



Trends, Growth, Production Instability and Export Dynamics Analysis of Basmati Rice in India

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ARTICLE INFO

Keywords: Basmati rice, Production, Export, Trends, Growth rate, Instability, Regression

<https://doi.org/10.48165/IJEE.2024.60206>

Conflict of Interest: None

Research ethics statement(s):

Informed consent of the participants

ABSTRACT

The research examined the trends, growth rates, and instability in Basmati rice production and export in India from 2001 to 2021. Secondary time series data on these parameters were collected from diverse sources including the official websites of the Department of Agriculture and Farmer's Welfare, Directorate General of Commercial Intelligence, the Agricultural and Processed Food Product Export Development Authority (APEDA) and Statistics (DGCI&S) and Ministry of Commerce and Industry. Various analytical tools such as Compound Annual Growth Rate (CAGR) for growth rate analysis, Coefficient of Variation (CV), Coppock Instability Index, Cuddy Della Valle Index, and Index Number for instability analysis, and R-square for linear, second-degree, and polynomial regression for trend analysis were employed which served as a metric for goodness of fit. The analysis revealed significant insights into the dynamics of Basmati rice production and export over the study period. Notable findings include fluctuations in growth rates, trends indicating periods of acceleration or deceleration, and instability factors impacting production and export. These findings contribute to a deeper understanding of the Basmati rice industry in India, informing policymakers, stakeholders, and researchers for effective decision-making and strategic planning.

INTRODUCTION

India is one of the major producers and exporters of Basmati rice. India accounts for approximately 70 per cent of the world's Basmati rice production. China, Pakistan, and Philippines are the other major producers. Saudi Arabia, Iran and UAE are the largest importers for Indian Basmati rice. In recent times, Yemen, Jordan, and the Netherlands have witnessed a sharp rise in demands for Indian Basmati rice (Wani et al., 2015). Indian states of Jammu and Kashmir, Haryana, Himachal Pradesh, Punjab, and Western Uttar Pradesh have cultivated Basmati rice for multiple generations (Singh & Singh, 2009). Furthermore, Punjab, Pakistan's population

depends heavily on basmati rice for their livelihood (Ashfaq et al., 2015). Production may also be improved using ICT tools and running awareness and education schemes for farmers (Kumar et al., 2023). The farmers' potential challenges in the form of ill preparedness for adoption of GAPs in basmati rice need to be looked into through policy interventions and extension efforts to reinforce the adoption process (Pandit et al., 2017). Paddy farmers should be given current, trustworthy knowledge in this era of climate change effects on production so they can use it to make more educated decisions and increase productivity (Shanabhoga et al., 2023; Yalakonda & Chandrasekaran, 2023). Concern over Rice Farming for Food Security and Ecological Sustainability were

raised by Rejula et al., (2017) and macroeconomic scenario by Bisen et al., (2023). The production and export of Basmati rice underwent a journey of transformation between 2001 and 2021, characterized by growth, trends, and occasional volatility. Because of its unique aroma and long grains, basmati rice is highly valued in both domestic and international trade. Existing studies like that of Kumari (2022) deal with growth and instability of production, area and productivity for Basmati rice but not export quantity and value. Study by Kamboj (2021) dealt with production trends. To quantify the growth rate of Basmati rice production and export over the years, this study employs Compound Annual Growth Rate (CAGR). By utilizing CAGR it was aimed to provide a quantitative understanding of the expansion of Basmati rice production and export during the study period. Furthermore, this research delves into the realm of instability, recognizing its nuanced manifestations in agricultural markets. Employing analytical tools such as Coefficient of Variation (CV), Coppock's instability index, Cuddy Della Valle instability index, and index numbers, we endeavour to unravel the volatility and fluctuations in Basmati rice production and export. These tools offer insights into the degree and nature of instability, enabling a comprehensive understanding of the market dynamics that influence the Basmati rice trade.

