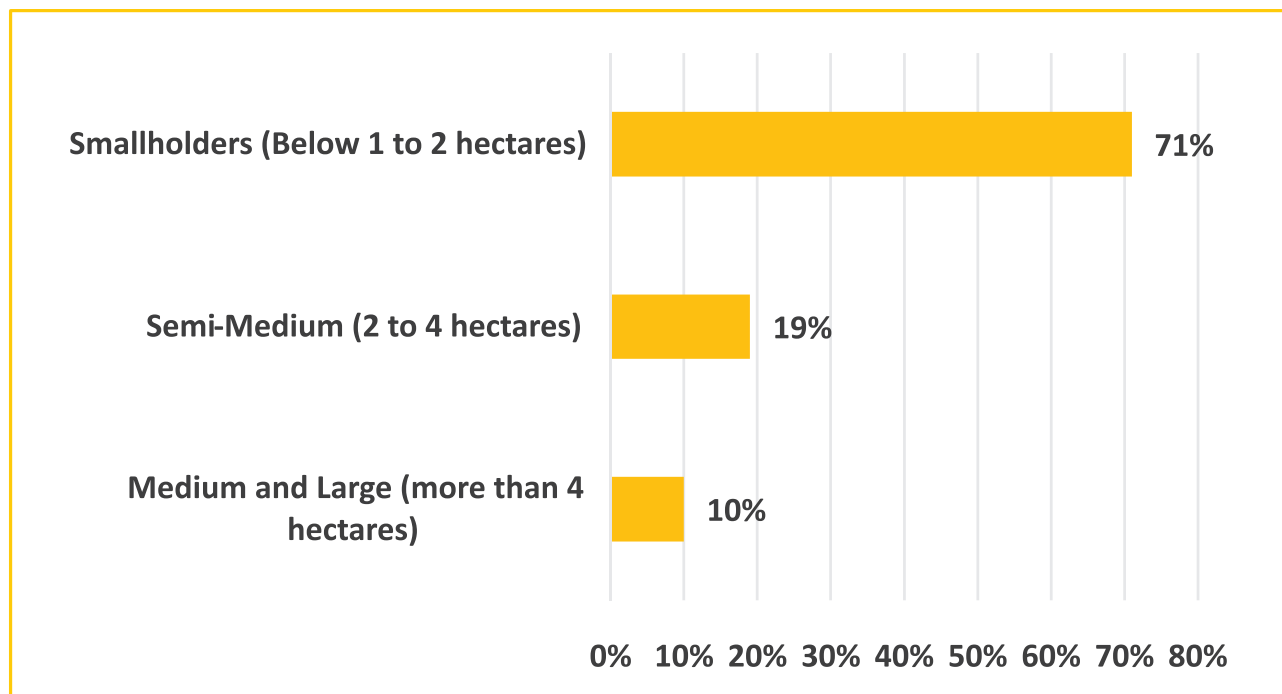
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During the study, the FPOs for horticulture crops have also not been found in the study area. The input suppliers had somehow received good credibility in the areas and hold a strong place in value chain. FPOs can be a suitable replacement for them but they have to go long way to be an integral part of the value chain. Proper extension and technical knowledge support is lacking for the tomato growers in the study area and there is a need for creating a trained extension support team.

Farmers

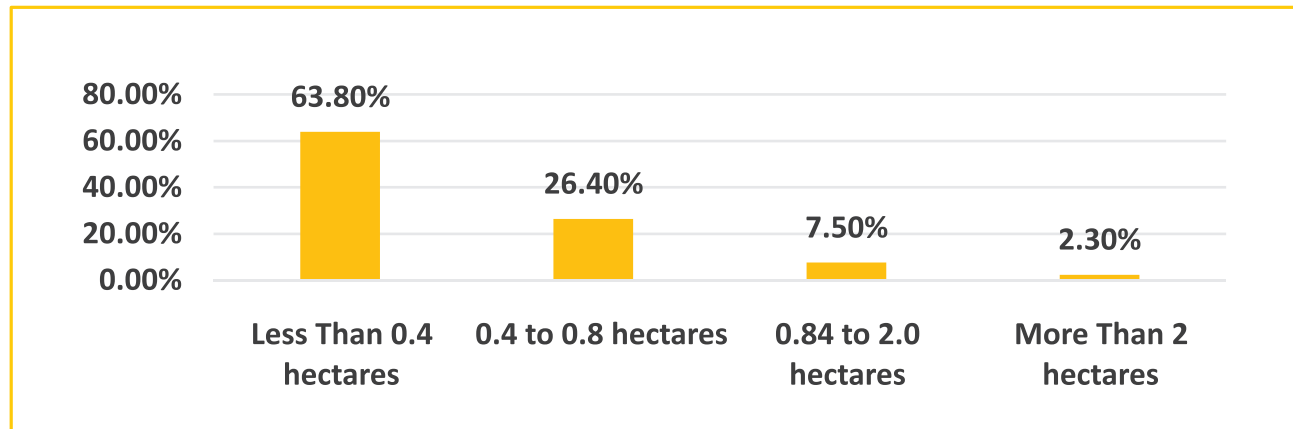
About 71% of the farmers interviewed were small and marginal landholders and about 10% farmers were big farmers with more than 10 acres of land. The different category of farmers was studied to get diverse insights and information (Chart 7).

Chart 7 : Tomato Farmers Category



It was observed that out of the surveyed farmers around 64% were cultivating tomato in 0.4 hectares, 26% upto 0.8 hectares and around 9% in 1 hectare and more land area. Research found that the area under tomato cultivation has a negative growth, with a CAGR of -0.62% while comparing the last 10 years of area coverage data. In the year 2014-15, the area of tomatoes had sharply declined from 882,000 ha to 767,000 ha and after that, it slowly rose to 813,000 ha in the year 2019-20. Despite increased area and production of tomatoes, this negative growth is the matter of concern for value chain players.

Chart 8 : Average Land Under Tomato Cultivation



A TOMATO FARMER

Following are the reasons due to which area under tomato is going down

1. **Price uncertainty and distress sale:** The farmers generally grew tomato on the basis of previous year's market prices however in such conditions, the sown area gets increased and due to glut the prices crashes down. There is no existing area forecasting mechanism developed by concerned department to warn or update farmers about area coverage position. Due to the overproduction, farmers are in the situation of distress sale.

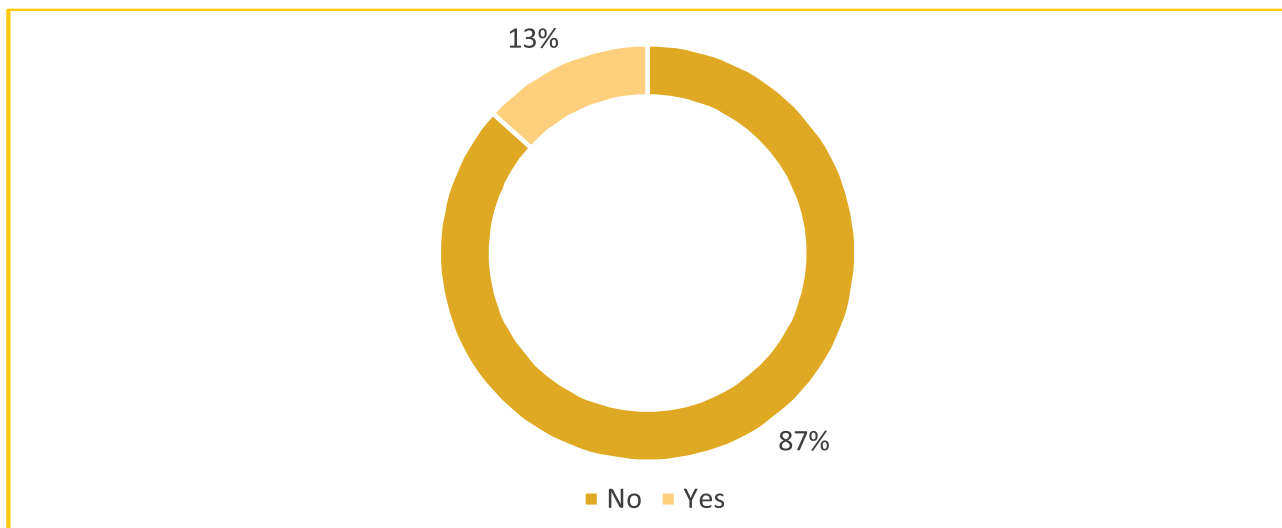
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2. **Crop failure due to climatic conditions:** Due to heavy rains or frost in central India, crop failure has been common in past several years. Farmers are less adaptable to the changing climatic situations.
3. **Problem of pest and diseases:** Due to climatic changes and erratic rains, incidences of sucking pests and diseases have increased, and hence the farmers could not harvest as per their expectation. There are gaps in the popularization of resistant seed varieties.
4. **High cost of Inputs:** As per study conducted, out of total expenditure, around 50% share is of inputs like seeds, fertilizers and plant protection chemicals.

The other possible reasons are related to value chain fragmentation, quality and quantity losses, non-availability of storage infrastructures and low levels of processing (only 1% goes into the processing).

During the interaction with farmers, it was observed that they were not aware about the processable varieties of tomato (Chart 9) . Although the farmers knew about tomato processed products (namely; sauce, ketchup, pickle), they were un-aware about the right variety used for production of these processed products. For processing, the high TSS content varieties are necessary for maximum recovery of finished product but un-fortunately the farmers were not aware about these varieties. According to the farmers they had preference for improved seed varieties which has higher pulp content, less vulnerable to insect/ pest attack, longer shelf life and less vulnerable to damages during the transportation.

Chart 9 : Awareness about Processable Varieties of Tomatoes



Major tomato varieties grown in Study Area

It was found that the majority of farmers used the hybrid seeds for Tomato cultivation. The information about right seed variety was mainly obtained from input dealers or fellow farmers. In some cases, it was revealed that the farmers gained knowledge from online agri-knowledge portals as well. The name of some of the major tomato seed varieties in cultivation is given in Table 5.

