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India's basmati rice exports: Trends, trade patterns, and global prospects

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Abstract
The study examines the positive and significant growth in the area, production, productivity, export quantity, and export value of rice in India. For basmati rice exports, Iraq and Iran recorded the highest compound growth rates in both quantity and value, while the United Kingdom showed the lowest growth rate. Iraq and Iran were also identified as loyal importers of Indian basmati rice, retaining 89% and 84% of their previous market shares, respectively, as indicated by the diagonal transitional probability values. The study concludes that strengthening the growth and export performance of basmati rice is essential for formulating strategic policies to boost India's rice exports, given its significant role in the national economy and the challenges present in the international market.

Keywords: Export, growth rate and Markow chain analysis

1. Introduction

Basmati rice holds a distinguished place in the global agricultural market as one of India's most valued and iconic export commodities. Celebrated for its unique aroma, long slender grains, and superior cooking qualities, basmati rice has carved out a premium niche in international trade. India's diverse agro-climatic zones, particularly in the northern regions, provide ideal conditions for the cultivation of this high-quality variety. Over the years, basmati rice has become a significant contributor to India's agricultural economy, not only supporting millions of farming households but also generating substantial foreign exchange earnings. With growing global demand, especially from regions such as the Middle East, Europe, North America, and Southeast Asia, India has strengthened its position as the world's largest exporter of basmati rice. Institutions like the Agricultural and Processed Food Products Export Development Authority (APEDA) play a critical role in promoting basmati exports by offering regulatory support, quality certification, and market development initiatives. Given its economic importance and increasing global footprint, the study of basmati rice production and export dynamics is crucial for understanding the broader trends shaping India's agricultural trade and rural livelihoods.

2. Methodology

The present study relied on secondary data, covering the period from 1991-1992 to 2020-21, sourced from various secondary sources. These include the Agricultural and Processed Food Products Export Development Authority (APEDA), Directorate General of Commercial Intelligence and Statistics (DGCI&S), Department of Commerce, Ministry of Commerce and Industry, Government of India, Directorate General of Foreign Trade, World Trade Integrated Solutions, DIC, and the Joint Department of Agricultural Office in Thane, among others. For analysis, the collected data were organized and examined using appropriate statistical and economic tools. Additionally, formulas and add-ons in MS Excel, as well as the statistical software Lingo, Arima model were employed to facilitate further analysis.

2.1 Analytical tools

2.1.1 Estimation of Growth Rates

The growth rates in area, production, yield; export of Basmati Rice in India was studied by using compound growth rates.

The growth rate was estimated using following model

$$Y = a.b^t \quad \text{..... (1)}$$

Where,

Y = Dependent variable for which growth rate is to be estimated
(Quantity exported / export value / unit value)
a = Intercept
b = Regression Coefficient
t = Time Variable

This equation was estimated after transforming (1) as follows,

$$\text{Log } y = \log a + t \text{ Log } b \quad \text{..... (2)}$$

Then the percent compound growth rate (g) was computed using the relationship.

$$\text{CGR (g)} = (\text{antilog } b - 1) \times 100 \quad \text{..... (3)}$$

The significance of the regression coefficient was tested using the student 't' test.

2.2.2. Markov chain analysis

The trade directions of Basmati Rice export were analyzed by using the first order Markov chain approach. Central to Markov chain analysis is the estimation of transitional probability matrix P. The elements P_{ij} of the matrix P indicates the probability that export was switch from country i to country j with the passage of time. The diagonal elements of the matrix measure the probability that the export share of a country was retained. Hence, an examination of the diagonal elements indicates the loyalty of an importing country to a particular country's export.

In the context of the current application major Basmati Rice importing countries were considered. The average exports to a particular country was considered to be a random variable which depends only on the past export to that country which can be denoted algebraically as

$$E_{jt} = \sum_{i=1}^{r} \left(E_{it-1} * P_{ij} + e_{jt} \right)$$

Where,

E_{jt}= Exports from India to j^{th} country during the year t

E_{it-1} = Exports to i^{th} country during the period t-1

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

e_{jt} = The error term which is statistically independent of E_{it-1}

t = Number of years considered for the analysis

r = Number of importing countries

The transitional probabilities P_{ij} which can be arranged in a (c * r) matrix have the following properties

$$0 \leq P_{ij} \leq 1$$

$$\sum_{i=1}^{n} Pij = 1 \text{ for all}$$

Thus, the expected export shares of each country during period 't' was obtained by multiplying the export to these countries in the previous period (t- 1) with transitional probability matrix.

