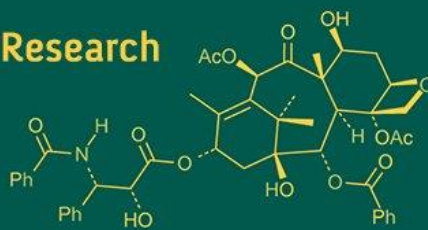


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(7): 1153-1159
www.biochemjournal.com
Received: 26-04-2026
Accepted: 30-05-2026

Tanuja Ekka
Ph.D. Scholar (Agri-Business Management), Department of Agri-Business and Rural Management, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

AK Gauraha
Professor, Department of Agri-Business and Rural Management, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Hulas Pathak
Professor and Head, Department of Agri-Business and Rural Management, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Corresponding Author:
Tanuja Ekka
Ph.D. Scholar (Agri-Business Management), Department of Agri-Business and Rural Management, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Post-harvest constraints across the vegetable value chain: A multi-actor Garrett ranking of growers, wholesalers and retailers in central India

Tanuja Ekka, AK Gauraha and Hulas Pathak

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i7Sn.9193>

Abstract

Post-harvest loss is a tractable yet neglected source of value erosion in vegetable supply chains of the Global South. Although its magnitude in India is well documented, few studies prioritise constraints simultaneously across the producer, wholesale and retail nodes of a single chain. This study identified and prioritised post-harvest constraints among three actor groups in the Chhattisgarh Plains, central India, and derived actor-specific agribusiness opportunities from the resulting hierarchies. Primary data were collected during 2024-25 from 390 respondents — 300 vegetable growers, 45 wholesalers and 45 retailers — across the purposively selected districts of Raipur, Durg and Bilaspur, using pre-tested structured schedules, and prioritised by Garrett's ranking technique. Growers ranked glut-driven distress sale and price fluctuation first (mean Garrett score 57.53), followed by absence of cold storage in production areas (56.13) and poor transport causing transit damage (55.99). Wholesalers ranked sharp price volatility first (61.33), then high commission charges and statutory deductions (60.78) and inadequate mandi-level cold storage (59.47). Retailers recorded the study's highest score for daily spoilage and shrinkage (62.09), followed by absence of display refrigeration (60.84) and end-of-day distress disposal (58.71). Infrastructure and price-risk constraints occupied every top-three position, whereas financial and knowledge constraints ranked consistently lower. The three hierarchies describe one chain-wide syndrome: price risk compounded by an inability to hold or move produce, reappearing at each node one stage downstream. Single-actor interventions are therefore unlikely to succeed; decentralised cold-chain capacity, aggregation and price-risk management yield the greatest returns when deployed jointly across the chain.

Keywords: Post-harvest losses, Garrett ranking, vegetable value chain, cold-chain infrastructure, agribusiness opportunities, market efficiency, Chhattisgarh

1. Introduction

Food loss between harvest and retail depresses producer income after cultivation costs are sunk and wastes the land, water, labour and energy embodied in discarded produce; its reduction is embedded in SDG 12.3 (UNEP, 2024; FAO, 2019) ^[19, 5]. The problem is acute for horticultural commodities, whose high moisture content, active respiration and mechanical fragility make them less forgiving of handling and storage deficiencies than cereals.

India, the world's second-largest vegetable producer, illustrates the tension. Quantitative post-harvest losses for vegetables are estimated at 4.9-11.6 percent, with a material share arising at market handling rather than on the farm (Jha *et al.*, 2015; NABCONS, 2022) ^[10, 13]. The policy response has been dominated by infrastructural provision, with little attention to which constraints actors themselves regard as binding. This has allocative consequences: since infrastructure access, chain length and holding duration outweigh actors' socio-economic attributes in explaining loss (Aidoo *et al.*, 2014; Kitinoja & Kader, 2015) ^[2, 11], facilities addressing non-binding constraints yield little, whereas relieving the constraint that forces distress disposal can unlock disproportionate gains.

Indian ranking studies consistently identify perishability, price fluctuation, inadequate storage and intermediary exploitation as leading grower problems (Kumar *et al.*, 2019; Sidhu *et al.*, 2010) ^[12, 17], but rarely prioritise constraints across multiple actor groups within one chain and geography, precluding assessment of whether constraints at successive nodes are independent or manifestations of a common deficiency.

