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RESEARCH ARTICLE

India's organic exports: Pathways for global integration and sustainable development

Indhushree A[1*], Anbarassan A[1], Periasami N[1], Thulasiram R[1], Sathaiah M[1] & Malathi V[2*]

[1]Department of Agricultural Economics, SRM College of Agricultural Sciences, SRM Institute of Science and Technology, Chengalpattu 603 201, Tamil Nadu, India

[2]Department of Agricultural Engineering, SRM College of Agricultural Sciences, SRM Institute of Science and Technology, Chengalpattu 603 201, Tamil Nadu, India

*Correspondence email - indhuashree@gmail.com; malathiv@srmist.edu.in

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Abstract

Organic agriculture presents a promising pathway for sustainable farming, responding to the growing global demand driven by increasing health consciousness and environmental awareness. Owing to its diverse agro-climatic conditions and long-standing traditional farming systems, India possesses significant potential for growth in organic cultivation. However, the sector is constrained by challenges such as market concentration, price competitiveness, complex regulatory frameworks and limited product diversification in comparison to global competitors. This study conducts a comprehensive analysis of growth patterns, export instability and geographic concentration in India's organic exports. Using quantitative methods, SWOT analysis and a detailed policy review, the research identifies actionable strategies to address current limitations. Porter's Five Forces analysis assesses competitiveness, while key performance indicators (KPIs) track progress. The study proposes a strategic framework designed to streamline regulatory processes, diversify target markets and enhance value-added products within the organic products sector. These measures aim to enhance India's competitiveness and sustainability in the global organic marketplace. With the right strategies and policies, India can lead the global organic market, reach USD 5 billion in exports by 2030 and promote both ecological balance and rural development.

Keywords: growth analysis; organic exports; performance indicators; policy strategy; sustainable agriculture

Introduction

The rising global population has intensified the demand for agricultural products, highlighting the need for sustainable farming practices. Organic farming is a method to preserve and enhance the natural balance of the environment, thereby promoting sustainability. It encourages the production of chemical-free crops while enhancing soil fertility, maintaining ecological balance and contributing to sustainable economic development in the long run. The increased awareness of the environmental and health benefits of organic farming has led to a global demand for organic products. By 2022, nearly two percent of the total agricultural land around the world came under organic cultivation and 4.5 million farmers (1). Australia ranks first in total area under organic cultivation, followed by India and Argentina. With a market size of $61.7 billion, the US has the largest organic market in the world, followed by Germany and China (1). These global trends provide opportunities for India to expand its role in the organic sector.

India has significant potential for producing and marketing organic agricultural products due to its favorable agro-climatic conditions. The growing demand for organic produce in domestic and international markets further enhances these opportunities. India currently has the largest number of organic producers, around 55 % of the total organic producers in the world. However, they accounted for only 2.8 % of the total farmers in the country. India ranks second in terms of organic land area (4.7 million hectares) in the world. In 2023-24, India's production and export of certified organic products were approximately 3.6 million tonnes and 2,61,029 MT respectively (2). Despite this potential, India's organic export sector faces structural and policy-related challenges that require strategic interventions.

India is emerging as a significant player in organic farming, with significant contributions from states like Madhya Pradesh, Maharashtra, Gujarat and Rajasthan. Together, these four states account for roughly three-quarters of the total area under organic cultivation in the country. However, smaller states such as Sikkim and Uttarakhand excel in the proportion of organic farming relative to their total cultivated land, with Sikkim achieving a remarkable 98 % and Uttarakhand at 39 % (3). This contrast highlights both the scale and diversity of organic farming practices across India.

The Indian organic market has experienced rapid growth in recent years, reaching an estimated value of ₹16800 crore (around $2 billion) in fiscal 2023. This accounts for a modest 1.4 % of the global organic market and 1.2 % of the domestic fast-moving consumer goods (FMCG) sector. Export activities represent a significant share, contributing ₹5520 crore (32 %) of the market. Meanwhile, the organized domestic market, comprising supermarkets, branded retail chains and cooperatives, accounts for 20 %, the unorganized domestic sector (including local vendors, traditional markets and other unregulated channels) 10 % and a sizable portion (38 %) comprises organic products sold as conventional goods (1). These figures underscore the need for enhanced market structuring and targeted policy interventions to mitigate inefficiencies and boost profitability.