3. Results and Discussion

3.1 Compound growth rate of area, production and productivity of rice in India

The information on performance of rice with respect to production and export for a period from 1999-2000 to 2020-21 is presented in table 1. The study period was divided into three sub periods i.e., Period I (1991-92 to 2004-2005), Period II (2005-2006 to 2020-21) and overall period (1991-92 to 2020-21).

Table 1: Compound annual growth rate of area, production and productivity of rice in India

Sr. No	Period	Area (000 ha)			Production (000 Tons)			Productivity (kg/ha)		
		CAGR	R^2	t-value	CAGR	R^2	t-value	CAGR	R^2	t-value
1	Period I	0.10 ^{NS}	0.023	0.55	1.06**	0.33	2.57	0.96**	0.46	3.35
2	Period II	0.23*	0.19	1.81	2.06***	0.87	9.96	1.83***	0.92	13.35
3	Overall	0.13**	0.18	2.52	1.65***	0.87	14.19	1.52***	0.91	18.10

(***, ** and * denotes significance at 1 per cent 5 per cent and 10 per cent level, respectively)

Period I: 1991-92 to 2004-05
Period II: 2005-06 to 2020-21
Overall Period: 1991-1992 to 2020-21

The area under rice cultivation in India showed an increase of 0.13 per cent per annum during the overall study period, with a slightly higher growth rate of 0.23 per annum observed in Period II. Rice production increased at an annual rate of 1.65 per cent, primarily driven by yield improvements of 1.52 per cent per annum across the study period. Specifically, production growth rates stood at 1.06 per cent, 2.06 per cent, and 1.65 per cent per annum during Period I, Period II, and the overall period, respectively. Similarly, rice yields improved annually by 0.96 percent, 1.83 per cent, and 1.52 per cent during the same respective periods. Throughout the study period, positive compound growth rates were recorded for area, production, and productivity. Among these, production exhibited the highest compound growth rate of 1.65 per cent per annum, followed by productivity at 1.52 per cent and area at 0.13 per cent per annum.

3.2 Compound growth rate of area, production and productivity of basmati rice in India

The basmati is the world famous rice variety grown in northern India. The information on growth in area, production and productivity of basmati rice is given in table 2.

Table 2: Compound annual growth rate of area, production and productivity of basmati rice in India

Sr. No	Period	Area (000 ha)			Production (000 Tons)			Productivity (kg/ha)		
		CAGR	R^2	t-value	CAGR	R^2	t- value	CAGR	R^2	t- value
1	Period I	7.16*	0.22	1.52	17.39***	0.65	3.92	9.55***	0.84	6.70
2	Period II	0.37 ^{NS}	0.009	0.27	1.65^{NS}	0.10	0.96	-12.16	0.30	1.86
3	Overall	5.62***	0.52	4.45	8.53***	0.63	5.54	2.75***	0.43	3.72

(***, ** and * denotes significance at 1 per cent, 5 per cent and 10 per cent level, respectively)

Period I: 1999-2000to 2009-2010
Period II: 2010 -11 to 2020-21
Overall Period: 1999-2000 to 2020-21

Between 1999-2000 and 2020-21, rice cultivation in India demonstrated statistically significant growth in area, production, and productivity, with annual growth rates of 5.62 per cent, 8.53 per cent, and 2.75 per cent, respectively. These figures highlight the need to sustain growth, particularly in response to rising consumer demand for premium varieties such as basmati rice. A closer analysis of Period I and Period II reveals that while Period I recorded satisfactory growth, the growth rates in Period II were statistically significant. Basmati rice performed notably well during Period I, showing positive and statistically significant growth across area, production, and productivity. However, despite these positive trends in earlier years, recent patterns emphasize the necessity of renewed efforts to expand cultivation areas and sustain the momentum for future growth.

3.3 Compound growth rate of area, production and productivity of rice in Konkan region

The information on growth in area, production and productivity of rice in Konkan region is given in table 3.