The Chhattisgarh Plains — dominated by small holdings, commercially active in the peri-urban catchments of Raipur, Durg and Bilaspur, yet with minimal cold-chain penetration — offer an instructive setting that earlier state-level work (Gauraha & Thakur, 2008; Raghuvanshi *et al.*, 2018) ^[8, 14] has not examined in these terms.

This study therefore prioritises post-harvest constraints as perceived separately by growers, wholesalers and retailers using Garrett's technique, and derives actor-specific opportunities and policy measures from the resulting hierarchies. Its novelty lies in the simultaneous, comparable treatment of three actor groups within one chain, permitting assessment of whether constraints propagate along the chain or arise independently — a distinction with direct consequences for the sequencing of intervention.

2. Materials and Methods

2.1 Study area and sampling

The study was conducted in the Chhattisgarh Plains agro-climatic zone of central India, where Raipur, Durg and Bilaspur districts were selected purposively for their prominence in vegetable cultivation and functioning regulated markets. A multi-stage purposive procedure yielded 100 growers per district ($n = 300$), supplemented by 45 wholesalers and 45 retailers in the principal markets, giving 390 respondents. Data were collected during 2024-25

through pre-tested structured schedules administered face-to-face, with separate instruments per actor group. Constraint inventories, drawn from the post-harvest literature and refined through field discussions, comprised thirteen constraints for farmers and twelve each for wholesalers and retailers.

2.2 Analytical technique

Constraints were prioritised using Garrett's ranking technique (Garrett & Woodworth, 1969) ^[6], preferred because it converts ordinal ranks to an interval scale and, being scaled to the number of items ranked, permits comparison across groups ranking different numbers of constraints. Respondents ranked all constraints from most to least severe without repetition, and each rank was converted to a percent position:

$$\text{Percent position} = 100 (R_{ij} - 0.5) / N_j$$

where R_{ij} is the rank assigned to the i th constraint by the j th respondent and N_j the number of constraints ranked. Percent positions were converted to Garrett scores using the standard conversion table (Table 1), mean scores obtained by dividing totals by the number of respondents, and constraints ranked in descending order.

Table 1: Conversion of ranks to percent positions and Garrett values

Rank	Farmers ($N_j = 13$): percent position	Garrett value	Traders ($N_j = 12$): percent position	Garrett value
1	3.85	85	4.17	83
2	11.54	74	12.50	71
3	19.23	68	20.83	65
4	26.92	63	29.17	60
5	34.62	58	37.50	55
6	42.31	54	45.83	50
7	50.00	50	54.17	46
8	57.69	47	62.50	42
9	65.38	43	70.83	37
10	73.08	38	79.17	31
11	80.77	33	87.50	24
12	88.46	27	95.83	13
13	96.15	16	—	—

Source: Computed from field survey data, 2024-25.

3. Results and Discussion

3.1 Constraints perceived by vegetable growers

The constraint ranked first by growers is structural rather than biological (Table 2). Glut-driven distress sale and

associated price fluctuation scored highest (57.53), ahead of absent cold storage in production areas (56.13) and poor transport causing transit damage (55.99).

Table 2: Garrett prioritisation of post-harvest constraints perceived by vegetable growers ($n = 300$)

Code	Constraint	Total score	Mean score	Rank
F1	Increased market arrivals leading to glut and distress sale (price fluctuation)	17,259	57.53	I
F3	Lack of cold storage facilities, especially in production areas	16,838	56.13	II
F2	Poor transport facilities causing damage and spoilage during transit	16,798	55.99	III
F4	Exploitation by unorganised middlemen	16,689	55.63	IV
F5	High commission charges and inefficiencies in regulated markets	16,342	54.47	V
F6	Non-availability or distant location of processing units	15,980	53.27	VI
F7	Lack of market intelligence and awareness about prices and schemes	15,877	52.92	VII
F8	Shortage of labour during peak harvesting and post-harvest operations	14,965	49.88	VIII
F9	Over-maturity of produce due to delayed harvesting and improper planning	14,012	46.71	IX
F10	Inadequate knowledge of scientific post-harvest management practices	13,968	46.56	X
F11	Low awareness and utilisation of government schemes	13,223	44.08	XI
F12	Lack of timely availability of quality planting material	13,022	43.41	XII
F13	Low level of aggregation through FPOs reducing bargaining power	11,827	39.42	XIII

Source: Field survey, 2024-25.