Globally, India's position in organic exports is relatively modest, despite the growing demand for organic products. As of 2022, India supplied only 6.2 % of the organic imports of major importing nations, according to data covering 14 countries. These markets, valued at $11.5 billion, are dominated by commodities such as bananas, soybeans and sugar, which together make up nearly half of global organic imports. Key importing nations, including the United States, the Netherlands, France and Germany, account for 73 % of these imports (1), suggesting significant opportunities for India to expand its presence in global organic trade.

In fiscal 2024, India exported 260,000 MT of organic products worth $0.49 billion. A strategic focus on the Indian diaspora residing in regions such as the Middle East, Europe and the United States has played a significant role in supporting exports. This population, exceeding 75 million, demonstrates a growing preference for organic products from India, driven by health awareness and a desire to protect traditional cultural food practices. Companies have been aligning their strategies to meet this demand, leveraging the diaspora's purchasing power to enhance their presence in global markets.

Despite these advancements, the organic sector in India faces several persistent challenges, including inadequate infrastructure such as cold storage facilities, logistic networks and processing units, high costs associated with certification, limited awareness among consumers and underdeveloped supply chains (4). Additionally, the diversity of organic produce remains restricted, which constrains diversification and competitiveness. Overcoming these obstacles is critical for India to unlock the full potential of its organic sector. Recent studies reinforce India's potential and highlight competitiveness gaps. The studies highlighted strong but uneven growth trends in India's organic exports (5, 6).

To address these challenges, the Government of India has launched several initiatives and policy frameworks, including the Paramparagat Krishi Vikas Yojana (Traditional Agriculture Development Scheme) under the National Mission for Sustainable Agriculture and the Mission Organic Value Chain Development for the North Eastern Region, aimed at strengthening the organic farming ecosystem. These efforts span the entire value chain, from production to exports and are designed to strengthen India's global position in the organic market.

Accordingly, this study analyses the historical performance of India's organic exports and proposes a strategic roadmap to enhance competitiveness, expand market reach and maximize value realization.

Methodology

A comprehensive approach combining quantitative analysis, qualitative assessment and policy evaluation was employed to generate evidence-based recommendations for enhancing India's organic export potential.

Data collection

Data on organic exports, including quantity, value and unit value were collected from the Agricultural and Processed Food Products Export Development Authority (APEDA), the International Federation of Organic Agriculture Movements - Organics International (IFOAM-Organics International), the Research Institute of Organic Agriculture (FiBL), the United States Department of Agriculture (USDA) reports and other government publications. The data were collected for the period from 2011-12 to 2021-22 based on the consistent availability of the export and other details. This period also marks significant shifts in trade policy, including the expansion of the National Programme for Organic Production (NPOP), the evolution of APEDA's export promotion initiatives and changes in global demand patterns, thereby providing a representative decade for analysing India's organic export performance. Government policies, initiatives under NPOP, APEDA reports and export promotion strategies were reviewed along with market reports and industry analysis reports from CRISIL, Yes Bank and global market intelligence on organic trade. These qualitative sources were examined using content analysis to identify recurring themes, policy gaps and strategic recommendations relevant to India's organic export sector. The qualitative and quantitative analyses were carried out using Microsoft Excel.

Growth rate analysis

An Exponential Growth Model was applied to estimate the Compound Annual Growth Rate (CAGR) of export quantities, values and unit values and their statistical significance was tested using the t-test (7). Log-transformed data were used in the exponential model to ensure linearity of the growth trend. CAGR was preferred over a simple linear growth rate as it captures the compounding effect over time, thereby providing a more realistic measure of long-term growth dynamics.

Instability analysis

Coppock's Instability Index was employed to assess export volatility and capture temporal fluctuations during the study period (8). This index was selected over alternatives such as the Cuddy-Della Valle index or the simple coefficient of variation because it accounts better for year-to-year fluctuations in time-series data and is widely used in agricultural trade studies. Results are interpreted such that higher values indicate greater instability, while lower values reflect relatively stable export performance.