Table 3: Compound annual growth rate of area, production and productivity of rice in Konkan region of Maharashtra state

Sr. No.	Period	Area (000 ha)			Production (000 Tons)			Productivity (kg/ha)		
		CAGR	R^2	t-value	CAGR	R^2	t- value	CAGR	R^2	t- value
1	Thane	-7.96 ***	0.72	-6.06	-7.71***	0.65	-5.09	0.24	0.01^{NS}	0.37
2	Palghar	-0.21 **	0.57	-3.31	-1.79 ^{NS}	0.11 ^{NS}	-1.07	-0.22 ^{NS}	0.001 ^{NS}	-0.10
3	Raigad	-2.64 ***	0.90	-11.43	-3.42***	0.52	-3.90	-0.83^{NS}	0.08^{NS}	-1.16
4	Ratnagiri	-0.68**	0.29	-2.39	0.23 ^{NS}	0.01^{NS}	-0.40	0.50 ^{NS}	0.10^{NS}	1.29
5	Sindhudurg	-2.07***	0.90	-11.78	-2.25 ^{NS}	0.65	-5.16	-0.21	0.012 ^{NS}	-0.42
6	Total Konkan	-3.30***	0.86	-9.28	-1.84^{NS}	0.07^{NS}	-1.04	-0.08^{NS}	0.003^{NS}	-0.20

(***, ** and * denotes significance at 1 per cent 5 per cent and 10 per cent level, respectively)

Period: 2008-09 to 2023-24

The table outlines agricultural trends in Konkan districts, showcasing Compound Annual Growth Rate (CAGR) and coefficient of determinant (R^2) values for area, production, and productivity. Thane district witnesses a negative CAGR in both area and production, with moderate reliability. Palghar exhibits marginal decreases, and Raigad experiences negative CAGR in area and production, supported by high coefficient of determinant (R^2) values. Ratnagiri shows slight changes with generally lower reliability, while Sindhudurg indicates a decline in area and production but with higher reliability. The overall Konkan region faces a significantly negative CAGR in area; however production and productivity show negative but non-significant. The analysis underscores the importance of considering R^2 values for result reliability, with data showing varying agricultural dynamics across districts in the region.

3.4 Compound Annual Growth Rate of Export Quantity (in MT) and Export Value (in Rs. Lakhs and) of Basmati rice from India

The information regarding growth in export of basmati rice both in terms of quantity as well as value is given in table 4.

Table 4: Trend of Basmati Rice export from India

Particulars	CAGR	R^2	bi	t -value
Export Quantity (MT)				
Period I	12.19***	0.84	0.049	7.06
Period II	2.34**	0.67	0.010	4.30
Overall Period	10.36***	0.89	0.042	13.42
Export Value (in Rs. Lakhs)				
Period I	15.79***	0.87	0.063	8.13
Period II	3.97**	0.43	0.016	2.60
Overall Period	19.57***	0.93	0.077	15.51

(*** and **denotes significance at 1 per cent and 5 per cent level, respectively)

Period I: 1999-2000to 2009-2010
Period II: 2010 -11 to 2020-21
Overall Period: 1999-2000 to 2020-21

The data indicates that the export quantity of basmati rice increased at a rate of 10.36 per cent per annum during the overall study period. In Period I, the export quantity grew at a higher rate of 12.19 per cent per annum, while in Period II, it was comparatively lower at 2.34 per cent per annum. This suggests that the overall growth in export quantity during the study period was satisfactory. Regarding export earnings, the growth rate for the overall period was 19.57 per cent per annum. However, a notable difference was observed between the two periods, with a significantly higher growth rate of 15.79 per cent per annum in Period I compared to 3.97 per cent per annum in Period II.

3.5 Country wise Compound Annual Growth Rate of Basmati Rice from India

Table 5 highlights the growth trends in Basmati rice exports from India to major importing countries. Saudi Arabia emerged as the largest importer, accounting for 32.05 per cent of India's total global Basmati rice exports from 1991-92 to 2021-22. The compound annual growth rates (CAGR) for export quantity and value to Saudi Arabia were both statistically significant at the one percent level, registering 6.32 per cent and 12.55 per cent, respectively. The United Arab Emirates (UAE) demonstrated impressive growth, with significant CAGR in export quantity (13.52 per cent) and value (18.45 per cent). Iran and Iraq also featured as prominent destinations, showcasing remarkable growth rates in both quantity and value, supported by statistically significant CAGR. Collectively, the top ten importing countries represented a substantial portion of India’s total Basmati rice exports, with Iraq, Iran, Yemen Republic, and Qatar standing out as key markets. These trends reflect a steady and consistent rise in India's Basmati rice exports over the years.