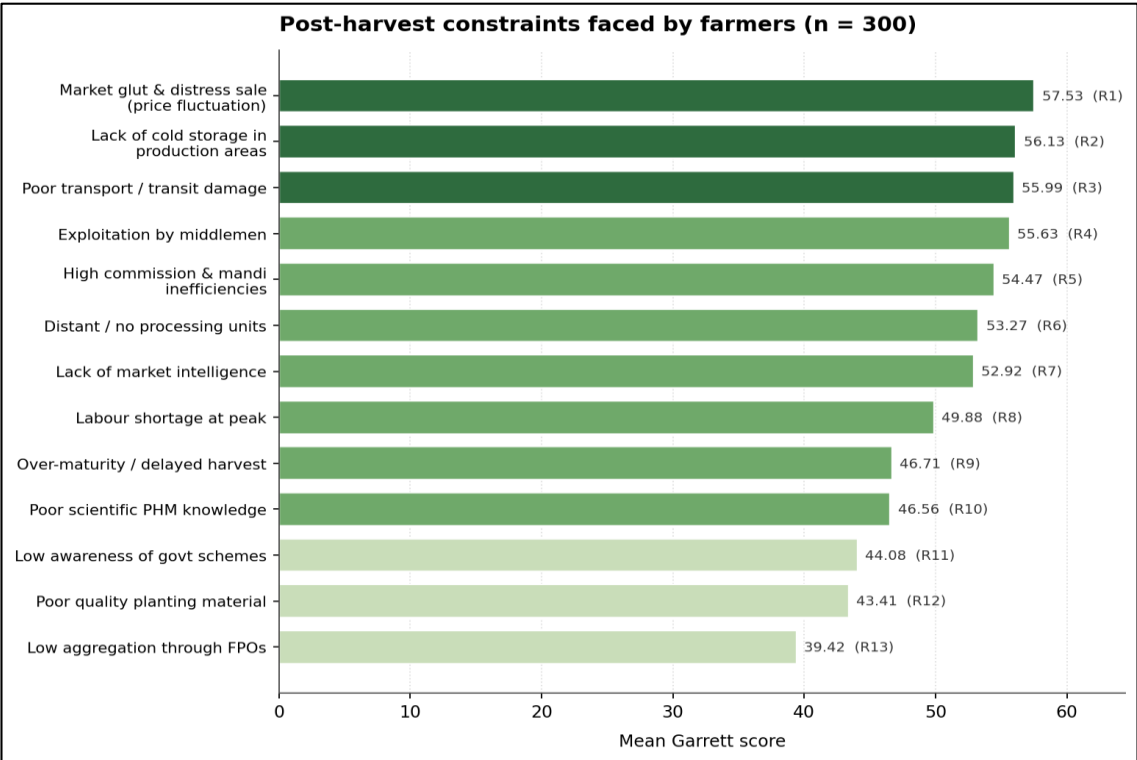


Fig 1: Post-harvest constraints faced by farmers (n = 300).

The narrow band spanned by the three leading constraints (55.99-57.53) describes not three separable problems but one causal mechanism: when a seasonal glut depresses prices, absent cold storage removes the option of withholding produce, and inadequate transport constrains the search for a better market. Relieving any single element leaves the mechanism substantially intact. The middle tier — intermediary exploitation (55.63), commission charges (54.47), distant processing (53.27) and weak market intelligence (52.92) — describes the institutional environment converting a physical glut into a low realised price, consistent with evidence on the attenuation of producer share as intermediation lengthens (Sidhu *et al.*, 2010; Reddy *et al.*, 2010; Chand *et al.*, 2018) ^[17, 15, 3]. The lowest-ranked constraints are knowledge- and organisation-related: scheme awareness (44.08), planting material (43.41) and FPO aggregation (39.42). These scores indicate low salience rather than low importance, growers experiencing them as background conditions rather than the proximate cause of loss on a given harvest day. The distinction matters, since the last-ranked constraint is

precisely the institutional lever through which the highest-ranked constraints could be relieved. The problem set reproduces that reported across Indian states and crops for over a decade (Kumar *et al.*, 2019; Sidhu *et al.*, 2010; Singh & Toppo, 2010) ^[12, 17, 18], but with an instructive shift in emphasis: earlier studies typically ranked perishability first, an inherent property of the commodity, whereas the leading constraint here describes the market and infrastructure environment. Respondents thus attribute losses to correctable structural gaps rather than unavoidable crop characteristics, aligning perceptions with econometric evidence that infrastructure access, not physiology alone, governs loss magnitude (Aidoo *et al.*, 2014; Kitinoja & Kader, 2015) ^[2, 11].