Geographic concentration

The concentration of India's organic exports across destination markets was assessed using the Hirschman-Herfindahl Index (HHI), where a declining HHI indicates diversification. At the same time, a higher index reflects dependency, which helps assess the risks of overdependence on a few export markets (9).

SWOT analysis and comparative study

A comprehensive Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis was conducted based on literature review, market data and stakeholder perspectives. Stakeholder input was obtained from secondary reports, published industry surveys and expert commentaries available through APEDA, as well as international market studies. For a comparative case study, Peru (quinoa exports) and Thailand (organic fruits) were selected because both represent successful small and medium organic exporters with crop portfolios and export structures comparable to India's niche products (10). Additionally, Central India's organic cotton sector was included as a domestic benchmark for successful integration into global markets. Policies under NPOP, APEDA guidelines and international standards for organic certification were reviewed and regulatory bottlenecks were identified through comparative policy analysis with leading organic exporting countries.

Porter's five forces model

Porter's Five Forces was applied to evaluate the competitive landscape of India's organic exports globally (11). The framework includes defining the industry scope to encompass key organic agricultural exports, such as cereals, fruits and processed products, with a focus on global markets, including the USA, EU and emerging economies. Data were gathered from secondary sources, including APEDA, USDA, FiBL and industry reports like CRISIL and Yes Bank. Each of the five forces, viz. threat of new entrants, bargaining power of buyers and suppliers, threat of substitutes and industry rivalry, as outlined by Porter (Fig. 1), was assessed using criteria such as entry barriers, buyer concentration, supply chain organization and competition intensity. Each force was qualitatively scored (Low, Moderate, High) based on the evaluation criteria and data analysis. Expert opinions from industry reports and prior studies were incorporated to validate assessments.

Impact metrics development

Impact metrics and key performance indicators are measurable values that demonstrate how effectively a sector, policy or strategy is achieving its targeted outcomes. In the context of the organic export sector, key performance indicators help monitor progress toward strategic goals, such as market diversification, value addition and export growth. Key performance indicators were developed based on extensive reviews (2, 12, 13). These metrics facilitate evidence-based decision-making by providing quantitative benchmarks against which policy interventions and market strategies can be evaluated.

Key Performance Indicators were developed by aligning with the strategic objectives identified through a SWOT analysis, Porter's Five Forces analysis and policy assessments to track progress in areas such as market diversification, competitiveness and sustainability. The indicators were selected following the SMART (Specific, Measurable, Achievable, Relevant, Time-bound) criteria and benchmarks were established based on historical data, comparative global standards (international best practices) and national policy aspirations as targets outlined by APEDA (2) and global reports such as FiBL and IFOAM (1).

Results and Discussion

Growth and diversification of organic products export from India

The trajectory of India's organic agricultural exports from 2011-12 to 2021-22 reveals a complex combination of growth momentum, market volatility and systemic constraints that define the sector's global positioning (Fig. 2). Between 2011-12 and 2020-21, India's organic agricultural exports surged by nearly 670 %, while export values exhibited a 495 % rise. However, in 2021-22, both quantity and value declined sharply by 48 % and 26 % respectively, reflecting regulatory and market challenges (4). Unit value dropped from USD 1517.45 in 2011-12 to USD 874.59 in 2017-18, but recovered to USD 1676.64 by 2021-22, indicating a shift toward higher-value products. Bulk commodities dominated exports, comprising 98 %-99 % in 2020, with retail products growing to 5 %-7 % by 2024 (2). Growth was driven by global health consciousness, India's agro-climatic diversity and supportive policies like the National Programme for Organic Production (NPOP), yet the COVID-19 pandemic, overlapping APEDA and FSSAI regulations and competition from other countries contributed to recent declines (4, 14).

