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Marketing and Supply Chain of Fruits and Vegetables in Gujarat: Constraints, Price Spread, and Strategic Interventions

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Abstract
Gujarat occupies a pivotal position in India's horticultural economy, ranking sixth in vegetable production (1,85,01,856 MT) and fifth in fruit production (85,81,591 MT) nationally as of 2024-25. Despite this prominence, farmers in Gujarat receive only 37-69% of the final consumer price, depending on the crop, with substantial value being absorbed by intermediaries, logistics, and post-harvest losses. This review synthesises empirical evidence from peer-reviewed studies, institutional reports, and district-level horticultural data across Gujarat's four agro-climatic zones — South, Middle, North, and Saurashtra-Kutch — to examine the structure and performance of the fruit and vegetable supply chain. It systematically documents marketing constraints under six thematic categories: market intelligence, economic and price risks, physical infrastructure, logistics and distribution, market structure, and labour availability. Post-harvest losses range from 6.02-15.05% for fruits and 4.87-11.61% for vegetables. The review proposes targeted interventions including FPO-led aggregation, cold chain expansion, digital price discovery platforms, grading and standardisation, and policy reforms.

Keywords: Supply chain, fruits and vegetables, Gujarat, post-harvest losses, marketing constraints

1. Introduction
India is the world's second-largest producer of fruits and vegetables, with a combined output exceeding 330 million metric tonnes annually (Government of India, 2025). Despite such productive abundance, the fresh food supply chain in India faces severe structural challenges, including fragmented logistics, inadequate cold chain infrastructure, and weak market linkages, which result in enormous post-harvest losses at every stage (Kumar & Agrawal, 2023) [14]. The quantitative post-harvest losses for fruits range between 6.02 per cent and 15.05 per cent, while those for vegetables fall between 4.87 per cent and 11.61 per cent, as established by a 2022 study commissioned by the Ministry of Food Processing Industries (MoFPI). These losses translate to a significant monetary burden to the national economy (Gulati *et al.*, 2019) [8]. Gujarat stands at the forefront of this challenge and opportunity. The state ranked sixth in vegetable production and fifth in fruit production in India in 2024-25, harvesting 1,85,01,856 MT of vegetables from 8,75,268 hectares and 85,81,591 MT of fruits from 4,44,125 hectares (Directorate of Horticulture, 2025). Despite this scale, supply chains remain predominantly traditional, multi-layered, fragmented, and largely devoid of cold-chain infrastructure, leaving producers with a disproportionately small share of the final consumer price. This review critically examines supply chain structure, empirically documented constraints, and proposes evidence-based interventions to improve supply chain efficiency and farmer welfare in Gujarat.

2. Gujarat's Position in India's Horticulture Sector
2.1 National Rankings - Vegetable Production
Nationally, Uttar Pradesh leads vegetable production with 38,322,400 MT, followed by West Bengal and Madhya Pradesh. Gujarat ranks 6th nationally with 16,500,630 MT from 824,160 hectares, contributing approximately 7.65 per cent of India's total vegetable output (Government of India, 2025). Table 1 presents the national ranking of top vegetable-producing states.

Table 1: Top 10 Vegetable Producing States in India (2024-25)

Rank	State	Area (ha)	Production (MT)
1	Uttar Pradesh	1,484,660	38,322,400
2	West Bengal	1,580,940	29,133,620
3	Madhya Pradesh	1,296,230	24,222,460
4	Maharashtra	1,244,160	17,022,540
5	Bihar	902,610	16,688,170
6	Gujarat	824,160	16,500,630
7	Odisha	704,180	9,704,190
8	Tamil Nadu	359,200	9,650,980
9	Andhra Pradesh	225,830	8,310,400
10	Karnataka	402,710	7,090,820
All India Total		11,707,240	215,683,720

Source: Ministry of Agriculture and Farmers Welfare [MoAFW], 2025.

2.2 National Rankings - Fruit Production

In fruit production, Andhra Pradesh leads nationally with 19,350,110 MT, followed by Maharashtra and Uttar Pradesh. Gujarat ranks 5th with 9,347,560 MT from 479,730 hectares, contributing 7.87 per cent of the national fruit output. This places Gujarat among the top five fruit-producing states alongside states with far larger land areas, reflecting the productivity advantages of banana, mango, and sapota cultivation in the state (Government of India, 2025). Table 2 presents the full national ranking.

