RESEARCH PAPER

Growth, Instability, and Competitiveness of India's Rice Sector: An Empirical Time- Series Study

Vandana Vig[1], Dr. Devinder Kumar[2], Dr. Sakshi[3]

[1]Research Scholar, Lovely Professional University, Phagwara, Punjab, India.

[2]Assistant Professor, Lovely Professional University, Phagwara, Punjab, India.

[3]Assistant Professor, Lovely Professional University, Phagwara, Punjab, India.

ABSTRACT

This study analyses the long-term growth, instability, and export competitiveness of India's rice sector using time-series data on production and area under cultivation from 1950–51 to 2023–25, and export performance from 1988–89 to 2023–24. Growth and instability are examined using Compound Annual Growth Rate (CAGR), year-on-year growth rates, coefficients of variation, and the Cuddy–Della Valle instability index, while export competitiveness is assessed through Revealed Comparative Advantage (RCA) and Revealed Symmetric Comparative Advantage (RSCA) indices. The results show that average rice production increased from about 26 million tonnes in the 1950s to over 108 million tonnes during 2010–20, reflecting sustained long-term growth driven by technological progress, irrigation expansion, and supportive policy interventions. Although production exhibited substantial inter-year variation (CV = 43.64%), trend-adjusted instability remained low (CDVI = 3.78), indicating a relatively stable long-run production trajectory. In contrast, rice exports displayed pronounced volatility, particularly in export value (CV = 118.64%; CDVI = 55.65), reflecting sensitivity to trade policies and international price fluctuations. Export volumes showed comparatively lower adjusted instability (CDVI = 46.85), suggesting stronger trend-driven growth in physical shipments. Competitiveness analysis confirms India's strong position in global rice trade, with RCA values consistently above 16 and RSCA exceeding 0.88 during 2019–2023, despite rising competition from Thailand, Vietnam, and Pakistan. West Asian countries emerged as the principal destinations for Indian rice exports, underscoring their strategic importance.

Keywords: Rice sector, production trends, export dynamics, growth behaviour, long-term analysis.

How to cite this article: Vig V, Kumar D, Sakshi. Growth, Instability, and Competitiveness of India's Rice Sector: An Empirical Time-Series Study. Int J Drug Deliv Technol. 2026;16(32s):520-532. DOI: 10.25258/ijddt.16.32s.62

Source of support: Nil

Conflict of interest: None

1. INTRODUCTION

Rice occupies a pivotal position in India's agricultural economy, food security system, and rural livelihoods. As the staple food for a large proportion of the population, rice contributes significantly to caloric intake while providing employment and income to millions of small and marginal farmers. India is recognised as one of the earliest centres of rice cultivation and continues to rank among the world's leading rice-producing countries, reflecting the crop's wide adaptability across diverse agro-climatic regions, from rainfed lowlands to intensively irrigated ecosystems (AIREA, 2019; Mahajan et al., 2017). Since Independence, rice production in India has expanded substantially due to the combined effects of the Green Revolution, irrigation development, adoption of high-yielding varieties, and institutional support through minimum support prices and public procurement (Bhalla & Singh, 2009; Praduman Kumar & Rosegrant, 1994). Despite these gains, the sector faces persistent challenges, including regional disparities in productivity, stagnation of cultivated area in recent decades, rising input costs, and increasing vulnerability to climate variability (Ahmad et al., 2017; Kumar et al., 2021). Alongside growth in production, India's rice sector has undergone a notable transformation in export performance. Trade liberalisation and greater integration with global markets facilitated a steady expansion of rice exports, particularly basmati rice, which enjoys a strong demand premium in international markets due to its quality attributes (Singh, 2001; Adhikari et al., 2016). India has emerged as one of the world's largest rice exporters, with West Asian and African countries accounting for a major share of export destinations (Sidhu et al., 2024; Joshi & Kumar, 2023). However, export performance has been characterised by considerable volatility, especially in export value, reflecting sensitivity to domestic policy interventions such as export bans and minimum export prices, fluctuations in international prices, and exchange rate movements (Fathelrahman et al., 2024; Dalal et al., 2024). While export volumes have generally followed an upward trend, instability in export earnings has posed challenges for farmers, traders, and policymakers. A substantial body of empirical literature has examined various dimensions of India's rice economy. Several studies have analysed growth patterns, productivity trends, and efficiency of resource use at national and regional levels, highlighting the role of technological progress and institutional support while also documenting regional disparities (Ahmad et al., 2017; Mahajan et al., 2017). Other studies have focused on rice export performance and competitiveness, identifying India's strong revealed comparative advantage in global rice trade, particularly in recent years, alongside increasing competition from Thailand, Vietnam, and Pakistan (Adhikari et al., 2016; Dalal et al., 2024). Recent research has further examined export instability and the welfare implications of trade restrictions, underscoring the sensitivity of rice exports to policy and global market shocks (Fathelrahman et al., 2024). Although the literature recognises the positive role of trade liberalisation in expanding India's rice exports, it largely concentrates on export growth outcomes, with limited attention to long-term instability and competitiveness implications. Moreover, existing studies rarely integrate the effects of liberalisation on domestic production dynamics with export performance over an extended time horizon. Consequently, comprehensive analyses linking production trends, instability patterns, and revealed comparative advantage of India's rice sector across the liberalisation period using updated data remain limited. In this context, the present study undertakes a comprehensive long-term assessment of India's rice sector by jointly analysing trends in area and production, instability in production and exports, and export competitiveness using revealed comparative advantage indicators. By integrating these dimensions over an extended time horizon, the study contributes to the literature and provides policy-relevant insights for enhancing production resilience, managing export volatility, and sustaining India's competitive position in the global rice market.

2. LITERATURE REVIEW

Adhikar (2016) emphasises the role of international trade in economic development and highlights India's prominent position in global rice exports. The study identifies production capacity, global demand, export prices, exchange rate movements, domestic consumption, and trade policies as key determinants of rice export performance. It further stresses the importance of price competitiveness, quality standards, and supportive policy frameworks in sustaining India's export growth.

Ahmed et al. (2017) focus on efficiency analysis using Data Envelopment Analysis (DEA) to evaluate rice cultivation performance in Bihar. The findings reveal an average technical efficiency of approximately 62 per cent, while allocative and cost efficiencies remain relatively low at around 38.8 per cent, indicating inefficient resource utilisation. The study underscores the need for improvements in farmers' education, access to quality seeds, and irrigation infrastructure to enhance productivity and farm efficiency.

