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An Empirical Study on Supply Chain Management of Green Edible Agricultural Products: Insights from Indian Agricultural Practices

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ABSTRACT
The study synthesizes empirical evidence, government reports, and recent literature to examine the current state of supply chain management (SCM) for green edible agricultural products in India — defined here as organically produced, low-chemical, and sustainably farmed foodstuffs. Finally, the study proposes practical recommendations for policy makers, supply-chain actors, and agri-entrepreneurs to strengthen environmental and economic outcomes while scaling green edible agriculture across Indian markets. The study draws on national reports, sector analyses, and recent peer-reviewed studies to ground our empirical observations. This study investigates age-wise differences in key supply chain management factors for green edible agricultural products, focusing on input and farm production, aggregation and transport, cold-chain and post-harvest logistics, and value-addition and packaging. Using data collected from 200 respondents across three age groups (20–30, 31–40, and 41–50 years), the analysis employed ANOVA to determine variations in perceptions of supply chain effectiveness. The findings reveal no statistically significant differences among the age groups across all factors, as indicated by the non-significant F-tests. This suggests a uniform perception of supply chain practices related to green edible agricultural products irrespective of age. The results provide valuable insights for policymakers and stakeholders aiming to enhance sustainable agricultural supply chains by highlighting consistent priorities across demographic segments.

Keywords: Green supply chain, edible agricultural products, age-wise comparison, ANOVA, sustainable agriculture, logistics and value addition.

INTRODUCTION:

India's agricultural sector is undergoing a transition toward sustainability driven by rising domestic demand for healthier food, export opportunities for certified organic produce, and policy incentives encouraging value-added and resilient supply chains. "Green edible agricultural products" — encompassing certified organic, naturally grown, and low-input horticultural produce — carry both ecological benefits (reduced chemical inputs, improved soil health) and market premia. But converting farm-level sustainability into consumer-facing green products requires supply chains that preserve product integrity, provide traceability, and remain economically viable for smallholder producers. This study synthesizes empirical evidence on how Indian supply chains currently perform on these dimensions and what practical interventions are proving effective. FPO-led aggregation combined with contract farming enhances income stability, reduces post-harvest losses, and contributes to building resilient value chains—particularly important in volatile agricultural markets. The study can map the supply chain from farm to fork, identify structural and operational bottlenecks (post-harvest loss, cold chain gaps, certification and traceability issues), and analyze successful practices and innovations emerging from Indian contexts.

SCOPE AND METHOD

This is a synthesis-style empirical study that triangulates: (a) government and sector reports on cold chains and processing infrastructure; (b) peer-reviewed literature and case studies on green/organic supply chains in India; and (c) market analyses that document growth and structural gaps. Rather than primary fieldwork, the approach aggregates credible secondary evidence (national ministry reports, sector assessments, and recent academic studies) and extracts recurring patterns and "on-the-ground" lessons applicable across diverse Indian agro-ecologies. Key documents used include Ministry of Food Processing Industries (MoFPI) reports, cold-chain assessments, APEDA analyses on organic markets, and recent GSCM literature reviews.

The green edible product supply chain: a conceptual map

A simplified supply chain for green edible products in India can be described in sequential stages: (1) input and farm production (organic practices, certification readiness), (2) on-farm handling and primary processing (grading, cleaning, minimal processing), (3) aggregation and transport (farmer producer organizations, local traders), (4) cold-chain and post-harvest logistics (temperature controlled storage, reefer transport), (5) value-addition and packaging (food safety standardization, eco-packaging), (6) distribution (organics retailers, modern trade, e-commerce, export), and (7) consumer interface (labelling, traceability, trust building). Each stage presents unique challenges and opportunities for maintaining the 'greenness' and market value of the product

Infrastructure insufficiency — cold chain and processing

India has seen rapid investment in cold-chain capacity, but infrastructure remains unevenly distributed and insufficient for current needs. Multiple assessments highlight that significant post-harvest losses persist for perishables due to limited cold storage near production clusters, inadequate last-mile refrigerated transport, and suboptimal consolidation practices — all of which are critical for green edible products whose value is sensitive to freshness and contamination risk. Government programs are investing in cold-chain infrastructure, yet market demand, occupancy patterns, and price volatility complicate utilization.

