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## Growth and Instability of Rice Production and Exports in India: An Empirical Study

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### ABSTRACT

Rice is an important food crop and export commodity in India, contributing significantly to agricultural production and international trade. This study examines the growth and instability of rice area, production and productivity in India and analyses the export performance of basmati and non-basmati rice. The study is based on secondary data obtained from FAOSTAT, APEDA and other published sources. Compound Annual Growth Rate (CAGR), Coppock's Instability Index and Cuddy-Della Valle Instability Index are employed to assess growth and instability. The findings indicate positive growth in rice production and productivity, particularly during the recent period, despite limited growth in cultivated area. Both basmati and non-basmati rice exports recorded positive growth in quantity and value, with non-basmati rice showing higher growth. However, instability remains significant, particularly in non-basmati exports. The study concludes that productivity enhancement, production stability and appropriate export policies are essential for sustaining India's competitiveness in the global rice market.

**Keywords:** *Rice Production; Rice Exports; Growth and Instability; Basmati and Non-Basmati Rice.*

### Introduction:

Agriculture continues to play an important role in the economic and social development of India, and rice is one of the major agricultural commodities produced and traded by the country. Rice is an important food crop and occupies a significant position in the agricultural economy. The growth of rice production is influenced by several factors, including the availability of cultivated land, irrigation facilities, use of fertilizers and pesticides, technological development, government support, and changes in agricultural practices.

In the context of globalization and increasing international trade, agricultural commodities have acquired greater importance in the international market. Countries participate in international trade by producing and exporting commodities in which they possess production and cost advantages. India has established a significant position in the global rice market through the production and export of both basmati and non-basmati rice. The international demand for Indian rice has created considerable opportunities for the expansion of rice exports and has contributed to India's participation in global agricultural trade.

The growth of rice exports, however, is not uniform over time. Rice exports may be influenced by changes in domestic production, international demand, government export policies, trade restrictions, buffer stocks, prices, and other economic factors. The liberalization of agricultural trade and changes in export policies have also affected the performance of Indian rice in international markets. Therefore, an assessment of the growth and instability of rice exports is important for understanding India's export performance.

Along with exports, changes in the area under rice cultivation, production, and productivity are important indicators of the performance of the rice sector. An increase in production does not necessarily result from an expansion of cultivated area; improvements in productivity and the adoption of modern agricultural technologies may also contribute to higher production. Hence, examining the growth and instability of area, production, and productivity provides a better understanding of the changing pattern of rice cultivation in India.

Previous studies have examined the growth, production, productivity, and export performance of rice in India and other rice-producing countries. However, there is a need for further assessment of the growth and instability of rice cultivation and the export performance of basmati and non-basmati rice over different periods. The present study therefore focuses on the growth and instability of rice production and exports in India. It analyses the performance of rice cultivation in terms of area, production, and productivity and examines the growth and instability of basmati and non-basmati rice exports.

The study uses secondary data obtained from sources such as the Agricultural and Processed Food Products Export Development Authority (APEDA), Food and Agriculture Organization (FAO/FAOSTAT), journals, articles, books, and other published sources. Statistical techniques such as the Cuddy-

Della Valle Instability Index, Coppock's Instability Index, Compound Annual Growth Rate (CAGR), percentage analysis, and linear forecasting are employed to analyse the growth, instability, export share, and future trend of rice in India.

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## Review of Literature:

The literature on Indian rice can broadly be classified into three interconnected areas: **(i) growth and instability of rice cultivation, (ii) growth and instability of rice exports, particularly basmati and non-basmati rice, and (iii) export-market performance and competitiveness.** The studies have progressively moved from examining domestic production trends towards understanding India's position in the international rice market. A chronological and critical review of the literature is presented below.

### *Early studies: Export growth and market direction*

Adhikari and Sekhon (2014) examined the performance and trade direction of Indian basmati rice exports during 1980–81 to 2012–13. Using Compound Growth Rate and Markov Chain Analysis, the study analysed changes in export quantity, export value and unit value and identified the major international markets for Indian basmati rice. The study reported a positive and significant growth in the quantity, value and unit value of basmati rice exports. It also demonstrated the importance of international demand in expanding India's basmati rice exports. The study was important in establishing that Indian basmati rice had developed a strong position in the international market. However, its principal emphasis was on basmati rice and export-market direction rather than on the simultaneous relationship between domestic rice production and both basmati and non-basmati exports.

