PLANT SCIENCE TODAY
Vol x(x): xx–xx
https://doi.org/10.14719/pst.8879

eISSN 2348-1900

RESEARCH ARTICLE

Comprehensive analysis of the International trade of chilli and cumin in India

Sowmiya K[1*], Selvanayaki S[1], Velavan C[1], Nelson Navamaniraj K[2] & Sridevy S[3]

[1]Department of Agricultural and Rural Management, Tamil Nadu Agricultural University, Coimbatore 641 003, India
[2]Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore 641 003, India
[3]Department of Physical Science and Information Technology, Tamil Nadu Agricultural University, Coimbatore 641 003, India

*Correspondence email - sowmiyakanagaraj06@gmail.com

Received: 15 April 2025; Accepted: 19 July 2025; Available online: Version 1.0: 14 September 2025

Cite this article: Sowmiya K, Selvanayaki S, Velavan C, Nelson NK, Sridevy S. Comprehensive analysis of the International trade of chilli and cumin in India. Plant Science Today (Early Access). https:/doi.org/10.14719/pst.8879

Abstract

Cumin and chilli rank among Indias' leading spice exports, establishing the country as a key player in the global spice trade. This study provides a comprehensive analysis of Indias' performance in international trade of these spices, utilizing the Compound Growth Rate (CGR), Instability Index and Markov Chain analysis. The study period for chilli is (2001-2024) and cumin is (2010-2024). The study aims to assess the growth trends, volatility and market dynamics of Indian chilli and cumin exports in order to offer crucial insights into their long-term viability and competitive position. CGR is used to calculate the annual growth rate in export volume, value and price, thereby illustrating trends in Indias' spice trade. Changes in export performance are measured by the Cuddy-Della Valle Instability Index, which accounts for the impact of external shocks, policy changes and price volatility. The probability of a trade transition is also examined using Markov Chain Analysis to ascertain the stability of Indias' export destinations and potential market moves over time. The results indicate a notable increase in cumin and chilli exports, but with regular fluctuations caused by changing trade laws, weather patterns and global demand. The Markov Chain model provides a framework for predicting future trade trends, identifying key export destinations and their retention potential. This report is a strategic tool that policymakers, exporters and other stakeholders can utilize to lower risks, enhance market stability and support Indias' global spice trade.

Keywords: CGR; chilli; cumin; instability analysis; international trade; markov chain

Introduction

India has been a traditional and largest producer, consumer and exporter of spices. Most of the spices are native of our country and hence India is rightly known as the Land of Spices. Over the past few years, the production of all kinds of spices has been increasing significantly (1). India is expected to produce around 11 MMT in 2023-2024, which will contribute approximately 40 % to the global demand for spice production. India is also projected to export $ 4.46 billion worth of spices, setting a new record in 2023-2024. Among these, chilli and cumin emerged as the top exported spices during the period (2). India exported 28732 metric tons of chilli in 2023-2024, which was worth approximately ₹ 6000 crore. India is the worlds' largest producer of chilli, with 1.98 million metric tons produced in 2023-2024 (3). According to the spice board of India, Andhra Pradesh leads chilli production, contributing 44 % of the national output, followed by Telangana (19 %), Karnataka (17 %), Madhya Pradesh (15 %), Orissa (9 %), Tamilnadu (3 %) and Gujarat (2 %). Indian chillies are renowned for their vibrant color and varying levels of pungency (4).

Cumin, commonly known as "Zeera" It has a warm aroma due to its essential oil content. India produces over 1.84 lakh metric tonnes of cumin per year, which accounts for approximately 2.2 lakh metric tonnes of jeera produced globally. This makes india the worlds' largest producer, exporter and consumer of cumin seeds (5). Gujarat produces over 420000 MT of cumin seeds (57.9 % of Indias' total domestic production), followed by Rajasthan with 303500 mt (41.85 %) and West Bengal with 1510 metric tons (0.2 %). In 2023-2024, India exported more than 1.6 lakh metric tonnes of cumin (6). Major export destinations include China, Bangladesh, the United States, the United Arab Emirates and Afghanistan (7).

Trends in area, production and productivity of chilli from 2000-01 to 2023-24 are illustrated in Fig. 1. The area under cultivation has not increased significantly; however, the rise in productivity has been a major factor contributing to higher production levels. This suggests a shift towards more efficient farming practices rather than merely expanding cultivated land. The last few years have shown a sharp rise in both production and productivity, indicating possible government interventions, improved hybrid seed adoption, or favourable weather conditions (8). This has been depicted in Fig. 1.

Fig. 2 illustrates the trends in cumin cultivation, including area, production and productivity, between 2000-01 and 2023-24. The continuous expansion in area, production

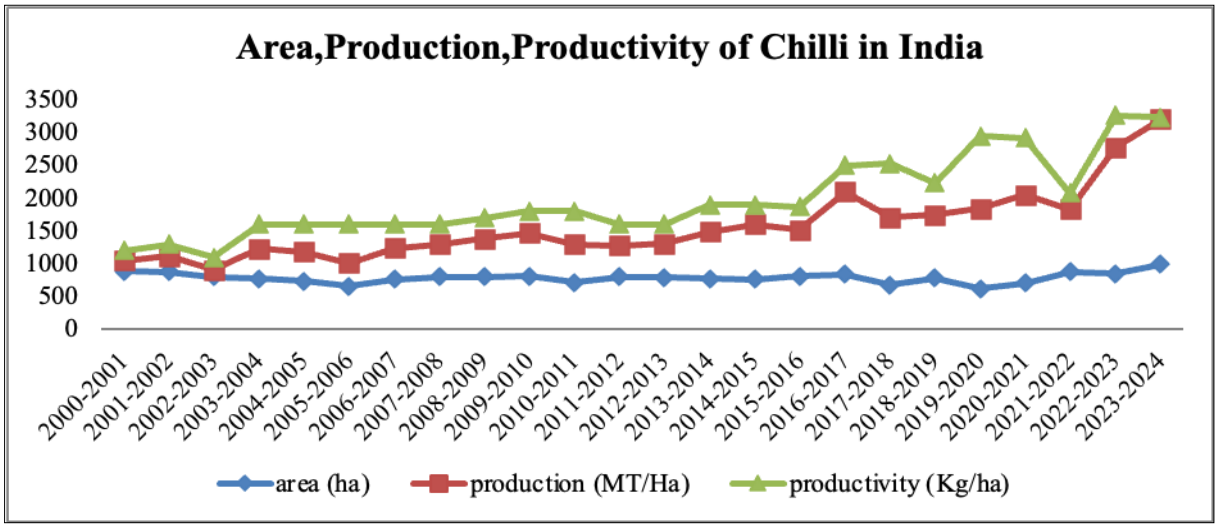

Fig. 1. Area, Production and Productivity of Chilli in India (2000-01 to 2023- 24).