Table 5 : Major Tomato Seed Varieties Grown in the Study Area

Variety	Company	Characteristics
Abhilash	Seminis	Suitable for both Kharif and Rabi seasons, flat round, red colour with 80-85 gm average weight, first picking starts from 60 to 65 days after transplanting.
Abhinav	Syngenta	Broad leaves with excellent foliage cover. Firm fruits with good keeping quality, square shape and medium size (80 -100 gm) fruits. Fruit harvesting starts 60-65 days after transplantation. Uniform fruit ripening.
1057	Syngenta	Semi indeterminate open plants, square fruits with weight 80-100 gm, uniform ripening & very firm fruits, excellent fruits setting in summer and fruits can be transported to the long distances.
Himsona	Syngenta	Indeterminate tall vigorous plants and medium foliage cover with profuse branching, high yield potential. Fruit harvesting starts 65-75 days after transplantation. Fruits can be transported to long distances.
Meghdoot (TO-3251 2048)	Syngenta	High yielding variety, sturdy semi determinate plant with dense green foliage providing fruit shelter and fruits are oval in shape with firm dark red colour.
Sahoo (TO-3251)	Syngenta	Determinate plant, flat round type, uniform green with 90-100 gm fruit, high Yield potential and good firm fruits.
Laxmi	Nunhems	Large determinate plants. Maturity of fruits 55-60 days after transplanting. Flat round firm fruits of 80- 90 gm with sour taste. Good heat set. Can be grown in Kharif, Rabi and Summer season.
Rishika	Clause seeds	Determinate plants, fruits are deep Red and oval with 90-100 gm weight, 1st picking starts 70-75 days after transplanting.
Viraj	Novel Seeds	Single fruit wt. around 95-100 gm with deep red colour and thick peel and good flexibility. Suitable for long distance transportation. Good resistance to TyLCV& leaf mold with highly tolerant to early & late blight disease. Suitable for rainy and winter season cultivation.
Naveen 2000	Indo-american	Plants are in-determinant type with light green foliage. Total duration of the plant is 185-190 days and first harvest starts in 70 days from planting. Fruits are medium sized, oblong, green shouldered, intense red, square, and average weight is 90-110 gm. Plants are in determinant type and suitable for staggered harvesting. The variety is most suitable for Rabi season.

Research on Improved Varieties of Tomatoes

Research on improved varieties of tomatoes have been ongoing to look for varieties which have a greater shelf life and firmness, so that the post-harvest losses in tomatoes can be reduced. Various research and studies are conducted by the ICAR institutes and Agricultural Universities in the country to develop a suitable variety of tomato which have high productivity, longer shelf life, high TSS and firmness.

In a study for Bayer; Wageningen University, The Netherlands has developed a new hybrid tomato variety “Ansal”, which has an increased shelf life and thick cuticle, to allow for long-distance transport with minimum losses under ambient conditions. It has been found that the reduction in post-harvest losses in “Ansal” tomato has been from 30% to 10%. The team of Bayer has also developed some other varieties namely: Virang, Kaushal, and Aryaman. All these varieties have a longer shelf life and more firmness. Popularisation of such kind of new varieties will help the small holders to achieve better productivity and ensure profitability.

Further, innovative technologies in cultivation can also bring a positive change in productivity and profitability. The ICAR-Indian Institute of Horticulture Research, Bangalore has initiated technology demonstration on plastic mulching, drip irrigation and fertigation in tomato crop. A team of researchers in Ladakh has developed a new model of greenhouse to grow tomatoes during winter months. The role of rural entrepreneurs, farmer groups/ collectives (FPOs), Government Department extension team and CSOs becomes pertinent in sharing of knowledge and extension support for new agriculture technology and varieties.

Cost Economics of Tomato Farmers

The cost of cultivation for tomato in the districts studied varied from ₹ 1,00,000.00 (€ 1211,08) to ₹ 1,50,000.00 (€ 1816,62) per hectare with average cost of about ₹ 1,29,000/hectare (€ 1562,29) . Out of the total expenditure, more than 40% was spent for inputs; like seeds, fertilizers and plant protection chemicals. This cost also varied on the basis of practices and technology adopted by the farmers. Most of the farmers were using drip irrigation system along with plastic mulching with bamboo and GI wire-based staking system. The study brought out that only 3% of the sampled farmers received subsidies from State Government schemes specifically for micro Irrigation and plastic mulching. For marketing, farmers prefer to sell their produce to aggregators/ wholesalers and commission agents. Only 1.8% farmers had pre-harvest marketing contract with agents and only 1.5% sold their produce to the processors once in a while.

The gross income from tomato cultivation ranged between ₹ 4.87 lakh (€ 5897,90) and ₹ 6.09 lakh (€ 7375,43) depending upon the market practices in the study area (Table 6) . However net earning did not show much difference in either case. This indicated that distant markets might offer better prices but net returns did not differ much. Price gap in alternate markets had its own limitations.

Table 6 : Economics of Tomato Farmer (Per hectare)

S. No.	Component	Total
A	Cost of cultivation	
1	Land Preparation	₹4000 (€ 48,44)
2	Seed/Planting Material	₹15000 (€ 181,64)
3	Transplanting	₹15000 (€ 181,64)
4	Farm Yard Manure	₹5000 (€ 60,54)
5	Fertilizers	₹20000 (€ 242,19)
6	Plant Protection Chemicals	₹20000 (€ 242,19)
7	Irrigation Charges (Fuel/Electricity/ Labour)	₹5000 (€ 60,54)
8	Growth Regulators and Foliar Nutrients	₹5000 (€ 60,54)
9	Trellising / Training / Pruning	₹20000 (€ 242,19)
10	Harvesting	₹20000 (€ 242,19)
	Total cost of Production	₹1,29,000 (€ 1562,16)
B	Yield 700 quintals (2800 crates)	
C	Post -Harvest losses	12.98%
D	Net Marketable Yield	609.86 quintals
E	Sale Price –Local Market	800/q (€ 9,68)
F	Sale Price –Distant Market	1000/q (€ 12,11)
F	Gross profit - Local Market	₹487888 (€ 5908,33)
H	Gross profit - Distant Market	₹609860 (€ 7385,44)
I	Transportation cost	
1.	1. Nearby market @ ₹ 12/crate	₹29273.28 (€ 354,50)
2.	2. Delhi/Ahmedabad market @ ₹ 62.5/crate	₹152465 (€ 1846,36)
J	Commission of Local aggregator @ ₹ 5/crate	₹14000 (€ 169,54)
K	Commission of Distant Mandi Agent @ 5%	₹30493 (€ 369,27)
L	Sorting, grading, packaging, handling etc @ ₹ 5/q	₹3049.3 (€ 36,92)
M	Cost per ha (Local)	₹175352.58 (€ 2123,53)
N	Cost per ha (Distant)	₹315007.30 (€ 3814,77)
O	Net Earning – Distant Markets	₹294852.70 (€ 3570,70)
P	Net Earning – Local Markets	₹312535.42 (€ 3784,84)

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Some of the major issues and constraints faced by the small holders in tomato cultivation are as given below:

- **Extension support and crop advisory :** For extension support the farmers are largely dependent on the local agri-input dealers and fellow farmers. Although the little advisory received from the local people was a great support to the farmers, the competency of the person playing the role of crop advisor in the area is quite questionable. A lack of access to proper scientific extension support and crop advisory for the tomato farmers was found here. The farmers had limited exposure to Government advisory bodies like the Horticulture Department and Krishi Vigyan Kendra. This greatly impacted the crop productivity and market opportunities potential for the farmers in the region. Few active and motivated farmers have alternatively explored app based advisory services.
- **Shortage of labour and un-skilled labour :** The tomato cultivation is labor intensive; starting from sowing to storage. The workforce engaged in the cultivation process were often unskilled / semiskilled. Gaps were identified in skills of workforce engaged for pre- harvest management, harvesting techniques and post-harvest management. Along with, unavailability of labour had also been cited as a problem during the different cultivation processes. The shortage of labour during the time of harvesting delayed the harvesting process and incurred heavy losses due to delayed harvesting.
- **Lower prices at the time of peak harvesting season :** The market price during peak harvesting season often dropped due to which the farmers had to sell their produce at a low price. Sometimes they waited for better price during the peak harvesting stage and faced around 20-30 % loss of produce.
- **Crop damage by frost and virus attack :** Due to high frequency and occurrence of extreme weather events, an impact of Global Climate Change, the standing crops of tomato were damaged due to frost attack and diseases.
- **Small volumes produced :** The small volume produced by farmers restricted them to search for alternative market channels.
- **Availability of storage infrastructure :** There is a shortage of storage infrastructures for storing of tomatoes in the study areas that hindered the farmers' intent to store the tomatoes till the right market price. Tomatoes have a low shelf life, and cannot be stored in open. Due to the shortage of storage facilities, farmers remained helpless with no other options, but of distress sale during the glut period.
- **Excessive use of insecticides and pesticides :** With growing incidences of insect/pest and disease attack in tomato crops, an excessive high use of insecticides and pesticides was reported. Prolonged use of insecticides and pesticides pose threat of exceeding the MRL which in turn becomes detrimental to human health and environmental safety.

- **Processing Industries:** Absence of processing industries for primary and secondary processing was also noted in the districts. Lack of linkages between cold storage owners and processors with producers were also found. FPOs dealing with horticulture commodities in the state are also at a nascent stage and mostly struggling with basic management and business compliances. Gap in continuous support towards their capacity building and sustainability was identified. No crop specific FPO/ collectives were found at the study area. A need to set up more crop specific FPOs in the area was recognized. Further, promotion of Buyer – Seller platforms with support of Government Departments/Agencies should be worked out.
- **Lack of cultivation of processable varieties:** A large portion of tomatoes produced is sold as fresh fruits. Negligible produce is sold for processing. The varieties cultivated by farmers are not viable as well as suitable for processing.
- **Seasonal Price Variability:** During the FGDs it was observed that during peak season the tomato prices areas low as less than ₹ 1 (€0.01) per kg, sometimes. Whereas, the cost of cultivation of tomatoes has been reported to be between ₹ 2.50 (€0.03) and 3.00 (€0.03) per kg in traditional cultivation. In case of mulching, drip and staking the cost increased to ₹ 3.0-4.0 (€0.03-0.04) per kg. Hence during the peak season, the farmers were left with no options but to dump their produce.