Moreover, this study employs regression analysis to identify and analyse trends in Basmati rice production and export. By utilizing techniques such as linear regression, second-degree regression, and third-degree regression, we aim to discern the underlying trends shaping the trajectory of Basmati rice. Through regression analysis, we seek to unveil the patterns, inflection points, and long-term tendencies governing the production and export of Basmati rice in India. In summary, this research embarks on a comprehensive exploration of the trends, growth rates, and instability characterizing Basmati rice production and export in India from 2001 to 2021. This study endeavours to offer valuable insights into the dynamic landscape of Basmati rice trade, thereby contributing to the broader understanding of agricultural markets and international trade dynamics.

METHODOLOGY

The primary aim of this study was to analyse the trends, growth rates, and instability in the production and export of Basmati rice in India from 2001 to 2021. The methodology employed a combination of quantitative analyses and statistical tools to derive insights from the time series secondary data collected from various sources, including Department of Agriculture and Farmer's Welfare, Directorate General of Commercial Intelligence and Statistics (DGCI&S), Agricultural and Processed Food Product Export Development Authority (APEDA) and Ministry of Commerce and Industry. The data included annual figures for Basmati rice production and export volumes, allowing for a detailed analysis of trends and fluctuations over time. To analyse the trend of Basmati rice production and export, the data was plotted against time and R^2 values were computed from three regression lines: linear, degree-2 polynomial and degree-3 polynomial. To analyse the growth rates of Basmati rice production and export, the Compound Annual Growth Rate (CAGR) was calculated. CAGR provides a measure of the average annual growth rate,

assuming compounding over the specified period. The instability in Basmati rice production and export was assessed using various statistical measures, including the Coefficient of Variation (CV), Cuddy-Della Valle Index (CDVI), and Coppock Instability Index (CII). Coefficient of variation (CV) quantifies the degree of variation relative to the mean and was used to assess instability in both production and export volumes. The Cuddy-Della Valle index (CDVI) proposed by Cuddy-Della Valle (Cuddy & Valle, 1978) was also applied to the measurement of instability in time series data. If the data are dispersed around the positive or negative trend line, this technique corrects the coefficient of variation. The ranges of CDVI are as follows: low instability is 0 to 15, medium instability is 15 to 30 and high instability is 30 and above. According to Coppock (1962), the Coppock Instability Index (CII) is a close approximation of the average yearly percentage variation that has been adjusted for trend. By employing these methodologies, this study aimed to offer a comprehensive analysis of the trends, growth rates, and instability in Basmati rice production and export in India over the twenty-year period, thereby contributing to a deeper understanding of the dynamics shaping the Basmati rice industry.

RESULTS

Trend

Linear, polynomial degree-2 and polynomial degree-3 regression was performed for basmati rice production, export quantity and export value over the 20-year period. R-square values were also computed for each regression analysis performed and presented in Figure 1, Figure 2 and Figure 3. The R^2 values for the trendlines fitted to the Basmati rice production and export data (Table 1) show how much variability in the data is explained by the respective trendlines. A higher R-squared value indicates that the trendline accounts for a bigger fraction of the data variability, implying a stronger link between the independent variable (time) and the dependent variable (production, export quantities or export values). For the production data, the R-squared values of 0.45, 0.63 and 0.71 for the linear, degree-2 polynomial and degree-3 polynomial trendlines, respectively, suggest a moderate to strong fit of the trendlines to the data. This indicates that the production of Basmati rice in India has shown a discernible trend over the years, with the degree-3 polynomial curve providing the best fit to the data. A peak in basmati rice production was observed during 2014-16 period and after that slow decline in production is seen. Similarly, for the export data, the R-squared values of 0.95, 0.95, and 0.98 for the linear, degree-2 polynomial, and degree-3 polynomial trendlines, respectively, indicate a strong fit of the trendlines to the data. This suggests a clear trend in Basmati rice exports from India, with the degree-3 polynomial curve providing the best fit. Overall, these results indicate that there is a significant trend in Basmati rice production and export from India, with the export quantity and export value trends showing a higher level of predictability compared to the production trend.