Table 2: Top 10 Fruit Producing States in India (2024-25)

Rank	State	Area (ha)	Production (MT)
1	Andhra Pradesh	807,340	19,350,110
2	Maharashtra	896,590	16,840,670
3	Uttar Pradesh	589,550	14,715,960
4	Madhya Pradesh	480,170	10,207,320
5	Gujarat	479,730	9,347,560
6	Tamil Nadu	336,520	7,832,770
7	Karnataka	298,560	5,326,600
8	Bihar	371,440	4,656,090
9	West Bengal	319,100	4,289,950
10	Kerala	294,420	4,117,220
All India Total		7,170,490	118,759,630

Source: Ministry of Agriculture and Farmers Welfare, 2024-25.

2.3 Zone-wise and District-wise Production in Gujarat

Gujarat's horticultural production is distinctly spatially differentiated across four agro-climatic zones. Table 3 provides the zone-wise summary of vegetable and fruit production across zones.

Table 3: Zone-wise Area and Production of Vegetables and Fruits in Gujarat (2024-25)

Zone	Veg. Area (ha)	Vegetable Production (MT)	Fruit Area (ha)	Fruit Production (MT)	Veg. Share (%)	Fruit Share (%)
South Gujarat	1,21,566	18,78,735	1,56,898	30,83,830	10.20	35.90
Middle Gujarat	2,45,998	44,05,025	83,987	27,81,232	23.80	32.40
North Gujarat	3,02,194	77,92,363	1,10,759	17,31,675	42.10	20.20
Saurashtra-Kutch	2,05,510	44,25,733	92,481	9,84,854	23.90	11.50
Gujarat Total	8,75,268	1,85,01,856	4,44,125	85,81,591	100.00	100.00

Source: Directorate of Horticulture (2025).

North Gujarat alone accounts for over 42.1 per cent of the state's total vegetable production, driven primarily by large-scale potato cultivation in Banaskantha (23,66,126 MT), Sabarkantha (21,67,226 MT), and Gandhinagar (10,48,688 MT). In fruit production, South Gujarat holds the largest area (1,56,898 ha) dominated by mango in Navsari, Valsad, and Bharuch. Table 4 shows the top three vegetable-producing districts by zone.

Table 4: Top 3 Vegetable Producing Districts by Zone in Gujarat (2024-25)

Zone	Rank	District	Area (ha)	Production (MT)
South Gujarat	1	Surat	44,664	6,99,481
	2	Valsad	17,430	2,97,802
	3	Tapi	18,057	2,67,019
Middle Gujarat	1	Anand	61,972	12,48,428
	2	Kheda	49,926	9,63,940
	3	Vadodara	37,758	6,82,410
North Gujarat	1	Banaskantha	92,632	23,66,126
	2	Sabarkantha	64,417	21,67,226
	3	Gandhinagar	51,281	10,48,688
Saurashtra-Kutch	1	Bhavnagar	60,142	14,42,580
	2	Amreli	36,419	7,74,968
	3	Rajkot	34,937	7,73,677

Source: Directorate of Horticulture (2025).

For fruit production, Table 5 shows the dominant districts by zone. Anand in Middle Gujarat leads with 10,49,517 MT due to banana cultivation, while Bharuch in South Gujarat contributes 9,78,545 MT driven by banana and mango.

Table 5: Top 3 Fruit Producing Districts by Zone in Gujarat (2024-25)

Zone	Rank	District	Area (ha)	Production (MT)
South Gujarat	1	Bharuch	17,194	9,78,545
	2	Narmada	14,749	8,10,647
	3	Navsari	44,565	3,73,015
Middle Gujarat	1	Anand	20,612	10,49,517
	2	Chhota Udepur	12,578	6,30,437
	3	Vadodara	18,845	6,16,062
North Gujarat	1	Kutch	61,569	8,90,784
	2	Banaskantha	14,752	2,59,325
	3	Mehsana	17,305	2,28,834
Saurashtra-Kutch	1	Bhavnagar	21,234	2,81,543
	2	Junagadh	16,450	1,78,951
	3	Gir Somnath	22,156	1,70,542

Source: Directorate of Horticulture (2025).

2.4 Major Crops: Area, Production and Productivity

Among vegetables, potato leads in production (47,89,149 MT) with the highest productivity (30.64 MT/ha), followed by onion and cucurbits. Among fruits, banana dominates production (42,16,812 MT) with a remarkable productivity of 70.19 MT/ha despite having less than half the area under mango (1,84,032 ha). Tables 6 and 7 present these details.