Need of Training and Capacity Building Support

Out of total surveyed farmers only 3% of them received training from extension departments. Almost all the farmers expressed their interested in getting trained and educating knowledge on the following subjects:

- Modern Cultivation Practices
- Protected Cultivation
- Micro Irrigation
- Processing
- Aggregation
- Marketing

Access to Facilities/ Infrastructure

The farmers in the studied districts had low or no access to facilities and infrastructure related to soil and water testing and agri-clinics (Chart 10 and 11). They were also not very much connected with Integrated pack houses, food parks, irradiation facilities, certification agencies, MRL testing labs and Processing industries.

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Chart 10 : Access to Soil and Water Testing Facilities

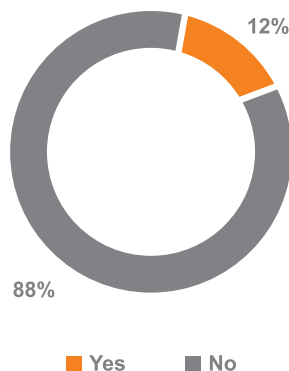
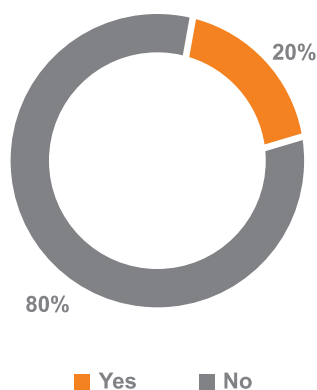


Chart 11 : Access to Agri Clinics



The above-mentioned issues can be addressed by the promotion of farmers' collectives i.e. Farmer Producer Organisations (FPOs). These FPOs can facilitate:

- Collective procurement of quality inputs at reasonable prices
- Aggregation of produce for scalable volume and collective marketing
- Resource pooling
- Establishment of infrastructure facilities
- Value addition (sorting, grading, packing)

Local Aggregator

The Local aggregators identified in the study area are the big established farmers who act on behalf of local mandi agents and in some cases, as agents of distant mandis. They make a link between farmers and market functionaries. Being local person, these aggregators facilitate for setting up of deals, fulfilling quality requirements of buyer, aggregation and transport, etc. They are also responsible for the payments to farmers.



TOMATOES PACKED IN PLASTIC CRATES FOR TRANSPORT TO MARKET BY AN AGGREGATOR IN DHAR DISTRICT

These local aggregators earned about ₹ 4-6 (€ 0.04 – € 0.07) per crate. On an average they handled around 40-50 crates daily basis. In peak seasons they aggregated around 200-250 crates in a day. The profit earned by a local aggregator in the study area is presented below (Table 7).

Table 7 : Economics of a Local Aggregator

Quantity Procured (crates)	Quantity (q)	Purchase Price (Rs/q)	Operational Cost (Rs/crate)	Operational cost (Rs/q)	Sale Price at Mandi (Rs/q)	Profit (Rs/q)
200	50	₹800 (€ 9,68)	₹2.5 (€ 0.03)	₹10 (€ 0.12)	₹830 (€ 10,05)	₹20 (€ 0.24)

Local Mandi Traders

A Local Mandi trader is a district level market functionary who deals directly with farmers/farmer's groups/ local aggregators. As found during the study, the local Mandi traders majorly dealt with local aggregators for purchasing the produce. These traders dealt at different small mandis of the district. They also arranged transportation facility for collection of produce from selected locations. The trader further sold the tomatoes to different renowned mandis of the state namely; Dhar, Indore, Ujjain, Bhopal, Ratlam and Chhindwara districts. The produce was also sold at distant mandis (Delhi, Jaipur, Ahmedabad) through distant mandi agents. The economics of a local mandi trader has been given below (Table 8).

Table 8 : Economics of Local Mandi Traders

S. No.	Particular	Unit cost (Rs/q)	Total cost (Rs/q)
A	Purchase Price of Local Aggregator	₹830	₹830
		Sub Total	₹830 (€ 10,05)
B	Operational Cost		
1	Mandi Tax & Others	2%	₹16.60 (€ 0.20)
2	Loading & Unloading, Weighing	10	₹10.00 (€ 0.12)
3	Spoilage	2%	₹16.60 (€ 0.20)
4	Misc . Cost @ Rs 20/quintal	20	₹20 (€ 0.24)
		Sub Total	₹63.20 (€ 0.76)
	Total Cost (A+B)		₹893.20 (€ 10,81)
C	Selling price for Wholesaler/Trader/ Processor	₹940	₹940.0 (€ 11,38)
D	Profit		₹46.80 (€ 0.56)

Commission Agents/Traders at distant markets

The commission agents work at big mandis at locations in Jaipur, Ahmedabad and Delhi. They purchased the tomatoes from state through their network of local aggregators, farmers groups and local mandi agents. Important part to mention here is that in some cases, the transporters also played the role of aggregators owing to the years of experience they have gained. However, they also dealt through same channel. These transporters were mostly approached by new comers (traders and processors) in tomato business. A commission agent made a profit of around ₹ 160 (€ 1,93) per quintal as was calculated during the study (Table 9).

Table 9 : Economics of Commission Agents / Traders at distant markets

S. No.	Particular	Unit cost (Rs/q)	Total cost (Rs. /q)
A	Purchase Price of Local Traders	₹940.0	₹ 940.0
		Sub Total A	₹940.0 (€11,38)
B	Operational Cost		
1	Mandi Tax & Others	5%	₹47.0 (€0.56)
2	Loading & Unloading, Weighing	10	₹10.00 (€0.12)
3	Transportation (₹ 60/crate)	240	₹240.0 (€2,90)
4	Spoilage	3.5%	₹32.90 (€0.39)
5	Misc. Cost @ ₹ 20/quintal	20	₹20 (€0.24)
		Sub Total B	₹349.90 (€4,23)
	Total Cost (A + B)		₹1289.90 (€15,62)
C	Selling price for Trader/ Processor	₹1450	₹1450.00 (€17,56)
D	Profit		₹160.10 (€1,93)

Processors

During the study, fewer tomato processing plants were found in Ujjain, Indore and Chhindwara divisions. Recently, a tomato processing plant M/s Frutx Industries has been established in Indus Mega Food Park in Nimrani, Khargone having raw material consumption capacity of 15000 MT. The processors do not directly procure from farmers as they cannot deal with large number of farmers because of:

- a. Quality concern (homogeneous quality assurance)
- b. Man power requirement in building supply chain
- c. Payment and price related issues

Wholesalers

Wholesalers are market functionaries situated in various districts who purchased produce from mandi agents. They catered the demand of retailers and institutional buyers (e.g. Super Market, Hotels, Mess etc). The profit earned by a wholesaler in every quintal of tomato produce has been calculated for the study area (Table 10).

Table 10 : Economics of a Wholesaler

S. No.	Particular	Unit cost (Rs./qtl.)	Total cost (Rs./qtl.)
A	Purchase Price from Mandi Agents	₹940.0	₹940.0
		Sub Total A	₹940.0 (€ 11,38)
B	Operational Cost		
1	Commission	3%	₹28.20 (€ 0.34)
2	Loading & Unloading, Weighing	10	₹10.00 (€ 0.12)
3	Misc . Cost @ Rs 20/quintal	20	₹20.00 (€ 0.24)
		Sub Total B	₹58.20 (€ 0.70)
	Total Cost (A+B)		₹998.20 (€ 12,08)
C	Selling price for Wholesaler/Trader/ Processor	₹1180	₹1080.00 (€ 13,07)
D	Profit		₹81.80 (€ 0.99)

In districts like Jhabua and Dhar, where vegetable crop production was significant but market infrastructure was not developed, intermediaries got the opportunity to set the market prices in absence of price setting mechanism/ regulation. So, a need for establishing market yards in such districts is imperative so that the farmers have direct and transparent mechanism to access buyers at single place.

Retailers

They are the small-scale sellers of tomato who directly sells to the consumers. They procured tomatoes from wholesalers. As was found during the study, retailers invested less but received maximum profit (Table 11), although post-harvest losses at their end were also high.

Table 11 : Economics of a retailer

S. No.	Particular	Unit cost (Rs/q)	Total cost (Rs /q)
A	Purchase price from Local Wholesaler	₹1080.00	₹1080.00
		Sub Total A	₹1080.00 (€ 13,07)
B	Operational Cost		
1	Transport	10	₹10.00 (€ 0.12)
2	Spoilage	8%	₹86.40 (€ 1,04)
		Sub Total B	₹96.40 (€ 1,16)
	Total Cost (A+B)		₹1176.40 (€ 14,24)
C	Selling Price for Consumer	₹1500	₹1500.00 (€ 18,16)
D	Profit		₹323.60 (€ 3,91)



A TOMATO RETAILER IN SEHORE DISTRICT

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Exporters

Exporters generally do not make direct contact with producers or FPOs, they procure directly from traders (Fresh tomatoes) and processors (Processed tomatoes). Currently tomatoes are exported to countries namely; UAE, Bangladesh, Nepal, Oman, Maldives, KSA and Bahrain. During the FGD, it was observed that only 5% of the farmers had knowledge of export channel of their produce. At present, the aggregators or exporters from the states of Maharashtra and Gujarat procured the produce from local mandi agents or wholesalers of the Madhya Pradesh state, and exported this produce from closest ports. The non-availability of Integrated Pack Houses in Madhya Pradesh is also a major obstacle in direct export from the state.