Quantitative assessments demonstrate a significant upward trajectory (Fig. 3), with the Compound Annual Growth Rate (CAGR) for export quantity recorded at 19.85 % and for export value at 19.26 %, suggesting a robust market expansion fuelled by increasing global awareness towards health, sustainability and environmentally benign agricultural practices (1). However, this

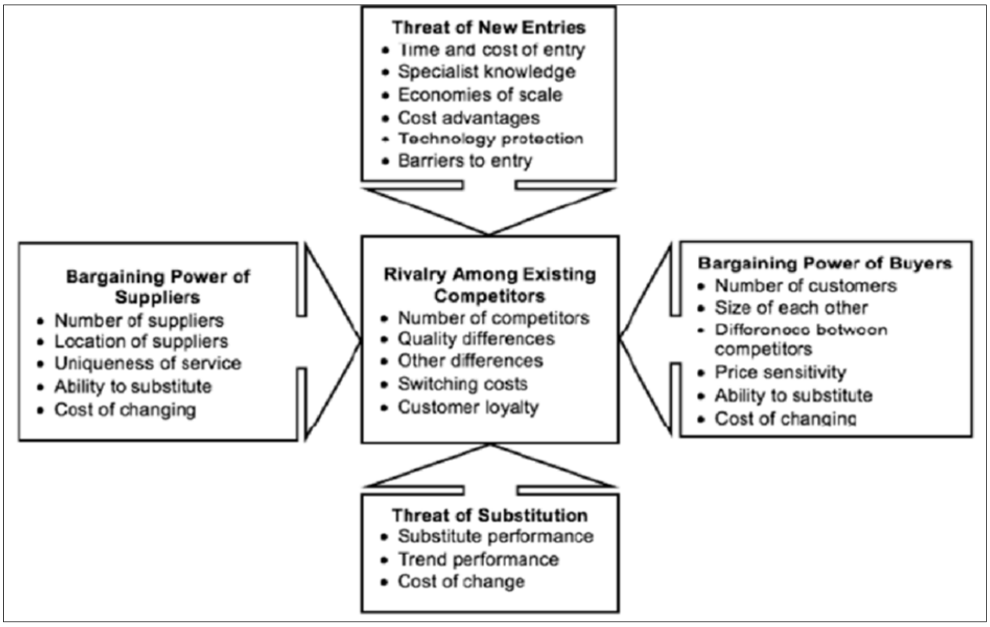

Fig. 1. Porter's five forces model (11).

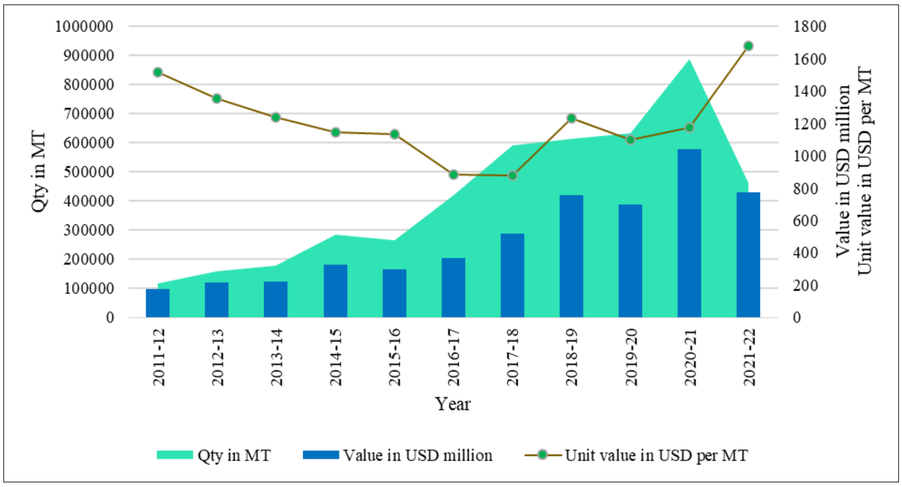

Fig. 2. Trends in organic agricultural products exports from India (2011-12 to 2021-22).

