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RESEARCH PAPER

Growth Performance, Instability and Decomposition Analysis of Rapeseed and Mustard Production in Rajasthan: A District-Level Assessment of Alwar and Bharatpur

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ABSTRACT

This study analyzes the growth performance, instability, and sources of production change in rapeseed and mustard across Rajasthan and its key districts, Alwar and Bharatpur, during 2003-04 to 2022-23. Using compound annual growth rate (CAGR), Cuddy Della Valle Index (CDVI) and decomposition analysis, the research provides insights into temporal shifts in area, production, productivity, and farm harvest prices. The findings indicate that Rajasthan achieved modest but positive growth in production (2.12%) and productivity (2.13%), with farm harvest prices rising significantly (6-7% annually). Alwar outperformed state averages, recording consistent expansion in area and higher productivity growth, reflecting successful adoption of improved technologies. In contrast, Bharatpur exhibited mixed trends, with strong initial growth but declining productivity in later years, likely due to climatic and resource constraints. Instability analysis revealed declining acreage variability at the state level, while production fluctuations persisted. Decomposition results highlighted yield as the dominant contributor to production growth in Rajasthan, while area expansion played a stronger role in Bharatpur. Overall, the study underscores the critical role of technological improvements and resource management in enhancing rapeseed and mustard output, while also pointing to regional disparities that require targeted policy interventions.

HIGHLIGHTS

- Rapeseed and mustard production in Rajasthan recorded positive growth during 2003-04 to 2022-23.
- Alwar showed better performance than Bharatpur in area, production, and productivity growth.
- Price and production instability remained significant across Rajasthan and selected districts.
- Yield was the major driver of output growth in Rajasthan, while area expansion dominated in Bharatpur.

Keywords: Rapeseed and Mustard, Growth Analysis, Instability Index, Cuddy-Della Valle Index, Decomposition Analysis, Productivity, Rajasthan

Indian agriculture was practiced way back from Indus valley civilization or Bronze Age which carried diverse practices in modern India. Many technological advancements made Indian agriculture as competing agriculture to the globe. Ever since India got independence from colonial rule, its food grain production has been registered to increase about fivefold to 353 million MT in 2024-25 (Ministry of Agriculture and Farmers' Welfare releases Third Advance Estimates, PIB Delhi). The total area and production under the nine oilseeds crops grown in India, Rapeseed and mustard accounts for 30.3% of the acreage and 33.2% of the production (2023-24). With the production of 13.2 million tons during 2023-24, Rapeseed and mustard became the first

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largest oilseed crop in India. The average Rapeseed and mustard yield are about 1443 kg/ha compared to the combined oilseeds crops average of 1314 kg/ha (2023-24). Although Rapeseed and mustard is cultivated in majority of states of the country, bulk of the production comes from Rajasthan (45.40%), Madhya Pradesh (13.28%) Uttar Pradesh (14.24%) Haryana (10.78%), and West Bengal (6.0%) during (2023-24). Nearly 74 per cent of the area under the crop is irrigated. Rajasthan is a leading state in rapeseed and mustard production in India, contributing significantly to the country's overall output. The Rajasthan stands first position in India with acreage (3.75 million hectares) and production (6.23 million tonnes) of rapeseed and mustard crop in 2023-24 (Directorate of Economic and Statistics, Rajasthan, 2023-24). However, productivity in the Rajasthan relatively lower (1185 kg/ha) as compared to Gujarat (1396 kg/ha) and Haryana (1343 kg/ha). The national yield of 1151 kg/ha (Department of Agriculture and Farmers' Welfare, 2024). Rajasthan state accounted for 47.45% of the country's total production of rapeseed and mustard.

Materials and Methods

The present study was based entirely on secondary data collected for rapeseed and mustard cultivation in Rajasthan and its two major producing districts, namely Alwar and Bharatpur, for a period of twenty years from 2003-04 to 2022-23. Data related to area (ha), production (tonnes), productivity (kg/ha), and farm harvest prices (₹/quintal) were compiled from authentic published sources such as the Directorate of Economics and Statistics, Government of Rajasthan, *Agricultural Statistics at a Glance*, and other official agricultural reports. For analytical convenience, the entire study period was divided into two sub-periods: Period-I (2003-04 to 2012-13) and Period-II (2013-14 to 2022-23), along with the overall period to examine temporal changes in growth, variability, and production dynamics of rapeseed and mustard cultivation.

To estimate the growth performance of area, production, productivity, and farm harvest prices, the Compound Annual Growth Rate (CAGR) was calculated by fitting an exponential growth function to the time-series data. The functional form used in the study was:

$$Y = ab^{tu}_{t} \quad ...(1)$$

where, Y = area, production, productivity, and farm harvest prices of rapeseed and mustard, a = constant term, b = regression coefficient, t = time in years, and u_t = random error term.