Consumers

Consumers are the end piece of a commodity value chain. They are the ultimate buyers of produce. Tomato is consumed in the form of fresh tomatoes, puree, ketchup, powder, juice, etc. Fresh tomatoes are a daily need of households for salads and curry preparation. Processed forms such as sauce are consumed in various continental dishes at households and institutional level (hotel, restaurants, etc.).

Comparative Analysis of Economics in Value Chain

Based on the data collected from interviews and FGDs, the comparative analysis of economics of value chain players has been computed (Table 12). Understanding the cost benefit analysis for each value chain functionary is pertinent to the study.

Table 12 : Comparative Analysis of Economics in Value Chain

S. No	Particulars	Producer	Local Aggregator	Local Mandi Trader	Wholesaler	Retailer	Consumer	Total
1	Purchase Price (Rs/q)	0	₹800 (€ 9,68)	₹830 (€ 10,05)	₹940 (€ 11,38)	₹1080 (€ 13,07)	₹1500 (€ 18,16)	
2	Cost in Rs (per quintal)	₹ 287.52 (€ 3,48)	₹10 (€ 0.12)	₹63.2 (€ 0.76)	₹58.2 (€ 0.70)	₹96.4 (€ 1,16)	-	₹515.32 (€ 6,24)
	Percentage share in cost	55.79	1.94	12.26	11.29	18.71	-	100%
3	Selling price (Rs/q)	₹800 (€ 9,68)	₹830 (€ 10,05)	₹940 (€ 11,38)	₹1080 (€ 13,07)	₹1500 (€ 18,16)		

4	Profit (Rs/q)	₹512.48 (€ 6,20)	₹30 (€ 0.36)	₹110 (€ 1,33)	₹140 (€ 1,69)	₹420 (€ 5,08)	-	
5	Share in consumer price	53.33	2.00	7.33	9.33	28.00	-	100%

Price Gap between tomato producer and end consumer

Price Payable to Farmer (Rs. /q)	₹800.00 (€ 9,68)
Price Payable by End Consumer (Rs. /q)	₹1,500.00 (€ 18,16)
Price Gap (Rs. /q)	₹700.00 (€ 8,47)

It is evident from the above table that the producer bore the maximum portion (55.7%) of cost but his/her share in the consumer price was only 53.3%. Remaining value was shared between various intermediaries. Distant mandi agents also shared major cost (due to significant transportation cost) but they enjoyed higher business volumes. Retailers earned second highest shares (in percentage) in terms of profit but they had low business volumes in terms of revenue. Here in value chain, price was being decided by the market intermediaries instead of the producer. Producers were also unaware about the price setting mechanism as they rarely dealt directly with the market.

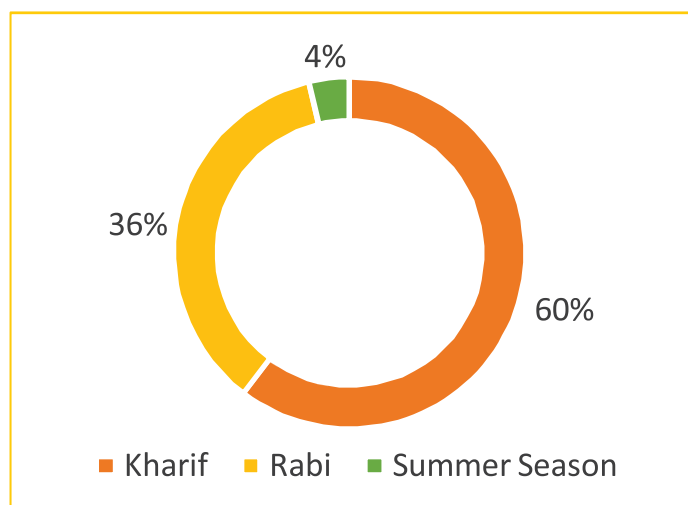
Thus, it is imperative in the tomato value chain that producers should be directly linked to competitive markets. It is also crucial that the producers have options of alternative market channels which they can explore for greater profits. Smallholders, however, may face challenges in having direct access to markets individually, but by forming collectives / FPOs they can ensure direct access to these markets.

Seasonality and Price Trends

The tomatoes are largely grown in two seasons i.e. Kharif (Monsoon) and Rabi (Winter) season. During the Kharif season, transplantation starts in the months of June and July and the early harvest starts from November to mid of March. Whereas during Rabi season, the transplantation is done in the months of November-December and the early harvest starts in the months of February-March.

Majority of the farmers (60%) in the study area, preferred the Kharif season for tomato cultivation (Chart 12), whereas 36% of the

Chart : 12 Preferable Season for Growing Tomatoes



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farmers cultivated tomatoes in Rabi season and only 4.0% of the farmers selected season for cultivation as per existing market rates.



A TOMATO FARM IN RABI SEASON

The other major tomato producing states i.e., Andhra Pradesh and Karnataka largely grow this crop in Rabi season, where the transplantation starts from October and early harvest starts from December to mid of June. Therefore, from December to February/March some time glut situations occurred due to the arrival of both Kharif and Rabi crops simultaneously along with the peak of Rabi crop in the month of March. During these four months farmers suffered due to lower prices for their produce (Table 13) . The farmers received better prices in the July, August, September and October months due to the low supplies.

Table 13 : Seasonality and Price Trends in Madhya Pradesh (Price in Rs per 100 kg)

2019						2020					
JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
₹1615 (€ 19,55)	₹1681 (€ 20,35)	₹1258 (€ 15,23)	₹1573 (€ 19,04)	₹1399 (€ 16,94)	₹1087 (€ 13,16)	₹923 (€ 11,17)	₹860 (€ 10,41)	₹691 (€ 8,36)	₹766 (€ 9,27)	₹719 (€ 8,70)	₹1320 (€ 16)
2020						2021					
JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
₹ 2878 (€ 34,85)	₹2481 (€ 30,04)	₹2733 (€ 33,09)	₹2334 (€ 28,26)	₹1846 (€ 22,35)	₹1502 (€ 18,18)	₹937 (€ 11,34)	₹871 (€ 10,54)	₹632 (€ 7,65)	₹799 (€ 9,67)	₹928 (€ 11,23)	₹959 (€ 11,61)

■ PEAK SEASON
 ■ LEAN SEASON
 ■ Local + other state

Source: Agmark

The above given table clearly indicates the increasing price trend during the lean season and lower price trend during the peak season. The seasonality in production and irregular shocks are the two important components contributing to the variations in the prices of perishable commodities like tomato. Seasonality in prices is a result of the varying pattern of production of these commodities during different months of a year. On the other hand, shocks often originated from the uncertain weather conditions and other unpredictable events.

Government Policy Initiatives to Address Price Crash in Tomatoes

The Government of Madhya Pradesh has announced the Mukhymantri Bhavantar Bhugtan Yojna (Price Deficit Financing Scheme) in 2017-18 and Mukhymantri Krishak Smridhhi Yojna in 2018-19 for mitigation of escalated price of agricultural and horticultural produces. Under Bhavantar Bhugtan Yojna, two horticultural crops were included namely Onion and Garlic in selected districts of state. The Government had paid price difference from model rates of ₹ 8/kg (€0.09/ kg) for Onion and ₹ 32 (€0.38) for Garlic to the farmers upto ₹ 8 (€ 0.09) and ₹ 4 (€ 0.04) respectively for Onion and Garlic. As per Krishak Smridhhi Yojna only Onion crop was included in the state in 20 selected districts of Madhya Pradesh and the farmers got benefited by selling their produce in designated mandis of Madhya Pradesh. However, tomatoes were are not included in the Bhavantar Bhugtan scheme. The farmers are demanding that the Government should bring tomato farmers under the Bhavantar Bhugtan Yojna, where farmers are paid the difference between market price and support price of crop wherever the market prices fall.

Apart from this, MOFPI has (GOI) launched Operation Greens (TOP to TOTAL) scheme on 11.06.2020, with the objectives to protect the growers of fruits and vegetables from making distress sale due to the current Covid-19 lockdown situation and reduce the post-harvest losses.

Under this scheme, entities like Food Processors, FPO/FPC, Co-operative Societies, Individual Farmers, Licensed Commission Agent, Exporters, State Marketing/Co- operative Federation, Retailers etc; engaged in processing/ marketing of fruits and vegetables can avail subsidy @ 50% of the cost of the following two components, subject to the cost norms:

1. Transportation of eligible crops from surplus production cluster to consumption centre; and/or
2. Hiring of appropriate storage facilities for eligible crops (for maximum period of 3 months);

This Scheme is operational now. Eligible entities, who comply with the aforesaid essential criteria may undertake the transportation and/or storage of notified crops from notified surplus production cluster, without any prior approval from MoFPI and thereafter submit their claim on online portal of MOFPI.

Post-Harvest Losses in the Tomato Value Chain

The post-harvest practices followed in the tomato cultivation directly impact the post-harvest quality and shelf life of the tomato fruits. The tomato is a climacteric fruit; in other words, the tomato fruits ripen even after harvest and have a relatively short post-harvest life. Therefore, the practices followed post-harvest

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of the tomato fruit should be such that it leads to less loss of the produce. Some of the practices like; harvesting, precooling, cleaning and disinfecting, sorting and grading, packaging, storing, and transportation play an important role in maintaining quality and extending shelf life of tomato fruits. Failure to adhere to these practices results in considerable loss of tomato fruits also known as post-harvest losses in tomato.

There are several reasons behind post-harvest losses of tomato during its cultivation namely; less care in harvesting method and time, inappropriate packaging, shortage of storage facilities, transportation issues, lack of processing industries, and lack of market access. The physiological maturity of any fruit at harvest has an important effect on postharvest quality of that fruit. Less care in harvesting method and time leads to higher post-harvest losses. Post-harvest loss is one of the major problems in tomato production in Madhya Pradesh. In Madhya Pradesh, post harvest losses is around 12.89% in tomato crops and has emerged as major problems in tomato production in the state. The post-harvest practices followed by farmers in the study districts have been outlined (Table 14) in comparison to the recommended post-harvest practices for Tomato crops.