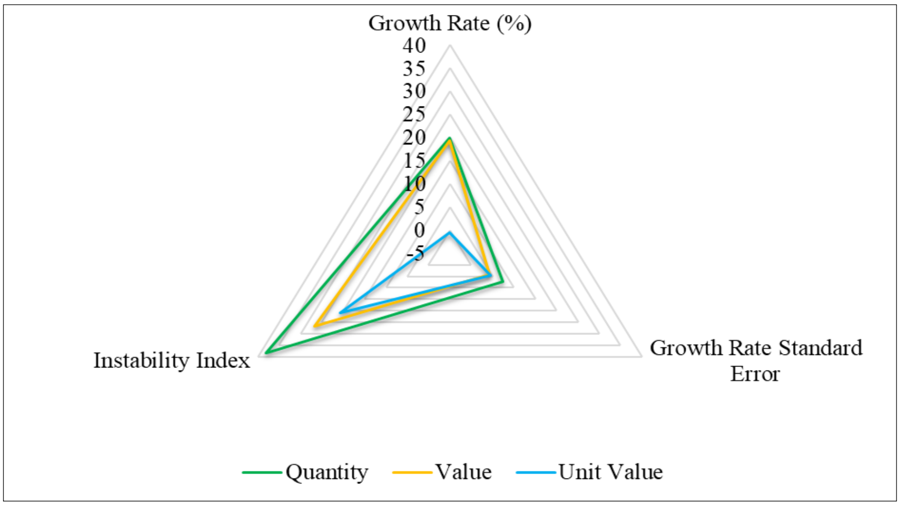

Fig. 3. Growth rate and instability in organic agricultural products exports from India (2011-12 to 2021-22).

promising growth is tempered by a slight decline of -0.49 % in the unit value of exports, indicating that while volumes have surged, the sector continues to grapple with price-based competition and limited value capture.

The volatility inherent in India's organic export sector is quantitatively captured through Coppock's Instability Index, with export quantities reflecting the highest volatility at 38.02 %, followed by export values at 26.65 % and unit values at 20.63 % (Table 1). This pronounced instability can be attributed to a combination of domestic and international factors, including supply chain disruptions induced by the COVID-19 pandemic and unpredictable shifts in consumer demand in key importing markets, such as the United States and the European Union. Moreover, the intricate regulatory frameworks in export destinations, coupled with fluctuating global trade policies, have further exacerbated this instability.

Table 1. Growth rate and instability in the export of organic agricultural products from India for the period 2011-12 to 2021-22

	Quantity	Value	Unit value
Exponential Growth Rate (%)	19.84552	19.25845	-0.48985
Growth Rate Standard Error	7.498469	4.306714	4.542306
Growth Rate Significance	0.377842	0.223627	-9.27276
Coppock's Instability Index	38.01585	26.645	20.6338

Geographic concentration analysis through the Hirschman-Herfindahl Index (HHI) provides further insight into the structural vulnerabilities of India's organic exports. A decline in HHI from 64.58 in 2018-19 to 58.27 in 2021-22 (Fig. 4) suggests promising efforts towards market diversification owing to rising global demand for organic products (15). But still, the majority of exports to a limited cluster of destinations remains a critical risk. The concentration on established markets subjects India's organic exports to stringent quality standards and volatile economic cycles, often to the disadvantage of smallholder organic producers who dominate the production landscape and smallholder producers face high compliance costs and are vulnerable to rejection risks (2).

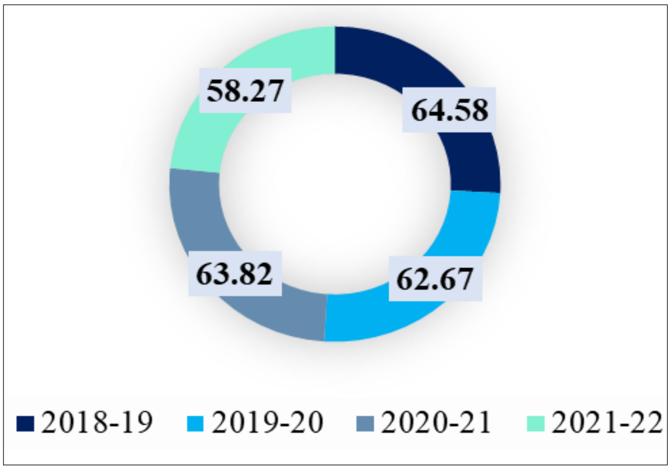

Fig. 4. Hirschman index of geographic concentration of organic agricultural products exports from India.