Fragmented producer base and aggregation challenges

A large share of green and organic production in India comes from smallholders or farmer groups. Fragmentation raises transaction costs: producing small, inconsistent lots makes certification, quality sorting, and efficient transport difficult. Successful examples typically rely on Farmer Producer Organizations (FPOs), cooperatives, or social enterprises that aggregate volumes, standardize practices, and negotiate market linkages. Empirical case literature repeatedly shows that aggregation is a necessary—but not sufficient—condition for scalable green supply chains.

Certification, traceability and trust

Certification (third-party organic, Participatory Guarantee Systems) and clear traceability are central to market access for green products. However, the certification process can be costly and administratively heavy for smallholders. Informal reputational networks and retailer auditing partly fill the gap in domestic markets, but exports and premium channels rely on formal certification. Digital traceability pilots (QR codes, block chain trials) show promise but have limited penetration outside larger value chains.

Economic viability and market dynamics

Domestic demand for organic and green produce is growing, driven by urban consumers and e-commerce penetration; market research shows promising growth rates for the organic segment. Nevertheless, price volatility and willingness-to-pay constraints persist — consumers may value 'green' attributes but are sensitive to price and convenience. Producers face tradeoffs between investing in sustainable practices and capturing immediate income. Value addition (processing, minimal processing) often unlocks better margins and reduces waste.

Environmental performance and co-benefits

Green supply chains can lower chemical runoff, improve biodiversity, and reduce lifecycle emissions — but only if logistics and processing are also managed sustainably. For example, energy-intensive cold chains can increase emissions unless coupled with renewable energy solutions or energy-efficient technologies. Integrated analysis of GSCM (green supply chain management) emphasizes that environmental gains at the farm level must be matched by low-carbon logistics and packaging strategies to achieve net sustainability.

Successful practices and innovations observed in India

Drawing on case studies and sector reports, several recurring successful practices emerge:

1. FPO-Led Aggregation and Contract Farming

Farmer Producer Organizations (FPOs) play a crucial role in consolidating the farm output of small and marginal farmers, improving their bargaining power, and ensuring better market access. Through aggregation, FPOs can streamline input procurement, reduce transaction costs, and negotiate more competitive prices. Contract farming further strengthens this system by establishing pre-agreed terms between farmers and buyers, ensuring assured procurement, stable pricing, and reduced market risks. When FPOs facilitate contract farming, they provide institutional support, quality assurance mechanisms, and compliance monitoring, thereby enhancing trust between producers and buyers. This model promotes standardization, improves adherence to quality specifications, and attracts private investments in agriculture. Additionally, it enables farmers to adopt improved technologies and sustainable practices since buyers often provide extension services and training.

2. Localized Cold Hubs and Multi-Purpose Pack Houses

Localized cold hubs and multi-purpose pack houses provide essential infrastructure for preserving the quality and shelf life of perishable commodities. Cold hubs situated close to production clusters reduce post-harvest losses by enabling immediate pre-cooling, temporary storage, and quality maintenance before products enter longer cold-chain routes. Multi-purpose pack houses add value by offering facilities for sorting, grading, washing, packing, and minimal processing; ensuring produce meets market and export standards. These infrastructures help farmers capture better prices by maintaining freshness and reducing deterioration during transit. They also decentralize the post-harvest handling process, enabling smallholder farmers to access markets previously unavailable due to quality and logistics barriers. When integrated with digital tools for inventory and temperature monitoring, such hubs improve efficiency and transparency. Together, localized cold hubs and pack houses form a foundational layer for modern, demand-driven supply chains, supporting rural employment and enhancing overall value chain competitiveness.

3. Value Addition at Origin

Value addition at the farm or village level involves transforming raw agricultural produce into higher-value products before shipping them to markets. This may include activities such as cleaning, grading, drying, processing, or packaging. By undertaking value addition at the origin, farmers and local enterprises can significantly increase profit margins, reduce transport costs, and improve marketability. It allows producers to respond to changing consumer preferences for processed or semi-processed foods while ensuring traceability and quality control. Origin-based value addition also reduces post-harvest food losses, as produce is stabilized and preserved earlier in the supply chain. The approach supports rural entrepreneurship, enhances women's participation through cottage-scale processing units, and stimulates local economies. Furthermore, it helps diversify income sources, making farming communities more resilient to price fluctuations. This model aligns with modern value-chain strategies that emphasize sustainability, local empowerment, and shorter farm-to-market cycles.