Bhalla et al. (2009) examine the impact of economic reforms on agricultural growth in India and find that liberalisation did not lead to the expected acceleration in agricultural output. State-level evidence suggests a slowdown in crop output and yield growth during the post-reform period, accompanied by persistent regional disparities. The study attributes these outcomes to inadequate investment in irrigation, infrastructure, and technological inputs, which constrained productivity and diversification.

Fathelrahman et al. (2024) analyse the welfare implications of India's ban on non-basmati rice exports, which accounted for nearly 25 per cent of total rice exports. The study reports significant welfare losses for producers and global consumers, while domestic consumer welfare gains remained limited due to inelastic demand. The findings highlight the trade-offs between domestic food security objectives and export competitiveness, noting that tariff reductions by importing countries partially offset global welfare losses.

Dalal et al. (2024) investigate trends in basmati rice production and exports in India and report a positive compound annual growth rate of about 5 per cent in production during 2001–2020, followed by stagnation in the later period. In contrast, basmati rice exports showed strong growth, with export quantity and value growing at approximately 10 per cent and 15 per cent per annum, respectively. The study observes improved stability in recent years, indicating increasing market maturity.

Kumar et al. (2021) assess structural changes in paddy cultivation in Andhra Pradesh between 1991–92 and 2018–19. The results indicate a marginal decline in cultivated area alongside moderate growth in productivity and output, with moderate instability in area, yield, and production as measured by the Cuddy–Della Valle Index. The study highlights the susceptibility of paddy cultivation to climatic variability and stresses the need for adaptive strategies and climate-informed agricultural planning.

Madhu et al. (2024) discuss the global importance of rice, particularly in South Asia, and underscore India's role as one of the world's leading rice producers and exporters. The study distinguishes between the strong global demand for basmati rice due to its quality attributes and the price competitiveness of non-basmati rice. However, it cautions that India's relatively lower rice productivity compared to major exporters could constrain long-term export competitiveness.

Sidhu et al. (2024) document robust growth in India's basmati rice exports, with export quantity and value recording compound annual growth rates of about 10.5 per cent and 16.2 per cent, respectively. The study finds export value to be more unstable

than export volume due to international price fluctuations. Trade projections identify Iran and Saudi Arabia as key destination markets, emphasising the importance of quality assurance and production enhancement for sustaining future export growth.

3. METHODOLOGY

The study adopts a time-series analytical approach based entirely on secondary data to examine growth, instability, and competitiveness in India's rice sector. Data on rice area and production for the period 1950–51 to 2023–25 were sourced from publications of the Reserve Bank of India (RBI), while rice export value and volume data for 1988–89 to 2023–24, along with destination-wise exports for major importing countries during 2019–2023, were obtained from the UN COMTRADE (Comtrade Plus) database. Long-term trends were analysed using descriptive statistics and graphical techniques, followed by

growth in rice area, production, and exports is examined using the Compound Annual Growth Rate (CAGR) and year-on-year growth rates. Instability is measured through the Coefficient of Variation (CV) and the Cuddy–Della Valle Instability Index (CDVI), while export competitiveness is assessed using the Revealed Comparative Advantage (RCA) and Revealed Symmetric Comparative Advantage (RSCA) indices.

3.1 GROWTH MEASURES

Growth estimation through the Compound Annual Growth Rate (CAGR), which provides a smoothed measure of long-run growth and is computed as

$$\text{CAGR}=\left(\frac{V_t}{V_o}\right)^{\frac{1}{n}}-1,$$

where V_t and V_o are terminal and base-year values, and denotes the number of years (Goyal & Singh, 2020).

Short-term fluctuations were captured using Year-on-Year (YoY) growth, calculated as YoY Growth= $\frac{V_t - V_{t-1}}{V_{t-1}}$ X 100

where V_t and V_{t-1} represent the values in the current and preceding years, respectively.

3.2 INSTABILITY MEASURES

The Coefficient of Variation(CV) provides a preliminary measure of variability. It is computed as:

$$\text{CV} = \frac{\sigma}{\mu} \text{ X } 100$$

where σ is standard deviation, μ is the mean of the series.

To obtain a trend- adjustment measure of instability, the Cuddy–Della Valle Instability Index (CDVI) is used:

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

which adjusts for trend effects using the coefficient of determination $\left(R^2\right)$ from a time-trend regression, thereby providing a more reliable measure of instability than simple dispersion indices (Cuddy & Della Valle, 1978).

3.3 EXPORT COMPETITIVNESS MEASURES

Export competitiveness is analysed using both RCA and RSCA indices, as they complement each other in interpretation and robustness.

The RCA index, proposed by Balassa, measures a country's relative export advantage in a specific commodity compared to the world. It is calculated as:

$$RCA_{ij} = \frac{\left(\frac{X_{ij}}{X_i}\right)}{\left(\frac{X_j}{X}\right)}$$

Where:

RCA_{ij} = Revealed Comparative Advantage of country i in commodity j.

X_{ij} = Exports o commodity j by country i,

X_i = Total exports of country i

X_j = Total world exports of commodity j,

X = Total world exports of all commodities,

which ranges from zero to infinity. An RCA value greater than unity indicates that a country's share of exports in a particular commodity exceeds its share in Asia's total trade, signifying comparative advantage, whereas an RCA value below one reflects comparative disadvantage.

Despite its usefulness, the RCA measure is asymmetric and unbounded, which may lead to skewed interpretation and double-counting issues.

3.4 REVEALED SYSMMETRICAL COMPETITIVENESS ADVANTAGES

To address these limitations, the Revealed Symmetric Comparative Advantage (RSCA) index, proposed by Vollrath (1991) and formalised by Dalum et al. (1998), is employed alongside RCA. The RSCA is calculated as :

RSCA= $\frac{RCA-1}{RCA+1}$, which corrects for asymmetry and facilitates cross-country comparison (Dalum et al., 1998) and ranges between –1 and +1, providing a symmetric and scale-neutral measure. Positive RSCA values indicate comparative advantage, while negative values denote comparative disadvantage. The joint use of RCA and RSCA ensures a more robust and balanced assessment of India's competitiveness in the global rice trade. All computations and visualisations were carried out using Microsoft Excel, ensuring a systematic and robust evaluation of long-term growth behaviour, instability, and global competitiveness in India's rice sector.

4. RESULTS AND DISCUSSION

Overall, the findings indicate that the future sustainability and trade competitiveness of India's rice sector will hinge on adaptive policy support, climate-resilient technological adoption, and judicious management of land and water resources.