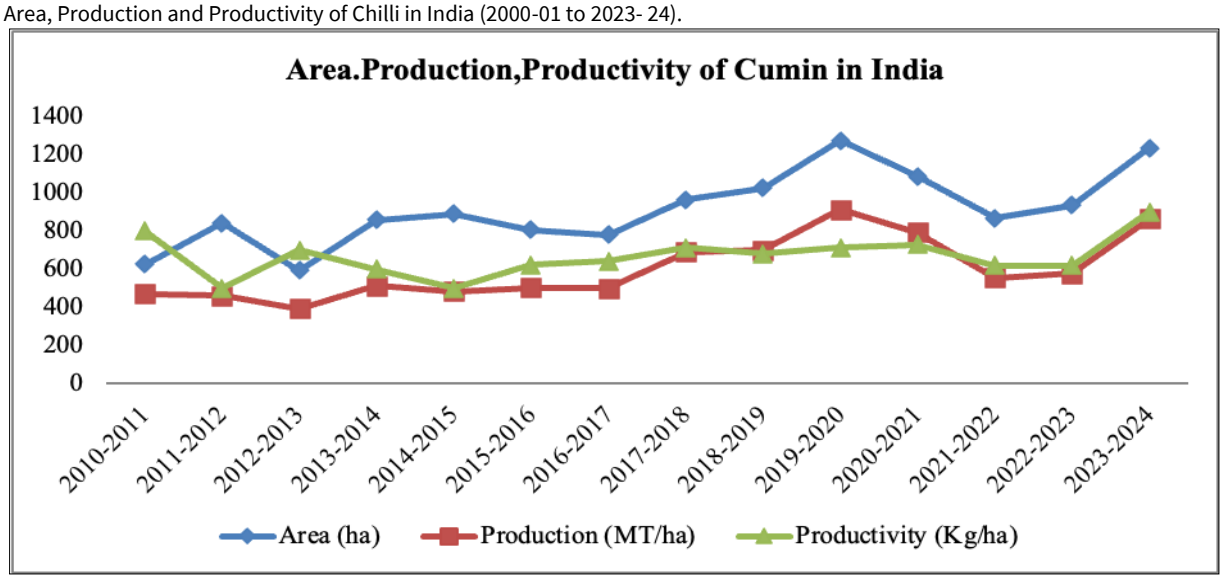

Fig. 2. Area, production and productivity of cumin in India (2010-2024).

and productivity in recent years suggests increased investment and technological advancements in cumin farming. The adoption of organic farming and increased export demand may also contribute to boosting cumin production. Government support through subsidies, research and extension services could be a driving factor for the growth in cumin cultivation (9), as represented in Fig. 2.

Significant contributions from several countries characterize the global chilli export market, each playing a pivotal role in meeting international demand. India continues to be the worlds' leading producer and exporter of dried chilli. The country accounts for more than 28 % of global chilli exports, with major export markets including China, Bangladesh, the USA, the UAE, Vietnam and Thailand. Vietnam is the second largest exporter of chilli in the world market. The country exported green chilli and red chilli in value of 22 % and 17 %. The main export markets of Vietnamese chilli include China and Laos. China is a significant player in the chilli export market both as a producer and exporter. The country exports a variety of chilli products, including dried chillies and chilli powders, to numerous countries worldwide. Other countries contributing to the global chilli export market include Indonesia, Bangladesh, Thailand and Mexico. Each of these nations exports significant quantities of chilli products, catering to regional and international markets. It has been depicted in Fig. 3.

A few key countries dominate the global cumin seed export market. India exports 616.58 million dollars to other nations in 2024. India, China and the UAE are the leading exporters of cumin seeds in the international market as of 2024, with India holding the largest share of 71 % of worlds' total cumin exports. Indian cumin is highly regarded for its distinct flavour and its demand remains robust in many countries, especially in the Middle East, Southeast Asia, Europe and the United States. Other notable exporters include Turkey, the Netherlands, Egypt and Spain, although their market shares are comparatively smaller. A detailed overview of these trends is provided in Table 1 and Fig. 4

India has experienced significant growth in its chilli export from 2000 to 2024. In the base year 2000-01 exports were approximately 62448 T valued at ₹ 22973 lakh. By 2020-21, these figures had risen to 649815 tonnes worth ₹ 924126 lakh, reflecting a compound annual growth rate (CAGR) of 11.79 % in quantity and 19.23 % in value. In India the area, production, productivity of chilli are expected to increasing year by year. This growth will boost both the domestic consumption and international trade. In 2020-2021 the export of chilli from India accounts for 649815 tonnes valued at ₹ 924126.56 lakhs and 2023-24 it was decreased by 601084 metric tonnes. Overall, while Indias' chilli export growth has been ordinary over the past two decades, recent fluctuations highlight the impact of global demand and climatic factors on