3.2 Constraints perceived by wholesalers

Sharp price volatility headed the wholesaler hierarchy (61.33), followed by commission charges and statutory deductions (60.78) and inadequate mandi-level cold storage (59.47) (Table 3).

Table 3: Garrett prioritisation of post-harvest constraints perceived by wholesalers (n = 45)

Code	Constraint	Total score	Mean score	Rank
W1	Sharp price volatility and intra-day fluctuations	2,760	61.33	I
W3	High commission charges and statutory deductions	2,735	60.78	II
W2	Inadequate cold storage at mandi level	2,676	59.47	III
W5	Poor transport and shortage of reefer vehicles	2,585	57.44	IV
W4	Seasonal supply gluts and peak-arrival congestion	2,524	56.09	V
W6	Credit-risk exposure from downstream clients	2,406	53.47	VI
W7	Absence of standardised grading and packaging	2,295	51.00	VII
W8	Inadequate market intelligence and price forecasting	2,160	48.00	VIII
W10	High rental cost and limited shed allocation	1,855	41.22	IX
W9	Shortage of skilled handling labour	1,679	37.31	X
W11	Weak APMC enforcement and weighment disputes	1,295	28.78	XI
W12	Limited access to institutional working-capital credit	995	22.11	XII

Source: Field survey, 2024-25.