Table 6: Area, Production and Productivity of Major Vegetable Crops in Gujarat (2024-25)

Rank	Vegetable	Area (ha)	Production (MT)	Productivity (MT/ha)
1	**Potato**	**1,56,280**	**47,89,149**	**30.64**
2	Onion	1,02,210	27,18,321	26.60
3	Cucurbits	1,40,245	22,61,593	16.13
4	Tomato	66,416	20,21,993	30.44
5	Brinjal	78,148	15,86,326	20.30

Source: Directorate of Horticulture (2025).

Table 7: Area, Production and Productivity of Major Fruit Crops in Gujarat (2024-25)

Rank	Fruit	Area (ha)	Production (MT)	Productivity (MT/ha)
1	**Banana**	**60,081**	**42,16,812**	**70.19**
2	Mango	1,84,032	12,72,639	6.92
3	Papaya	17,014	10,07,505	59.22
4	Pomegranate	43,490	6,26,315	14.40
5	Citrus	42,226	5,31,359	12.58

Source: Directorate of Horticulture (2025).

2.5 Export Potential: India's Processed F&V Trade

Gujarat's production base feeds not only domestic consumption but also India's growing processed food export market. Table 8 shows India's top five export destinations for processed vegetables and fruits in 2024-25. The USA is the largest market for both processed vegetables (USD 63,811 thousand) and processed fruits (USD 1,85,943 thousand).

Table 8: India's Top 5 Export Destinations - Processed Vegetables (HS 2001) and Fruits (HS Chapter 20), 2024-25.

(a) Processed Vegetables			(b) Processed Fruits		
Sr. No.	**Country**	**Exports (USD '000)**	**Sr. No.**	**Country**	**Exports (USD '000)**
1	USA	63,811	1	USA	1,85,943
2	Germany	37,108	2	Netherlands	85,400
3	UK	32,844	3	UAE	73,084
4	Canada	23,519	4	UK	72,191
5	Australia	20,424	5	Saudi Arabia	69,541

Source: MoFPI (2025)

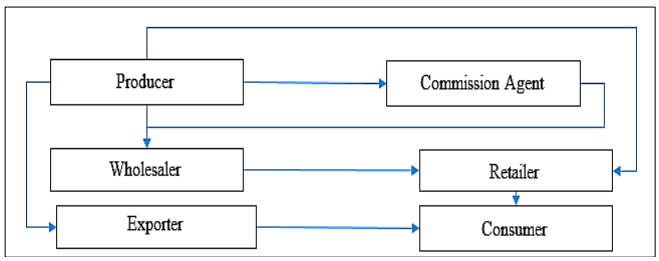
3. Supply Chain Structure of Major Crops in Gujarat

3.1 General Framework

The supply chain of fruits and vegetables in Gujarat follows a broadly similar structure: producers sell at the farm gate or through APMCs to village traders, commission agents, pre-harvest contractors, and wholesalers, who supply retailers and ultimately consumers. The specific actors and the number of intermediary levels vary by crop, region, and season. This multi-tiered structure results in transaction costs that erode a significant fraction of the consumer price before it reaches the farmer. The APMC system, despite its regulatory mandate, has often been criticised for reinforcing monopolistic tendencies, creating institutional barriers, and generating high costs through mandatory commissions and market fees (Farmonaut, 2026) [4].

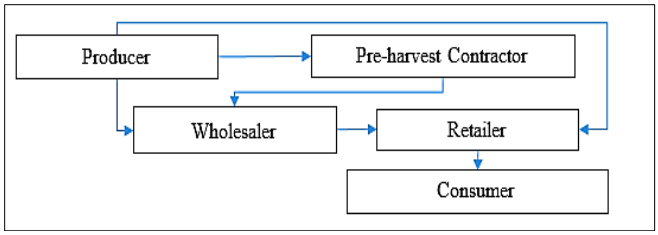
3.2 Fruit Supply Chain Diagrams

Figures 1, 2, 3, and 4 present the supply chain flow diagrams for five major fruit crops. The pre-harvest contractor model dominates mango and papaya supply chains, fundamentally shifting price-discovery power away from farmers.