SWOT analysis and qualitative assessment

Complementing these quantitative insights, the SWOT analysis outlines the sector's internal strengths and weaknesses, alongside the external opportunities and threats. Table 2 provides a picture of the SWOT identified for India's organic products export. India's diverse agro-climatic conditions and the world's most extensive base of organic producers constitute pivotal strengths (1). Nevertheless, systemic weaknesses such as fragmented supply chains, inadequate post-harvest infrastructure and prohibitive certification costs hinder scalability and competitiveness. These observations align with previous studies, which argue that the underutilization of Northeast India's organic farming potential is indicative of broader infrastructural and policy-level deficits (16).

SWOT analysis highlights the need for strategic interventions that capitalize on India's strengths and opportunities, such as technological adoption and market diversification, while simultaneously addressing weaknesses and mitigating threats through policy reforms, infrastructure development and targeted capacity building. These strategies can be operationalized through initiatives such as the Paramparagat Krishi Vikas Yojana (PKVY), which promotes organic farming clusters, the Jaivik Kheti Portal for digital market access and traceability and APEDA's export promotion schemes. These initiatives collectively strengthen certification, branding and international market penetration.

The qualitative assessment, conducted through comparative case studies, offers instructive parallels (Table 3). In Peru, the deliberate branding and certification of organic quinoa have significantly strengthened its global market position and improved unit value realization (17, 18). Similarly, Thailand has demonstrated notable success in exporting organic fruits, driven by consistent government support, efficient certification systems and investment in value-added processing infrastructure (19, 20). These experiences highlight the importance of branding and certification reforms for India to shift from bulk commodities to premium retail markets.

Ethiopia's rise in organic coffee exports is primarily attributed to targeted government subsidies and a strategic focus on niche markets within the organic coffee segment (21-23). In contrast, Vietnam's achievements in organic exports have been facilitated through the establishment of public-private partnerships, integrated supply chain development and coordinated sectoral initiatives (19, 24-28). Collectively, these cases underscore the crucial role of institutional support, value chain coordination and targeted policy frameworks in promoting effective organic export strategies. For India, replicating Vietnam's PPP-based model and Ethiopia's niche focus could address supply chain fragmentation and help Indian exports move up the value chain.

Policy and institutional analysis of the organic export sector

To understand the policy and institutional landscape that shapes India's organic exports, a comparative assessment was conducted. Table 4 summarizes the key policy frameworks and institutional mechanisms of India and selected countries. The analysis reveals that while initiatives like the National Programme for Organic Production (NPOP) have laid foundational governance

Table 2. SWOT analysis of India's organic products export sector

Strengths	Weaknesses
1.Diverse agro-climatic zones suitable for a wide range of organic crops.	1. Fragmented and unorganized supply chains limit scalability.
2.Largest number of organic producers globally.	2. Inadequate cold storage, logistics and post-harvest infrastructure.
3.Government support through policies like the National Programme for Organic Production.	3. High cost and complexity of certification processes.
4.Traditional farming practices in regions like Northeast India are inherently organic.	4. Limited product diversification; dominance of bulk exports over value-added products.
Opportunities	**Threats**
1.Growing global demand for organic and sustainably sourced products.	1. Intense competition from countries like Peru, Thailand, Ethiopia and Vietnam.
2.Emerging markets in Asia, Africa and Latin America with growing organic preferences.	2. Stringent and evolving international quality and sustainability standards.
3.Increasing demand for processed, packaged and retail-ready organic products.	3. Market volatility and price competition leading to unstable export earnings.
4.Potential for leveraging technology (e.g., blockchain) for traceability and supply chain efficiency.	4. Risk of market dependency on the USA and the EU due to high geographic concentration.