4. Digital Traceability Pilots

Digital traceability pilots introduce technological solutions—such as QR codes, blockchain, RFID tags, or IoT sensors—to track agricultural products from farm to consumer. These systems capture data on production practices, input usage, harvesting timelines, storage conditions, and logistics, creating a transparent digital record. Traceability enhances consumer confidence, strengthens food safety compliance, and supports certification for domestic and export markets. For farmers and supply-chain actors, it helps identify inefficiencies, reduce disputes, and improve market linkages with premium buyers who value verified sourcing. Pilot-level implementation allows testing of technology feasibility, cost-effectiveness, and user adoption in real-world rural contexts. Through pilots, stakeholders can assess data accuracy, training needs, and infrastructure requirements before scaling up. When integrated with digital payment systems and quality assessment tools, traceability becomes a powerful enabler of trust and efficiency. Overall, digital traceability pilots lay the groundwork for modern, transparent agricultural ecosystems.

5. Energy-Efficient Cold Chain Trials

Energy-efficient cold chain trials aim to evaluate innovative cooling technologies that reduce energy consumption, operating costs, and environmental impact across the refrigerated supply chain. These trials often test solar-powered cold rooms, phase-change material (PCM)-based refrigeration, variable-speed compressors, and IoT-enabled energy-monitoring systems. By implementing such technologies in real operational settings, stakeholders can measure performance under varying climatic and load conditions. Energy-efficient solutions not only lower greenhouse gas emissions but also make cold chains more affordable and accessible for smallholder-centric supply systems. Efficient cooling minimizes post-harvest losses, maintains nutritional quality, and extends product shelf life, particularly for perishables like fruits, vegetables, dairy, and fish. Trials help identify scalability challenges, such as maintenance requirements, financing needs, and user training gaps. Successful pilots generate evidence for policy support, subsidies, and private investments, enabling a sustainable, resilient, and economically viable cold-chain infrastructure for rural and urban markets.

Bottlenecks and systemic barriers

Despite pockets of success, several systemic barriers slow scaling:

High Upfront Costs and Financing Gaps

Agricultural value-chain modernization often faces significant challenges due to high initial capital requirements. Infrastructure such as cold storage, pack houses, reefer vehicles, and digital traceability tools require substantial investment, which is difficult for smallholders and FPOs to afford. Limited access to credit, high collateral demands, and long payback periods further widen financing gaps. Financial institutions often perceive agri-infrastructure as high-risk, resulting in low credit flow. Even when subsidies exist, delays in disbursement and complex processes hinder adoption. As a result, many promising technologies and models fail to scale, slowing modernization and preventing farmers from capturing higher-value market opportunities.

Coordination Failures: Market Fragmentation and Trust

Coordination failures arise when multiple actors—farmers, traders, processors, logistics providers, and retailers—operate in silos without aligned incentives. Market fragmentation results in inconsistent quality standards, weak information flow, and unpredictable supply. Trust deficits between farmers and buyers often lead to side-selling, delayed payments, and disputes over quality or pricing. Lack of formal agreements, limited transparency, and inconsistent enforcement worsen the problem. Without strong institutional mechanisms such as FPOs, digital platforms, or contract farming systems, collaboration remains weak. These issues hinder value-chain efficiency, discourage private investment, and prevent the development of long-term, mutually beneficial partnerships.

• Logistics and Last-Mile Inefficiency

Inadequate rural infrastructure and fragmented logistics networks often lead to high transit times, product damage, and inconsistent delivery schedules. Many producing regions lack reliable first-mile connectivity, refrigerated transport options, or proper loading facilities. This results in quality deterioration, particularly for perishable commodities. Last-mile inefficiencies also arise from poor route planning, low vehicle utilization, and limited digital coordination among transporters and buyers. High logistics costs—often 2x to 3x higher than global benchmarks—directly reduce farmer margins and consumer affordability. A weak logistics backbone undermines the competitiveness of agri-value chains, making it difficult to meet the expectations of modern retail and export markets.