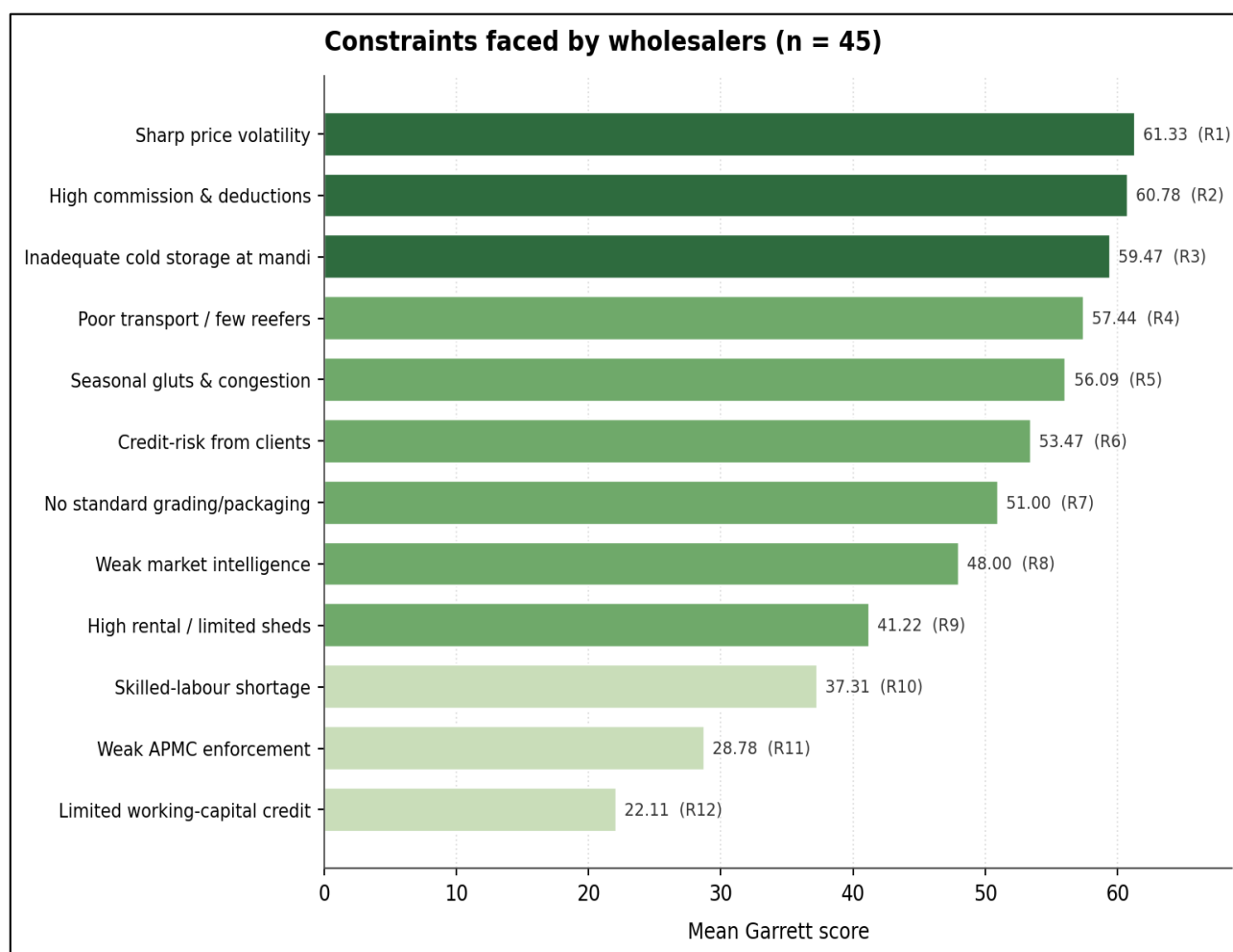


Fig 2: Post-harvest constraints faced by wholesalers (n = 45).

All four leading constraints exceed 57, indicating that the wholesaler's central difficulty is managing price risk on stock that can neither be held safely nor moved quickly. This is the growers' cluster observed one stage downstream: the same glut and cold-chain deficiency reappear as intra-day price swings and peak-arrival congestion (56.09) — the study's central comparative finding. Two features distinguish the wholesaler profile. Financial and counterparty concerns rank higher than elsewhere, downstream credit-risk exposure falling in the upper-middle band (53.47) and reflecting trade credit extended to organised retail and institutional buyers, a constraint rarely itemised in older

cash-market-centred studies. Conversely, weak APMC enforcement (28.78) and limited institutional credit (22.11) score well below the corresponding farmer tail, since established wholesalers self-finance through own or informal capital and have adapted to regulatory weaknesses.

3.3 Constraints perceived by retailers

Daily spoilage and shrinkage recorded 62.09 — the highest score in the study — followed by absent cold storage or display refrigeration (60.84) and end-of-day distress disposal (58.71) (Table 4).

Table 4: Garrett prioritisation of post-harvest constraints perceived by retailers (n = 45)

Code	Constraint	Total score	Mean score	Rank
R1	High daily spoilage and shrinkage of perishables	2,794	62.09	I
R3	Absence of cold storage/display refrigeration	2,738	60.84	II
R5	Unsold-stock disposal and end-of-day distress sale	2,642	58.71	III
R2	Procurement-price volatility from wholesalers	2,524	56.09	IV
R10	Last-mile handling and transportation losses	2,464	54.76	V
R6	Inadequate supply consistency and erratic quality	2,271	50.47	VI
R8	Inadequate retail-point infrastructure	2,164	48.09	VII
R4	Competition from organised retail and e-commerce	2,118	47.07	VIII
R9	Municipal harassment and licensing friction	2,049	45.53	IX
R7	Consumer-credit recovery and default exposure	1,807	40.16	X
R12	Weak bargaining power vis-à-vis wholesalers	1,215	27.00	XI
R11	Limited access to working-capital credit	1,179	26.20	XII

Source: Field survey, 2024-25.