Table 3. Comparative case study of successful organic exporting countries with relevance to India

Country	Key strategies implemented	Outcomes achieved	Relevance to India
Peru	1. Strong government-industry collaboration 2. Global branding of quinoa 3. Increased certification with innovative	1.Elevated global brand recognition 2.Higher unit value for exports 3.Sustainable producer incomes	India can implement GI for unique organic products (e.g., spices, millets) to enhance brand value and encourage the certification.
Thailand	1. Streamlined certification process 2. Investment in processing and packaging 3. Active participation in international trade fairs	1. Increased export volume of organic fruits 2. Diversified market base	India can simplify certification and enhance its processing infrastructure to improve export readiness.
Ethiopia	1. Government-backed organic agriculture policy 2. Export subsidies and technical support 3. Focus on niche organic coffee	1. Established premium market position for organic coffee 2. Enhanced farmer incomes	India can adapt high-demand organic crops, such as tea and coffee.
Vietnam	1. Public-private partnerships in the organic sector 2. Focus on traceability and quality standards 3. Integrated supply chain development	1. Strengthened presence in organic rice and spices markets 2. Improved supply chain efficiency	India can foster public-private partnerships to build robust supply chains and enhance traceability.

Table 4. Policy and institutional comparison in organic export development of successful countries with relevance to India

Aspect	India	Peru	Thailand	Ethiopia	Vietnam
Certification system	NPOP (export) and PGS-India (domestic); complex dual framework	RTPO under SENASA; mandatory for domestic and export markets	Unified national standard under ACFS	Export-focused certification aligned with international standards	Integrated national system with third-party certification
Export promotion body	APEDA; limited targeted organic branding	MINCETUR and SENASA; strong government-industry coordination	National Board of Trade; dedicated organic export schemes	MoT and Coffee & Tea Authority; export-oriented initiatives	MOIT with PPP coordination; active public-private integration
Financial support	NPOP subsidies; limited export incentives	Certification and marketing subsidies	Export finance and processor subsidies	Export subsidies for certified organic coffee	Government grants for certification and value addition
Branding and marketing	Fragmented; includes Jaivik Bharat, limited regional branding	Strong collective branding	Effective promotion of tropical fruits	Premium niche focus on organic coffee	Emphasis on traceability and certified labels
Infrastructure support	Limited cold chain and logistics systems	Moderate support for niche product exports (e.g. quinoa)	Strong facilities for packaging and export of fresh produce	Government investment in coffee processing and logistics	Ongoing investment in supply chain and traceability systems

frameworks, the coexistence of multiple certification and regulatory authorities, such as APEDA and FSSAI, creates procedural redundancies and increases compliance costs. Comparative international policy reviews suggest that countries with unified organic certification frameworks, backed by dedicated export promotion bodies, demonstrate higher export efficiency and lower market entry barriers. This underscores the need for India to develop a coherent national organic export policy, streamline certification, enhance branding efforts and improve infrastructure to match international best practices. Without harmonization, India risks losing competitiveness despite being the world's most extensive organic producer base.

Porter's Five Forces analysis (Table 5) indicates that India's organic sector faces high bargaining power from buyers in developed markets, significant threats from substitute products and intense rivalry from emerging organic producers, such as Ethiopia and Vietnam. This competitive pressure necessitates India's shift from bulk exports to differentiated, branded organic products.

Furthermore, the lack of digital traceability and supply chain transparency hinders India's ability to meet the increasingly sophisticated expectations of consumers in developed markets. Integrating blockchain-based traceability systems could not only enhance compliance with international standards but also build brand credibility, which is a critical factor identified by the Yes Bank and APEDA report (15). India could pilot blockchain traceability under APEDA's Jaivik Kheti initiative.

Key Performance Indicators and Proposed Strategies

The Key Performance Indicators serve as practical metrics for policymakers, exporters and stakeholders to track progress over time. The proposed key performance indicators and benchmarks for enhancing India's organic exports, including supply chain infrastructure (29) and blockchain-based traceability, are presented in Table 6. Regular assessments against these benchmarks can be conducted through APEDA's monitoring mechanisms, annual export reports and third-party evaluations aligned with the Sustainable Development Goals (SDGs), particularly Goal 12 (Responsible Consumption and Production).