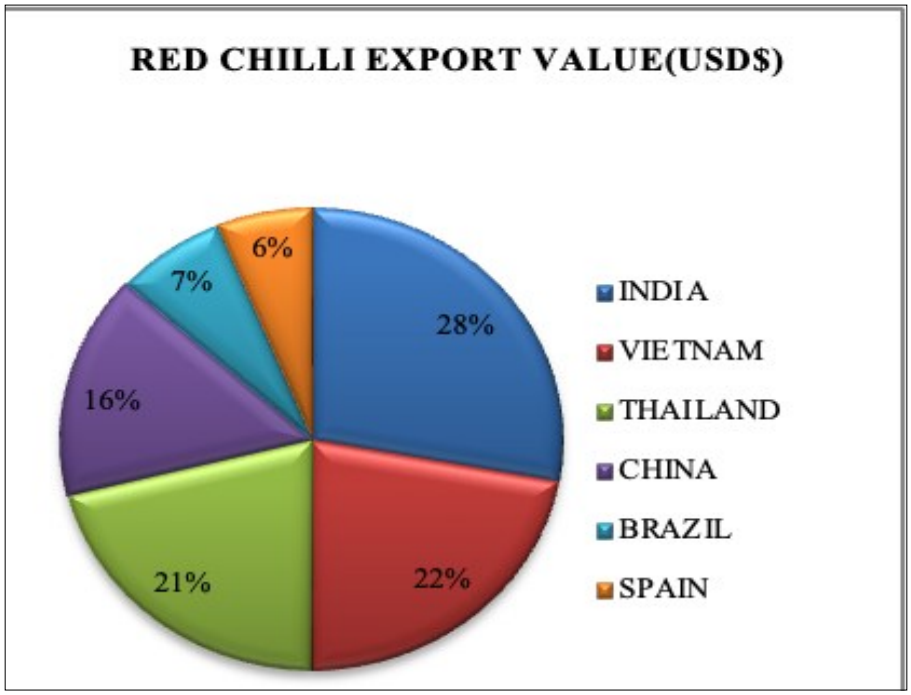

Fig. 3. Current scenario of chilli exports in the International market (2023-2024).

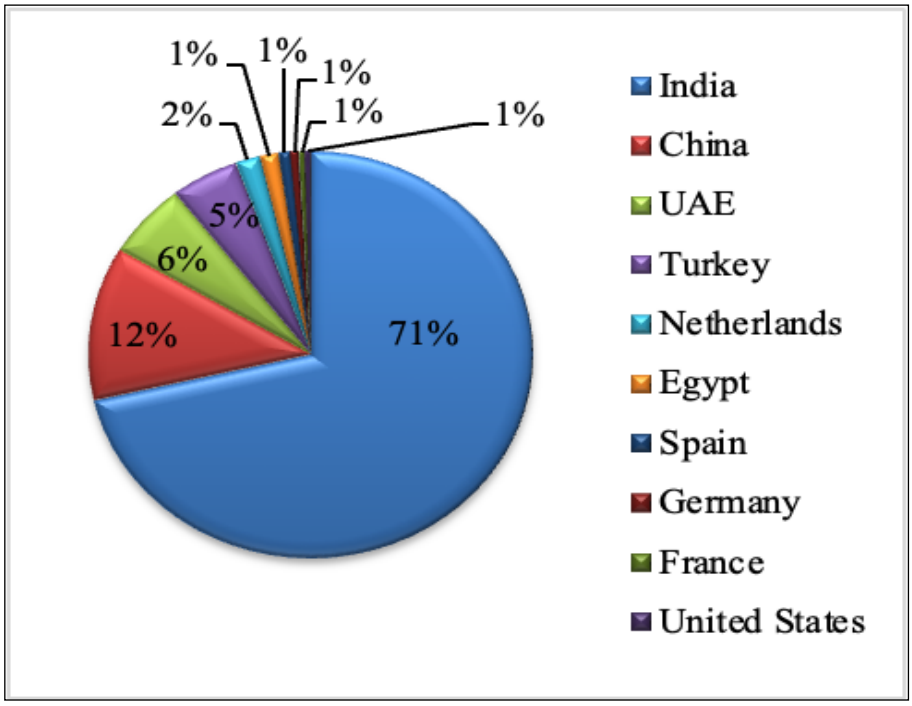

Fig. 4. Current scenario of cumin exports in the International market (2023-2024) as per the Ministry of Commerce and Industry.

Table 1. Cumin exporting countries in the international market (2023-24) (1)

Cumin Exporting Countries	Export value (US$ Million)
India	616.58
China	105.7
UAE	51.75
Turkey	42.51
Netherlands	15.45
Egypt	11.71
Spain	7.87
Germany	4.96
France	3.69
United States	3.67

Source : (1)

export performance. Indian exporters have increasingly focused on supplying processed chilli products, such as chilli powder, chilli flakes and oleoresins (chilli extract), which are gaining popularity in the global market for both culinary and medicinal purposes. Countries such as the United States, China, Bangladesh, Sri Lanka and the Middle East (e.g., UAE, Saudi Arabia) are major buyers of Indian chillies, both in fresh and dried form. It has been depicted in Fig. 5.

India has established itself as a leading producer and exporter of cumin, with significant growth in export volumes and values from 2010 to 2024. In 2010-11, India exported approximately 32500 tonnes of cumin valued at ₹ 39597 lakh. By 2020-21, exports had increased to around 298423 tonnes worth ₹ 425154 lakh, reflecting a compound annual growth rate (CAGR) of 22.33 % in quantity and 24.08 % in value. In