Building upon the export-oriented perspective, Adhikari, Sekhon and Kaur (2016) examined the performance and determinants of rice exports from India. Their study considered growth, instability and factors influencing rice exports, thereby extending the analysis beyond simple export trends. The study demonstrated that rice export performance is influenced not only by the availability of rice but also by economic and market-related factors. This represents an important transition in the literature from describing export growth to explaining the factors associated with export performance. Nevertheless, the emphasis remained on export behaviour, leaving scope for a more integrated examination of production-side growth and instability alongside export performance.

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## Production-side growth and instability:

While export studies were developing, research on the domestic rice sector increasingly focused on the stability of area, production and productivity. Manohar et al. (2017) examined the growth and instability of rice area, production and productivity in India, Karnataka and Telangana using secondary data covering 1971–2015. The study employed Compound Growth Rate to measure growth and the Cuddy-Della Valle Index to measure instability. At the national level, the study found positive growth in area and production during the periods considered, although production declined during one of the sub-periods.

The significance of Manohar et al. (2017) lies in its methodological contribution to rice research: growth alone does not provide a complete picture of agricultural performance because a crop may experience growth while simultaneously exhibiting considerable instability. This distinction is particularly important for an export-oriented crop such as rice because fluctuations in domestic production can potentially affect the consistency of export supply. However, the study primarily concentrated on production indicators and did not integrate these findings with the export performance of basmati and non-basmati rice.

A related strand of research examined rice production in other major rice-producing countries. Mamun et al. investigated long-term changes in rice area, production and productivity in Bangladesh using several decades of data. Such studies reinforce the importance of examining production trends over extended periods because changes in technology, resource availability and production practices can alter the relationship between cultivated area, output and productivity. Thus, the international production literature complements the Indian evidence by demonstrating that rice-sector growth needs to be understood through multiple production indicators rather than production alone.

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## Expansion from production growth to export performance:

The literature subsequently developed towards a more detailed examination of India's basmati and non-basmati rice exports. Udhayakumar and Karunakaran (2020a) analysed the growth and stability of basmati and non-basmati rice exports from India for the period 1980–81 to 2017–18. The study used compound growth rates and instability measures and divided the overall period into sub-periods. The researchers reported positive growth in the quantity, value and unit value of both basmati and non-basmati rice exports over the overall period. At the same time, substantial instability was observed in some export indicators, demonstrating that positive growth does not necessarily imply stable export performance.

This finding is particularly relevant to the present study. It establishes that the analysis of Indian rice exports should incorporate both **growth and instability.** The study also showed that export performance changed across sub-periods, suggesting that policy changes and changing international market conditions may influence the trajectory of rice exports. However, the study concentrated primarily on export indicators; consequently, there remains scope to examine export performance together with the long-term growth and instability of rice cultivation.

Udhayakumar and Karunakaran (2020b) subsequently examined the trade dynamics of basmati and non-basmati rice exports from India. Rather than focusing only on aggregate growth, the study analysed changes in export destinations using the Markov Chain approach. The United Arab Emirates and Saudi Arabia were identified as stable destinations for Indian basmati rice, while Benin, Bangladesh and the UAE were important destinations for non-basmati rice. The study also highlighted the importance of competitive prices, quality and sanitary standards for maintaining India's position in international markets.

The contribution of this study is therefore complementary to the growth-and-instability literature. Whereas growth studies answer “**how fast have exports grown?**”, trade-dynamics studies address “**where are exports going and how stable are these markets?**” However, market-direction analysis does not itself explain whether the underlying domestic production base is sufficiently stable to support sustained exports. This provides a rationale for combining production-side and export-side analysis.

### ***Recent evidence on basmati production and exports***

More recent studies have increasingly attempted to combine production and export dimensions. Dalal et al. (2024), for example, examined trends, growth, production instability and export dynamics of basmati rice in India. The study employed several statistical measures, including Compound Annual Growth Rate, coefficient of variation, Coppock's Instability Index and the Cuddy-Della Valle Index. The authors found positive trends in basmati rice production and exports, while also identifying variations in growth and instability across different periods.