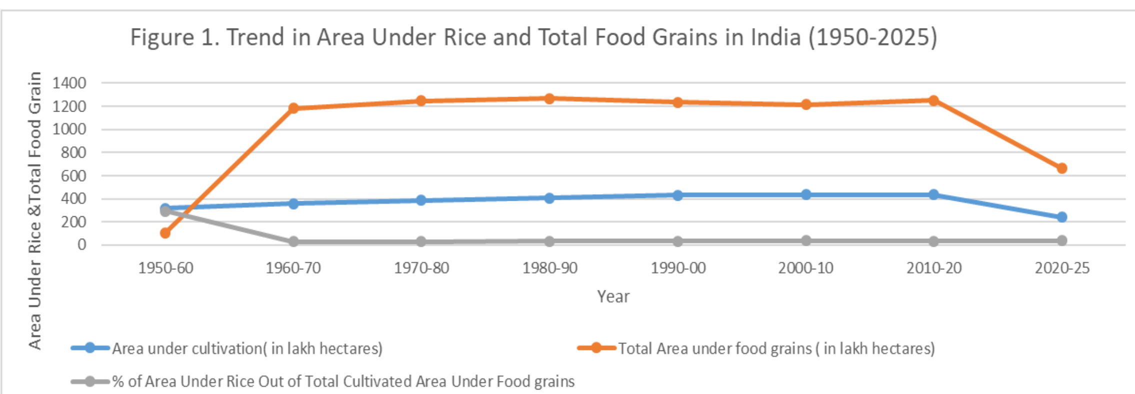
4.1. THE AREA UNDER RICE CULTIVATION

The proportion of area under rice cultivation was estimated as the ratio of rice-cultivated area to the total food-grain cultivated area, expressed in percentage terms.

Table1. Area Under Rice and Total Food Grains in India (1950-2025) (in lakh ha)

Year	Area under Rice	Area under Total Foodgrians	% of Area of Rice
1950-60	315.76	107.51	293.70
1960-70	358.59	1182	30.34
1970-80	386.39	1248.12	30.96
1980-90	406.55	1268.09	32.06
1990-00	432.15	1236.11	34.96
2000-10	434.1	1214.9	35.73
2010-20	436.8	1251.9	34.89
2020-25	239.1	661.6	36.14

Source: Reserve Bank of India,2003 & 2025



Source: Reserve Bank of India,2003 & 2025

Table 1 and Figure 1 together illustrate the long-term evolution of the area under rice cultivation in relation to the total food-grains area in India from 1950–60 to 2020–25. In the initial post-independence decade (1950–60), rice occupied an average of about 316 lakh hectares, constituting roughly 29–31 per cent of the total food-grains area. This relatively moderate share reflects the transitional nature of Indian agriculture during the early post-independence period, when institutional reforms such as the abolition of intermediaries and improvements in tenancy arrangements enhanced cultivators' access to land and laid the foundation for the expansion of food-grain cultivation, including rice (Ray, 1996; Mearns, 1999). Figure 1 visually depicts this phase as one of gradual expansion, with rice area moving broadly in line with total food-grains area. The subsequent decades witnessed a steady increase in the area under rice cultivation, a trend that coincides with the diffusion of Green Revolution technologies. The adoption of high-yielding varieties, expansion of irrigation infrastructure, and increased use of chemical fertilisers significantly improved the relative profitability and productivity of rice cultivation, encouraging farmers to shift land away from coarse cereals and pulses towards major cereals such as rice (Bhalla et al., 2009). As shown in both Table 1 and Figure 1, this period was characterised by a stable rice share of around 30–32 per cent of the total food-grains area, indicating that rice expansion largely occurred alongside, rather than at the expense of, overall food-grains cultivation.The upward trajectory strengthened during the 1980s and 1990s, when the average area under rice cultivation increased to about 407 lakh hectares in 1980–90 and further to 432 lakh hectares in 1990–2000. This expansion raised rice's share to nearly 35 per cent of the total food-grains area. Figure 1 clearly highlights this phase as one of consolidation, reflecting the cumulative impact of sustained public investment in irrigation, the institutionalisation of minimum support prices, and an expanding procurement system. These policy interventions reinforced cereal-based agricultural growth and entrenched rice as a dominant component of India's cropping pattern (Bhalla et al., 2009).During the 2000–10 and 2010–20 periods, the area under rice cultivation stabilised at around 434–437 lakh hectares, while its share in total food-grains area remained close to 35–36 per cent. This stabilisation, evident in the flattening of the rice area curve in Figure 1, suggests a saturation of land expansion possibilities and a gradual shift in policy and production emphasis from acreage growth towards productivity enhancement through technological improvements and input intensification. The relative stability of rice's share during this phase indicates that rice continued to retain its central role within the food-grains sector despite emerging diversification pressures. A notable structural change emerges in the most recent period (2020–25), when the average area under rice cultivation declined sharply to about 239 lakh hectares. Figure 1 vividly captures this contraction, which contrasts with the earlier phases of expansion and stabilisation. Despite this decline in absolute area, rice continued to account for over 36 per cent of the total food-grains area, implying a more pronounced contraction in non-rice food-grain crops. This pattern points towards underlying structural adjustments in Indian agriculture, possibly driven by climatic variability, water scarcity, rising production costs, and policy-induced shifts towards sustainability and crop diversification. Thus, while Table 1 provides precise period-wise averages, Figure 1 complements it by highlighting the dynamic evolution, turning points, and emerging structural changes in the role of rice within India's food-grains economy