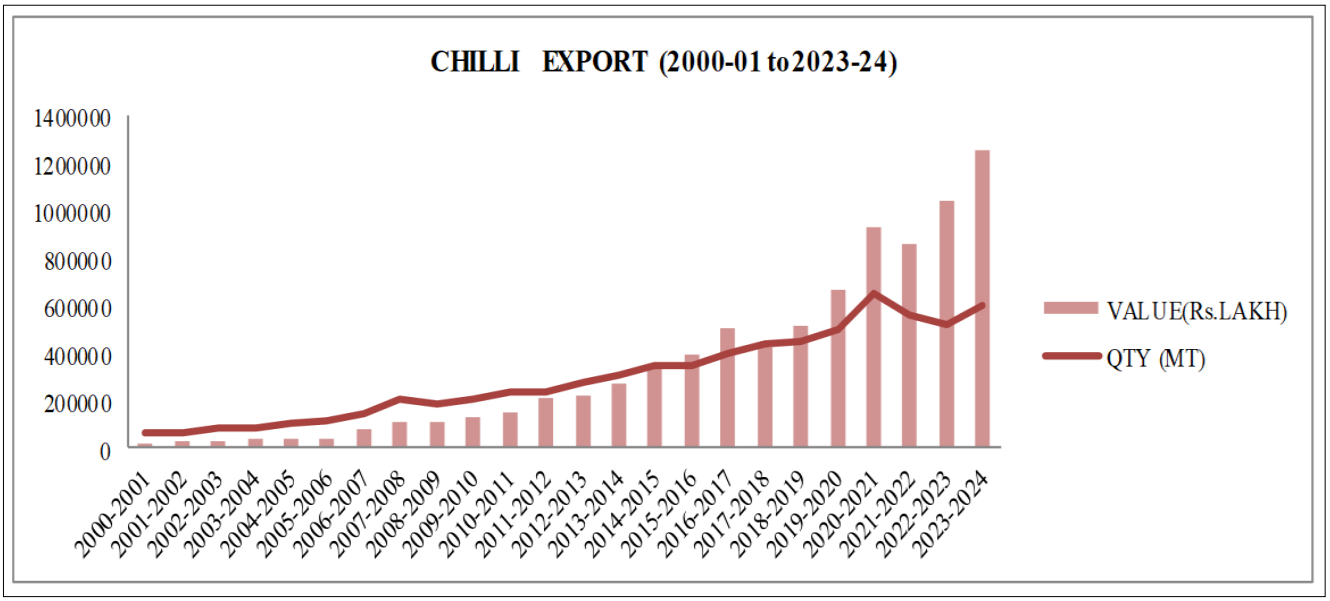

Fig. 5. Growth pattern of export of chilli in India (2000-01 to 2023-24) as per the Spice Board of India.

2023-24, the cumin export from India decreased by 165269 tonnes, valued at ₹ 579723 lakh. The reduction in volume over the past four years can be attributed to disruptions caused by the COVID-19 pandemic, which began affecting global supply chains in 2020. This caused delays in production, transportation and shipment of cumin. Additionally, India faced logistical challenges, including a shortage of containers and rising freight costs, which made its exports less competitive. Indias' primary markets for cumin exports include China, United States and Bangladesh. It has been depicted in Fig. 6.

Materials and Methods

Methodology

This study is based on secondary data sources. Data on area, production and productivity for chilli (2000-01 to 2023-24) and cumin (2010-11 to 2023-24) were obtained from Indiastats.com and Spice Board of India. Export statistics, including price and volume, were sourced from the Spice Board, India stats. com and the Ministry of Commerce and Industry. Chilli and cumin were selected for detailed analysis based on their significant export volumes over the past decade.

Compound growth rate

The compound growth rate (CGR) was used to evaluate the annual growth trends in area, production, productivity and exports (both volume and value) of chilli and cumin. This metric provides a standardized approach to evaluating long-term performance and consistency in export growth. Time-series data were modelled using an exponential function of the form:

$Y = a.e^{bt}$ (Eqn. 1)

Where,

Y = Index number of Chilli and Cumin as the dependent variable

T = Time variable

a = Intercept

b = Regression coefficient

Equation (1) can be expressed in logarithmic form as follows:

$\log Y = \log a + t \log b$ (Eqn. 2)

$\log Y = A + B t$ (Eqn. 3)

Where,

$A = \log a; B = \log b$ (Eqn. 4)

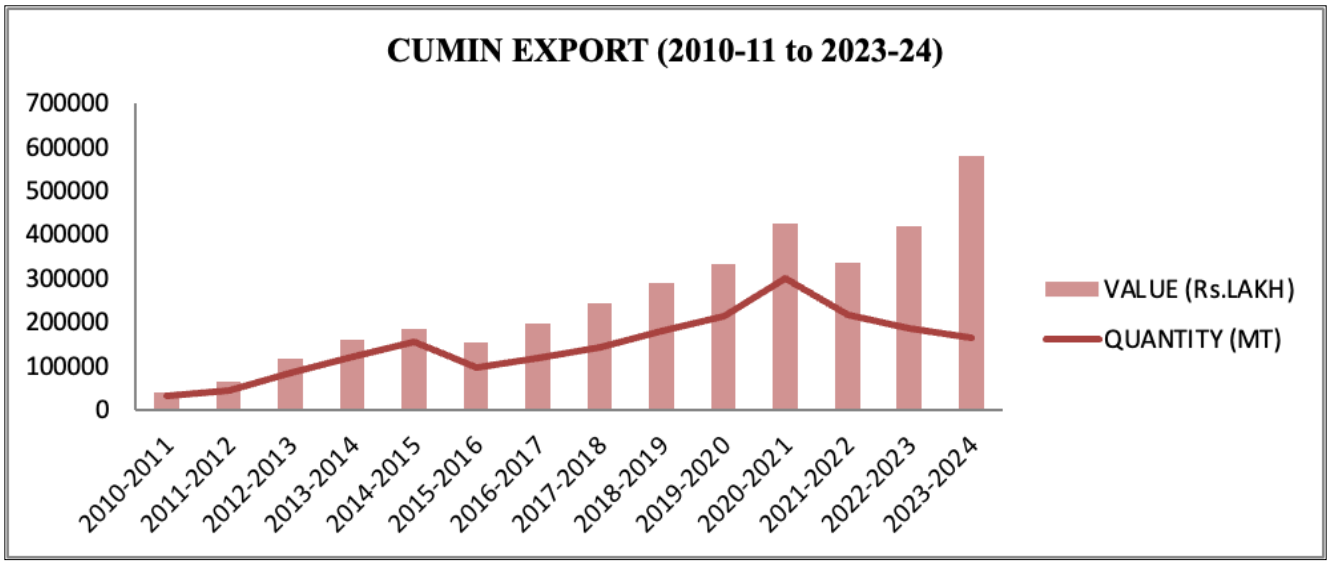

Fig. 6. Growth pattern of export of cumin in India (2010-11 to 2023-24) as per the Spice Board of India.

The compound growth rate "r" was computed as;

CGR (%) r = (Antilog of b - 1) × 100 (Eqn. 5)

Instability analysis

The index is used to measure the degree of volatility persistence basically, how long volatility persists in a time series. Its' commonly used to capture the long-term variation or trend of volatility over time. The index of instability was computed using the formula proposed by Cuddy and Della. The stability of exports over time was examined using the Instability Index.

In order to address this issue, the CV was corrected using the Cuddy Della Valle Index.