Table 14 : Post- Harvest Practices

S.No.	Recommended Practice	Actual Practice
A	Harvesting	
1	Harvesting with clippers	Manually (Twisting)
2	Collection in non -sharp edge container	Plastic Crates
3	Harvest time -Early or late hours of day	All day (as per labours working hours)
4	Harvesting stage a. Longer shelf life- Matured green state b. Shorter shelf life- Ripen stage	Producers targeting distant markets harvest their tomatoes in a matured green state For domestic markets ripen tomato is preferred
B	Precooling, Cleaning & Disinfecting	
1	Dipping fruits in cold water (hydro cooling) mixed with disinfectants such as thiabendazole and sodium hypochlorite to remove field heat and infection	No
2	Sodium hypochlorite solution to reduce fungal infection	No
C	Grading and Sorting	
1	Sorting- Removal of rotten, damaged, or diseased fruits from the healthy and clean ones	Yes
2	Grading- Categorizing on the basis of color, size, stage of maturity, or degree of ripening.	Partially Traditional eye judging method
D	Packaging	
1	Wooden crates, cardboard boxes, plastic crates with shredded paper cushion	Plastic crates with Newspaper base
E	Storage	
1	Short-term storage (up to a week) - ambient conditions	Only short -term storage is done as cold storage facility is not available
2	Longer-term storage - 10–15°C and 85–95% relative humidity	

The above table indicated that the post-harvest practices followed by the majority of farmers was not aligned with the recommended practices. The major reason behind this was lack of access to technical knowledge/ extension support by the farmers. The practices followed by the farmers are mainly learnt from other fellow farmers or local level agri-input dealers. The farmers were not updated about the good practices to be followed during the production process.



PLUCKING AND HARVESTING OF TOMATOES BY A WOMAN FARMER

The tomatoes were packed in plastic crates with newspaper laid in the bottom and transported to the nearest market. Generally, the plastic crates were provided by the local aggregators on rental basis to the farmers. Sometimes the crates were broken or damaged. All these issues resulted in post-harvest losses of tomato. During the interviews, the farmers discussed and informed about all these issues at length. Along with the above-mentioned limitations, lack of proper market linkages and market volatility were also some of the major concerns among the Tomato growers. Access to ready market is a big challenge when dealing with highly perishable crops.

Storage Practices

Fruits and vegetables are living organisms and even after harvesting; fruits/ vegetables plucked from plants keep respiring especially in case of climacteric fruits. This respiration causes deterioration in their quality i.e., freshness, glow, taste, shape, smoothness, texture, and weight. The tomato is such climacteric fruit and have a short post-harvest life. Shelf life of tomato can be enhanced by precooling right after harvesting and storing them at low temperature by removing the field heat. The respiration rate, moisture loss and reaction with atmospheric gases can be reduced by preserving it in the controlled atmospheric conditions. Cold Rooms, Low Energy Cool Chamber, Zero Energy Cool Chambers and Cold Storages are some of the infrastructures necessary for tomato storage. Choice of these infrastructures

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depend on the duration and quantity of storage. Generally, cold storages are suitable for long time storages whereas other mentioned infrastructures suit well for on-farm short term storages.

In the study area, due to the lack of storage facilities at the village or block level the farmers were compelled to sell the tomatoes right after harvesting in the nearby market. Due to the short shelf life and un-availability of storage facilities, farmers did not wait for better prices if the present market prices were lower than the farmers' expectation. Although during interactions, the farmers welcomed the idea of storage facilities at field-level (like; Zero Energy Cool Chamber) for short duration storage. This is a practical technique to extend storage life of tomatoes by reducing quality degradation at farmers' field.

In general, in Madhya Pradesh, there are around a total of 164 cold storages with capacity of 1.2 million tons, moreover around 80% of these cold storages are suitable for potato. This number is quite inadequate to facilitate the needed storage for a substantial volume of fruits and vegetables produced (more than 300 million tons) and particularly for tomatoes, which is a highly vulnerable commodity.

Market Practices

It was found during the interview that most of the smallholder farmers sold their produce to the local aggregators. A local aggregator is a big farmer in the village who collects or aggregates the produce from the farmers and transport it to nearest market or APMC. An aggregator charges the farmers (on per crate basis) for transportation and packaging which is deducted during payment of final price for the produce. Generally, a farmer had to pay an aggregator around ₹ 10 (€0.12) to ₹ 25 (€0.30) per crate for the services. In some cases, the farmers have also themselves transported the produce to nearest APMC for selling. Before selling, the farmers obtained information about current market prices of different APMC / Mandi; telephonically and sold their produce accordingly.

Some of the farmers have also formed groups and an established network with district Mandi agents and distant Mandi agents. Distant Mandi locations in case of study districts; Shajapur, Dewas, Jhabua, and Mandasaur are Indore, Ujjain, Bhopal, Mandasaur, and states like; Gujarat, Rajasthan and Delhi (Azaadpur Mandi) as well. For selling directly to Delhi or other states Mandi a commission of 12-15% was paid by the farmers. This commission included local aggregator commission, transport, loading-unloading and damage expenses.

Some farmers have informed that from the last 4-5 years, pre-harvest contracts with aggregators for selling their produce in distant market as well as with few processors were also established. In such case, rates of produce ranged between ₹ 600 (€7,26) and ₹ 800 (€9,68) per quintal for selling in distant locations Mandi, and between ₹ 400 (€4,84) and ₹ 500 (€6,05) per quintal for selling to processors. The farmers have shared their satisfaction in selling their produce to the processors at a lower price because the processors procured the entire produce irrespective of the quality or grade of the produce. Thus, tomatoes of low grade or damaged or small sized ones were also bought by the processors.

The market channels identified during the study have been presented herewith:

Channel - I



Channel - II



Estimation of Losses in the Tomato Value Chain in Madhya Pradesh

Tomatoes are highly perishable and transportation and storage can result in significant physical losses of as high as 20-25%. As per FGD observations, it has been estimated that about 17.4% losses occurred during entire value chain of fresh tomatoes. At the farm level the losses were 6% which included harvesting, grading, packing and aggregation; local trader and wholesaler level losses were 3.4 %, whereas, remaining losses occurred at retailer level which was about 8.0%.



TOMATOES WASTED DURING HARVESTING AND GRADING PROCESS

It was observed that the post-harvest losses in fresh tomato value chain were very high in comparison with the processed tomato value chain. The losses in the processed tomato value chain are around 3 % (sorting of diseased, insect affected and rotten tomatoes), this is because of the shorter supply chain in

processed tomatoes. The estimation of losses is quantified using the data gathered through different consultations with the value chain players (Table 15).

Table 15 : Estimation of Losses in Different Stages of Tomato Value Chain

	Stages	Loss %
Farm Level losses	Harvesting	1.6
	Grading, Packing and Aggregation	2.8
	Transportation	1.6
	Total Farm Level Losses	6
Local Trader Level Losses	Loading and Unloading	0.8
	Handling and Spoilage	0.5
	Total Local Trader Level Losses	1.3
Wholeseller Level Losses	Loading and Unloading	1
	Handling and Spoilage	1.1
	Total Wholesale Level Losses	2.1
Retailer Level Losses	Loading and Unloading	0.8
	Cleaning and Grading	2.8
	Sorting by Customers	4.4
	Total Retailer Level Losses	8
Total Post-Harvest Losses		17.4

We have referred to the study conducted by the World Resources Institute¹ on “FOOD LOSS AND WASTE IN INDIA: THE KNOWN AND THE UNKNOWN”. It has compiled different research work and studies around food waste and food losses across various commodities, however there is not much facts/insights available related to tomatoes.

The above results are also associated with following national studies:

1. As per study published “Post-Harvest Losses in Selected Fruits and Vegetables in India” in technical bulletin of Indian Institute of Horticulture Research, Bengaluru² overall post-harvest losses in tomato is about 12.98%. out of which maximum losses were observed from harvesting to transportation.
2. Gajanana, T.M. et.al (2006)³ undertook systematic studies on post-harvest loss assessment at different levels of handling in the major tomato growing state of Karnataka bought out that the total post-harvest losses in tomato was about 19 per cent consisting of 9.43 per cent at field level, 4-5 per cent at market level and about 5 per cent at the retail level. (Source: Gajanana, T. M. et al. (2006). Marketing and estimation of post-harvest loss of tomato crop in Karnataka. Indian Journal of Agricultural Marketing 20 (1):1-11)

¹https://wri-india.org/sites/default/files/Food%20Loss%20and%20Waste_August%202021.pdf

²https://ijras.org/administrator/components/com_jresearch/files/publications/IJRAS_976_FINAL.pdf

³https://www.researchgate.net/publication/272483955_Marketing_and_Estimation_of_Post_Harvest_Losses_of_Tomato_crop_in_Karnataka

Quantification of % losses of tomato at different levels

Harvesting	Collection	Sorting/grading	Packaging	Transportation	Total losses in farm operations	Farm level storages	Godown/ cold storages	Wholesaler level storage	Retailer level storage	Processing unit level storage	Total loss in storage	Overall Total Loss
1.73	1.06	3.24	0.77	3.14	9.94±1.03	1.22	0.01	0.72	1.16	0.17	3.04+0.84	12.98±1.0

Climate Change Adaptation, Mitigation and Resilience in the Context of Tomato Production

The climate change poses serious threat to the tomato production. The climate change impacts and extreme weather events limit the productivity and quality of tomato production considerably. During the study, the farmers also informed about the crop-losses due to sudden change in climatic conditions and extreme weather events. Loss to tomato crops is caused due to several identified climatic factors like; heavy rainfall, flooding, extreme temperatures, sudden dip in temperature and frost incidences.