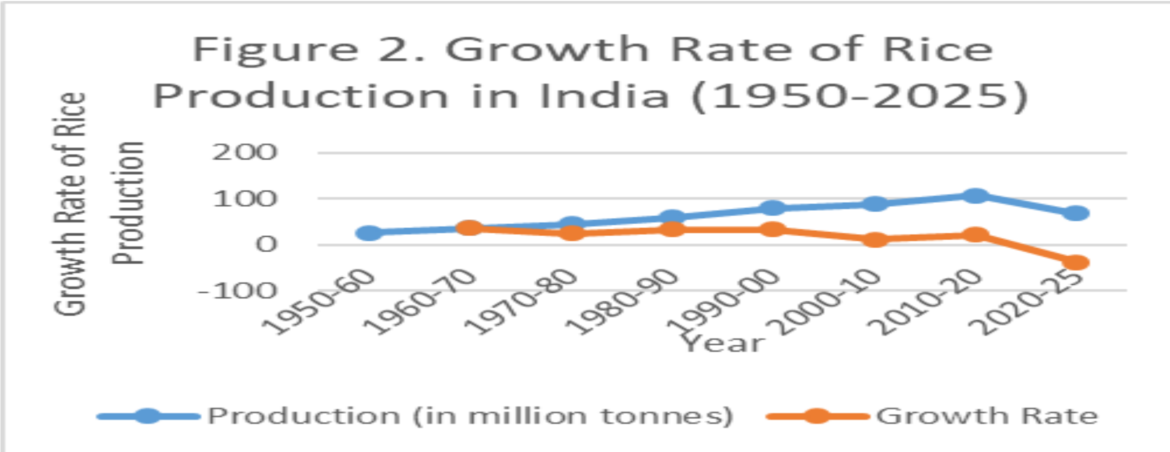
4.2.Trends in rice production

The trend in rice production was examined using year-to-year growth rates, which capture the percentage change in production between the current year and the previous year. Positive growth rates indicate an expansion in rice output, whereas negative values reflect a contraction in production during the respective years.

Table 2. Production and Growth of Rice in India, (1950-2024) (in million tonnes)

Year	Production	Growth Rate
1950-60	26.29	--------
1960-70	35.86	36.40
1970-80	44.76	24.82
1980-90	59.75	33.49
1990-00	80.1	34.06
2000-10	89.18	11.34
2010-20	108.09	21.20
2020-25	67.64	-37.42

Source: Reserve Bank of India,2003 & 2025



Source: Reserve Bank of India,2003 & 2025

Table 2 presents the period-wise average rice production and corresponding growth rates in India from 1950–60 to 2020–25. During the 1950–60 period, average rice production stood at 26.29 million tonnes, reflecting the modest production base of the early post-Independence years. This phase was characterised by limited technological inputs and heavy dependence on monsoon rainfall, although land reforms and institutional changes gradually encouraged the expansion of cultivated area and laid the foundation for future growth (Ray, 1996; Mearns, 1999). A substantial improvement in rice production is observed during 1960–70, when average production increased to 35.86 million tonnes, recording a growth rate of 36.40 per cent, the highest among the early decades. This acceleration corresponds with the introduction of non-lodging rice varieties, high-yielding seeds, incentive price policies, and the adoption of modern agricultural technologies, which collectively culminated in the New Agricultural Strategy or Green Revolution (Economic Survey, 1966–67; Mahadevappa, 2013; Parsad & Tripathi, 2009).

During 1970–80, average rice production rose further to 44.76 million tonnes, although the growth rate moderated to 24.82 per cent. The deceleration in growth has been attributed to recurrent droughts, rising fertiliser prices, and constraints in fertiliser availability, which reduced input use and slowed productivity gains during this period (Sarma & Gandhi, 1990). Despite these challenges, the long-term upward trend in production continued. The 1980–90 period witnessed a notable increase in average rice production to 59.75 million tonnes, with a growth rate of 33.49 per cent. This improvement reflects partial benefits from agricultural policy reforms and gradual technological diffusion. However, production gains were uneven across regions: northern and southern states benefitted more from improved irrigation and technology adoption, while western and eastern regions lagged due to infrastructural and institutional constraints (Kumar et al., 1994). In the 1990–2000 period, average rice production increased substantially to 80.10 million tonnes, recording a growth rate of 34.06 per cent (Figure 2). This phase coincides with economic liberalisation, increased profitability of rice cultivation, subsidised inputs, and improved market incentives, particularly in major rice-producing states such as Punjab, Haryana, West Bengal, and Bihar (Bhalla et al., 2009; Khanna, 2011). However, growth slowed during 2000–10, when average production rose marginally to 89.18 million tonnes, with a significantly lower growth rate of 11.34 per cent. This slowdown indicates yield saturation in intensively cultivated regions, rising costs of production, and increasing pressure on land and water resources. A moderate recovery is observed during 2010–20, with average rice production reaching 108.09 million tonnes and growth improving to 21.20 per cent, supported by hybrid rice adoption, diversification strategies, and state-level productivity initiatives (Bhalla et al., 2009; Kannan, 2011; Jain, 2018). The most striking feature emerges in the 2020–25 period, where average rice production declined sharply to 67.64 million tonnes, registering a negative growth rate of –37.42 per cent. This contraction reflects heightened climate variability, increased frequency of extreme weather events, volatility in input markets, and structural vulnerabilities within India's rice production system (Dalal et al., 2024).

4.3. TRENDS IN THE EXPORT OF RICE FROM 1988-89 TO 2023-24

The trend in rice production was estimated using the compound annual growth rate (CAGR), computed as the ratio of the difference between the current year's production and the previous year's production to the previous year's production, multiplied by 100.

Table 3. Trends in the Trade Value and Volume of Rice from India, (1988-24)
(in US $ millions & million tonnes)

Year	Trade Value	CAGR	Trade Volume	CAGR
1988-89	227.27	---	0.35	---
1990-91	254.37	5.79	0.51	20.71
1995-96	1361.52	39.87	4.91	57.29
2000-01	629.93	-14.29	1.48	-21.33
2005-06	163.65	-23.63	5.06	27.87
2010-11	2295.81	69.59	2.5	-13.15
2015-16	6380.08	22.68	11.03	34.56
2020-21	7980.03	4.58	14.61	5.78
2023-24	10453.28	9.42	17.86	6.92

Source: United Nations(UN) Comtrade Database, UNSD,accessed December 2025.