Instability Index (%) = $CV \times \sqrt{(1-R^2)}$ (Eqn. 6)

Where,

CV = Coefficient of Variation (%)

R^2 = adjusted coefficient of determination

Markov chain analysis

The first order Markov Chain Approach was used to evaluate the trade directions of a selection of Indian spices. This study used Markov chain analysis to analyze the structural change in Indian spice exports in terms of market switching and retention. Country-wise export data (in quantity terms) for the period 2000-01 to 2023-24 (for chilli) and 2010-11 to 2023-24 (for cumin) was collected from the Spices Board, indiastat.com and the Ministry of Commerce and Industry.

A key analytical component was the estimation of the transitional probability matrix (P), where each element P_{ij} represents the probability of shifting exports from the i^{th} country to j^{th} country over time. In other words, the diagonal elements P_{ij}, where i=j, quantified the loyalty of an importing country to a certain exporting country by indicating the chance that the export share of a country would be maintained throughout the periods. China, Vietnam, Malaysia, Brazil, the United Arab Emirates, Indonesia, Bangladesh, Nepal and other nations were considered the five main importers of specific spices in this regard. As a random variable, the average export to a given nation was determined only by its previous exports to that nation, which were represented algebraically by

$$Ejt = \sum_{i=1}^{n} E_{jt-1} P_{ij} + e_{jt} \quad \text{(Eqn. 7)}$$

Ejt = exports from India to the j^{th} country during the year t

E_{ji-1} = Exports to the i^{th} country during the year t-1

P_{ij} = Probability that exports will shift from the i^{th} country to j^{th} country

e_{jt} = Error term which is statistically independent of e_{jt-1} and

r = Number of importing countries

The transitional probabilities Pij, which can be arranged in a (c × r) matrix, having following properties: $0 \leq P_{ij} \leq 1$ and $\sum_{i=1}^{n} P_{ij}$ 1 for all i

In the linear programming (LP) framework, the transition probability matrix was evaluated using a technique known as minimization of mean absolute deviation (MAD); the LP formulation for analysis was expressed as follows:

Min O $P^* + I_e$ (2)

Subject to,

$XP^* + V = Y$

$GP^* = 1$

$P^* \geq \phi$

Where,

P^* is a vector of the probabilities P_{ij}

O is the vector of zeros

I is an appropriately dimensional vectors of areas

E is the vector of absolute errors

Y is the proportion of exports to each country

X is a block diagonal matrix of lagged values of Y

V is the vector of errors

G is a grouping matrix to add the row elements of P arranged in P^* to unity

Exports of specific spices to various countries were forecasted using the anticipated transitional probabilities, which were multiplied by the corresponding base-year shares. Using 2-, 3- and 4-step transitional probabilities, the export proportions of specific Indian spices to various countries were predicted for the years 2025-2030.

Results and Discussion

Growth analysis of chilli in India (Area, Production and Productivity)

To assess the growth trends in chilli cultivation and exports, a compound growth trend equation was applied to data from 2000-01 to 2023-24, covering area, production, productivity, export volume and export value. Table 2 represents the growth in area, production and productivity of chilli in major states of India. The area, production, and productivity of chilli during the study period from 2000-01 to 2023-24 showed a notable positive annual growth rate of 0.01, 3.99 % and 3.91 %, respectively. The production and productivity seemed to be higher compared to the area, which is consistent with the observation made by previous studies (10) during the period from 2000-01 to 2023-24. The primary factor driving production growth was high productivity, likely due to the introduction of high-yielding varieties in conjunction with Integrated Nutrient Management. Andhra Pradesh and Madhya Pradesh, two of the biggest chilli-growing states, exhibit favourable growth rates in terms of area. This growth was driven by government support,

Table 2. Growth in area, production, productivity of chilli in India (2000-01 to 2023-24)

Chilli % per annum			
States	**Area**	**Production**	**Productivity**
Andhra Pradesh	0.68	1.81*	2.68**
Madhya Pradesh	5.47**	1.81*	7.61*
Karnataka	-0.3	2.27	2.56*
Tamilnadu	-1.82*	-4.3*	-2.02*
Orissa	-0.07	1.16*	1.49*
India	0.01	3.99**	3.91**

Note : * indicates significance at 1 % level, ** indicates significance at 5 % level .Source: (2)

improved irrigation infrastructure and rising domestic and international demand for chillies. Tamil Nadu shows significant negative growth in area, production and productivity, which is similar to the previous research (11). This trend, consistent with earlier studies, is mainly due to water scarcity, market price fluctuations and a shift toward more remunerative or less water-intensive crops like sugarcane, cotton and banana (11, 12).

Table 3 presents the growth in area, production and productivity of cumin in the major states of India. The area under cumin shows significant positive growth at a rate of 3.99 per cent per year. This expansion is largely attributed to the crops' higher profitability compared to alternatives, as well as favourable climatic conditions and increasing global demand. The production of cumin was recorded to have an impressive annual yield, with moderate temperatures and timely rainfall, which boosted yields (13, 14). Profitability has encouraged many farmers to shift from less remunerative crops to cumin, especially in regions with appropriate soil and water availability (15, 16). Gujarat, a major cumin-producing state, exhibited growth rates of 1.50 %, 4.14 %, 2.42 % in area, production and productivity respectively. Rajasthan demonstrated even higher growth rate, 60.2 % in area, 8.20 % in production and 0.56 % productivity respectively. These trends indicate increased farmer interest in cumin cultivation, driven by expectations of favorable market returns and stable export demand (17).

Table 3. Growth in area, production and productivity of cumin in India (2010-11 to 2023-24)

	Cumin % per annum		
States	**Area**	**Production**	**Productivity**
Gujarat	1.506**	4.14*	2.42*
Rajasthan	6.02*	8.207*	0.56
India	3.99*	4.701*	1.404

Note: *indicates significance at 1 % level, ** indicates significance at 5 % level Source: Indiastat.com, Spice Board of India (3, 4)

Growth and instability in the export of Chilli and Cumin

The growth rate and instability index of chilli and cumin exports from India are represented in Table 4. The export quantity of chilli has shown a robust annual growth rate of 10.69 %, reflecting a steady increase in global demand for Indian chillies (18). China and Bangladesh are increasingly importing Indian chillies, contributing to higher export volumes. The value growth of 19.57 % is significantly higher than the quantity growth rate. This indicates that the price per unit of chilli exported is increasing at a faster rate. It suggests that while the quantity of chilli exports has grown gradually, the price at which they are being sold has increased significantly (19). The instability index of export quantity of chilli is 13.08, which means that the fluctuations in the volume of chilli exported are relatively moderate (20). A lower instability index in terms of quantity suggests that export volumes are more stable and less prone to drastic changes year-to-year. However, there is still some variability in export volumes, which could be due to climate variability, such as weather patterns, seasonal variations and market demand fluctuations (21). An instability index of 40.95 for export value indicates a much higher level of volatility in the price or value of chilli exports. This suggests that the price per unit of chilli is quite unstable and can fluctuate significantly from year to year (22).