Extreme and high temperatures reduce the quality of tomatoes and cause significant losses in its productivity by reducing fruit sets, smaller fruits and lower quality of fruits. Due to high temperatures, fruit set failure like; bud drop, abnormal flower development, poor pollen production, poor viability and other reproductive abnormalities are common. Signs of sun blistering, a visual defect caused due to extreme heat and temperatures, can also render the entire produce unsellable. On the other hand, sudden dip in temperatures in winters reduce seed germination, growth rate of pollen tube and percent of fruit set in tomato.

Changes in rainfall pattern and untimely rain also cause severe losses in the tomato crop. Heavy rainfall due to climate stress affects the production of tomato. During floods, tomato plants accumulate endogenous ethylene which causes damage to plants. Water deficits immediately after transplanting, during flowering and fruit development hampers the growth of the crop. Tomatoes are sensitive to drought stress and fruit set can be seriously reduced if crop is subjected to water stress. Extreme weather events like hail storm, storms, strong winds also cause significant damage to standing crops.

The tomato crop is also impacted due to insect/ pest and disease attack related to climate change. Many viruses infecting tomato have been reported while new viral diseases have also emerged. The occurrence of white flies and blight can damage 60-70% crop at once. The climatic changes can also be a contributing factor to the spread of newly emerging viruses, as well as establishment of diseases in the areas that were previously either unfavourable or absent. The tomato crop infected by diseases can have reduced yields, shorter shelf life, reduced nutritional content, poor fruit quality; which can render it unmarketable. In extreme situations, these diseases force the farmers to abandon tomato production all together.

In order to overcome the problem of pest and disease infestation, adoption of IPM strategies is necessary. The incorporation of biopesticides and IPM technology is gaining importance in recent years. Studies have found that integration of all these control measures along with the judicious application of pesticides can reduce the pest and disease problem to a great extent. Some of the methods that can be adopted are; cultivation of tolerant varieties, intercropping, bio control agents, biorational insecticides, growing of trap crops like; marigold, and other IPM interventions (pheromone traps, need based spray of pesticides).

For the climate change adaptation, the adaptive capacities of farmers need to be built following several measures like adjusting to time of sowing, suitable climate resilient seed variety, optimising water use efficiency (drip irrigation), fertigation, mulching, watershed management, soil incorporation of organic manures/residue to improve soil health, promotion of regenerative agriculture and ecologically sustainable climate resilient production system etc. The mitigation efforts around reduced GHG emissions through reduced use of synthetic fertilizers and chemicals and limiting crop residue burning, in the field, minimizing tillage, etc, and carbon sequestration through enhancing activities that entrap Carbon with in the soil layer as soil carbon sink (e.g. composting, tree planting mulching, cover crops, etc.) need to be promoted.

To build the climate resilience attitude among farmers, the proper extension support and scientific crop advisory is essential in the tomato growing clusters. In this regard training and capacity building of the farmers with support of Agriculture Department, Horticulture Department and Krishi Vigyan Kendra can be conducted at village/ cluster level. The support role of CSOs/ NGOs in this regard is crucial for field-based extension support to farmers, setting up demonstration plots, establishing Farmer Field Schools, forming Farmer collectives or FPOs.

SWOT Analysis

This section presents the SWOT analysis of tomato production and issues related to post-harvest management in the study area of Madhya Pradesh state.

Strengths

- **Leading Tomato Producing State:** Madhya Pradesh is the leading Tomato producing state in the country. In the year 2019-20, it produced over 11.5 % of the country's total tomatoes from an area of over 93,000 hectares.
- **Suitable Soil and Climatic Conditions:** State has suitable climatic and soil conditions for large-scale expansion of area under tomatoes cultivation
- **Year-round availability of raw tomatoes in the market, except for peak summer season**
- **Potential for Processing Industries:** There is a huge -potential of processing industries due to high volume of tomato production and surplus availability of tomato produce for processing
- **Investment Potential:** Besides the volume cost benefits, the state government is also providing attractive investment benefits to potential investors.
- **Enabling Government Schemes:** There are number of Government schemes to support Horticulture crop production in the state.
- **Progressive Farmers:** It was found during the study that there is a considerable number of active farmers in tomato cultivation who are self-motivated.
- **Most of the districts where the study had been undertaken are also the major tomato producing districts of Madhya Pradesh. The major tomato producing districts in the state are; Shivpuri, Chhindwara, Sagar, Raisen, Barwani, Jhabua, Satna, Dhar, Dewas and Annuppur.**

Weaknesses

- **Vulnerable to Climate Change:** Tomato crop is vulnerable to changing weather and climatic conditions. Incidences of virus/ insect/ pest attack like; occurrence of white flies and blight can damage 60-70% crop at once.
- **Labour Intensive:** Tomato cultivation is labour intensive and it involves labour for activities like; transplanting, weeding, stacking, harvesting and grading. Often due to unavailability of labour, the activities get delayed thus hampering production.
- **Lack of extension and technical knowledge support**
- **Lack of Farmers' Collective:** There is lack of farmers' collectives and majorly of farmers are smallholders in the state.
- **Lack of Infrastructure Facilities:** The state is lacking in infrastructure facilities for the storage of tomatoes. Tomato being a low shelf life is highly perishable.
- **Lack of Availability and Awareness about Processable Varieties:** There is lack of availability and awareness about the processable varieties tomatoes. This results in low cultivation of processable varieties of tomato here.
- **Lack of Processing Industries:** There are not adequate processing industries for tomato processed products in the study area and the state.
- **Lack of Integrated Pack Houses:** Number of integrated pack houses are less in the state compared to the quantum to tomato production.
- **Lack of MRL testing facilities**
- **Poor Market Linkages:** The market linkages are to be improved for Tomato value chain. The Tomato marketing practices are heavily dependent on intermediaries here.

Opportunities

- **Diverse Climatic Conditions:**The state of MP has diverse climatic conditions with 11 agro-climatic zones suitable for year-round cultivation of tomato.
- **Huge Raw Material Base for Processing:** The state is having huge raw material base for processing industry: The state produces vast quantities of tomato.
- **Surplus Tomato Production:** Around 1687 thousand MT of tomato produce is surplus in the state. This presents a wonderful opportunity for the processing industries.
- **Scope for development of more storage post-harvest infrastructures facilities.**
- **Setting up of grading and packing units at cluster level to boost exports.** Also, setting up of export houses can be explored.
- **Increasing Demand of Tomato Processed Products:** Tomato processed products are namely; sauce, pickle, soups, ketchup etc is increasing every year. In the last few years an increased consumption of these products has been noted in the state and country at household, commercial and institutional level. This opportunity can be tapped by the processing industries.
- **Demand and Supply Gap:** The rising gap in global demand and supply of tomatoes can be addressed by increasing tomato production from the state and the country.
- **Potential for Organic Tomatoes:** There is an increased demand for organic food and commodities, and the same can be explored for tomato production in the state.

Threats

- **Vulnerable to Climate Change and Weather Conditions:** Tomato crop is vulnerable to sudden changes in temperature and weather like; erratic rains, flood, low temperature, frost etc.
- **Pest and Insect Issues:** High occurrences of insect/ pest/ disease attack have been found in the area which causes crop loss.
- **Gap in Scientific Advisories:** As observed during the study, there is a gap in receiving of proper scientific crop advisories by the farmers.
- **Lack of Awareness About Govt Schemes:** The farmers are not much aware about the relevant Govt. Schemes that could support them in cultivation of Horticulture crops.
- **Volatile Market Prices:** The market prices for tomatoes are highly volatile and fluctuating due to which farmers are affected through the low-profit margins etc. Many farmers have reduced their area of tomato cultivation and some farmers have even discontinued tomato farming due to the market volatility.
- **Lack of Alternative Marketing Channel:**In the present marketing channel, Tomatoes are sold to village level aggregators who sale it further to APMC/ Mandi. There is no other alternative marketing channel for tomato in the area. Buy back arrangements with Processing industries, developing FPOs for horticulture commodities; will be necessary to create diverse marketing channels.
- **Lack of effective production control mechanism.** This makes glut situation due to over production.

Key Value Chain Gaps

Some of the important gaps that have been identified in the tomato value chain studied in the selected clusters have been discussed in the current section.

Crop advisory and quality inputs: The crop advisory received by the tomato farmers (especially; smallholders) was totally based on knowledge of fellow farmers neighborhoods and input suppliers. The input suppliers provided advisory on seed variety selection, fertilizers use, doses, methods, pesticides, etc. Competency of the person playing the role of crop advisor was questionable in majority of the cases. Generally, the farmers had limited reach to recognized advisory bodies such as the Horticulture Department, Agriculture Department and Krishi Vigyan Kendra. Reliable scientific crop advisory was found to be a crucial gap in value chain. Timely availability of scientific crop advisory was also a big challenge in the value chain.

Post-harvest losses and shelf-life enhancement techniques: In the study, lack of awareness was observed among the farmers about proper pre- and post-harvest practices and techniques for ensuring better yield and for storing tomatoes, to extend its shelf life. There was a gap of awareness level about the practices that ought to be done at pre- and post-harvest level, and that can minimize the losses and increase the shelf life of tomatoes maintaining the quality. Post-harvest losses were found to be as high as 23%. No post-harvest storages were done in the state at producer level.

Shortage of labour during harvesting season: The tomato crop needs frequent harvesting. Timely harvest gives an additional window to farmers to keep it for longer period in case market price is not favourable. The tomato harvesting was done in the cluster manually by hand picking. A good number of semiskilled labour was engaged on a regular basis in this activity. But in case of shortage of labour, unskilled labour was employed, who were not competent enough to pick right fruit. This had been identified as a prominent gap in the value chain as it resulted in losses of tomato produce due to inexperience in handling.

Lack of Storage Facility: On the basis of preferred time of storage, tomatoes can be stored in zero energy cool chamber, low energy cool chamber, cold room or in cold storages. The most appropriate storage option is Controlled Atmospheric (CA) storage which is complex and expensive as well. There was a lack of packhouses, on-farm storage structures, and cold storages in the cluster. The absence of storage facilities created situations under which farmers were bound to sell the produce afresh. Addressing this gap is necessary to ensure a profitable value chain for tomatoes. The linkages between cold storage owners and processor with producers were also not established in the clusters. The tomato value chain needs to be supported by creation of network of storage facilities.