Table 3 highlights how India's rice trade experienced sharp fluctuations from the early 1990s to 2024, reflecting the combined influence of policy reforms, global market dynamics, and domestic production variability. The early 1990s marked a decisive shift: trade value and volume rose notably by 5.79 per cent and 20.71 per cent in 1990-91, respectively, indicating the initial gains from trade liberalisation and India's entry into a rules-based multilateral system under the WTO and the Agreement on Agriculture (Anjum & Khan, 2017). These reforms removed several long-standing export controls, and the devaluation of the rupee made Indian rice more price-competitive globally. The elimination of quantitative restrictions on non-Basmati rice further accelerated export expansion in the mid-1990s (Basin, 2000), which is reflected in the exceptionally high CAGR values for 1995–96, when both value and volume surged by 39.87 per cent and 57.29 per cent. However, the table also reveals the fragility of these early gains. By the late 1990s, inconsistent export policies and market uncertainties reversed the growth momentum, causing trade indicators to weaken (Udhayakumar et al., 2020). This downward trend becomes more pronounced in the 2000–01 period, with trade value contracting by –14.29 per cent and volume by –21.33 per cent. The negative growth during 2000–2010, including –23.63 per cent in value (2005–06) and –13.15 per cent in volume (2010–11), corresponds with episodes of currency volatility, export bans on non-Basmati rice, and increased tariffs on Basmati varieties—measures typically imposed to stabilize domestic supply and prices (Bhattacharya, 2011; Adhikari, 2016; Fathelrahman et al., 2024). These policy shifts disrupted India's reliability in international markets, causing export performance to fluctuate despite rising global demand. A decisive turnaround begins after 2010. The data show a strong recovery, with trade value rising to USD 6380.08 million in 2015–16 and corresponding volume reaching 11.03 million tonnes. The positive CAGR values during this period (22.68 per cent in value and 34.56 per cent in volume) indicate the re-establishment of India as a leading global rice exporter. This improvement reflects more stable export policies, expansion of procurement systems, and the growing international preference for Indian Basmati and parboiled rice. The upward trajectory continues into 2020–21 and 2023–24, when trade value reached USD 7980.03 million and USD 10453.28 million, respectively. Although growth rates during these years (4.58–9.42 per cent in value and 5.78–6.92 per cent in volume) are moderate, they demonstrate resilience despite global disruptions and price volatility.

4.4. INSTABILITY IN RICE PRODUCTION AND EXPORT PERFORMANCE

Instability in rice production, export value, and export volume was assessed using the Cuddy–Della Valle index. The results indicate the extent of year-to-year fluctuations after accounting for long-term trends. Lower CDVI values suggest a more predictable and consistent pattern over time, whereas higher values point to greater uncertainty and irregular movements in production and export indicators during the study period.

Table 4. Instability Index for Rice Production and Export Indicator

Indicator	Production (in million tonnes)	Trade Value (in US$ million)	Trade Volume (in million tonnes)
Mean	63.96	3305.10	6.48
Standard Deviation(SD)	27.91	3921.23	6.47
Coefficient of Variation(CV%)	43.64	118.64	99.86
R^2	0.74	0.78	0.78
CDVI(Adjusted Instability Index)	3.78	55.65	46.85

Source: Author's Calculation based on Reserve Bank of India(2003 & 2025) & UNComtrade (December 2025).

The descriptive indicators reveal distinct patterns of variability across production and export performance during the study period. The mean level of production remained relatively high, yet the coefficient of variation, 63.96 per cent (Table 4), shows that production fluctuated substantially around its average. This degree of dispersion indicates that production levels did not follow a stable pattern across years. Although the trend component, reflected by a value of 0.74, captures a major portion of the long term movement in production, the low CDVI value of 3.78 demonstrates that most of the observed variation aligns with the underlying positive trend. This means that while year-to-year production values deviated from the average, very little instability remains once the long-term trajectory is accounted for. In contrast, export trade value presents a much more volatile pattern. The mean trade value of about USD 3305 million masks considerable fluctuations, as highlighted by an exceptionally high CV of 118.64 per cent. This implies that export earnings deviated widely from the average, indicating strong instability in nominal performance. After adjusting for trend effects, the CDVI reduces to 62.97, which shows that a portion of the variability corresponds to the upward movement over time. However, the remaining level of instability remains sizeable, meaning that export earnings did not grow in a uniform manner even though the overall trend was upward. The trend component is moderately strong, as indicated by a value of 0.718, but not strong enough to offset the large year-to-year fluctuations captured by the CV. Export trade volume displays a relatively more consistent pattern compared to trade value. The average export volume during the period was around 6.48 million tonnes, yet the CV of 99.86 indicates substantial variability around this mean. When the effect of the long-term trend is considered, the CDVI declines to 45.30, which is considerably lower than that of trade value. This suggests that a large share of variation in volume corresponds to a sustained upward trend, a result supported by the relatively higher value of 0.794. Thus, although the raw data exhibit substantial dispersion, the adjusted instability measure reveals a more orderly pattern of growth in physical export quantities than in export earnings This implies that India’s rice sector is more vulnerable to international price and policy shocks than to domestic production shocks.

4.5. Major Destinations Markets for India's Rice Exports

The analysis of export destinations indicates that Saudi Arabia, Iran, Iraq, the United Arab Emirates, and Yemen constitute the top five markets for rice exports, collectively accounting for a substantial share of total export value and volume.

Table 5. India' s Rice Export Value and Volume in Major Destination Markets from 2019-23 (in US $ million & in million tonnes)

Country	2019		2020		2021		2022		2023	
	Trade Value[a]	Trade Volume[b]	Trade Value[a]	Trade Volume[b]	Trade Value[a]	Trade Volume[b]	Trade Value[a]	Trade Volume[b]	Trade Value[a]	Trade Volume[b]

Saudi Arabia	1070.64	1.08	1096.89	1.28	788.16	0.91	989.79	1.01	1279.22	1.23
Iran	1444.56	1.39	875.58	1.10	662.01	0.87	1155.11	1.25	734.29	0.75
Iraq	472.8	0.51	589.94	0.82	521.97	0.75	354.32	0.38	732.90	0.69
UAE	351.53	0.47	385.39	0.56	319.29	0.48	432.99	0.54	463.66	0.56
Yemen	249.34	0.26	307.50	0.39	239.57	0.31	329.68	0.34	335.06	0.34

Source: United Nations(UN) Comtrade Database, UNSD,accessed December 2025.