Growth

CAGR was calculated for the entire 20-year period (Table 1). Index values were calculated keeping the average of first three

Figure 1. Regression Analysis for Basmati Rice Production

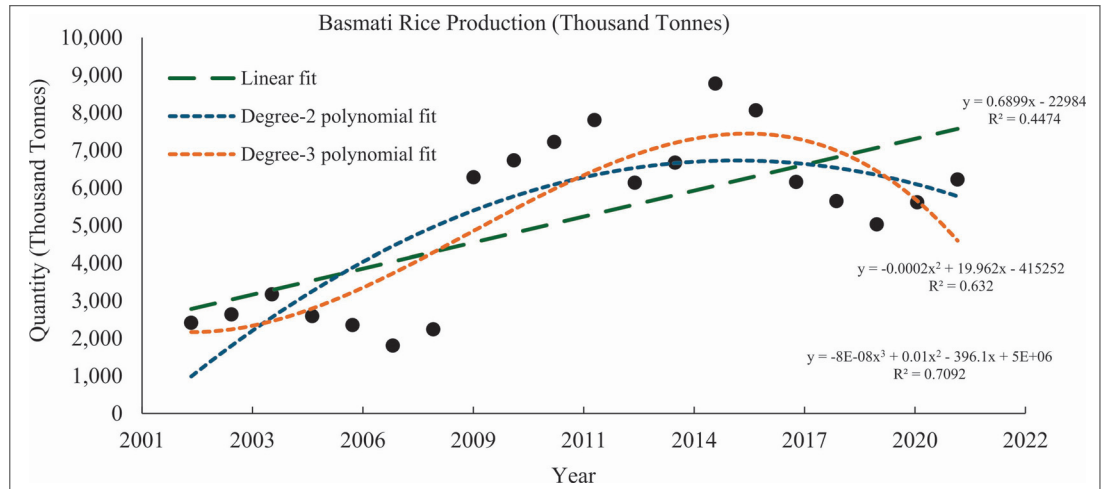


Figure 2. Regression Analysis for Basmati Rice Export Quantity

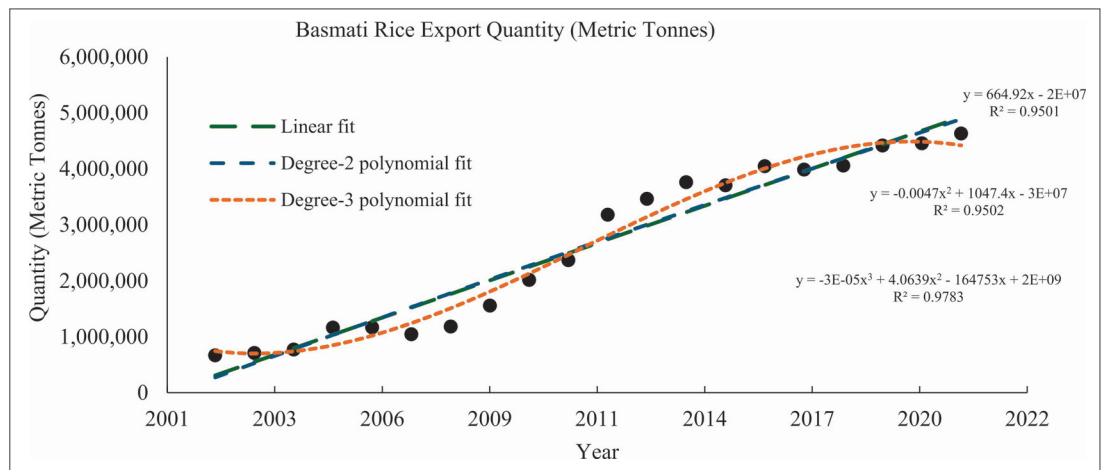
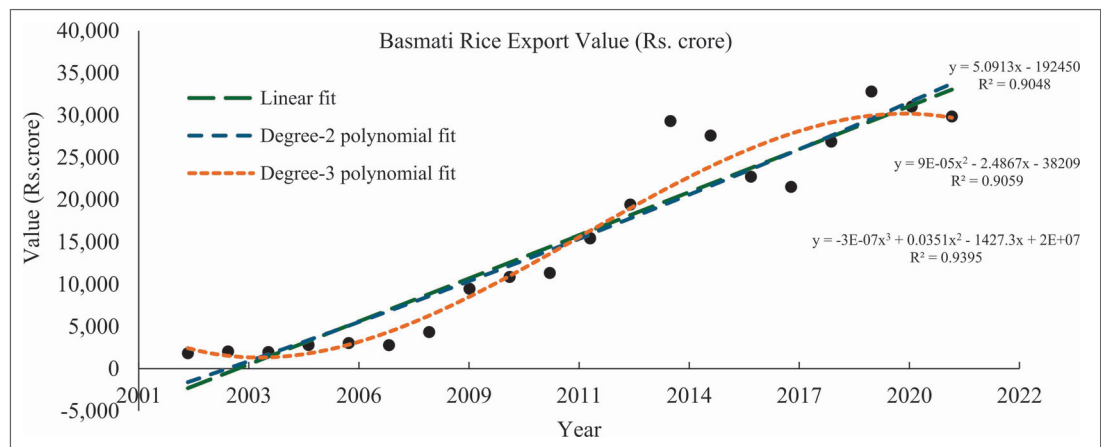