Market Linkages: The producers have reported to not have any direct access to market. In some clusters, the producers formed informal groups and directly sold their produce to distant markets (Mandis at different states and cities). Few producers secured pre-harvest price contract with processors and sold their produce to them, but these kinds of arrangements were rarely found in the state and the study area. Alternative marketing channels or linkages were also not found in the clusters. The farmers sold their produce only to district or distant Mandis. There is a need for developing alternate

markets for tomato and marketing infrastructure for strengthening the tomato value chain. This can be done with intensive efforts on creation of support infrastructure and capacity building.

Farmers' collectives: The FPO's which were working in the clusters were not directly conducting any business, and restricted themselves to input supply. With the help of Department of Horticulture, SFAC, NABARD, and NGOs; some producer collectives were formed in the state although the FPOs required consistent support in terms of capacity building for business orientation and value addition opportunities. Due to absence and non-existence of FPOs in the area and state; producers did not have much options to sell their produce. Even in local markets, the farmers were not able to sell their produce without agents/wholesaler's help. Also, there is need to educate FPOs for collective marketing, this will be requiring consistent support in terms of capacity building for business orientation and value addition opportunities.

Lack of processing industries: The tomato value chain requires huge support from processing industry as it is the only way to increase its shelf life. During the study, absence of processing industries was reported in the districts. Promotion and incentives to tomato puree, powder, flakes manufacturing units in the tomato clusters can prove as a lifeline for tomato producers. Recently the Ministry of Food Processing and Industries (MoFPI-GOI) launched PMFME scheme on pan India basis for formalization and establishment of micro food processing units in country.

Export of tomatoes: The export pattern of Indian tomato and tomato products is not in line with the demand pattern of major importing countries. The major importer countries are importing preserved or processed tomatoes while Indian export is focused on fresh and chilled tomatoes. Due to lack of APEDA accredited integrated pack houses, MRL testing facilities, perishable cargo, and refer vans; export of tomatoes had not been reported from Madhya Pradesh.

Key Recommendations

The key recommendations and intervention suggestions are as given below;

- 1. Awareness of Good Agricultural Practices (GAPs) :** High production cost is the major concern raised during the study. Plant protection chemicals and fertilizers shared more than 40% of the production cost. Hence, by adoption of GAPs, Integrated Pest Management and fertigation techniques; cost of cultivation could be reduced in tomato production. There is urgent need to take actions towards addressing the climate change through appropriate measures on adaptation, mitigation and resilience. On-farm demonstrations and hands on training needs to be organized for the farmers in key clusters through CSO/NGO interventions.
- 2. Setting-up of Centre of Excellence (CoE) for tomatoes:** The Centre of Excellence can be set-up for Tomatoes. The center would address all value chain related issues from production to consumption. It will showcase the technological achievements of the Netherlands by activities such as demonstrations, visits, exchange of information etc. It will also show-case the improved technologies related to post-harvest handling, storage and marketing of produce. The center would incubate entrepreneurs on different aspects of tomato value chain. The research and development related aspects would also be organized in collaboration of ICAR research institutes and the Wageningen University. Various training programmes for farmers, entrepreneurs, logistic service providers and processors will be organized by the experts. Overall, the center would provide a major boost to tomato production and address the issue of losses and wastage within the supply chain.
- 3. Introduction of Processable and diseases resistant Tomato Varieties :** The state of Madhya Pradesh is the second-largest producer of Tomatoes having 2723 (000) MT production with about 50% of surplus production. But the produce available could not fulfill the requirements of processing industries because of quality issues. Therefore, it is urgent to introduce processable type varieties in extension system through consultations with State Agricultural universities, ICAR research centers, Seed companies and Processing Industries.
Validation of production potential (> 75 tons/ha) of triple disease (bacterial wilt, tomato leaf curl virus and Alternaria) resistant tomato variety- “Arka Rakshak” (developed by IIHR, Bengaluru) will lower down production losses and thus ensure sizeable quantity for processing.
- 4. Promotion of Protected Cultivation :** Madhya Pradesh endowed with its diverse nature of soil and climate conditions but the vagaries of climate most of the times plays a negative role in production of tomato. Which can be managed with hi-tech production technologies especially protected cultivation, plastic mulching and drip-fertigation techniques. Further, the productivity of tomato crops remains lower to that of top tomato producing states and very low as compared to that of other top tomato producing countries. This can be suitably modified by disseminating the technology on hi-tech cultivation and increasing per unit productivity and thereby increasing the profitability.

5. **Promotion of Suitable Mechanization Options:** The tomato is a seasonal crop with life span of 5-7 months. Starting from land preparation, transplanting to harvesting of produce till marketing, manual labour is involved at every step which increase the cost of production for the farmer thus decreasing the net profit. Hence, suitable mechanization options should be made available to the farmers. Introduction of land preparation equipment, automated seed sowing machine, mechanical transplanter, drone-based sprayers, harvester, grading and sorting equipment is the need of hour.
6. **Infrastructure Development:** Setting-up of facilities like soil, water, leaf tissue analysis, Maximum Residual Level (MRL) testing, Agri-Clinic, Custom Hiring Centers (horticultural implements and machineries) facilities in cluster or division level should be created. Along with developing Zero Energy Cool Chambers, Cold Rooms and Packhouses at individual or cluster/block level, to minimize post- harvest losses should be worked on. Followings are few more important points under the infrastructure development
 - I. Establishment of Integrated packhouse, grading sorting units, CA (Controlled Atmosphere) storages at cluster level could also be explored.
 - II. Linkages of growers with cold storages or packhouse owners on rental basis can be done.
 - III. Establishment of common processing facilities and Incubation centers through PPP mode can also be explored.
 - IV. Coverage of fruits and vegetable regulated markets needs to be widened through establishments of sub market yards within districts.
 - V. Development of grading-sorting and storages facilities at APMC's of tomato producing districts could be made.
7. **Skill Development:** There is a need to sensitize the farmers through proper training on pre - harvest management, harvesting techniques and post-harvest management techniques. Under “Skill India”, several informal courses for skill development are designed by the Government like Greenhouse operator, Supply chain field assistant, vegetable growers', Micro irrigation technician, Plant protection worker, Pack house worker and so on. Thus, need based courses should be implemented through any relevant agency in these clusters. Identification of local youths, involved in farming, should be done and trained from a crop specific training or research center so that these youths can be further engaged as crop masters or resource person during capacity building programmes.
8. **Market Information:** As per the information gathered during survey, there was no specific marketing information system established in the clusters. Growers used their own sources to gather price related information from middle man, local aggregators or from commission agents. A proper marketing information system could be established for the farmers so that they can obtain information about market prices location wise. In this regard, app-based systems can be thought of and developed.

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9. **Adoption of Government Schemes:** For enhancement of production, productivity and post-harvest management, various state and central sector schemes had been operational in the state. Notable schemes are; Mission on Integrated Development of Horticulture (MIDH), Rashtriya Krishi Vikas Yojna (RKVY), Pradhan Mantri Krishi SinchaiYojna (PMKSY), PM Formalization of Micro Enterprises (PMFME), Pradhan Mantri Kisan SampadaYojna (PMKSY), Weather based crop insurance scheme (WBCIS), Operation Green. In spite of presence of these schemes, the farmers had limited knowledge and information on them. Efforts should be made at cluster level by the Government Departments and the CSOs/NGOs to sensitize the farmers about the existing schemes and ensure maximum adoption of the schemes by the farmers. Identifying the district with best production potential will help in exploiting the benefits of “One District One Product” (ODOP) scheme of the Government.
10. **Promotion of Country Specific Tomato Export Zone:** The tomato can be processed in the form of; puree, paste, sauce, powder and flakes. The above-mentioned products can be manufactured in small and medium scale industries. A focused policy framework on promotion of such “crop cluster-based industry” by giving special incentives for such project may be helpful in raising the level of processing and uptake of processing units. A careful and detailed study of tomato and processed products importer needs to be carried out to identify product variants, market potential, statutory and export compliances, technology requirement, industrial support and incentives, need of export houses and investment promotion strategy.
11. **Promotion of Farmers Collectives:** Promotion of Farmers' collectives such as cooperatives/societies/producer groups and most revolutionary concept Farmer Producer Organizations (FPO) should be promoted and significant investment is required in building their capacities. These FPOs can help in making informed decision on farm planning and marketing, increase in production and quality through shared knowledge, reducing cost of production through resource pooling, increase in access to transparent markets for better prices, enhanced capacity for farm gate processing opportunities through collective efforts and reduced influence of intermediaries in value chain. The FPOs need support in administrative operations, business orientation, system establishments, market support, and creating skilled manpower.
12. **Task Force for Liaison Between Different Stakeholders:** A task force/platform can be formed with the representation of Government, Netherlands Embassy, Research institutes, Businesses and related supply chain stakeholders. This would provide a platform to have dialogues on the sector issues, enabling policies and collective and coordinated efforts of stakeholders.
13. **Development of Sustainable Tomato Supply Chain Standards:** The supply chain standards for sustainable tomato can also be developed. This would provide a framework and ensure the social, environmental and economic performance of the supply chain processes.
14. **Introduction of Digital IoT Based Platform:** An integrated ICT platform can be created which would have different tools for extension as well as communication. The IoT based solutions and smart sensors can be introduced for crop monitoring and dissemination of precise advisories and weather information to farmers.

Potential Contribution to UN Sustainable Development Goals

The findings of study highlight the potential areas where actions are needed. The interventions proposed to address the food loss and food waste would potentially contribute towards increased availability of food, enhancing farmers' income, easing pressure on land and water resources and reducing greenhouse gas (GHG) emissions. The actions undertaken to address the causes of food losses in the tomato value chain would potentially contribute towards multiple UN Sustainable Development Goals (SDGs) and the project will deliver on a range of UN Sustainable Development Goals (SDG's). These include SDG 1 for ending poverty, SDG 2 for ending hunger, SDG 5 for gender equality; SDG 8 promote inclusive and sustainable economic growth, employment and decent work for all; SDG 12 for reduction in food losses along the production and supply chains, including post-harvest losses, responsible consumption and production, SDG 13 for climate action and SDG 17 for strong partnerships to achieve the goals.