Notes: [a] Values in US$ million
b Quantities in million tonnes

The trade value and volume of rice in major destinations are shown in Table 5. Saudi Arabia, a non-rice-producing country, has been a major importer of Basmati rice (Adhikari et al., 2016). In 2019, the trade value (Figure 4) and volume of rice imports were $1,070.64 million and 1.08 million tonnes, respectively. By 2023, these figures had increased to $1,279.23 million and 1.23 million tonnes, respectively. However, in 2021, both trade value and volume declined to $788.26 million and 0.91 million. This decline was primarily attributed to increased global demand for Indian rice, which reduced the share exported to Saudi Arabia (Singh et al., 2024). The United Arab Emirates (UAE) was ranked as the second-largest importer of Indian Basmati rice during the study period. However, trade figures fluctuated significantly. In 2019, the trade value and volume were $351.53 million and 0.47 million tonnes. These increased in 2020 to $385.29 million and 0.56 million tonnes. A decline followed in 2021, with trade value and volume falling to $319.29 million and 0.48 million tonnes. From 2022 onwards, the trend reversed, with trade values and volumes increasing to $432.99 million and 0.54 million tonnes in 2022 and further to $463.66 million and 0.56 million tonnes in 2023. This growth was driven by the UAE food industry's request for the Indian government's support in ensuring a stable rice supply. Measures included streamlined certification processes, harmonisation of standards, and improved coordination with the Agricultural and Processed Food Products Export Development Authority (APEDA) (Goyal, 2023). Iran was the third-largest importer of Indian Basmati rice during this period, though exports to the country were highly volatile. In 2019, exports were valued at $1,444.56 million, with a volume of 1.39 million tonnes. These figures fell sharply in 2020 and 2021, with export values dropping to $875.58 million and $662.01 million and volumes declining to 1.10 million tonnes and 0.87 million tonnes, respectively. The primary reason was a substantial increase in Iran’s domestic rice production (Madhu et al., 2023). The volatility continued in 2022 and 2023, with export values fluctuating from $1,155.11 million to $734.29 million and volumes from 1.25 million tonnes to 0.75 million tonnes. Notably, in 2023, the export value and volume significantly increased from the previous year, rising from $732.90 million to $1,155.11 million and from 0.69 million tonnes to 1.25 million tonnes, respectively. In Iraq, Basmati rice imports experienced notable fluctuations between 2019 and 2023. From 2019 to 2020, the trade value rose from $472.80 million to $589.94 million, and the volume from 0.51 million tonnes to 0.82 million tonnes. This increase was primarily driven by declining domestic agricultural production, necessitating higher imports subsidised by oil revenues (Mahmud, 2021). However, from 2021 to 2022, both trade value and volume declined, dropping from $521.97 million to $354.32 million and volumes from 0.75 million tonnes to 0.38 million tonnes. The downturn was largely due to reduced contributions from the agriculture, forestry, and fishing sectors to the GDP, as well as ineffective agricultural policies (World Bank, 2023). In 2023, exports rebounded sharply to $732.90 million and 0.69 million tonnes. In Yemen, the value and volume of rice imports also fluctuated over the years. In 2019, rice imports were valued at $249.34 million, with a volume of 0.26 million tonnes. Both metrics increased in 2020 to $307.50 million and 0.39 million tonnes, respectively. A decline occurred in 2021, with figures dropping to $239.57 million and 0.31 million tonnes. The trend reversed in 2022, as imports rose to $329.68 million and 0.34 million tonnes due to population growth, rice's health benefits, its aromatic qualities, and its central role in Yemeni cuisine. The Yemeni government also implemented policies to ensure consistent rice availability (Sharma, 2022). In 2023, the trade value slightly increased to $335.06 million, while the volume remained unchanged at 0.34 million tonnes.

4.6. India's Competitive Position in Global Rice Trade
India's competitiveness in the global rice trade was evaluated through a comparative analysis of export volumes and the Revealed Comparative Advantage (RCA) and Revealed Symmetric Comparative Advantage (RSCA) indices of major rice exporting

countries. The results reveal India's relative trade advantage vis-à-vis competing exporters, highlighting its position in terms of both export performance and comparative strength in the international rice market.

4.7. India's Competitive Position in Global Rice Trade
India's competitiveness in the global rice trade was evaluated through a comparative analysis of export volumes and the Revealed Comparative Advantage (RCA) and Revealed Symmetric Comparative Advantage (RSCA) indices of major rice-exporting countries. The results reveal India's relative trade advantage vis-à-vis competing exporters, highlighting its position in terms of both export performance and comparative strength in the international rice market.

Table 6:Rice Export Volume of Major Countries from 2019-23 (in million tonnes)

Year	India	Thailand	Vietnam	Pakistan	USA	China
2019	9.82	7.58	5.47	4.59	3.63	2.75
2020	14.61	5.73	5.63	3.99	3.30	2.30
2021	21.28	6.30	5.71	3.99	3.38	2.45
2022	22.24	6.56	6.56	4.63	2.48	2.21
2023	17.87	8.77	7.75	7.74	2.70	1.63

Source: United Nations(UN) Comtrade Database, UNSD,accessed December 2025.

Table 6 presents the export volumes of rice from major exporting countries—India, Thailand, Vietnam, Pakistan, the USA, and China—over the period 2019–2023. The data highlight clear differences in export scale, growth patterns, and stability among these countries. In 2019, India emerged as the largest rice exporter with 9.82 million tonnes, clearly surpassing all other countries. Thailand ranked second with 7.58 million tonnes, followed by Vietnam at 5.47 million tonnes, indicating their strong but comparatively lower export presence. Pakistan exported 4.59 million tonnes, placing it behind the major Southeast Asian exporters, while the USA and China recorded much smaller volumes of 3.63 million tonnes and 2.75 million tonnes, respectively, reflecting their limited participation in global rice trade during that year. In 2020, India significantly strengthened its leading position by increasing exports to 14.61 million tonnes, creating a wide gap with other exporters. Thailand's exports declined sharply to 5.73 million tonnes, while Vietnam maintained a relatively stable level at 5.63 million tonnes. Pakistan's exports decreased to 3.99 million tonnes, and both the USA (3.30 million tonnes) and China (2.30 million tonnes) also experienced marginal reductions, suggesting an overall contraction among most exporters except India. During 2021, India continued its expansion, exporting 21.28 million tonnes, more than three times that of Thailand (6.30 million tonnes) and Vietnam (5.71 million tonnes). Thailand and Vietnam showed modest recovery compared to the previous year, while Pakistan's exports remained unchanged at 3.99 million tonnes. The USA (3.38 million tonnes) and China (2.45 million tonnes) recorded slight improvements but continued to trail far behind the leading exporters. In 2022, India reached its highest export level of the period at 22.24 million tonnes, consolidating its dominance in the global rice market. Thailand and Vietnam both exported 6.56 million tonnes, indicating convergence in their export performance. Pakistan's exports increased to 4.63 million tonnes, reflecting gradual strengthening. In contrast, the USA's exports declined to 2.48 million tonnes, and China's exports fell to 2.21 million tonnes, pointing to reduced export engagement by these countries. By 2023, India's rice exports declined to 17.87 million tonnes, though it remained the largest exporter. Thailand recorded a strong rebound to 8.77 million tonnes, overtaking Vietnam, whose exports also rose substantially to 7.75 million tonnes. Pakistan exhibited a sharp increase to 7.74 million tonnes, nearly matching Vietnam and highlighting a major shift in export dynamics. The USA showed a mild recovery to 2.70 million tonnes, while China's exports declined further to 1.63 million tonnes, reinforcing its diminishing role in the international rice export market..