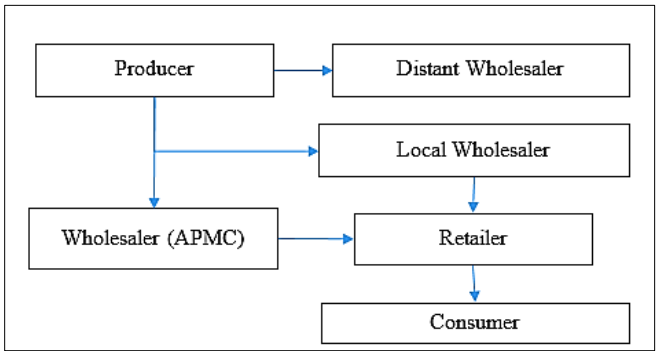
(**Source:** Pundir *et al*., 2024)

Fig 1: Supply Chain Diagrams - Banana



Source: IABMI (2022); Pundir *et al*. (2024a)

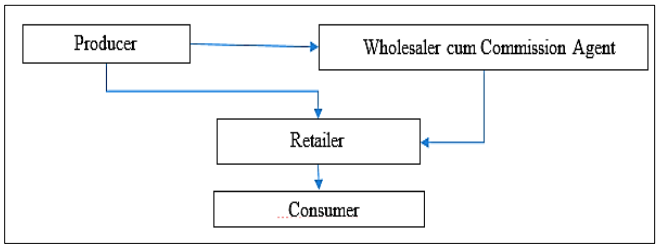
Fig 2: Supply Chain Diagrams - Papaya and Mango



Source: Patel & Pundir (2016)

Fig 3: Supply Chain Diagrams - Pomegranate

Citrus (lime) in Middle Gujarat uses a shorter channel: a wholesaler-cum-commission-agent model reduces intermediary layers, explaining why lime achieves the highest producer share (60.95%) among the studied fruits (IABMI, 2022).

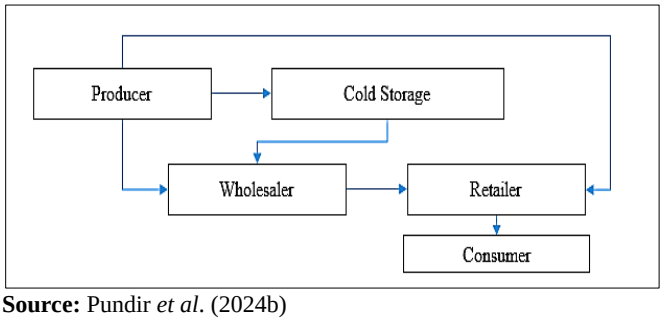


Source: IABMI (2022)

Fig 4: Supply Chain Diagram — Citrus (Lime)

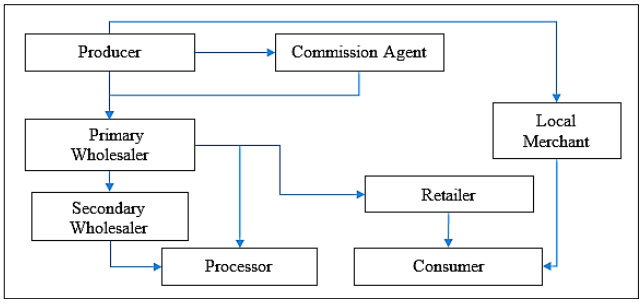
3.3 Vegetable Supply Chain Diagrams

Vegetable supply chains in Gujarat are differentiated by the strategic role of cold storage for potatoes and the complexity of the onion chain with multiple wholesaler tiers in Saurashtra. Tomato and brinjal follow shorter commission-agent-based channels, while cucurbits in Central Gujarat involve village merchants as an additional intermediary layer.



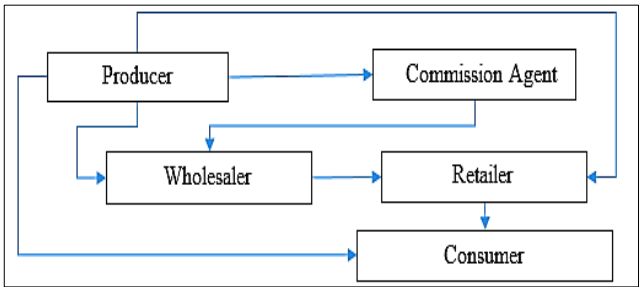
Source: Pundir *et al*. (2024b)