Figure 3. Regression Analysis for Basmati Rice Export Value



years as base value. CAGR was also calculated for 5-year periods for basmati production, basmati export quantity and basmati export value (Table 2). The index value for Basmati rice production stands at 227.2, indicating that the basmati rice production has more than doubled. However, the CAGR values over the four 5-year periods show a fluctuating trend. The period from 2001-06 experienced a slight decline (-0.01), followed by a substantial growth spurt from 2006-11 (0.32). The growth rate slowed down from 2011-16 (0.01), and the production remained stable from 2016-21 (0.00). This suggests that while there has been overall

growth in Basmati rice production, the growth rates have varied over time, influenced by several factors such as climate, market demand, agricultural practices, and government policies. The export quantity and export value experienced significant growth of 6 times and 15 times respectively as indicated by the index values of 646.61 and 1518.57. Similar to production, the maximum growth period was 2006-2011 for both export quantity and export value indicated by CAGR of 0.18 and 0.32 respectively. The analysis of Basmati rice production, export quantity, and export value indicates overall positive growth trends, with export quantity and

Table 1. Results for the period 2001-2021

	Production	Export Quantity	Export Value
Trend			
R ² (Linear)	0.45	0.95	0.90
R ² (Degree-2 Polynomial)	0.63	0.95	0.90
R ² (Degree-3 Polynomial)	0.71	0.98	0.94
Growth			
Compound Annual Growth Rate (CAGR)	0.05	0.10	0.15
Index	227.20	646.61	1518.57
Instability			
Coefficient of Variation (CV)	41.98	54.91	73.40
Coppock Instability Index (CII)	16.47	19.70	28.72
Cuddy Della Valle Index (CDVI)	22.61	8.13	17.98

Table 2. Results for consecutive 5-year periods

	Production			Export Quantity			Export Value		
	CAGR	CV	CII	CAGR	CV	CII	CAGR	CV	CII
2001-06	-0.01	12.31	11.11	0.12	27.75	12.76	0.11	23.02	12.23
2006-11	0.32	53.81	18.18	0.18	34.12	13.62	0.32	50.66	17.57
2011-16	0.01	14.30	11.39	0.05	9.01	10.85	0.08	24.97	12.64
2016-21	0.00	8.46	10.80	0.03	6.40	10.59	0.07	15.56	11.60

export value showing more consistent and robust growth compared to production. The fluctuations in production growth rates suggest that production may be influenced by a range of factors that can affect agricultural output. The steady growth in export quantity and value reflects the increasing demand and marketability of Basmati rice globally.

Instability

Instability was analysed using Coefficient of Variation (CV), Coppock Instability Index (CII) and Cuddy Della Valle Index (CDVI) and presented in Table 1. The CII and CV values were also calculated for the four periods 2001-06, 2006-11, 2011-16, 2016-21 for production, export quantity and export value and presented in Table 2.