Table 7:RCA of Major Rice Exporting Countries from 2019-23 (in US$ million)

Year	RCA India	RCA Thailand	RCA Vietnam	RCA Pakistan	RCA USA	RCA China
2019	16.11	13.08	7.04	73.20	0.87	0.32
2020	19.27	10.71	6.60	62.85	0.88	235.37
2021	19.17	10.01	7.04	68.61	0.87	0.25
2022	18.46	10.74	6.68	58.60	0.64	0.22
2023	16.25	11.48	8.31	66.75	0.67	0.20

Source: Author's Calculation based on Comtrade data base (2025)

Table 7 presents the revealed comparative advantage (RCA) of major rice-exporting countries from 2019 to 2023. In 2019, Pakistan exhibited an exceptionally high RCA, followed by India and Thailand, indicating strong export specialisation, while Vietnam showed a moderate advantage, and the USA and China remained at a comparative disadvantage. In 2020, India's RCA strengthened further despite global trade disruptions, Pakistan continued to dominate, Thailand and Vietnam experienced slight declines but retained an advantage, and China recorded an abnormal. In 2021, the comparative advantage of India and Pakistan remained strong, Thailand showed a marginal decline, Vietnam stabilised, and the USA and China continued below unity. During 2022, most countries recorded a mild reduction in RCA values, reflecting production and policy challenges, though India, Thailand, Vietnam, and Pakistan still maintained clear comparative advantages. By 2023, India's RCA moderated but remained high, Thailand and Vietnam improved their positions, and Pakistan rebounded strongly, whereas the USA and China consistently displayed comparative disadvantage throughout the period. Overall, the RCA pattern confirms the sustained dominance of Asian economies—particularly Pakistan and India—in global rice exports.

Table 8: RSCA of Major Rice Exporting Countries from 2019-23

Year	RSCA India	RSCA Thailand	RSCA Vietnam	RSCA Pakistan	RSCA USA	RSCA China
2019	0.88	0.86	0.75	0.97	-0.07	-0.51
2020	0.90	0.83	0.74	0.97	-0.06	0.99
2021	0.90	0.82	0.75	0.97	-0.07	-0.61
2022	0.90	0.83	0.74	0.97	-0.22	-0.63
2023	0.88	0.84	0.79	0.97	-0.20	-0.67

Source: Author's calculation from UNCOMTRADE(December 2025)

Table 8, presents the revealed symmetric comparative advantage (RSCA) of major rice-exporting countries from 2019 to 2023, where positive values indicate a comparative advantage and negative values indicate a disadvantage. In 2019, Pakistan recorded the highest RSCA (0.97), followed by India (0.88), Thailand (0.86), and Vietnam (0.75), confirming strong competitiveness, while the USA (-0.07) and China (-0.51) showed comparative disadvantage. In 2020, India's RSCA improved to 0.90, and Pakistan remained unchanged at a very high level (0.97). Thailand and Vietnam experienced slight declines but retained an advantage, and China showed an unusually high positive RSCA (0.99). In 2021, the comparative advantage of India (0.90), Thailand (0.82), Vietnam (0.75), and Pakistan (0.97) remained stable, whereas the USA (-0.07) and China (-0.61)

continued to exhibit a disadvantage. During 2022, India maintained strong competitiveness (0.90), Thailand and Vietnam showed marginal weakening, Pakistan remained consistently dominant, and the USA's disadvantage deepened (-0.22) alongside China (-0.63). By 2023, India's RSCA slightly moderated to 0.88, Thailand and Vietnam improved marginally, Pakistan continued to exhibit the strongest and most stable advantage, while the

USA and China remained persistently disadvantaged, underscoring the sustained dominance of Asian exporters in global rice trade.

5. CONCLUSION

The present study examined the long-term growth, instability, and export competitiveness of India's rice sector by integrating production and trade dimensions over an extended period. The analysis reveals that India's rice production has expanded significantly over time, increasing from 26.29 million tonnes in the 1950s to more than 108 million tonnes during 2010–20. This sustained growth can largely be attributed to technological advancements, expansion of irrigation infrastructure, adoption of high-yielding varieties, and consistent policy support. Although production exhibited noticeable inter-year variability, the low trend-adjusted instability suggests that these fluctuations followed a stable long-run growth trajectory rather than indicating structural weakness in the sector.

In contrast, the study finds that rice exports are characterised by substantially higher instability, particularly in value terms. Export value showed pronounced volatility, reflecting sensitivity to international price fluctuations, exchange rate movements, and domestic trade policy interventions such as export restrictions and minimum export price regulations. Export volume also displayed variability, though its adjusted instability was comparatively lower, indicating a more consistent expansion in physical shipments than in export earnings. These results underline the differing dynamics between domestic production stability and export market uncertainty. The competitiveness analysis further confirms India's strong and sustained comparative advantage in the global rice market. High RCA values and consistently positive RSCA indices during 2019–2023 demonstrate India's continued specialisation in rice exports, despite increasing competition from Thailand, Vietnam, and Pakistan. While competing exporters have shown improvements in export performance in recent years, India maintained its leadership position in terms of export volume, peaking in 2022. Destination-wise patterns also highlight the continued importance of West Asian markets, which absorb a significant share of India's rice exports and contribute to export stability.From a policy perspective, the findings emphasise the need to strengthen climate-resilient technologies, improve water and resource-use efficiency, and enhance productivity to sustain long-term production growth. At the same time, reducing uncertainty in export policy through predictable and calibrated trade measures is essential to manage export volatility, safeguard farmer incomes, and maintain India's credibility in international rice markets. Overall, the study provides valuable insights for designing balanced strategies that align food security objectives with export competitiveness and sustainability in India's rice sector.

Acknowledgement

The author gratefully acknowledges the academic guidance and institutional support received from the Department of Economics, Lovely Professional University, during the course of doctoral research from which this study is derived. The author sincerely appreciates the availability of secondary data from official sources, including the Reserve Bank of India, and UNCOMTRADE, which facilitated the empirical analysis. The author also thanks faculty members for their constructive suggestions that contributed to improving the quality of the research. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The authors remain solely responsible for the analysis, interpretations, and any errors in the manuscript.