Fig 5: Supply Chain Diagrams - Potato



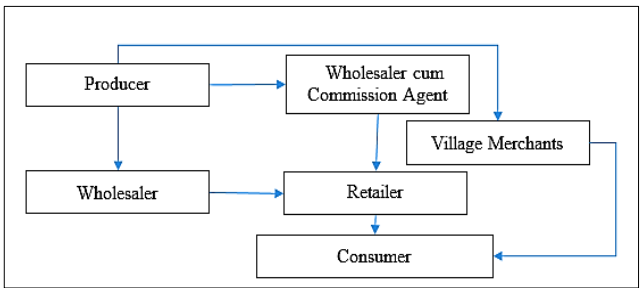
Source: Kantariya *et al*. (2018)

Fig 6: Supply Chain Diagrams - Onion



Source: IABMI (2022**)**

Fig 7: Supply Chain Diagrams - Tomato and Brinjal

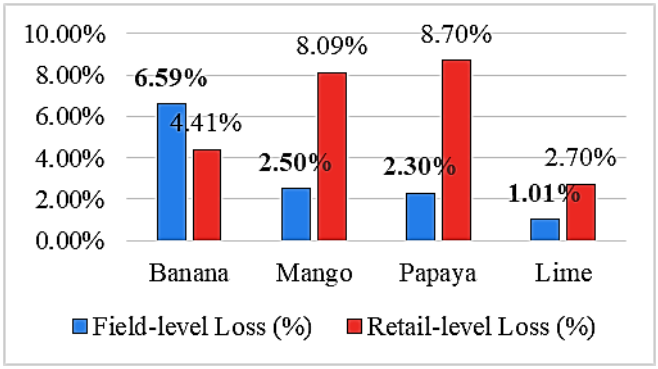


Source: Chotaliya (2017)

Fig 8: Supply Chain Diagram — Cucurbits (Little Gourd)

Cucurbits (little gourd) in Central Gujarat involve village merchants who aggregate small lots from dispersed farms before moving produce to the APMC-based wholesale channel, adding a cost layer that reduces the farmer's share to 53.95 per cent of the consumer price (Chotaliya, 2017).

4. Category-Wise and Stage-Wise Post-Harvest Losses in F&V

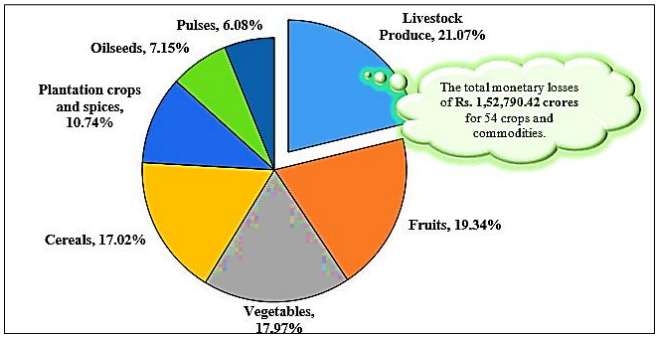


Source: Pundir *et al*. (2025).

Fig 9: Post-Harvest Losses in Fruit Supply Chains of Middle Gujarat

Table 7 shows that fruits and vegetables together account for a major share of India's post-harvest monetary losses, contributing 19.34 per cent and 17.97 per cent, respectively, to the national loss of ₹1,52,790.42 crore in 2021-22 (MoFPI, 2022). In other words, horticultural crops bear a disproportionate burden of value erosion compared with several other commodity groups, reflecting their higher perishability and greater sensitivity to lapses in handling, storage, and transport. These national estimates are in line with the NABCONS findings, which place fruit losses

between 6.02-15.05 per cent and vegetable losses between 4.87-11.61 per cent across different stages of the supply chain (MoFPI, 2022). Evidence from Gujarat further supports this pattern: studies in South and Middle Gujarat report sizeable field- and market-level losses in fruits such as mango, banana, sapota, tomato, and okra, largely attributed to mechanical damage, pest incidence, and inadequate cold-chain and logistics infrastructure, all of which translate into reduced effective returns for producers (Leua, 2010; Pundir, Patel, & Patel, 2024). Taken together, the monetary losses highlighted in Table 7 and the physical loss estimates from Gujarat's fruit and vegetable chains point to post-harvest management of horticultural produce as a critical entry point for safeguarding farm incomes and improving overall efficiency of the F&V supply system (MoFPI, 2022).