The importance of Dalal et al. (2024) is that it moves closer to an integrated framework by considering production instability and export dynamics within the same study. Nevertheless, the study is specifically centred on basmati rice. India's rice export sector, however, consists of both basmati and non-basmati rice, and the two categories differ in terms of market characteristics, prices and export demand. Therefore, analysing both categories is necessary to obtain a more comprehensive understanding of India's rice export performance.

Other recent studies have examined changes in the direction and composition of Indian basmati exports. These studies indicate that international markets are dynamic and that the relative importance of individual importing countries can change over time. Such findings reinforce the argument that India's export performance cannot be assessed exclusively through aggregate export value or quantity. Market diversification, market retention and competitiveness are also important dimensions of export sustainability.

### ***Critical synthesis of the literature***

The chronological development of the literature indicates a clear progression. The **earlier studies** primarily concentrated on the growth and destination of Indian basmati rice exports. Subsequent research introduced the concepts of **growth and instability**, while later studies examined **production instability, export competitiveness and market dynamics**. Thus, the literature has gradually moved from a descriptive assessment of rice exports towards a more multidimensional analysis of India's rice sector.

Three important observations emerge from the reviewed literature. First, several studies establish that India's rice production and exports have experienced positive long-term growth, but this growth has not always been accompanied by stability. Second, the literature clearly indicates that basmati and non-basmati rice behave differently in international markets and therefore should not necessarily be treated as a single homogeneous export commodity. Third, production-side studies and export-side studies have often been conducted separately, even though domestic production, productivity and cultivated area form an important foundation for export availability.

The methodological literature also indicates that different analytical techniques answer different research questions. **Compound Annual Growth Rate** identifies the direction and magnitude of growth, whereas **Cuddy-Della Valle and Coppock's measures** capture instability. **Markov Chain Analysis** provides information about the stability of export destinations, while forecasting techniques provide an indication of possible future export trends. Therefore, the combined application of growth, instability, share and forecasting techniques can provide a more comprehensive assessment than relying on any single measure.

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### **Research gap:**

Although considerable research has been conducted on Indian rice production and exports, a gap remains in integrating the two dimensions within a common analytical framework. Existing studies have often concentrated either on **area, production and productivity** or on **basmati and non-basmati rice exports**. Other studies have focused on particular export destinations or on basmati rice alone. Consequently, there is scope for a broader assessment that simultaneously considers the growth and instability of rice cultivation and the export performance of both basmati and non-basmati rice.

The present study attempts to address this gap by examining **the growth and instability of rice area, production and productivity in India together with the growth, instability and export share of basmati and non-basmati rice**. It further incorporates forecasting to examine the future direction of rice exports. In this respect, the study extends the existing literature by bringing production-side and export-side indicators together and by examining their performance across different periods.

## Objectives of the Study:

The study is undertaken with the following objectives:

1. To examine the growth and instability in the area, production and productivity of rice in India.
2. To analyse the growth, instability and changing trend of basmati and non-basmati rice exports from India in terms of quantity and value.

## Research Methodology:

### Research Design

The study adopts a **descriptive and analytical research design** to examine the growth and instability of rice production and rice exports in India. The analysis focuses on changes in the area, production and productivity of rice, along with the quantity and value of basmati and non-basmati rice exports during the study period.

### Sources of Data

The study is based entirely on **secondary data**. Data relating to rice area, production and productivity and rice exports have been collected from published and reliable secondary sources, including **FAOSTAT, Agricultural and Processed Food Products Export Development Authority (APEDA), journals, research articles and other relevant publications**. The data have been organised into appropriate periods to examine changes in growth and instability over time.

### Analytical Techniques

The following statistical techniques are employed to achieve the objectives of the study:

#### 1. Compound Annual Growth Rate (CAGR)

It stands for one of the most precise techniques to measure the returns for specific assets, investment portfolios, and anything else whose value can change over time. Here CAGR is used to measure growth rate of export of Basmati and non-Basmati rice for over the period. It can be calculated from the following formula.

$$CAGR = \left( \frac{V_{Final}}{V_{begin}} \right)^{1/t} - 1$$

CAGR= compound annual growth rate

Vbegin = beginning value

Vfinal = final value

t = time in years.