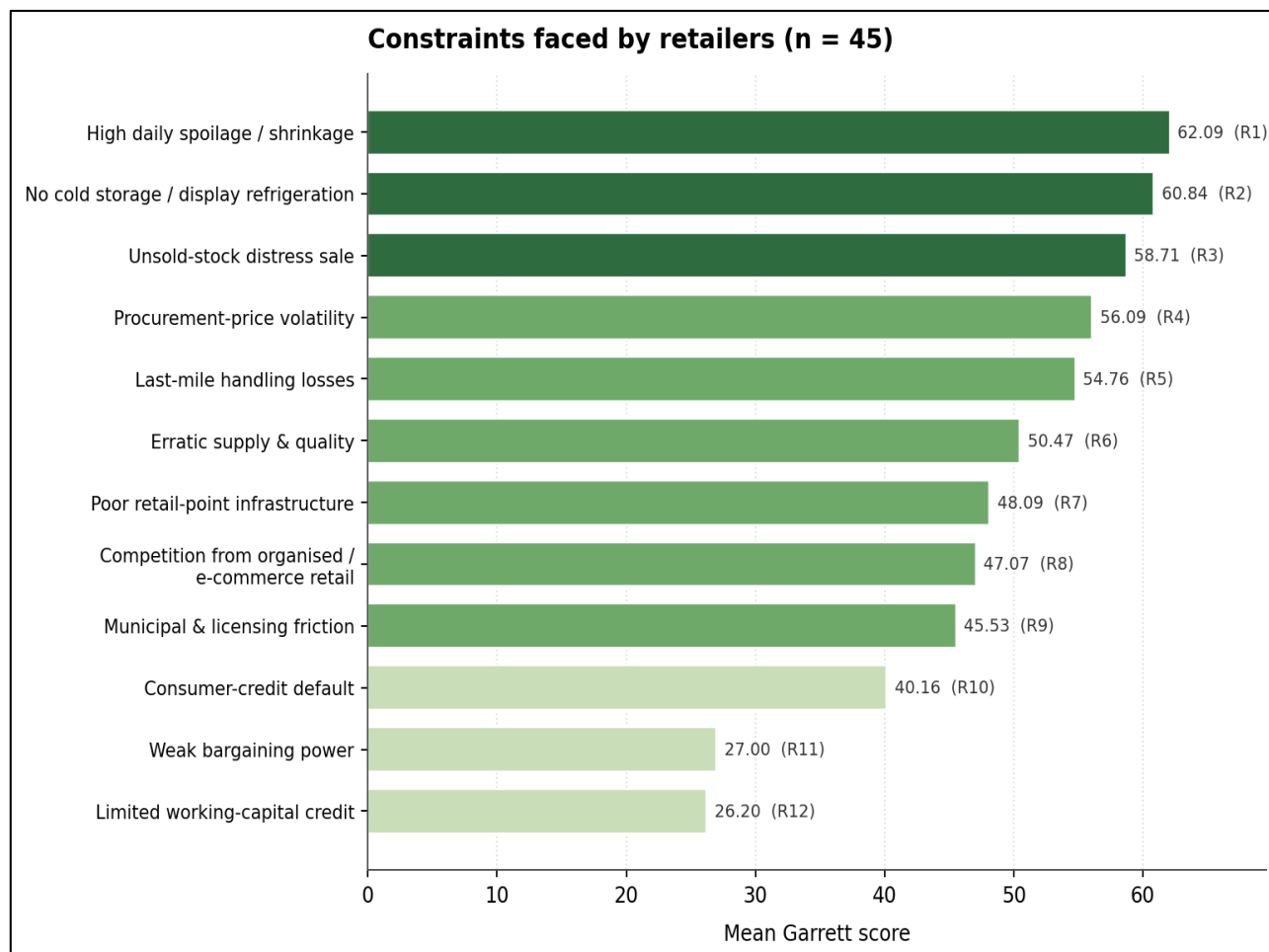


Fig 3: Post-harvest constraints faced by retailers (n = 45).

The top three retail constraints form one continuous mechanism: without refrigeration, unsold produce deteriorates within the trading day, deterioration compels disposal at whatever price is obtainable, and the resulting shrinkage registers as the spoilage ranked first. The mechanism is thermal in origin, explaining why display refrigeration ranks second despite being capital equipment rather than a market condition, and corresponds with national assessments attributing a distinct share of vegetable loss to market handling (NABCONS, 2022) ^[13]. Competition from organised retail and e-commerce scored only 47.07; its middling rank indicates that this threat remains secondary to the physics of perishability at the point of sale. Traditional vegetable retail is currently jeopardised less by digital competitors than by the absence of a cold room.

3.4 Thematic grouping across the chain

Aggregation into functional categories clarifies where the binding deficiencies lie. Infrastructure constraints (F2, F3, W2, W5, R3, R8, R10) occupy second or third position in every hierarchy without exception, and market and price-risk constraints (F1, W1, W4, R2, R5) occupy first position for farmers and wholesalers and third for retailers; together the two categories account for all top-three positions. Institutional constraints (F4, F5, W3, W11, R9) occupy the upper-middle band, except commission charges among wholesalers. Financial constraints (W6, W12, R7, R11) fall in the lower half of both trader hierarchies, as do knowledge and organisational constraints (F7, F10, F11, F13, W8) among farmers.

The ordering carries an implication running counter to much extension practice: the binding limitation on post-harvest performance is the infrastructure an actor can reach and the price risk that actor must absorb, not the information held or the credit obtainable. Training and advisory interventions, while valuable, are unlikely to shift the loss curve materially without the physical capacity to hold produce out of a glutted market.

4. Agribusiness Opportunities Emerging from the Constraint Structure

Because storage deficiency and price risk recur at every node, interventions addressing both simultaneously offer the greatest expected return. Opportunities are organised by level of operation, each anchored to the constraint from which it derives.