Source: MoFPI (2022)

Fig 9: Category-wise Post-Harvest Losses in Monetary Value (2021-22)

5. Price Spread and Marketing Efficiency in Gujarat

Price spread analysis examines the difference between consumer price and producer receipt, disaggregated across intermediary levels — a widely used measure of supply chain equity. Table 9 presents price spread data for major fruits and vegetables in Gujarat.

Table 9: Price Spread of Major Fruits and Vegetables in Gujarat

Crop	Type	Farm Price (Rs/q)	Consumer Price (Rs/q)	Producer Share (%)	Source
Potato	Vegetable	1,050	1,515	69.30	Pundir *et al.*, 2024b
Onion	Vegetable	422.71	845	50.02	Kantariya *et al.*, 2018 [13]
Cucurbits	Vegetable	1,381	2,560	53.95	Chotaliya, 2017 [13]
Brinjal	Vegetable	542	1,057	51.29	IABMI, 2022
Tomato	Vegetable	480	1,281	37.47	Mahera *et al.*, 2025 [17]
Banana	Fruit	1,113	2,561	43.45	Pundir *et al.*, 2024
Mango	Fruit	1,800	4,528	39.75	Pundir *et al.*, 2024a
Papaya	Fruit	1,022	2,670	38.28	IABMI, 2022
Pomegranate	Fruit	3,068	7,319	41.92	Patel & Pundir, 2016 [22]
Citrus (Lime)	Fruit	1,474	2,419	60.95	IABMI, 2022

Source: Authors' Compilation from multiple sources

Potato achieves the highest producer share (69.30%) due to its shorter supply channel, relative non-perishability, and direct sale relationships established by large-scale farmers in North Gujarat. Citrus (lime) follows at 60.95 per cent, with a wholesaler-cum-commission-agent model reducing layers. At the other extreme, tomato (37.47%), papaya (38.28%), and mango (39.75%) show the lowest shares — a direct consequence of high perishability, the pre-harvest contractor system, and the lack of effective cold-chain support.

6. Marketing Constraints in Gujarat's F&V Supply Chains

A systematic review of empirical studies from Gujarat reveals constraints organised into six thematic categories (Table 10).

Table 10: Consolidated Marketing Constraints in Gujarat's F&V Supply Chains

Constraint Category	Specific Constraints	Affected Crops	Key References
Market Intelligence	Lack of market information, price discovery, and demand signals	Banana, Mango, Papaya, Potato, Tomato	Pundir *et al.* (2024, 2024a, 2024b); Jadav *et al.* (2011) [11]; Shekhaliya & Mishra (2024) [30]
Economic & Price Risks	Low price realisation, price fluctuations, delayed payment, and lack of credit	Banana, Mango, Potato, Tomato, Onion	Pundir *et al.* (2024, 2024a, 2024b); Mungalpara *et al.* (2017) [20]; Jadav *et al.* (2011) [11]
Physical Infrastructure	Spoilage, lack of cold storage, ripening chambers, and general infrastructure deficit	Banana, Mango, Papaya, Potato	Vaghasiya *et al.* (2022) [34]; Mungalpara *et al.* (2017) [20]; Pundir *et al.* (2024, 2024b)
Logistics & Distribution	High transport cost, inadequate vehicles, long distances to market, transit losses	Banana, Mango, Papaya, Potato, Tomato	Pundir *et al.* (2024, 2024a, 2024b); Shekhaliya & Mishra (2024) [30]; Mahera *et al.* (2025) [17]
Market Structure	Excessive intermediaries, high commissions, malpractices, and a lack of grading	Banana, Mango, Papaya, Potato, Tomato, Onion	Vaghasiya *et al.* (2022) [34]; Shekhaliya & Mishra (2024) [30]; Patel *et al.* (2013) [21]
Labour & Input Constraints	Labour unavailability during harvest/transport, high input prices	Banana, Mango, Potato, Tomato	Pundir *et al.* (2024, 2024a, 2024b); Jadav *et al.* (2011) [11]; Patel *et al.* (2013) [21]

Source: Compiled from the reviewed literatures

6.1 Market Intelligence Failures

Lack of timely and accurate market information is the most universally documented constraint across all studied crops and zones in Gujarat. Pundir *et al.* (2024, 2024a, 2024b) identified this as critical for banana, mango, and potato farmers in Middle Gujarat. Without knowledge of prevailing wholesale prices in distant markets, farmers cannot negotiate effectively and often accept prices substantially below market rates. The e-NAM digital platform, integrating 1,522 mandis across 23 states by 2025, represents a significant policy response to bridge this information gap, though farmer uptake in Gujarat requires further strengthening (Kumar *et al.*, 2020) [15].