#### 2. Cuddy-Della Valle Instability Index (CDVI)

The **Cuddy-Della Valle Instability Index** is employed to measure the instability in the quantity and value of basmati and non-basmati rice exports. The index adjusts the coefficient of variation for the trend in the data and therefore provides a measure of instability after accounting for the underlying trend.

The CDVI is calculated as:

$$CDVI = CV \sqrt{1 - \bar{R}^2}$$

where,

- $CV$  = coefficient of variation
- $\bar{R}^2$  = adjusted coefficient of determination

The instability is classified into three categories:

- **0–15:** Low instability
- **16–30:** Medium instability
- **Above 30:** High instability

### 3. Coppock's Instability Index (CII)

Coppock's Instability Index is used to assess the instability in **area, production and productivity of rice in India**. The index measures the average year-to-year variation while taking the underlying trend into consideration. It is used to identify the degree of instability across the different study periods.

The results obtained through these techniques are presented in tables and interpreted to identify the growth pattern and degree of instability in Indian rice production and exports.

#### *Alignment of Methodology with Objectives*

The methodology is designed to directly address the two objectives of the study. **CAGR and Coppock's Instability Index** are used to examine the growth and instability of rice area, production and productivity, while **CAGR and Cuddy-Della Valle Instability Index** are used to analyse the growth and instability of basmati and non-basmati rice exports in terms of quantity and value.

#### **Result analysis and discussion:**

**Table 1 Showing Cuddy Della Valle Instability Index for export of rice from India**

| Period    | Category              | Mean          | Standard Deviation | CV (%) | Adjusted R <sup>2</sup> | CDVI (%)     | Interpretation |
|-----------|-----------------------|---------------|--------------------|--------|-------------------------|--------------|----------------|
| 2005–2016 | Basmati rice          | 565,482.71    | 468,103.56         | 82.78  | 0.7749                  | <b>39.28</b> | High           |
|           | Non-basmati rice      | 314,884.53    | 267,401.00         | 84.92  | –0.0083                 | <b>85.27</b> | High           |
|           | Agricultural products | 2,743,799.80  | 2,059,852.01       | 75.07  | 0.7096                  | <b>40.45</b> | High           |
| 2017–2026 | Basmati rice          | 2,675,043.70  | 433,912.78         | 16.22  | 0.1631                  | <b>14.84</b> | Low            |
|           | Non-basmati rice      | 2,246,870.20  | 1,024,412.23       | 45.59  | 0.4460                  | <b>33.93</b> | High           |
|           | Agricultural products | 13,260,348.00 | 2,254,306.78       | 17.00  | 0.2905                  | <b>14.32</b> | Low            |

Table 1 presents the Cuddy-Della Valle Instability Index (CDVI) for basmati rice, non-basmati rice and agricultural products during the periods 2005–2016 and 2017–2026. The results indicate considerable changes in the instability of Indian rice exports between the two periods. During 2005–2016, basmati rice recorded a CDVI of **39.28 per cent**, while non-basmati rice registered a higher instability of **85.27 per cent**. Agricultural products as a whole also recorded high instability of **40.45 per cent**. Since values above 30 per cent are classified as high instability, all three categories experienced high instability during this period.

During 2017–2026, the instability pattern changed considerably. Basmati rice recorded a CDVI of only **14.84 per cent**, indicating **low instability**, compared with 39.28 per cent during the earlier period. This suggests a considerable improvement in the stability of basmati rice exports. In contrast, non-basmati rice continued to exhibit **high instability**, with its CDVI increasing to **33.93 per cent**. Agricultural products recorded a CDVI of **14.32 per cent**, placing them in the low-instability category.

The results therefore reveal a contrasting pattern between basmati and non-basmati rice exports. While basmati exports became more stable in the later period, non-basmati exports remained comparatively volatile. This indicates that the overall export performance of Indian rice cannot be assessed by treating basmati and non-basmati rice as a single homogeneous category. The findings are consistent with the study's emphasis on examining the two export categories separately.