Environmental Trade-offs

Modernizing agricultural value chains often involves increased use of cold storage, packaging materials, energy-intensive processing, and transport—leading to higher carbon emissions, water usage, and waste generation. For example, expanded cold chains improve shelf life but can raise energy consumption unless efficient technologies are adopted. Similarly, improved packaging reduces spoilage but may contribute to plastic waste. Balancing growth with sustainability requires careful assessment of environmental impacts and adoption of green technologies such as renewable energy-based cold systems, biodegradable packaging, and energy-efficient logistics. Without proactive mitigation strategies, value-chain upgrades may unintentionally create ecological burdens that offset economic gains.

Policy levers and private-sector strategies

Targeted Infrastructure Subsidies and Location Planning

Targeted subsidies for critical agri-infrastructure—such as pack houses, cold rooms, grading lines, and collection centers—can significantly reduce capital burdens for FPOs, cooperatives, and rural enterprises. Effective location planning is equally important to avoid underutilized assets. Infrastructure should be strategically placed near high-production clusters, aggregation points, or transit corridors where demand is consistent. Data-driven planning that considers cropping patterns, volume density, and market linkages ensures optimal utilization. When combined with streamlined approval processes and public–private partnerships, these subsidies can accelerate value-chain development. Well-positioned infrastructure reduces post-harvest losses, improves quality compliance, and strengthens rural market competitiveness.

Financing Mechanisms for Certification and Capex

Certification processes—such as organic, GLOBALG.A.P. HACCP, or traceability compliance—often impose significant costs on farmers and FPOs. Dedicated financing mechanisms, including low-interest loans, blended finance, revolving funds, and outcome-based grants, can help cover certification expenses and capital investments. Innovative tools like pay-as-you-save models, leasing arrangements for equipment, or credit guarantees can reduce financial risk and encourage adoption. Public support for audits, training, and compliance systems enables smallholders to access premium markets. By simplifying financing for both certification and capex, stakeholders can build reliable, standards-driven value chains that meet domestic and export requirements.

Standards, Labeling, and Consumer Education

Clear quality standards and labeling frameworks help build consumer confidence and promote market differentiation. Standardization of grades, residue limits, and safety protocols ensures consistent product quality across the value chain. Labeling—such as freshness indicators, QR-based traceability, origin labels, and sustainability marks—empowers consumers to make informed choices. Consumer education campaigns, retail collaborations, and digital awareness tools can further drive demand for certified, safe, and sustainably produced food. As awareness grows, buyers become more willing to pay price premiums, incentivizing producers to adhere to quality norms. Strong standards and trusted labels ultimately strengthen the credibility and competitiveness of India’s agricultural products.

Energy Transition Incentives for Cold Chains

Cold chains are among the most energy-intensive components of the agri-value system. Incentives—such as subsidies for solar-powered refrigeration, tax credits for energy-efficient equipment, carbon-linked financing, and accelerated depreciation—can support the transition to greener technologies. Encouraging adoption of phase-change materials, variable-speed compressors, and IoT-based energy monitoring systems can reduce operational costs and emissions. Policies promoting renewable energy integration or micro-grids for rural cold storage can further enhance reliability. These incentives not only support environmental sustainability but also make cold chains more affordable for smallholder-centric supply networks. A structured energy transition plan would ensure long-term cost savings, resilience, and lower climate impact.

Policy recommendations

Build Aggregation-First Business Models

Aggregation-first business models prioritize the consolidation of produce from small and marginal farmers before moving into processing or distribution. By strengthening FPOs, cooperatives, and rural enterprises, these models reduce transaction costs, enable bulk sales, and create predictable supply for buyers. Aggregation allows for standardized quality control, efficient logistics, and improved negotiation power. It also assists in implementing uniform protocols for grading, packaging, and traceability. When combined with assured market contracts and digital procurement systems, aggregation-first models can unlock economies of scale and attract private investment. This approach forms the foundation for sustainable and inclusive value chains, especially in fragmented agricultural markets.

Invest in Near-Farm Processing

Near-farm processing involves undertaking primary or minimal processing—such as cleaning, grading, drying, pulping, or packaging—at or close to the production location. This reduces post-harvest losses, increases shelf life, and enhances the market value of agricultural produce. By processing early in the supply chain, farmers and local enterprises can capture a larger share of the value and reduce dependence on distant, centralized facilities. Near-farm units also promote rural employment, support women’s participation, and reduce logistics costs. With appropriate technology, training, and market linkages, near-farm processing can become a scalable model for building resilient, high-quality value chains that respond quickly to market demand.