Table 4. Growth and instability in export of chilli & cumin in India

S.No.	Spices	Export Quantity		Export Value
1	Chilli	CAGR	10.69*	19.57 *
		Instability index	13.08	40.95
2	Cumin	CAGR	17.01*	22.97**
		Instability index	5.98	0.42

Note : * indicates significance at 1 % level;** indicates significance at 5 % level . Source: (3-5)

The quantity of cumin being exported from India has been growing at an average annual rate of 17.01 % per annum. The growth in export quantity indicates that India has consistently increased the amount of cumin it exports to international markets (23). The annual growth rate in the value of cumin exports is 22.97 % per annum, suggesting that the value of cumin exports has been growing at a much faster rate compared to the quantity (24). This means that, while the volume of cumin being exported is growing steadily, the price of cumin is also increasing, leading to a higher total export value. The export quantity and value of cumins' instability index indicate low instability, which means low volatility in the export value of cumin over the period. This implies that the volume and value of the cumin exports has been relatively stable year to year (25).

Transitional probability matrix of Indian chilli

A Markov chain model was used to estimate the transition probability matrix in order to investigate the structural change in chilli exports from India. In Table 5, the transitional matrix was displayed. The major importing countries were China, Thailand, Bangladesh, USA, UAE and remaining countries were considered under 'Others' category (26). In this matrix, the diagonal elements represent the probability that a country retains its export share over time, while the off-diagonal elements indicate the likelihood of export shifts between countries (27). The results illustrates that the highest retention was noticed in China (55.70 %), UAE (48.48 %), Bangladesh (11.45 %), USA (10.11 %), Thailand (2.83 %) and other countries (76.49 %). China was the most stable market among the major importers of Indian chillies, as indicated by a retention probability of 55.70 %. But it has lost its share of 44.30 % to Thailand, Bangladesh and USA. China is the largest importer of Indian chilli, followed by Thailand, Bangladesh, the USA, the UAE and other countries. UAE was also found that stable market retention with 48.48 % while it loses a major share of 51.52 % to China, Thailand, USA and Other countries. The 'Others' category displayed the highest retention at 76.49 %, with only minor shifts in market share to Bangladesh and the USA (28). India follows strict quality measures, including proper grading, drying and packaging, to ensure consistent quality. This, along with competitive pricing, diverse varieties and established trade networks, makes Indian Chilli extremely popular throughout the world (29).

Table 5. Transitional probability matrix of Indian chilli exports to major importing countries (2000-01 to 2023-24) (Quantity)

Countries	China	Thailand	Bangladesh	USA	UAE	Others
China	0.5570	0.3009	0.0554	0.0866	0.000	0.0000
Thailand	0.0000	0.0283	0.0000	0.0000	0.5522	0.4194
Bangladesh	0.1302	0.0000	0.1145	0.0000	0.0000	0.7552
USA	0.0000	0.0000	0.0000	0.1011	0.0000	0.8989
UAE	0.2086	0.0890	0.0000	0.0513	0.4848	0.1662
Others	0.0000	0.0000	0.1534	0.0816	0.0000	0.7649

Source: Indiastat.com, Ministry of Commerce and Industry (30, 31)

Prediction of chilli exports

The market share predictions for Indian chilli exports to major importing countries were computed up to 2024-2030 using the transitional probability matrix. The actual and forecasted values of Indian chilli exports to major importers from 2001 to 2024 are shown in Table 6. China continues to be a dominant importer of Indian chillies; however, the predicted volume of exports to China is expected to decline during the 2024-2030 period. Bangladesh and the USA will increase their export volume in the following year. There is a slight difference between the actual and predicted quantities of exports. This is due to changes in policy and the international markets' demand (30).

Transitional probability matrix of Indian cumin

Table 7 represents the transitional probability matrix of cumin exports from India to other countries. It provides a broad indication of changes in the direction of trade of Indian cumin exports to different countries over the study period considered (31). Indias' top export destinations for cumin were Bangladesh, the United States, the United Arab Emirates, Nepal, Braziland every other country listed under "others". The study period under consideration produced the transitional probability matrix (32). The USA was the stable country, with a retention share of 41.41 %, which lost its major share of 58.59 % to the UAE and others. Bangladesh also found stable market retention of 39.81 %, which is lost majors of 60.19 % to USA, UAE, Nepal and Brazil. Other countries have major market retention of 95.05 % which lose it minor share of 4.95 % to Bangladesh (33). The sustained global demand for Indian cumin, driven by its high quality, competitive pricing and culinary significance, continues to make India a key player in the international cumin market (34).

Table 7. Transitional probability matrix of Indian cumin exports to major importing countries (2010-2011 to 2023-2024)

Countries	Bangladesh	USA	UAE	Nepal	Brazil	Others
Bangladesh	0.3981	0.3225	0.1379	0.1063	0.0349	0.0000
USA	0.0000	0.4141	0.0335	0.0000	0.0000	0.5522
UAE	0.0000	0.2874	0.0489	0.3436	0.3198	0.0000
Nepal	0.0000	0.0000	0.9348	0.0651	0.0000	0.0000
Brazil	0.3752	0.0000	0.0000	0.3045	0.3014	0.0187
Others	0.0495	0.0000	0.0000	0.0000	0.0000	0.9505

Source : (32, 33)

Prediction of cumin exports

Cumin exports to major importing countries were predicted up to 2030 using the transitional probability values derived from the matrix model (Table 8). The UAE, Nepal and Brazil were increasing their annual prediction of export volume. Bangladesh and the USA were decreasing their export volume over time (35).