Table 5: Country wise Compound Annual Growth Rate of Export Value of Basmati Rice from India at Real Prices (2011-12)

Sr. No	Name of Country	Export Quantity		Export Value		Export Value		Quantity (MT)	Cumulative per cent share
		CAGR	R^2	CAGR	R^2	CAGR	R^2		
1	Saudi Arabia	6.32***	0.85	12.55***	0.96	11.71***	0.90	560011 (32.05)	32.05
2	UAE	13.52***	0.70	18.45***	0.79	17.03***	0.83	208669 (11.94)	43.99
3	Iran	72.36***	0.62	75.34***	0.68	73.25***	0.67	364584 (20.86)	64.85
4	Iraq	125***	0.87	120.74***	0.89	120.51***	0.89	231728 (13.26)	78.11
5	Yemen republic	47.26***	0.71	51.20***	0.81	50.04***	0.82	75526 (4.32)	82.43
6	USA	10.69***	0.71	15.63***	0.85	14.41***	0.65	58945 (3.37)	85.80
7	Kuwait	8.85***	0.75	14.59***	0.88	13.93***	0.82	106663 (6.10)	91.90
8	UK	6.01***	0.72	10.67***	0.87	9.26***	0.72	89960 (5.14)	97.40
9	Oman	14.98***	0.75	20.77***	0.83	19.98***	0.74	26303 (1.50)	98.54
10	Qatar	19.06***	0.88	24.69***	0.90	23.29***	0.81	24770 (1.41)	99.95
Total								1747159	

(*** denotes significance at 1 per cent, level, respectively &Fig. in parentheses indicate percentage to total)

Period: 1991-92 to 2021-22

3.6 Transitional probability matrix of Basmati rice Export from India

The information regarding transitional probability of export of rice to major countries is presented in table 6.

Table 6: Transitional probability matrix of Basmati rice Export from India

Country	Saudi Arabia	UAE	Iran	Iraq	Yemen Republic	USA	others
Saudi Arabia	0.66	0.07	0	0	0.019	0.065	0.18
UAE	0	0.42	0.57	0	0	0	0
Iran	0	0	0.84	0	0.05	0	0
Iraq	0	0	0	0.89	0.1	0.49	0
Yemen Republic	0.13	0	0	0	0.37	0	0
USA	0	0	0	0	0	0.55	0
others	0.45	0.49	0	0	0	0	0.47

The analysis revealed that Iraq is one of the most stable importers of Indian Basmati rice, with a high retention probability of 0.89, indicating that 89 per cent of its previous import share was consistently retained over the study period. This makes Iraq the most reliable and loyal market for Indian Basmati rice. Similarly, Iran demonstrated a high retention probability of 0.84, maintaining 84 per cent of its prior import share. In comparison, Saudi Arabia retained 66 per cent, while other countries retained 45 per cent of their original shares. Other key importers, including the UAE (42 per cent retention) and the USA (55 per cent retention), along with a group of other countries (47 per cent retention), exhibited moderate stability as markets for Indian Basmati rice. Overall, the transitional probabilities of importing countries highlight strong prospects for the export of Basmati rice from India. To capitalize on these opportunities, greater emphasis should be placed on increasing Basmati rice production to meet growing demand.

3.7 Forecasted value of area production and Basmati - Rice export from India

Table 7 presents the projected values for Basmati rice exports from India, along with corresponding data on cultivation area and production from 2021 to 2025. The forecast reveals a consistent upward trend in Basmati rice exports over this five-year period, with figures gradually increasing each year. In 2021, Basmati rice exports were estimated at 3.82 units, with the area under cultivation at 4.47 units and production at 1.26 units. By 2025, exports are expected to rise to 4.31 units, while both the area under cultivation and production are projected to show steady annual increases. This growth indicates a potential expansion in India's agricultural sector. The data highlights the importance of Basmati rice as a key export commodity for India and reflects the country's ongoing efforts to strengthen and expand its presence in the global rice market.

Table 7: Forecasted value of area production and Basmati - Rice export from India

Sr. No	Year	Basmati Rice (mt)	Area (mha)	Production (mt)
1	2021	3.82	4.47	1.26
2	2022	3.95	4.40	1.27
3	2023	4.07	4.38	1.29
4	2024	4.19	4.37	1.31
5	2025	4.31	4.36	1.33

4. Conclusion

The study uncovers several key insights into India's rice export performance. Over the study period, the growth rates of rice area, production, and productivity in India were positive and statistically significant at the one percent level. In contrast, the Konkan region of Maharashtra experienced negative and non-significant growth trends. Basmati rice exports showed a strong positive trend, with compound growth rates of 10.36% in export quantity and 16.79% in export value, both statistically significant. A country-wise analysis revealed that Iran and Iraq recorded the highest growth in imports, while the United Kingdom showed the lowest. Basmati rice continues to demonstrate substantial export potential, underscoring the need to enhance its production and productivity. Iraq, notably, retained 89% of its previous market share, reflecting a stable and loyal demand base. Overall, the findings affirm that Basmati rice offers considerable opportunities for future growth, and strategic efforts are required to strengthen India's standing in the global rice market.

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