6.2 Economic and Price Risks

Price realisation and its variability constitute the second most significant constraint cluster. Mungalpara *et al.* (2017) [20] found that banana growers in Bharuch faced chronic low farm-gate prices, delayed payment, and limited marketing credit. Jadav *et al.* (2011) [11] documented significant price fluctuations and dominance of wholesaler margins in potato supply chains. Delayed payment is common in APMC transactions, where commission agents settle with farmers after reselling, creating cash flow problems, particularly affecting small and marginal farmers (Vaghasiya *et al.*, 2022) [34].

6.3 Physical Infrastructure Deficits

India's cold storage capacity of approximately 37 million MT is substantially below the annual production of perishable commodities estimated at 104 million MT, creating a significant structural gap in the cold chain (Rangar *et al.*, 2025) [28]. While Gujarat accounts for a significant share of national cold storage capacity, this infrastructure is skewed toward potato storage with limited purpose-built facilities for banana, mango, or papaya (BharatNama, 2025). Vaghasiya *et al.* (2022) [34] identified the absence of specialised ripening chambers as a major constraint in banana supply chains, while Mungalpara *et al.* (2017) [20] and Shekhaliya and Mishra (2024) [30] documented the lack of storage for banana and papaya producers in South and Middle Gujarat, respectively.

6.4 Logistics and Distribution Challenges

High transportation costs, inadequate infrastructure in tribal and semi-arid regions, long distances to markets, and significant transit losses collectively reduce farmer margins. The absence of pre-cooling units at collection points means produce is loaded at ambient temperatures, often 35-45°C in summer, directly accelerating spoilage. Jadav *et al.* (2011) [11] specifically highlighted labour shortages during transportation, losses due to poor packaging and non-refrigerated transport, and limited market transport as key performance constraints.

6.5 Market Structure and Malpractices

Vaghasiya *et al.* (2022) [34] documented the disproportionate power of commission agents in Vadodara's banana supply chain. Patel *et al.* (2013) [21] listed buyer malpractices, including under-weighing, adulteration of grading assessments, and delayed settlements, as significant constraints in North Gujarat vegetable markets. The lack of standardised grading and quality norms means price discovery is often opaque and contestable, leaving farmers at a structural disadvantage (Farmonaut, 2026) [4].

6.6 Labour and Input Constraints

Labour unavailability during peak harvest and transportation periods is documented for banana, mango, and potato. Pundir *et al.* (2024, 2024a, 2024b) and Jadav *et al.* (2011) [11] noted labour shortages coinciding with competing agricultural and non-agricultural demand in rural labour markets. Patel *et al.* (2013) [21] also cited high input prices as a constraint for vegetable growers in North Gujarat.

7. Interventions to Address Supply Chain Constraints

7.1 Digital Price Discovery and Market Intelligence

Expanding e-NAM integration with farmer-friendly mobile interfaces in Gujarati and SMS-based daily price alerts through KVKs can address market intelligence failures. Kumar *et al.* (2020) [15] argued that strengthening digital market infrastructure, including platforms for price discovery and direct buyer-seller connectivity, is among the most critical post-COVID reforms needed for Indian agriculture. Beyond e-NAM, dedicated apps for key markets like Ahmedabad Jamalpur Mandi, Surat, and Mumbai APMC can provide real-time price discovery for Gujarat's heterogeneous production zones.

7.2 FPO-Led Aggregation and Direct Market Linkages

Farmer-Producer Organisations (FPOs) represent the most powerful institutional mechanism to address both price realisation and market structure constraints simultaneously. By aggregating production from multiple smallholders, FPOs can negotiate with wholesalers, processors, and organised retailers at scale, reducing the leverage of individual commission agents. India achieved the target of 10,000 FPOs by February 2025 (Legacy IAS, 2026). FPO-mediated direct marketing arrangements have been shown to achieve significantly better price realization for horticulture producers compared to traditional APMC-routed sales, particularly for perishable crops (Kumar & Agrawal, 2023) [14]. In Gujarat, FPO-led direct marketing could enable banana producers in Narmada and Bharuch to sell directly to urban retailers in Ahmedabad, Surat, and Mumbai, bypassing intermediary layers.