Conclusion

India remains a key player in the global market for chilli and cumin, owing to its high production volume, diverse varieties and well-established export infrastructure. However, to maintain and grow its leadership, India must address challenges such as global competitiveness, supply chain disruptions and climate change. India should focus on expanding its market reach and exploring value-added products, such as sauces, extracts and powdered chillies. Additionally, improving post-harvest management and storage techniques can help mitigate price fluctuations. India is expected to maintain its dominant position in the cumin market, particularly as demand for premium, organic spices rises. Additional investments in irrigation infrastructure, climate-resilient farming techniques and sustainable production methods

Table 6. Predictions of Chilli exports to major importing countries (2024-2030)

		Chilli						
Country/year		2024	2025	2026	2027	2028	2029	2030
China	Actual	179672.4						
	predicted	98180.27	64844.52	52304.08	44697.66	39086.06	34881.21	31747.78
Thailand	Actual	59838.98						
	Predicted	60410.64	38638.19	28351.14	22984.85	19254.77	16479.15	14407.83
Bangladesh	Actual	90570.52						
	Predicted	48288.95	53054.91	58530.1	63185.17	66665.29	69263.15	71194.55
U.S.A	Actual	36413.22						
	Predicted	36799.12	38867.88	40002.16	40792.81	41262.65	41593.74	41836.8
U.A.E	Actual	52289.63						
	Predicted	82990.25	87033.3	72406.97	57918.83	46890.39	38715.83	32644.46
Others	Actual	182299.7						
	Predicted	274358.8	318532.8	349320.9	371279.9	387644.1	399814.2	408860

Source: (30, 31)

Table 8. Predictions of Cumin exports to major importing countries (2024-2030)

Cumin								
Country / Year		2024	2025	2026	2027	2028	2029	2030
Bangladesh	Actual	28027.38						
	predicted	17460.53	14529.99	13233.19	13338.59	13442.57	13467.07	13505.04
USA	Actual	12102.83						
	Predicted	13490.34	9487.988	10232.21	9488.972	9460.202	9540.474	9461.742
UAE	Actual	14196.32						
	Predicted	10266.85	16355.34	15243.18	14959.5	15204.84	14888.6	14940.51
Nepal	Actual	5667.05						
	Predicted	13894.92	12962.5	12881.98	13170.42	12804.99	12870.6	12817.38
Brazil	Actual	3356.5						
	Predicted	6533.176	5864.1	7507.303	7601.499	7542.844	7607.276	7526.403
Others	Actual	101919.5						
	Predicted	103623.7	106069.6	106171.7	106710.6	106814.1	106895.5	107018.5

Source: (32, 33)

could further enhance Indias' competitiveness globally. Indias' chilli and cumin trade seems to have an optimistic outlook, but sustaining a competitive edge in the global market would require ongoing investments in sustainability, innovation and quality.

Acknowledgements

I want to express my sincere gratitude to my chairman and advisory committee members for their invaluable guidance and support throughout this study. I also thank my colleagues for their constructive feedback and encouragement. Special thanks are due to Tamil Nadu Agricultural University for providing the necessary facilities and resources.

Authors' contributions

SK conceptualised the study and led the data collection. She designed the questionnaire, analysed the data, and wrote the original draft. SS[1], VC, NNK and SS[2] contributed to the literature review and edited the manuscript. All authors reviewed and approved the final version of the manuscript. [SS[1] stands for Selvanayaki S and SS[2] stands for Sridevy S].

Compliance with ethical standards.

Conflict of interest: The Authors do not have any conflict of interest.