For estimation purposes, the above equation was transformed into logarithmic form and estimated using the Ordinary Least Squares (OLS) method. The compound growth rate was computed using the following expression:

$$g = (\text{Antilog of } \ln b - 1) \times 100$$

The significance of the estimated regression coefficient was tested using the *t-test*, expressed as:

$$t_i = \frac{b_i}{SE(b_i)}$$

where, b_i = estimated regression coefficient, and $SE(b_i)$ = standard error of the coefficient.

To examine the degree of variability in area, production, productivity, and farm harvest prices, instability analysis was carried out using both the Coefficient of Variation (CV) and the Cuddy-Della Valle Index (CDVI). The coefficient of variation was estimated as:

$$CV = \frac{SD}{AM}$$

where, SD = standard deviation, and AM = arithmetic mean.

Since CV alone may overestimate instability in the presence of long-term trends, the Cuddy-Della Valle Index was employed to obtain a more refined measure of instability by adjusting for trend effects. The CDVI was estimated as:

$$CDVI = CV \times \sqrt{(1 - R^2)}$$

where, R^2 represents the coefficient of determination obtained from the time trend regression equation.

To identify the contribution of area expansion and yield improvement to changes in total production, decomposition analysis was performed using the model developed by Minhas and Vaidyanathan (1965). In this framework, A_0, P_0, and Y_0 denote

area, production, and yield in the base year, while A_n, P_n, and Y_n represent the corresponding values in the terminal year. The production relationship was expressed as:

$$P_0 = A_0 \times Y_0$$

$$P_n = A_n \times Y_n$$

The changes in production, area, and yield were represented as:

$$\Delta P = P_n - P_0$$

$$\Delta A = A_n - A_0$$

$$\Delta Y = Y_n - Y_0$$

Thus, the total change in production was decomposed into three components, namely area effect, yield effect, and interaction effect, which can be expressed as:

$$\Delta P = A_0 \Delta Y + Y_0 \Delta A + \Delta A \Delta Y$$

This decomposition approach helped in identifying whether production growth in rapeseed and mustard was primarily driven by expansion in cultivated area, improvements in productivity, or the combined effect of both factors. The analytical framework provided a comprehensive understanding of growth trends, instability patterns, and structural sources of output change in Rajasthan and the selected districts.

RESULTS AND DISCUSSION

The growth performance of rapeseed and mustard in Rajasthan and the selected districts revealed significant temporal variations in area, production, productivity, and farm harvest prices during the study period. As presented in Table 1, the area under rapeseed and mustard cultivation in Rajasthan declined during Period-I (2003-04 to 2012-13) at an annual rate of –1.36 per cent, but recovered significantly in Period-II (2013-14 to 2022-23) with a growth rate of 3.07 per cent, resulting in an overall increase of 1.78 per cent. Production exhibited substantial improvement from 0.08 per cent in Period-I to 7.41 per cent in Period-II, with an overall significant growth of 2.12 per cent, while productivity increased from 1.46 per cent to 4.20 per cent during the same period. Farm harvest prices also recorded a significant annual growth of 6.09 per cent over the overall period, indicating improved market incentives for farmers. These findings suggest that technological advancements, improved seed varieties, and better market prices contributed positively to mustard production growth in Rajasthan. Similar findings were reported by Sharma *et al.* (2022) and Verma *et al.* (2024), who observed positive growth trends in oilseed crops in Rajasthan.

Table 1: Compound growth rates (%) of area, production, productivity and farm harvest prices of rapeseed & mustard in Rajasthan

Component	Period-I (2003-04 to 2012-13)	Period-II (2013-14 to 2022-23)	Overall Period (2003-04 to 2022-23)
Area	-1.36^{NS}	3.07 **	1.78^{NS}
Production	0.08*	7.41*	2.12**
Productivity	1.46**	4.20*	2.13*
Farm harvest Price	7.75**	6.9**	6.09*

**Significant at 1% level of significance **Significant at 5% level of significance, NS (Non-Significant).*

Table 2: Compound growth rates (%) of area, production, productivity and farm harvest prices of rapeseed & mustard in Alwar

Component	Period-I (2003-04 to 2012-13)	Period-II (2013-14 to 2022-23)	Overall Period (2003-04 to 2022-23)
Area	2.62*	2.82**	1.06*
Production	5.97*	7.29**	4.33*
Productivity	3.24*	4.36**	3.23*
Farm harvest Price	9.04*	6.83**	6.96*

**Significant at 1% level of significance **Significant at 5% level of significance, NS (Non-Significant).*

At the district level, Table 2 indicates that Alwar performed better than the state average in terms of production growth and productivity improvement. The area under cultivation increased significantly by 2.62 per cent during Period-I and 2.82 per cent during Period-II, while production grew by 5.97 per cent and 7.29 per cent, respectively. Productivity also showed consistent growth throughout the study period, recording an overall growth rate of 3.23 per cent. Farm harvest prices increased

significantly by 6.96 per cent annually over the overall period. The better performance of Alwar may be attributed to greater irrigation coverage, adoption of improved production technologies, and better access to agricultural markets. These results are consistent with the findings of Snehdeep *et al.* (2017), who highlighted the importance of technological adoption in enhancing rapeseed and mustard productivity.