4.1 Production-cluster level

Decentralised cold storage, pack-houses and zero-energy cool chambers address F3 directly, enabling produce to be withheld from a glutted market; operated as pay-per-use custom-hiring facilities or producer-organisation assets under the Agriculture Infrastructure Fund, they convert a fixed-capital barrier into a variable-cost service, with solar-powered micro cold rooms extending the model to clusters lacking reliable grid supply. Producer-organisation aggregation addresses the paradox in Section 3.1 — ranked last because under-developed, yet the mechanism through which bargaining power (F4), commission burdens (F5) and the volume justifying a cold room would improve. Primary processing near production areas converts glut volumes into

storable higher-value products (F6); custom-hiring centres for post-harvest equipment reduce the mechanical damage later manifesting as transit loss (F2); and mobile market-intelligence services (F7) enable growers to time sales away from the price trough.

4.2 Wholesale (mandi) level

Mandi-level cold storage and pre-cooling target W2, permitting stock to be held through intra-day swings rather than liquidated into them, while shared reefer logistics address W5. Price-risk dashboards providing real-time prices, arrival data and short-horizon forecasts respond jointly to W1 and W8; standardised grading and packaging enterprises address W7 and reduce weight disputes (W11); transparent digital commission and settlement platforms respond to W3; and warehouse-receipt finance paired with storage assets allows borrowing against stored stock rather than dumping it.

4.3 Retail level

Affordable display refrigeration and shared neighbourhood cold rooms attack the mechanism underlying R1 and R3 at its origin. Last-mile refrigerated micro-logistics and insulated-crate delivery address R10; demand-forecasting and inventory tools reduce the over-stocking producing end-of-day disposal (R5); and surplus redistribution channels recover value from unsold stock. Quality-graded, pre-packed supply from upstream grading lines addresses erratic quality (R6), while ready-to-cook formats convert spoilage-prone loose stock into higher-margin lines.

A common feature unites these opportunities: each converts a lumpy fixed investment into a shared or rented service. Given that actors in this chain are predominantly small, with individual scale well below the threshold justifying dedicated cold-chain assets, this conversion is essential rather than incidental.

5. Policy Implications

State government and Department of Horticulture

Public investment should be sequenced by constraint hierarchy rather than administrative convenience. Since storage and transport occupy second or third position in all three hierarchies, decentralised cold-chain capacity at production clusters and mandis warrants precedence. The commission-and-fee structure of regulated markets — ranked second by wholesalers and fifth by farmers — merits review alongside electronic auctioning and same-day settlement.

NABARD and financing institutions

The coexistence of severe storage constraints with low-ranked credit access among traders suggests the binding financial problem is not credit availability but the absence of financeable assets. Warehouse-receipt and cold-storage-receipt financing, and products designed around producer-organisation-owned infrastructure, address this more precisely than general working-capital expansion.

Producer organisations and cooperatives

Since aggregation ranks last in salience while underpinning relief of the highest-ranked constraints, FPO promotion should be framed in terms of the problems growers report — price realisation during glut, storage access, bargaining power — rather than in institutional terms.

Extension agencies and agricultural universities

Because knowledge constraints rank below physical and market constraints, extension effort will yield most where bundled with infrastructure access. Priority areas indicated by the hierarchy are harvest-timing advisory (F9), scientific handling (F10) and scheme navigation (F11).

Private agribusiness firms

Section 4 identifies commercially addressable segments — shared cold-chain logistics, grading-and-packaging services and retail refrigeration — where demand is evidenced by actors' own constraint scores. Public-private partnership models combining public capital support with private operational management suit the pay-per-use configurations that the small scale of operation requires.

Collectively these measures bear on SDG 12.3, and connect to SDG 2 through availability effects and to SDGs 1 and 8 through the income and enterprise consequences of retaining a larger share of on-farm value.

6. Conclusion and Suggestions

This study prioritised post-harvest constraints simultaneously across three actor groups in a single vegetable chain and found that constraints at successive nodes are not independent problems but recurrent expressions of one syndrome. Price risk compounded by the inability to hold or move produce heads the grower hierarchy, reappears as intra-day volatility and mandi congestion for wholesalers, and terminates as the daily spoilage retailers rank most severe. The binding constraints are physical and market-related rather than informational or financial, so training and credit cannot substitute for the capacity to withhold produce from a glutted market; and because the syndrome propagates, interventions confined to one actor group will be attenuated by unrelieved constraints elsewhere, making chain-wide sequencing necessary. Public investment should therefore be sequenced according to constraints that intended beneficiaries report as binding, prioritising decentralised cold storage and market intelligence.