The findings advocate for a dual-pronged strategy: Firstly, fostering value addition through investments in processing and branding to increase unit value and reduce overreliance on bulk commodity exports; Secondly, implementing policy reforms aimed at simplifying certification, enhancing infrastructure and promoting targeted market diversification. Developing cold chain logistics, expanding market reach to emerging economies in Asia, Africa and Latin America and leveraging diaspora networks present actionable pathways to mitigate current structural deficiencies.

Table 5. Porter's five forces analysis for India's organic export sector

Force	Intensity	Key factors	Implications for India
Threat of new entrants	Moderate	1. High certification and compliance costs 2. Government support is limited in reducing entry barriers 3. Growing demand attracts new entrants	May face increasing competition from emerging exporters; requires policy support to ease entry while maintaining quality.
Bargaining power of buyers	High	1. Buyers from the USA and, EU dominate with strict standards 2. High demand for traceability and sustainability 3. Price sensitivity in bulk commodities	Limits India's pricing power; necessitates the development of branded, premium organic products to counteract.
Bargaining power of suppliers	Low	1. Predominantly smallholder farmers 2. Limited negotiation capacity 3. Lack of organized producer groups	Suppliers remain price-takers; strengthening cooperatives and producer groups could enhance their leverage.
Threat of substitutes	Moderate	1. Conventional products 2. Non-certified organic 3. Emerging superfoods from other regions	Need for innovation and product differentiation to reduce substitution risk.
Industry rivalry	High	1. Strong competitors: Peru (quinoa), Thailand (fruits), Ethiopia, Vietnam 2. Price competition and superior branding by competitors	India must invest in marketing, branding and quality enhancement to remain competitive in the global market.

Table 6. Proposed key performance indicators and benchmarks for enhancing India's organic exports

Key performance indicator	Current status (2021-22)	Target (by 2030)	Data source	Rationale
Total organic export value	USD 771.78 million	USD 5 billion	1, 2	Scaling export earnings in line with global demand growth.
Unit value of exports (USD/MT)	USD 1676.64	Increase by 30 %	2, 4	Indicates improved product value through processing and branding.
Share of retail-ready exports	5 %-7 % of total exports	20 %	2	Enhancing the share of processed and packaged products to improve margins.
Geographic diversification index (HI)	58.27	Below 50	Calculated from APEDA export data	Reduce market concentration risk by entering new markets.
Share of exports to emerging markets	Low (dominance of USA, EU)	25 % of total exports	2, 4	Penetration into Asia, Africa and Latin America for risk diversification.
Number of certified organic producers	Around 1.9 million	3 million	2, 3	Expanding production base to meet increased global demand.
Supply chain infrastructure score	Limited; fragmented	Develop 10 major cold chain clusters	29	Improve export logistics to reduce post-harvest losses.
Blockchain-based traceability adoption	Minimal	50 % adoption in exports	Proposed benchmark	Increase transparency to meet buyer expectations in developed markets.

Conclusion

The convergence of quantitative, qualitative and policy-oriented analyses underscores a critical imperative: India must shift from a volume-based model of organic exports to a value-driven framework that enhances its global competitiveness. Strengthened by empirical insights and guided by global best practices, this strategic shift is vital for India to unlock the full potential of its organic exports in an increasingly competitive world market. India's organic export sector holds immense untapped potential. Moving beyond bulk exports to diversified, value-added products, supported by policy reforms and infrastructure, can position India as a global leader. A structured, multi-pillar strategy can foster sustained growth and enhance resilience against market fluctuations in the organic export sector. Anchored in measurable Key Performance Indicators and aligned with the Sustainable Development Goals, a structured multi-pillar strategy will not only drive sustained export growth but also enhance resilience against global market fluctuations.

Authors' contributions

IA conceived and presented the idea; performed computations, interpreted results and prepared the manuscript. IA, AA and PN collected and analysed data. TR & SM guided in data collection and result interpretation. MV participated in data acquisition, review and editing. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: The Authors do not have any conflicts of interest to declare.

Ethical issues: None

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