SDG 1. End Poverty in all its form everywhere

- Improved productivity and income of smallholder farmers
- Build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events
- Equal rights to economic resources, as well as access to basic services



SDG 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture

- Sustainable food production systems and implement resilient agricultural practices
- Increased income and availability of food would contribute towards households being food secure and consumption of diversified food throughout the year.
- The promotion of crop diversification through vegetables including tomato would contribute towards the increased income, availability and consumption of nutritious vegetables. The vulnerable groups like women would realise the diversified food consumption
- The adoption of sustainable agricultural practices would contribute towards reduced use of chemicals and efficient use of natural resources i.e. water soil, botanicals. The efficient use of inputs and resources will also get reflected in the income increase of farmers.



SDG 5. Achieve gender equality and empower all women and girls

- Ensure women's effective participation and equal opportunities for entrepreneurship and leadership levels i.e., as member in Farmer Collective like FPO.

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- The improved knowledge about good agricultural practices, skill building on the post-harvest management and processing practices etc. would ensure household level decision making of women in farming and their contribution to generate additional income.



SDG 8. Promote Inclusive and Sustainable Economic Growth, Employment and Decent Work for All

- Employment opportunities would be created through skill building, training and capacity building of rural entrepreneurs (youth and women). These entrepreneurs would be trained for provision of services linked to sustainable agriculture, advisories, quality inputs and seeds, farm mechanization and collective sale of tomatoes and vegetables.



SDG 12. Ensure sustainable consumption and production patterns

- Sustainable management and efficient use of natural resources
- Address the food losses and food waste along the production and supply chains, including post-harvest losses
- Reduction of waste generation through prevention, reduction, recycling and reuse



SDG 13. Take urgent action to combat climate change and its impacts

- The sustainable agricultural practices including measures on climate change adaptation, mitigation and resilience would be promoted
- Efficient use of inputs and resources would strengthen the resilience and adaptive capacity of farmers. They will become more resilient to possible stresses and/or shocks of climate change
- Contribution to the GHG emissions reduction and carbon sequestration



SDG 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

- International cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms
- Resource pooling to jointly address the issues of food losses and food waste in the tomato value chain.

List of Stakeholders Interacted in the Study Districts

Government

- The Additional Chief Secretary, Horticulture and Food Processing, Government of Madhya Pradesh
- The Commissioner, Department of Horticulture and Food Processing, Government of Madhya Pradesh
- The AGM, Agricultural and Processed Food Products Export Development Authority (APEDA), Government of India
- The GM, Madhya Pradesh State Agro Industries Development Corp. Ltd., Government of Madhya Pradesh
- The Deputy Director Horticulture of concerned districts, Government of Madhya Pradesh
- The Mandi In-charge of concerned districts, Government of Madhya Pradesh

Private

- M/s Frutux Industries, Khargone
- M/S “Venkatesh Food Processor and V Nature Pvt Ltd”, Chhindwara
- Input suppliers (Seed & Pesticide companies)
- Irrigation suppliers (Netafim, Jain irrigation etc.)
- Nursery owners
- FPO's
- Cold storage owners

Universities/Institute

- Krishi Vigyan Kendra – Chhindwara, Dhar, Dewas, Jhabua, Mandsaur, Shajapur and Ujjain
- College of Horticulture, Mandsaur
- Jawahar Lal Nehru Krishi Vishwavidyalaya (JNKVV), Jabalpur
- Rajmata VijayarajeSindia Krishi Vishwavidyalaya (RVSKVV), Gwalior

Name of the Key Stakeholders

Name	Designation/ Role in Tomato Value Chain	Location Details
Mr. J.N. Kansotiya	The Addl. Chief Secretary	Department of Horticulture and Food Processing, Vallabh Bhawan, Bhopal , District Bhopal
Dr. E Ramesh Kumar, IAS	The Commissioner	Department of Horticulture and Food Processing, Bhopal, District Bhopal
Mr. Prashant Waghmare	The AGM	Agricultural and Processed Food Products Export Development Authority (APEDA), Kisan Bhawan, Bhopal, District Bhopal
Mr. Rajkumar Kori	Deputy Director Horticulture	Department of Horticulture, Chhindwara , District Chhindwara
Mr. Neeraj Sawaliya	Deputy Director Horticulture	Department of Horticulture, Dhar, District Dhar
Mr . Pankaj Sharma	Deputy Director Horticulture	Department of Horticulture, Dewas, District Dewas
Mr. Sunil Rathore	Senior Horticulture Development Officer	Department of Horticulture, Tarana, District Ujjain
Mr. Mujalda	Block Horticulture Officer	Department of Horticulture, Badnawar, District Dhar
Mr . Rajesh Jatav	Rural Horticulture Extension Officer	Department of Horticulture, Malhargarh, District Mandsaur
Mr. Kamlesh Gurjar	Rural Horticulture Extension Officer	Department of Horticulture, Shajapur, District Shajapur
Ms. Laxmi Juda	Rural Horticulture Extension Officer	Department of Horticulture and Food Processing, Bhopal, District Bhopal
Dr. Surendra Pannase	Programme Co-ordinator and Head, KVK	Krishi Vigyan Kendra, Chhindwara , District Chhindwara
Dr. G R Ambavatiya	Programme Co-ordinator and Head, KVK	Krishi Vigyan Kendra, Shajapur, District Shajapur
Dr. S SDhakad	Scientist- Agriculture Engineering	Krishi Vigyan Kendra, Shajapur, District Shajapur
Dr. Nishit Gupta	Scientist	Krishi Vigyan Kendra, Dewas, District Dewas
Mr. Rajesh Juneja	Managing Director	V Naturals Pvt Ltd, Chhindwara , District Chhindwara
Mr. Sirish Chandra Chandel	Plant Head	Venkatesh Food Industries, Chhindwara, District Chhindwara
Mr. Ramprasad Patidar	Nursery Owner	Ganesh Nursery, Sethkhedi, Sonkatch, District Dewas
Mr. Jeevan Chauhan	Trader	APMC, Mandsaur , District Mandsaur
Mr. Lala Khan	Trader	APMC, Mandsaur, District Mandsaur
Mr. Bharat Kag	Trader	Dhar, District Dhar
Mr. Rupchand Patel	Trader	Dhar, District Dhar
Mr. Rajendra Suryawansi	Wholesaler	Balaji trades, Chhindwara, District Chhindwara
Mr. DurgadasParthi	Retailer	Chhindwara, District Chhindwara
Mr. Rajiv Devikar	Retailer	Chhindwara, District Chhindwara
Mr. Vijay Bagadi	Aggregator	Chhindwara, District Chhindwara
Mr. Chandu Dabare	Aggregator	Chhindwara, District Chhindwara
Mr. Nikhil Patel	Aggregator	Dhar, District Dhar
Mr. Mohanlal Patel	Aggregator	Dhar, District Dhar
Mr. Mangilal Patidar	Aggregator	Chakrod, District Shajapur
Mr. Dharmendra Dhakar	Aggregator	Sunera, District Shajapur
Mr. Sachin Gawli	Aggregator	Shajapur, District Shajapur
Mr. Rahul Verma	Aggregator	Petlawad, District Jhabua

Definition of Processing

According to the Food and Agricultural Organisation (FAO) definition, processed foods can be of three types: primary, secondary and tertiary.

Primary processed foods involve basic cleaning, grading and packaging, eg: packaged atta and branded tea.

Secondary processing means modification of the basic product to a stage just before the final preparation at the consumer's kitchen, e.g. tomato puree, ground coffee, etc.

Tertiary processing involves high value-added ready-to-eat products like berry products, ice cream, instant noodles, sauces jams etc.

The Government of India has classified processing into two parts:

Primary processing: Includes cleaning, grading, sorting, Pre-cooling, packaging etc.

Processing: Includes both secondary and tertiary processing.

1 EUR = 82.5693 INR, on the Date : 9th April 2022

Gallery



Meeting and discussion with Shri J.N. Kansotiya IAS, The Addl. Chief Secretary, Department of Horticulture and Food Processing, Bhopal MP



FGD with Tomato farmers in Ujjain district



FGD with Tomato farmers in Mandsaur district



FGD with Tomato farmers in Dewas district



FGD with Tomato farmers in Jhabua district



FGD with Tomato farmers in Chhindwara district

Gallery



Interaction and meeting with Scientists of Krishi Vigyan Kendra, Shajapur district



Meeting with official of Horticulture Department of Shajapur district



Discussion with Tomato Aggregator in Sardarpur block, Dhar district



Discussion with Tomato trader in Mandsaur district



Interaction with a Tomato farmer in Makrond block, Ujjain district



Interaction with a Tomato farmer during questionnaire survey

Gallery



Interaction with a Tomato farmer on field



Mulching in Tomato farm



A Tomato farm



Staking in tomato crop



A woman farmer in her tomato farm



Plucking and harvesting of tomatoes from field

Gallery



Harvested tomatoes collected at one place for grading and sorting



Grading and sorting of tomatoes by a woman farmer on field



Tomatoes discarded after grading and sorting process



Graded Tomatoes after sorting



Tomatoes packed in plastic crates post grading and sorting



Packing and loading of tomatoes in plastic crates by Aggregator for transport to market

Gallery



Tomatoes packed in plastic crates by Aggregator for transport to market



Tomato crates loaded in vehicle for transport to Market



Selling of tomatoes in open market by Retailer



A Farmer selling tomatoes and other vegetables of his farm by setting up roadside stall







CHANGE THAT MATTERS

Solidaridad



Kingdom of the Netherlands

SOLIDARIDAD REGIONAL EXPERTISE CENTRE

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