Adopt Tiered Certification Approaches

Tiered certification frameworks allow producers to transition gradually toward higher standards without facing prohibitive costs. This approach creates multiple compliance levels—basic, intermediate, and advanced—enabling farmers and FPOs to adopt standards progressively as capacity and volume grow. By lowering entry barriers and simplifying documentation, tiered systems encourage broader participation, especially among smallholders who might otherwise avoid certification due to complexity and expense.

Digitize Operations for Traceability and Demand Matching

Digitizing operations enables real-time tracking of produce, efficient inventory management, and better alignment between supply and demand. Tools such as mobile procurement apps, QR-coded batches, IoT sensors, digital ledgers, and demand forecasting systems enhance accuracy and transparency across the value chain. Digital traceability builds buyer confidence by documenting farming practices, quality checks, storage conditions, and logistics data. Demand-matching systems help avoid gluts, reduce wastage, and ensure farmers produce what markets need. Digitization also improves payment transparency, strengthens record-keeping for credit access, and supports compliance with certification requirements. Overall, digital operations create a more efficient, data-driven, and competitive agricultural ecosystem.

Roadmap for scaling: an integrated model

An integrated model for scaling green edible supply chains in India would combine the following elements:
Cluster approach: Identify agro-ecological clusters with comparative advantage for specific green commodities (e.g., spices, pulses, vegetables). Concentrate infrastructure investments there to achieve scale economies

FPO + aggregator partnership: Strengthen FPO capacity for quality control and partner them with logistics providers and processors.

Multi-stakeholder cold hubs: Design cold hubs as shared assets with transparent pricing and scheduling to enhance occupancy and viability. Pilot solar and energy optimization to reduce lifecycle emissions.

Layered certification and digital traceability: Use participatory guarantees for domestic markets while digitally tagging export-bound consignments with full compliance documentation.

Value-added processing: Embed small-scale processing units to convert surplus or imperfect produce into shelf-stable products, reducing waste and increasing farmer income.

Objectives and methodology

To examine whether there are statistically significant age-wise differences in key supply chain management factors—input and farm production, aggregation and transport, cold-chain and post-harvest logistics, and value-addition and packaging—related to green edible agricultural products.

This study employed a quantitative research design to examine age-wise differences in key supply chain management factors of green edible agricultural products. A convenience sampling technique was used to select 200 respondents involved in various stages of the agricultural supply chain, including production, aggregation, transportation, logistics, and value-addition activities. To assess age-wise differences in the identified factors, one-way Analysis of Variance (ANOVA) was performed. Descriptive statistics, including means and standard deviations, were also generated to summarize the data. The use of convenience sampling allowed for efficient data collection; however, it may limit the generalizability of the findings. Despite this limitation, the methodology provides useful insights into demographic influences on green agricultural supply chain perceptions.

FINDINGS AND RESULTS

The table presents the mean scores, standard deviations, and ANOVA results for four critical components of supply chain management—Input and Farm Production, Aggregation and Transport, Cold-Chain and Post-Harvest Logistics, and Value-Addition and Packaging—across three age groups of respondents (20–30 years, 31–40 years, and 41–50 years). The F-test and significance values indicate whether age-based differences in perceptions are statistically significant.

Table 1 Age-wise Comparison of Key Factors in the Supply Chain Management of Green Edible Agricultural Products

Factors		N	Mean	Std. Deviation	F test	Sig
Input and farm production	20-30	96	3.86	.936	.487	.615
	31-40	70	3.74	.704		
	41-50	34	3.83	.775		
	Total	200	3.82	.833		
Aggregation and transport	20-30	96	3.63	1.069	1.174	.311
	31-40	70	3.74	.924		

	41-50	34	3.92	.841		
	Total	200	3.72	.984		
Cold-chain and post-harvest logistics	20-30	96	3.49	1.086	.636	.530
	31-40	70	3.68	1.014		
	41-50	34	3.56	.998		
	Total	200	3.57	1.045		
Value-addition and packaging	20-30	96	3.51	1.133	.911	.404
	31-40	70	3.74	.987		
	41-50	34	3.64	.990		
	Total	200	3.61	1.060		

The analysis compares respondent perceptions across three age groups regarding key components of the supply chain management (SCM) of green edible agricultural products. For Input and Farm Production, the mean scores across the age groups (3.74–3.86) show relatively high agreement, with the F-test value (0.487) and non-significant p-value (0.615) indicating no meaningful age-related differences. This suggests that respondents across all age groups similarly recognize the importance of sustainable farming practices and input management in green agricultural production.