Coefficient of Variation (CV)

The coefficient of variation assesses the relative dispersion of data around the mean. A higher CV indicates greater variability. In our analysis, the production of Basmati rice shows a CV of 41.98, indicating a moderate level of variability over the period studied. This suggests that while there is a trend in production, there are also fluctuations from year to year. Similarly, the export quantity and export value of Basmati rice exhibit higher levels of variability, with CVs of 54.91 and 73.40, respectively. This indicates that the export quantities and values of Basmati rice are more variable compared to the production quantities. The CV calculated for each of the 5-year periods suggests that the export value shows the most instability. The higher CV for export value compared to export quantity suggests that the variability in export value is influenced not only by the quantity exported but also by other factors such as market prices and exchange rates. This highlights the complex nature of international trade in agricultural commodities like Basmati rice.

Coppock Instability Index (CII)

The Coppock Instability Index (CII) is a measure of instability in a time series data set, calculated based on the rate of change of the data. A higher CII value indicates greater instability. In our analysis, the CII values for Basmati rice production, export quantity, and export value for the overall period are 16.47, 19.70 and 28.72 respectively. The values were also computed for 5-year blocks as well. The most unstable period with respect to Basmati rice production, export quantity and export value was 2006-11 followed by 2001-06. This may be due to 2008 ban by Indian government on export of non-Basmati rice and global increase in rice prices (Childs & Kiawu, 2009). The instability has decreased over the years. These values suggest that Basmati rice production and export quantities have experienced low to moderate levels of instability over the period studied. The export value experienced the most instability compared to export quantity and production. This may indicate that the instability in export value is influenced not only by the quantity exported but also by other factors such as market prices and exchange rates.

Cuddy and Della Valle Index (CDVI)

The Cuddy and Della Valle Index (CDVI) is a measure of instability in a time series data set. A higher CDVI value indicates greater instability. For Basmati rice production, the CDVI values are on the higher side (22.61) indicating moderate instability. Basmati rice export quantity exhibits the lowest CDVI values (<15) indicating stability. CDVI values (between 15 and 30) for basmati rice export value indicate moderate instability. These results indicate that, despite fluctuations in production, export quantity, and export value from year to year, the overall trends in Basmati rice production and export from India have shown little instability.

DISCUSSION

The production of Basmati rice increased at a rate of 5% compound growth rate over the studied period indicating a high rate of growth. The results closely associated with the results reported by Satishkumar et al., (2016), who found the growth rate to be 2.4% during the period 1955-2014. Basmati rice production experienced most growth during 2006-11 probably due to Indian government export ban on non-Basmati rice and global rice crisis of 2008 (Childs & Kiawu, 2009). The recent years with negligible CAGR for Basmati rice production showed stagnation in the Basmati rice sector. During 2001-2020, total rice exports in terms of quantity and value increased at a significant rate of 10% and 15%, respectively, which could be attributed to increased demand for basmati rice in the international market, consistent policies for basmati rice export, higher international prices, and increased domestic production, resulting in a secure inventory of rice in the central food stocks (Gangwar & Rai, 1995; Shende et al., 1998). Export value grew at a faster rate than export quantity due to growth in unit value realization as documented by Udhayakumar & Karunakaran (2020). The instability in production of Basmati rice depicted by the Coefficient of Variation is 41.67 which was comparable to 46.77 obtained by Kumari et al., (2022) for the period 1999-2000 to 2018-2019. The instability in Basmati rice production decreased over the years as indicated by the decreasing values of Coefficient of Variation and Coppock Instability Indices. The high R^2 values obtained for Basmati rice export quantity and export values indicate that the trends obtained were robust and may be used for predictive analysis.

CONCLUSION

The study analysed the production, export quantity and export value of Basmati rice in India during the two decades of 2001-2020. CAGR for the production of Basmati rice is 5% over the 20-year period indicating positive growth overall. Recent years have shown more stability in Basmati rice production and almost no growth (approximately 0% CAGR over 2016-21 period). Export quantity and export value of Basmati rice continue to perform well at an overall CAGR of 10 per cent and 15 per cent, respectively. The recent years show stability in terms of export quantity and value. The trends are more predictable as compared to early and mid-2000s. Policymakers and stakeholders in the Basmati rice industry can use these findings to understand the trends and instability in the market and to develop strategies for sustainable growth and trade.

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