REFERENCES

1. Adhikari, A., Sekhon, M. K., & Kaur, M. (2016). Export of rice from India: Performance and determinants. Agricultural Economics Research Review, 29(1), 135–150.
2. Ahmad, N., Sinha, D., & Singh, K. M. (2017). Estimating production efficiency in rice cultivation of Bihar: An economic approach (SSRN Working Paper No. 3052070). https://ssrn.com/abstract=3052070
3. Ahuja, S. C., Panwar, D. V. S., Ahuja, U., & Gupta, K. R. (1995). Basmati rice – The scented pearl. Directorate of Publications, CCS Haryana Agricultural University.
4. All India Rice Exporters' Association. (2019). All India Rice Exporters' Association. New Delhi, India.
5. Anjum, S., & Khan, A. (2017). Changing pattern in India's agricultural exports under WTO. Economic Affairs, 62(2), 253–262.
6. Bhalla, G. S., & Singh, G. (2009). Economic liberalisation and Indian agriculture: A statewise analysis. Economic and Political Weekly, 44(52), 34–44. http://www.jstor.org/stable/25663938
7. Bhasin, V. K. (2000). India and the emerging global rice trade. In Aromatic rices (pp. 252–276).
8. Bhattacharya, M. (2011). Spatio-temporal analysis of Indian basmati rice trade and its comparison with Pakistan. Foreign Trade Review, 46(2), 86–107.
9. Cuddy, J. D. A., & Della Valle, P. A. (1978). Measuring the instability of time series data. Oxford Bulletin of Economics and Statistics, 40(1), 79–85.
10. Dalal, K., Ghalawat, S., Girdhar, A., Goyal, M., Malik, J. S., & Kaushal, N. (2024). Trends, growth, production instability and export dynamics analysis of basmati rice in India. Indian Journal of Extension Education, 60(2), 33–37.

11. Dalum, B., Laursen, K., & Villumsen, G. (1998). Structural change in OECD export specialisation patterns. International Review of Applied Economics, 12(3), 423–443.
12. Fathelrahman, E., Osman, R., Hoag, D. L. K., Sixt, G. N., & Strzepek, K. (2024). Bilateral trade welfare impacts of India's export ban of non-basmati rice using the Global Partial Equilibrium Simulation Model (GSIM). Foods, 13(19), Article 3124.
13. Government of India, Ministry of Finance. (1966). Economic survey 1966. Ministry of Finance. http://www.indiabudget.gov.in
14. Goyal, A., & Singh, A. (2020). Growth analysis in agricultural commodities: A methodological perspective. Agricultural Economics Research Review, 33(1), 1–12.
15. Goyal, P. (2023, October 8). Huge demand for Indian chicken and basmati rice in Middle East: UAE industry. Business Standard. https://www.businessstandard.com
16. Jain, A. (2018). Analysis of growth and instability in area, production, yield and price of rice in India. Journal of Social Change and Development, 2, 46–66.
17. Joshi, N., & Kumar, A. (2023). Basmati rice exports from India: Towards global food security. International Journal of Environment and Climate Change, 13(8), 996–1000.
18. Kannan, E. (2011). Trends in India's agricultural growth and its determinants. Asian Journal of Agriculture and Development, 8(2), 79–99.
19. Kannan, E., Paliwal, A., & Sparks, A. (2017). Spatial and temporal patterns of rice production and productivity. In The future rice strategy for India (pp. 39–68). Academic Press.
20. Kumar, K. R. B., Reddy, M. A., Karunakaran, K. R., & Shafeer, K. B. (2021). Trend and instability index analysis in paddy crop area, productivity and production across districts in Andhra Pradesh, India. 39(11), 69–78.
21. Madhu, S., Kamani, D., & Mesara, H. (2023). A study on production and export of rice from India. International Research Journal of Modern Engineering, Technology and Science, 5(3), 346.
22. Mahadevappa, M. (2013). Hybrid rice and water saving technologies: A possible solution for inter-state water dispute. National Institute of Advanced Studies.
23. Mahajan, G., Kumar, V., & Chauhan, B. S. (2017). Rice production in India. In Rice production worldwide (pp. 53–91).
24. Mahmud, S. F. (2021). Opportunities and challenges of sustainable agricultural development in Iraq. International Journal of Social Relevance and Concern, 9(1), 12–24.
25. Mearns, R. (1999). Access to land in rural India: Policy issues and options (World Bank Discussion Paper No. 2123). World Bank.
26. Nisha, Nain, M., & Aneja, D. R. (2019). Growth analysis of area, production and productivity of wheat crop in Haryana and India. Journal of Experimental Biology and Agricultural Sciences, 7(3), 266–272.
27. Praduman Kumar, & Rosegrant, M. W. (1994). Productivity and sources of growth for rice in India. Economic and Political Weekly, 29(53), A183–A188. http://www.jstor.org/stable/4402195
28. Prasad, R., Shivay, Y., & Nene, Y. L. (2016). Asia's contribution to evolution of world agriculture. Asian Agri-History, 20(4), 233–250.
29. Ray, S. K. (1996). Land system and its reforms in India. Indian Journal of Agricultural Economics, 51, 220–237.
30. Sarma, J. S., & Gandhi, V. P. (1990). Production and consumption of foodgrains in India: Implications of accelerated economic growth and poverty alleviation. International Food Policy Research Institute.
31. Sharma, P. (2022, May 25). Import basmati rice from India to Yemen. Medium. https://medium.com
32. Sidhu, A. S., Kaur, M., Arora, K., & Kingra, H. S. (2024). Global markets for Indian basmati rice: Trends and forecasts. Indian Journal of Economics and Development, 20(4), 749–759.
33. Singh, A., Yogeesh, K. J., Gowda, G. R., Nagaraja, M. S., & Hanumanthiah. (2015). Trend analysis of rice (Oryza sativa) production in India. Research Journal of Agricultural Sciences, 6(Special), 1697–1699.
34. Singh, K. (2001). Performance and prospects of agricultural exports of India (Doctoral dissertation). Punjab Agricultural University, Ludhiana, India.
35. Udhayakumar, M., & Karunakaran, K. R. (2020). Growth and stability of basmati and non-basmati rice export in India. Growth, 39, 40.
36. Vollrath, T. L. (1991). A theoretical evaluation of alternative trade intensity measures of revealed comparative advantage. Weltwirtschaftliches Archiv (Review of World Economics), 127(2), 265–280. https://doi.org/10.1007/BF02707986
37. World Bank. (2023). Agriculture, forestry and fishing, value added (% of GDP) – Iraq. World Development Indicators. https://data.worldbank.org