In the case of Aggregation and Transport, mean values range from 3.63 to 3.92, reflecting moderate to high agreement. Although the 41–50 age group shows slightly higher perception levels, the ANOVA test ($F = 1.174$; $p = 0.311$) again reveals no statistically significant differences. This implies a shared understanding across age groups of the role of transport networks and aggregation mechanisms in reducing post-harvest losses.

For Cold-Chain and Post-Harvest Logistics, the means (3.49–3.68) indicate moderate agreement among respondents. The F-test (0.636) and p-value (0.530) confirm uniformity across ages, suggesting that cold-chain challenges are universally recognized.

Lastly, Value-Addition and Packaging yields similar results, with no significant differences ($F = 0.911$; $p = 0.404$). Overall, the findings demonstrate consistent perceptions across age groups, reflecting common awareness of SCM challenges and priorities in promoting green edible agricultural products in India.

Key empirical findings: gaps and strengths

The findings from the age-wise analysis provide important insights into how different age groups perceive the effectiveness and challenges of supply chain management (SCM) for green edible agricultural products in India. Across all four components—input and farm production, aggregation and transport, cold-chain and post-harvest logistics, and value-addition and packaging—the results indicate no statistically significant variation among the age groups. This uniformity reflects a collective recognition of the key issues and priorities across generational segments involved in or knowledgeable about green agriculture.

The consistency in perceptions regarding input and farm production suggests that sustainable practices, organic inputs, and farm-level resource management are universally acknowledged as foundational to the success of green supply chains. Similarly, the shared views on aggregation and transport highlight a broad understanding of the need for efficient collection centers, streamlined transport routes, and reduced transit losses to maintain the quality of eco-friendly products. Perceptions of cold-chain and post-harvest logistics also show alignment across respondents. This is notable because cold-chain gaps remain one of the major barriers to scaling green agricultural products in India. The moderate scores combined with uniform responses suggest that stakeholders across age groups identify cold storage, temperature-controlled transport, and timely processing as crucial yet underdeveloped areas. Finally, the convergence of opinions in value-addition and packaging indicates universal awareness of the role these processes play in enhancing product marketability, shelf life, and consumer trust, especially within the green and organic market segment.

Limitations of this study

This synthesis relies on secondary sources and sector reports rather than primary fieldwork; therefore, while it captures high-level patterns and documented case lessons, it cannot substitute for localized empirical studies across India's diverse agro-ecologies. Moreover, rapidly evolving market dynamics (post-2023 investments, new policy measures) may have produced additional developments after the primary sources used here, so stakeholders should complement these insights with up-to-date local assessments.

Green edible agricultural products represent a strategic opportunity for India to combine environmental stewardship with rural prosperity. The empirical evidence points to four critical success factors: (1) reliable aggregation that organizes smallholders into market-ready lots; (2) contextually located cold and pack house infrastructure that minimizes first-mile losses; (3) cost-sensitive certification and transparent traceability to build consumer trust; and (4) energy-aware logistics to ensure that scaling does not increase carbon intensity. Achieving these requires coordinated policy actions, tailored finance instruments, and private-sector innovation focused on cluster-level solutions.

When these pieces align, Indian green supply chains can deliver improved livelihoods, reduced waste, and trusted green food for both domestic and international consumers.

CONCLUSION

The results indicate a broad consensus across age groups regarding the strengths and weaknesses of the green edible agricultural product supply chain in India. The absence of significant age-based differences suggests that challenges such as inadequate cold-chain infrastructure, inconsistent aggregation systems, and limited value-addition facilities are widely experienced and observed. This uniform perception reinforces the need for holistic, system-wide interventions rather than age-targeted strategies. Strengthening supply chain efficiency, fostering farmer-producer organizations (FPOs), promoting digital traceability, and expanding cold-chain capacity emerge as essential priorities for scaling sustainable agriculture in India. The findings underscore the collective readiness across stakeholder groups to support and adopt improvements that enhance the reliability, sustainability, and economic viability of green agricultural supply chains.

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