7.3 Cold Chain and Post-Harvest Infrastructure

Decentralised solar-powered cold storage units positioned near farm clusters represent a cost-effective approach to reducing post-harvest losses for smallholder horticulture producers. Produce cooled within hours of harvest has substantially lower spoilage rates during subsequent transport and storage compared to produce held at ambient temperatures (Shell Foundation, 2020). The Government of India's MIDH scheme provides capital support for cold storages up to 5,000 MT, while PMKSY supports end-to-end cold chain projects from farm-gate pre-cooling to reefer transport (Rinac India, 2026). Gujarat's horticulture department should facilitate FPO applications to access these central schemes, particularly for mango belts in South Gujarat and banana-growing areas in Narmada and Anand. Community sorting and grading centres near farm clusters

can additionally reduce spoilage from mechanical damage and improve quality consistency.

7.4 Transport and Logistics Improvements

For perishable commodities like mango, banana, and tomato, transitioning from open truck transport to refrigerated vehicles even partially can dramatically reduce transit spoilage. IoT-enabled temperature and humidity sensors in transport vehicles provide real-time alerts when conditions deviate from optimal ranges (Rinac India, 2026). Secondary collection centres at strategic nodes along transport corridors can reduce unnecessary vehicle movements and enable consolidated, better-packaged shipments to terminal markets.

7.5 APMC Reforms and Grading Standards

The Model APLM Act (2017) provides a framework for states to permit direct farm-gate sales by FPOs, establish unified trading licences valid across multiple mandis, and allow private market yards. Implementation of standardised grading and quality norms is complementary. Chauhan (2021) documented that organised intermediaries applying basic cleaning and grading at collection points in South Gujarat achieved higher prices and lower rejection rates at terminal markets.

7.6 Mechanisation and Extension

Selective mechanisation of harvesting and post-harvest handling can partially mitigate peak labour shortages. For potatoes, extending mechanical harvesting to medium-scale farmers through custom hiring centres (CHCs) can reduce the peak labour bottleneck. KVKs and agricultural universities should prioritise training on post-harvest handling best practices. Thanki *et al.* (2018) [32] found that farmers in Bharuch who received extension training achieved lower spoilage and better price realisation.

7.7 Value Addition and Agro-Processing

Expanding agro-processing capacity provides a structural long-term solution to cyclical price crashes. India's current horticultural processing rate of approximately 2-3 per cent of production, compared to 70-80per cent in developed countries, leaves enormous value unrealised and surplus produce without a market outlet during glut periods (Kumar & Agrawal, 2023) [14]. Gujarat has significant opportunities for fruit pulp processing (mango, papaya), dehydrated vegetables (onion, tomato), and banana-based products. Public-private partnerships in agro-processing zones near Surat (mango/vegetable), Anand (banana), and Rajkot (onion) should be actively encouraged.

8. Conclusion

Gujarat's fruit and vegetable sector is both a significant contributor to national food security and a sector characterised by deep structural inefficiencies that undermine farmer welfare. This review has synthesised evidence from Gujarat-specific studies, district-level data, and broader national and international literature to document the supply chain structure, price spread performance, post-harvest losses, and the spectrum of marketing constraints across the state's four agro-climatic zones.

The key findings can be summarised as follows. First, North Gujarat dominates vegetable production while Middle and South Gujarat are major fruit-producing zones, creating geographically concentrated supply chain vulnerabilities. Second, the producer's share in the consumer rupee ranges from 37.47 per cent (tomato) to 69.30 per cent (potato), with intermediaries capturing 30-63per cent of the final consumer price. Third, post-harvest losses of 2-9 per cent per supply chain stage represent a significant monetary and nutritional drain, concentrated in wholesale handling and retail, where cold chain infrastructure is absent. Fourth, marketing constraints cluster around six dimensions, simultaneously cutting across multiple crops and zones.

The interventions proposed FPO-led aggregation, digital price discovery, solar-powered decentralised cold storage, IoT-enabled transport monitoring, APMC reforms, standardised grading, mechanised post-harvest handling, and agro-processing expansion, which address these constraints in a complementary and mutually reinforcing manner. Evidence from pilot initiatives in Gujarat, including the Sabarkantha FPO solar cold storage project and e-NAM integration, provides an encouraging basis for scaling these solutions across the state.

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