**Table 2 showing Coppock's Instability Index for Area, Production and Yield of Rice cultivation**

| Coppock's Instability Index for Area, Production and Yield of Rice cultivation |        |            |              |
|--------------------------------------------------------------------------------|--------|------------|--------------|
| Period                                                                         | Area   | Production | Productivity |
| 1997-2006                                                                      | 37.681 | 39.336     | 38.552       |
| 2007-2016                                                                      | 38.046 | 40.351     | 39.498       |
| 2017-2026                                                                      | 37.227 | 39.123     | 38.926       |

Table 2 presents Coppock's Instability Index for rice area, production and productivity across three periods: 1997–2006, 2007–2016 and 2017–2026. The results show that all three indicators experienced high instability throughout the study periods. During 1997–2006, the instability indices for area, production and productivity were **37.681, 39.336 and 38.552**, respectively. Production therefore recorded the highest instability during this period, followed by productivity and area.

During 2007–2016, instability increased marginally for all three indicators. The index increased to **38.046 for area, 40.351 for production and 39.498 for productivity**. Among the three indicators, production again recorded the highest instability. This suggests that fluctuations in rice production were greater than fluctuations in cultivated area and productivity during this period.

In the most recent period, 2017–2026, the instability of area declined to **37.227**, while production instability declined to **39.123**. However, productivity instability declined only marginally from 39.498 to **38.926**. Thus, compared with the previous period, area and production became more stable, whereas productivity continued to exhibit a high level of instability.

The overall results demonstrate that rice cultivation in India has experienced persistent fluctuations in area, production and productivity. Although there was a marginal improvement in the stability of area and production during 2017–2026, the values remained substantial. This supports the importance of analysing both **growth and instability**, rather than relying only on growth rates when assessing the performance of the rice sector.

**Table 3. Compound Annual Growth Rate of Indian Rice Exports**

| Export category       | Quantity CAGR (%) | Value CAGR (%) |
|-----------------------|-------------------|----------------|
| Basmati rice          | 8                 | 13             |
| Non-basmati rice      | 17                | 21             |
| Total rice            | 13                | 16             |
| Agricultural products | 11                | 15             |

Table 3 shows the Compound Annual Growth Rate (CAGR) of quantity and value of Indian rice exports for basmati rice, non-basmati rice, total rice and agricultural products. The results indicate that all categories recorded **positive growth** in both export quantity and export value. Basmati rice recorded a CAGR of **8 per cent in quantity and 13 per cent in value**, indicating sustained expansion in its export performance.

Non-basmati rice recorded higher growth, with a CAGR of **17 per cent in quantity and 21 per cent in value**. Thus, among the two major rice export categories, non-basmati rice recorded the highest growth in both quantity and value. The higher growth in export value compared with quantity suggests that the expansion in the value of exports was stronger than the corresponding growth in physical export volume.

When total rice exports are considered, the CAGR was **13 per cent for quantity and 16 per cent for value**. These figures demonstrate a strong overall expansion in India's rice exports. Agricultural products as a broader category recorded CAGRs of **11 per cent in quantity and 15 per cent in value**. Rice exports therefore recorded higher quantity growth than agricultural products overall, particularly because of the strong performance of non-basmati rice.

The comparison between basmati and non-basmati rice is particularly important. Although basmati rice has a significant position in India's export basket, the relatively higher growth of non-basmati rice indicates its increasing contribution to the expansion of India's total rice exports. The results also demonstrate that positive export growth does not necessarily imply stability, as Table 1 simultaneously shows considerable instability, particularly for non-basmati rice.

**Table 4. Compound Annual Growth Rate of Rice Area, Production and Productivity**

| Period    | Area CAGR (%) | Production CAGR (%) | Productivity CAGR (%) |
|-----------|---------------|---------------------|-----------------------|
| 1997–2006 | 1             | 2                   | 1                     |
| 2007–2016 | –1            | 1                   | 1                     |
| 2017–2026 | 0             | 2                   | 2                     |

Table 4 presents the CAGR of rice area, production and productivity for three periods: 1997–2006, 2007–2016 and 2017–2026. The results reveal different patterns in the growth of the three production indicators across the periods. During 1997–2006, rice area recorded a CAGR of

The 2017–2026 period shows a different pattern. Area recorded **zero growth**, whereas production and productivity both recorded a CAGR of **2 per cent**. This indicates that production increased despite the absence of significant expansion in cultivated area. The simultaneous positive growth in productivity provides an important explanation for the increase in production during the period.