Table 3: Compound growth rates (%) of area, production, productivity and farm harvest prices of rapeseed & mustard in Bharatpur

Component	Period-I (2003-04 to 2012-13)	Period-II (2013-14 to 2022-23)	Overall Period (2003-04 to 2022-23)
Area	2.26 ^{NS}	2.84 ^{NS}	1.52**
Production	7.01*	3.54**	3.34**
Productivity	4.65*	-1.53 ^{NS}	1.28**
Farm harvest Price	9.60*	6.87**	7.01*

**Significant at 1% level of significance **Significant at 5% level of significance, NS (Non-Significant).*

Table 4: Variability in area, production and productivity of rapeseed & mustard in Rajasthan

Particulars	Period-I (2003 to 2012)		Period-II (2013 to 2022)		Overall Period (2003 to 2022)	
	CV	CDVI	CV	CDVI	CV	CDVI
Area	26.91	30.25	10.68	9.94	22.01	19.6
Production	29.61	36.17	19.64	12.08	31.75	21.84
Productivity	8.81	10.77	12.96	7.31	16.62	8.38

In contrast, Bharatpur exhibited comparatively unstable growth patterns, as shown in Table 3. The area under rapeseed and mustard cultivation increased by 2.26 per cent during Period-I and 2.84 per cent during Period-II, with an overall growth of 1.52 per cent. Production registered significant growth of 7.01 per cent in Period-I but slowed down to 3.54 per cent during Period-II. A notable concern was the decline in productivity during Period-II (–1.53 per cent), indicating possible constraints such as erratic rainfall, soil degradation, rising input costs, and inefficient crop management practices. However, farm harvest prices continued to rise significantly at 7.01 per cent annually, which may have encouraged farmers to maintain cultivation despite productivity challenges. Similar instability in oilseed productivity was also reported by Jaison (2020).

The instability analysis provided deeper insights into fluctuations in area, production, and productivity across the selected regions. As depicted in Table 4, Rajasthan recorded high instability in area during Period-I, with a CV of 26.91 per cent and CDVI of 30.25 per cent, which declined considerably during Period-II (CV 10.68 per cent, CDVI 9.94 per cent), indicating improved stability in cultivated area over time. Production instability remained relatively high throughout the study period, while productivity instability remained comparatively lower, suggesting that fluctuations in area played a greater role in output variability than yield fluctuations. These findings align with Kumar *et al.* (2019), who reported similar instability trends in major oilseed crops in India.

Table 5: Variability in area, production and productivity of rapeseed & mustard in Alwar

Particulars	Period-I (2003-2012)		Period-II (2013-2022)		Overall Period (2003-2022)	
	CV	CDVI	CV	CDVI	CV	CDVI
Area	14.38	11.76	13.84	9.34	14.13	12.25
Production	26.43	20.58	27.05	10.74	34.08	19.17
Productivity	20.22	19.48	17.43	10.03	25.57	14.61

Table 6: Variability in area, production and productivity of rapeseed & mustard in Bharatpur district

Particulars	Period-I (2003-2012)		Period-II (2013-2022)		Overall Period (2003-2022)	
	CV	CDVI	CV	CDVI	CV	CDVI
Area	14.77	13.59	13.77	9.50	15.58	12.18
Production	25.62	14.27	22.89	20.03	29.25	18.33
Productivity	19.25	10.47	22.64	18.60	22.24	12.74

The district-level instability analysis further highlighted regional disparities. According to Table 5, Alwar experienced relatively lower instability in area, with CV values around 14 per cent across both periods. However, production instability remained comparatively high, and productivity variability was also notable, with overall CV and CDVI values of 25.57 per cent and 14.61 per cent, respectively. This indicates that despite higher growth performance, Alwar still faced fluctuations

in yield outcomes due to weather variability and changing input use patterns.

Similarly, Table 6 shows that Bharatpur experienced moderate instability in area but relatively higher instability in productivity during Period-II, with a CV of 22.64 per cent and CDVI of 18.60 per cent. Production variability also remained substantial throughout the study period. These findings suggest that Bharatpur faced greater uncertainty in maintaining stable productivity levels compared to Rajasthan and Alwar, likely due to climatic vulnerability and resource constraints.