Ethical issues: None

References

1. Anantha VP, Sidana BK. Growth performance of Indian spices: State -wise analysis. Agri Res J. 2022;59(2):334–47. https://doi.org/10.5958/2395-146x.2022.00050.3
2. Devi IB, Srikala M, Ananda T, Subramanyam V. Direction of trade and export competitiveness of chillies in India. Agri Econ Res Rev. 2016;29(2):262–72. https://doi.org/10.5958/0974-0279.2016.00053.7
3. Adarsh VS, Gowthaman T, Elakkiya N, Sathees KK. Export instability scenario of chilli and cumin in India. J Exp Agri Int. 2023;45(11):198–202. https://doi.org/10.9734/jeai/2023/v45i112249
4. Abate T. Spices for export diversification. In: Abate T, editor. The Untold Stories of African Agriculture: Lessons from Ethiopia. Wallingford (GB): CABI; 2024 Jul 25. p. 149–64. https://doi.org/10.1079/9781800626386.0009
5. Devi Priya B, Thyagarajan M. An investigation on production and productivity export performance of significant spices in the country India. Indian J Sci Technol. 2020;13(48):4699–707. https://doi.org/10.17485/IJST/v13i48.2191
6. Joshi D, Singh HP, Gurung B. Stability analysis of Indian spices export–a Markov chain approach. Econ Aff. 2015;60(2):257–62. https://doi.org/10.5958/0976-4666.2015.00038.8
7. Prahadeeswaran M, Balaji R, Senthilnathan S, Lavanya SM, Gurunathan S. Trends in export of major agricultural commodities and products from India. Asian J Agric Ext Econ Sociol. 2022;40 (9):367–73. https://doi.org/10.9734/ajaees/2022/v40i931016
8. Nayak AK, Anwarudheen M, Kumar D. Export competency of the Indian spice industry. Indian J Econ Dev. 2017;13(2a):217–23. http://dx.doi.org/10.5958/2322-0430.2017.00068.3
9. Muthupandi P, Sekhar C, Karunakaran KR. Production and export performance of spices from India. Hortic Int J. 2018;2:425–30. https://doi.org/10.15406/hij.2018.02.00090
10. Babu PH. Export performance of spices in India: an empirical study. Parikalpana: KIIT J Manag. 2017;13(1):66–74. https://doi.org/10.23862/kiit-parikalpana/2017/v13/i1/151275
11. Anantha VP, Sidana BK. Economic analysis of export performance of major Indian spices. Int Res J Agri Econ Stat. 2019;10(2):302–10. https://doi.org/10.15740/has/irjaes/10.2/302-310
12. Buragohain A, Borah S. Growth and instability in production of selected major spices and their export scenario for India: a review. Bhartiya Krishi Anusandhan Patrika. 2022;37(4):334–8. https://doi.org/10.18805/BKAP541
13. Bansal R, Kumar M, Shaikh AS. Export performance of Indian chilli. Guj J Ext Edu 2022;34(1):66–72. https:// doi.org/10.56572/gjoee.2022.34.1.0014
14. Thomas L, Sanil PC. Competitiveness in spice export trade from India: a review. J Spices Arom Crops. 2019;28(1):1–19. https://doi.org/10.25081/josac.2019.v28.i1.5738
15. Bagal NU, Kshirsagar PJ, Torane SR, Manerikar SS. Export of spices from India: an instability analysis. Int Res J Agri Econ Stat. 2020;11 (1):55–63. https://doi.org/10.15740/has/irjaes/11.1/55-63
16. Kshirsagar PJ, Bagal NU, Wadkar SS, Manerikar SS. Export competitiveness in spices from India. Int J Comm Sys. 2020;8 (1):2450–3. https://doi.org/10.22271/chemi.2020.v8.i1ak.8634
17. Singh OP, Anoop M, Singh PK. Growth and direction of agricultural trade from India–an application of Markov chain analysis. Res J Agri Sci. 2023;14(01):38–43. https://doi.org/10.36713/epra18360
18. Karthick V, Alagumani T, Anbarassan A. Growth and export performance of ginger in India–an economic analysis. Econ Aff. 2015;60(2):207–14. https://doi.org/10.5958/0976-4666.2015.00030.3
19. Chhetri P, Mula G, Sarkar A, Ojha S, Mondal S. Transition in production and export potential of garlic in India. J App Hortic. 2024;26(2):148–53. https://doi.org/10.37855/jah.2024.v26i02.28
20. Maharjan NK, Grover DK. Growth trends and direction of international trade of pulses in India-a Markov chain approach. Indian J Econ Dev. 2019;15(1):84–90. http://dx.doi.org/10.5958/2322-0430.2019.00009.X
21. Bhatia JK, Mehta VP, Bhardwaj N, Nimbrayan PK. Export-import performance of major agricultural commodities in India. Econ Aff. 2021;66(1):117–26. http://dx.doi.org/10.46852/0424-2513.1.2021.15
22. Dev K, Raj D, Sharma R, Guleria A. Performance and prospects of agricultural commodities in India: an economic analysis. Indian J Econ Dev. 2022;18(3):655–63. https://doi.org/10.35716/IJED/22005
23. Jagadeshwaran P, Ashok KR, Vidhyavathi A, Prahadeeswaran M. India's trade potential and export opportunities for spices. J Appl Nat Sci. 2022;14(SI):98–104. https://doi.org/10.31018/jans.v14iSI.3574
24. Thomas L, Kuruvilla A, Meena M, Remashree AB, Madan MS. Economics, marketing and export of Spices: status and prospects. In: Ravindran PN, Sivaraman K, Devasahayam S, Nirmal K B, editors. Handbook of Spices in India: 75 Years of research and development. Singapore: Springer. 2023; p. 1095-145. https://doi.org/10.1007/978-981-19-3728-6_20
25. Pavani M, Sharon MM, Suseela K. Growth, instability and decomposition analysis of chilli cultivation in India. AJAEES. 2025;;43(3):136–43. https://doi.org/10.9734/ajaees/2025/v43i32708
26. Singh P. An analysis of the trend and export competitiveness of APEDA products, tobacco, spices, tea and coffee in India[Internet]. Tobacco, Spices, Tea and Coffee in India. 2023 Aug 5. https://doi.org/10.2139/ssrn.4532725
27. Kusuma Dk, Rudrapur S. Production and export performance of Indian onion- Markov chain analysis [Internet]. Vol. 11, Agric Update. 2016;11(1):70–4 [cited 2025 Jul 23]. Available from: https://doi.org/10.15740/has/au/11.1/70-74.
28. Kandeeban M, Mahendran K. A study on export direction of Indian cashew kernels-Markov chain approach. Int J Farm Sci. 2019;9(3):81 –4. https://doi.org/10.5958/2250-0499.2019.00077.6

29. Nagani CM, Vekariya SB, Vekariya DJ. Performance and stability analysis of spices and spice products export from India. Econ Aff. 2020;65(4):551–7. https:// doi.org/10.46852/0424-2513.4.2020.11

30. Devia IB, Srikalab M, Anandac T, Subramanyamc V. Direction of trade and export competitiveness of chillies in India. Agri Econ Res Rev. 2016;29(2):267–72. https://doi.org/10.5958/0974-0279.2016.00053.7

31. Rudrapur S, Hiremath D. Export performance of Indian onion: Markov chain approach. Veg Sci. 2024;51(02):269–74. https://doi.org/10.61180/vegsci.2024.v51.i2.10

32. Prabakar C. Markov chain analysis on the export prospects of Coconut in India. Plant Arch. 2020;20(2):4202–4. https://doiorg/10.51470/plantarchives.2021.v21.s1.330

33. Meena M, Jangir CK, Meena SS, Meena DC. Direction and determinants of Indian seed spices export: a case of cumin. Indian J Econ Dev. 2023;19(3):491–8. https://doi.org/10.35716/ijed-23005

34. Sunil J, Singh A. Structural change analysis of groundnut export markets of India: Markov chain approach. Indian J Econ Dev. 2021;9 (1):1–6. https://doi.org/10.17485/IJED/v9.2021.5

35. Bhagat A, Jadhav D. A study on growth, instability and forecasting of grape export from India. J Sci Res. 2021;65(9):1–6. https://doi.org/10.37398/jsr.2021.650901

Additional information

Peer review: Publisher thanks Sectional Editor and the other anonymous reviewers for their contribution to the peer review of this work.

Reprints & permissions information is available at https://horizonepublishing.com/journals/index.php/PST/open_access_policy

Publisher's Note: Horizon e-Publishing Group remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Indexing: Plant Science Today, published by Horizon e-Publishing Group, is covered by Scopus, Web of Science, BIOSIS Previews, Clarivate Analytics, NAAS, UGC Care, etc
See https://horizonepublishing.com/journals/index.php/PST/indexing_abstracting

Publisher information: Plant Science Today is published by HORIZON e-Publishing Group with support from Empirion Publishers Private Limited, Thiruvananthapuram, India.