Findings are cross-sectional and reflect perceived rather than measured severity, with trader samples drawn only from principal markets. Future work should employ multi-season and longitudinal designs, test the latent structure of constraint groupings through factor analysis and structural equation modelling, apply optimisation and GIS methods to cold-storage siting, and extend comparison across states.

References

1. Acharya SS, Agarwal NL. *Agricultural Marketing in India*. 5th ed. New Delhi: Oxford & IBH Publishing; 2011.
2. Aidoo R, Danfoku RA, Mensah JO. Determinants of postharvest losses in tomato production in the Offinso North District of Ghana. *Journal of Development and Agricultural Economics*. 2014;6(8):338-344.
3. Chand K, Kumar S, Suresh A, Dastagiri MB. Marketing efficiency of vegetables in developing economies: Evidences for critical intervention from Rajasthan, India. *The Indian Journal of Agricultural Sciences*. 2018;88(11):1729-1735.
4. Dastagiri MB, Chand R, Immanuelraj TK, Hanumanthaiah CV, Paramsivam P, Sidhu RS, *et al*. Indian vegetables: Production trends, marketing

- efficiency and export competitiveness. American Journal of Agriculture and Forestry. 2013;1(1):1-11.
5. Food and Agriculture Organization of the United Nations. The State of Food and Agriculture 2019: Moving Forward on Food Loss and Waste Reduction. Rome: FAO; 2019.
 6. Garrett HE, Woodworth RS. Statistics in Psychology and Education. Mumbai: Vakils, Feffer and Simons; 1969.
 7. Gauraha AK. Economic assessment of post-harvest losses in vegetable crops. Indian Journal of Agricultural Marketing. 1997;11(1-2):38-39.
 8. Gauraha AK, Thakur BS. Comparative economic analysis of post-harvest losses in vegetables and foodgrains crops in Chhattisgarh. Indian Journal of Agricultural Economics. 2008;63(3):376-376.
 9. Gulati A, Das R, Winter-Nelson A. Reducing Post-Harvest Losses in India: Farmer Level Interventions and Grain Management Strategies. New Delhi: ICRIER-ADM Institute for the Prevention of Postharvest Loss; 2024.
 10. Jha SN, Vishwakarma RK, Ahmad T, Rai A, Dixit AK. Assessment of Quantitative Harvest and Post-Harvest Losses of Major Crops and Commodities in India. Ludhiana: ICAR-Central Institute of Post-Harvest Engineering and Technology; 2015.
 11. Kitinaja L, Kader AA. Measuring Postharvest Losses of Fresh Fruits and Vegetables in Developing Countries. PEF White Paper No. 15-02. Davis (CA): The Postharvest Education Foundation; 2015.
 12. Kumar A, Sumit S, Yadav MK, Rohila AK. Constraints faced by the farmers in production and marketing of vegetables in Haryana. The Indian Journal of Agricultural Sciences. 2019;89(1):153-160.
 13. NABARD Consultancy Services. Study to Determine Post-Harvest Losses of Agri Produces in India. New Delhi: Ministry of Food Processing Industries, Government of India; 2022.
 14. Raghuvanshi A, Gauraha AK, Chandrakar MR. Post-harvest losses in potato and factors affecting post-harvest losses at farm level in Chhattisgarh. Journal of Pharmacognosy and Phytochemistry. 2018;7(3):3122-3124.
 15. Reddy GP, Murthy MRK, Meena PC. Value chains and retailing of fresh vegetables and fruits, Andhra Pradesh. Agricultural Economics Research Review. 2010;23(Conference Number):455-460.
 16. Sharma RK, Sharma SK, Thakur RK. Marketing of vegetables in Himachal Pradesh. Indian Journal of Agricultural Marketing. 1995;9(1):44-49.
 17. Sidhu RS, Kumar S, Vatta K, Singh P. Supply chain analysis of onion and cauliflower in Punjab. Agricultural Economics Research Review. 2010;23(Conference Number):445-453.
 18. Singh RP, Toppo A. Economics of production and marketing of tomato in Kanke Block of Ranchi district. Indian Journal of Agricultural Marketing. 2010;24(2):1-16.
 19. United Nations Environment Programme. Food Waste Index Report 2024. Nairobi: United Nations Environment Programme; 2024.