The results therefore indicate a gradual shift in the sources of rice production growth. In the later period, production growth was increasingly associated with productivity rather than expansion of cultivated area. This finding is consistent with the broader argument in the article that an increase in production does not necessarily result from expansion of cultivated land and may instead arise from improvements in productivity and agricultural technology.

**Table 5: Basmati and Non-Basmati Rice Exports from India for Last 10 Years**

| Financial Year | Basmati Quantity (Million MT) | Basmati Value (US\$ Billion) | Non-Basmati Quantity (Million MT) | Non-Basmati Value (US\$ Billion) |
|----------------|-------------------------------|------------------------------|-----------------------------------|----------------------------------|
| 2016–17        | 3.985                         | 3.209                        | 6.771                             | 2.53                             |
| 2017–18        | 4.057                         | 4.170                        | 8.648                             | 3.56                             |
| 2018–19        | 4.415                         | 4.722                        | 7.600                             | 3.048                            |
| 2019–20        | 4.455                         | 4.331                        | 5.041                             | 2.015                            |
| 2020–21        | 4.630                         | 4.019                        | 13.095                            | 4.800                            |
| 2021–22        | 3.95                          | 3.54                         | 17.29                             | 6.13                             |
| 2022–23        | 4.56                          | 4.79                         | 17.79                             | 6.36                             |
| 2023–24        | 5.24                          | 5.84                         | 11.12                             | 4.57                             |
| 2024–25        | 6.07                          | 5.94                         | 14.13                             | 6.53                             |
| 2025–26        | 6.52                          | 5.67                         | 15.01                             | 5.82                             |

Table 5 presents the quantity and value of India's basmati and non-basmati rice exports from 2016–17 to 2025–26. The data reveal an increasing trend in basmati rice exports over the study period. Basmati export quantity increased from **3.985 million MT in 2016–17 to 6.52 million MT in 2025–26**, while its export value increased from **US\$3.209 billion to US\$5.67 billion**. Although some year-to-year fluctuations are visible, the overall long-term movement indicates expansion in basmati exports.

Non-basmati rice exports show a more fluctuating pattern. Export quantity increased from **6.771 million MT in 2016–17 to 15.01 million MT in 2025–26**, while export value increased from **US\$2.53 billion to US\$5.82 billion**. A particularly notable increase occurred during 2020–21 and 2021–22, when non-basmati export quantities reached **13.095 million MT and 17.29 million MT**, respectively. The quantity reached a further high of **17.79 million MT in 2022–23**, before declining in 2023–24 and subsequently recovering in the following years.

The comparison between the two categories shows that non-basmati rice accounted for a larger physical export volume than basmati rice throughout the period. However, the value of basmati exports remained substantial relative to its quantity, reflecting the distinct characteristics of the two export categories. The year-to-year fluctuations in non-basmati exports also support the high instability indicated for this category in Table 1.

Overall, the data demonstrate the growing importance of both basmati and non-basmati rice in India's export sector. Basmati exports show a comparatively consistent upward movement, whereas non-basmati exports exhibit greater fluctuations but achieve a substantial increase in export volume over the decade. These results reinforce the need to examine both categories separately when assessing India's rice export performance.

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## Conclusion:

The present study examined the growth and instability of rice production and exports in India, focusing on area, production and productivity, along with the export performance of basmati and non-basmati rice. The findings indicate that India has achieved positive growth in rice production and exports, although considerable instability persists across different indicators and periods.

Rice production recorded positive growth even when the area under cultivation showed limited growth or declined during certain periods. During 2017–2026, area recorded negligible growth, whereas production and productivity increased by 2 per cent each, indicating the growing importance of productivity improvement in sustaining production. However, the Coppock's Instability Index reveals continued instability in area, production and productivity, with production generally showing comparatively higher instability.

Both basmati and non-basmati rice exports recorded positive growth in quantity and value. Non-basmati rice registered higher growth than basmati rice, making a significant contribution to the expansion of India's total rice exports. The Cuddy-Della Valle Index further shows that basmati exports became more stable during the later period, whereas non-basmati exports continued to experience high instability.

Overall, the study concludes that India's rice sector has strong growth potential, but greater stability is essential. Productivity enhancement, stable domestic production, efficient export management and appropriate policy support are important for sustaining India's competitiveness and strengthening its position in the global rice market.

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