Table 7: Variability in farm harvest price of rapeseed & mustard in APMCs

APMCs	Period (2003-04 to 2022-23)	
	CV	CDVI
Alwar	42.30	14.78
Bharatpur	41.20	13.94
Rajasthan	41.49	24.53

Table 8: Sources of output growth in rapeseed and mustard in Rajasthan (Percent)

Periods	Yield Effect	Area effect	Interaction Effect
Period-I (2003-4 to 2012-13)	42.67	38.90	18.43
Period-II (2013-14 to 2022-23)	52.65	32.48	14.87
Overall-Period (2003-04 to 2022-23)	47.52	33.74	18.74

Table 9: Sources of output growth in rapeseed and mustard in Alwar (Percent)

Periods	Yield Effect	Area effect	Interaction Effect
Period-I (2003-4 to 2012-13)	40.18	35.23	24.59
Period-II (2013-14 to 2022-23)	46.15	33.85	20.00
Overall-Period (2003-04 to 2022-23)	43.25	46.23	10.52

Table 10: Sources of output growth in rapeseed and mustard in Bharatpur (Percent)

Periods	Yield Effect	Area effect	Interaction Effect
Period-I (2003-4 to 2012-13)	43.12	44.85	12.03
Period-II (2013-14 to 2022-23)	42.36	33.25	24.39
Overall-Period (2003-04 to 2022-23)	39.36	48.63	12.01

Price instability analysis presented in Table 7 revealed substantial fluctuations in farm harvest prices across all selected regions. Rajasthan recorded the highest CDVI value (24.53 per cent) compared to Alwar (14.78 per cent) and Bharatpur (13.94 per cent), indicating relatively higher price instability at the state level. Such fluctuations in prices may influence farmers' production decisions and cropping patterns over time. Similar observations were reported by Ramoliya (2022) in Gujarat's oilseed sector.

The decomposition analysis identified the major contributors to production growth in rapeseed and mustard cultivation. As shown in Table 8, yield effect emerged as the dominant factor contributing to production growth in Rajasthan. During Period-I, yield contributed 42.67 per cent, while area contributed 38.90 per cent and interaction effect accounted for 18.43 per cent. During Period-II, the contribution of yield increased further to 52.65 per cent, indicating the growing role of technological improvements, improved crop management practices, and better input utilization in enhancing productivity. Over the overall period, yield contributed nearly 47.52 per cent to total production growth.

In Alwar, the decomposition results presented in Table 9 reveal that both yield and area expansion played important roles in production growth. During the overall period, area effect contributed 46.23 per cent, slightly higher than yield effect (43.25 per cent), while interaction effect accounted for 10.52 per cent. This suggests that expansion of cultivated land significantly supported production growth in the district.

In Bharatpur, Table 10 shows that area expansion emerged as the dominant source of production growth, contributing 48.63 per cent during the overall period, followed by yield effect (39.36 per cent) and interaction effect (12.01 per cent). The findings imply that production growth in Bharatpur was driven more by expansion in cultivated area rather than productivity improvement, highlighting the need for technological interventions to improve yield stability and long-term sustainability. Overall, the study clearly demonstrates that while Rajasthan has achieved positive growth in rapeseed and mustard production, regional disparities in productivity and

instability require location-specific policy measures to ensure sustainable growth in the oilseed sector.

CONCLUSION

The study concludes that rapeseed and mustard cultivation in Rajasthan registered positive long-term growth in production and productivity during 2003-04 to 2022-23, although regional disparities were evident. Rajasthan showed improved performance in the second period with higher growth in area, production, and productivity, supported by rising farm harvest prices. Among the selected districts, Alwar performed better with consistent growth in area, production, and yield, indicating effective adoption of improved technologies and better resource utilization. In contrast, Bharatpur experienced uneven growth, particularly a decline in productivity during the later period, reflecting challenges related to climatic variability and production inefficiencies.

The instability analysis revealed that variability in cultivated area declined over time at the state level, suggesting greater stability in acreage allocation. However, production and price fluctuations remained significant across Rajasthan and the selected districts. Bharatpur recorded relatively higher productivity instability, while Alwar showed comparatively better stability in production performance.

The decomposition analysis confirmed that yield improvement was the major source of production growth in Rajasthan, whereas area expansion contributed more significantly in Bharatpur and Alwar. Therefore, future policy efforts should focus on enhancing productivity through improved seed varieties, irrigation expansion, efficient input management, price stabilization mechanisms, and district-specific technological interventions to ensure sustainable growth in rapeseed and mustard production.

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