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OILSEED PRODUCTION TRENDS AND PERFORMANCE IN RAJASTHAN INDIA

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ABSTRACT

The agricultural sector is a cornerstone of India's economy, particularly for rural communities and marginalized groups. Rajasthan, the largest state in India, is a significant contributor to the nation's agricultural sector, particularly in the production of groundnut and rapeseed & mustard. Using secondary data from 2000-01 to 2021-22 collected from several authentic sources, the study employs Compound Annual Growth Rate (CAGR) analysis, instability indices, trend models to quantify these trends, and decomposition analysis. Groundnut production showed significant growth, particularly in yield, across the periods studied. The overall growth rate for groundnut production was found to be positive and significant, attributed largely to increase in both area and yield, driven by favourable Minimum Support Prices (MSP). For rapeseed & mustard, while production and yield showed positive growth, some periods exhibited non-significant growth rates. The overall period, however, reflected significant production growth, supported by increased MSPs. Instability analysis revealed considerable variability in the output of both crops, with higher variability noted in production compared to area and yield. Trend analysis identified quadratic and cubic patterns in the growth of groundnut and rapeseed & mustard, respectively. The decomposition analysis further highlighted that primary drivers of production growth were area expansion and yield improvements. The study suggests the need for targeted interventions to enhance agricultural productivity, stabilize prices, and support sustainable growth. Effective agricultural policies, and yield enhancement programs are essential to mitigate the challenges faced by farmers and ensure long-term food and nutritional security in India.

***Keywords*:** Groundnut, Rapeseed & Mustard, CAGR, CDVI, Trend Analysis

Introduction

The agricultural sector has historically been vital for rural communities in India. However, during the 1950s, the nation experienced a significant food grain shortage, necessitating large-scale imports from the USA and other developed countries. Frequent droughts and famines exacerbated the situation, making external food supplies essential. At that time, agriculture accounted for approximately 50.56% of India's GDP, reflecting its critical role in maintaining the country's food and nutritional security.

Agriculture continues to be a key driver of socio-economic development in India, supporting two-thirds of the population. This sector is particularly crucial for marginalized communities, including low-income individuals and vulnerable segments of society. The development of other sectors in India is closely tied to agricultural production through both backward and forward linkages. Between 2012-13 and 2018-19, the monthly income per agricultural household increased significantly from ≠6,426 to ≠10,218, marking a 59 per cent growth.

Rajasthan, the largest state in India, covers 34.22 million hectares, covering around 10.41 per cent of the nation's total geographical area. Agriculture and its allied sectors are crucial to the state's economy, serving as the primary contributors to the Gross State Domestic Product (GSDP). The Gross State Value Added (GSVA) saw a substantial increase from ≠1.569 lakh crore in 2018-19 to ≠2.089 lakh crore in 2022-23, achieving a compound annual growth rate (CAGR) of 7.5 per cent at constant prices of 2011-12. In current

prices, the GSVA of the agriculture and allied sectors grew from ≠2.22 lakh crore in 2018-19 to ≠3.79 lakh crore in 2022-23, representing a CAGR of 14.33 per cent. Within the cropping sector, the contribution to the Gross Value Added (GVA) stands at ≠1.83 lakh crore.

Prominent crops in Rajasthan include pearl millet, groundnut, and green gram among the kharif crops, while wheat, rapeseed, mustard, and gram are the main rabi crops contributing significantly to the state's GVA. As of 2021-22, the total area of the state was reported to be 342.2 lakh hectares. Of this, 4.89 per cent (16.57 lakh hectares) lies fallow, while 52.34 per cent (179.48 lakh hectares) is under net area sown (Department of Agriculture, Government of Rajasthan, 2022).

In the year 2022-23, Rajasthan achieved a significant milestone in food grain production, totalling 253.99 lakh tonnes. Kharif production contributed 97.98 lakh tonnes, while rabi food grain production reached 156.02 lakh tonnes. Noteworthy oilseed crops during the kharif season included groundnut, sesamum, soybean, and castor seed. In the rabi season, prominent oilseed crops were rapeseed and mustard, taramira, and linseed. The total production of oilseeds in 2022-23 was estimated at 99.78 lakh tonnes, with kharif oilseeds accounting for 33.64 lakh tonnes and rabi oilseeds contributing 66.14 lakh tonnes (Department of Agriculture, Government of Rajasthan, 2023).

Analyzing the growth, variability, and trends in area, production, and yield over time is essential for developing an effective price policy. The consensus among economists is that agricultural growth is a crucial component and a prerequisite for overall economic development. Although the decomposition of output growth is a long-established concept in agricultural growth analysis, it remains vital for researchers and policymakers to understand the underlying causes of variations in agricultural output. To maintain economic growth, it is essential to quantitatively evaluate the factors contributing to the increase in agricultural output. By breaking down growth into components such as area, yield, and cropping patterns, it becomes possible to project output under different targets and policies. Therefore, examining the key factors contributing to the recent high growth performance is imperative (Rehman *et al.*, 2011).

Materials and Methods

The study utilized secondary data obtained from multiple sources, including Rajasthan Agricultural Statistics at a Glance and the Directorate of Economics and Statistics, Government of Rajasthan. The data encompassed a time span of 22 years, from 2000-01 to 2021-22.

Compound Annual Growth Rate Analysis

The Compound Annual Growth Rate (CAGR) was calculated for the area, production, and yield of groundnut and rapeseed & mustard in Rajasthan over a 22-year period from 2000-01 to 2021-22. The data was then divided into two distinct sub-periods: Period-I (2000-01 to 2010-11) and Period-II (2011-12 to 2021-22). An exponential function, as detailed below, was employed for this analytical procedure.

$$Y = a\, b^t e^{Ut} \qquad (1)$$

Where,

Y = Area / Production /Yield

a = Intercept

b = Regression coefficient (*'a'* and *'b'* are the parameters to be estimated)

U_t = Disturbance term in year *'t'*

Equation (1) was converted into a log-linear format and expressed as follows:

$$logY = loga + tlogb + U_t + loge \qquad (2)$$

The compound growth rate (g) was subsequently computed as follows:

$$g = (b - 1)100 \qquad (3)$$

Where,

g: Compound growth rate in (%) per annum

b: Antilog of log b

Instability Analysis

The instability was evaluated using the Cuddy-Della-Valle Index, a method proposed by Cuddy and Della Valle in 1978. The Cuddy-Della-Valle Index has been widely utilized in various studies to assess instability in different contexts, including agriculture:

$$CDVI = CV\,(1 - R^2)^{0.5}$$

CV= Coefficient of variation (in per cent)

R^2= The coefficient of determination

Trend Analysis

To examine the trends in the area, production, and yield of major oilseeds, a variety of models were employed, including linear, quadratic, cubic, exponential, and other relevant models.

A) For Linear trend

$$X_t = a + b_t$$

Where,

X_t = Area/production/yield in year 't'.

t = time element which takes the value 1,2,…n.

a = intercept

b_t = regression coefficient

B) For Exponential trend

$$X_t = ab^t$$

$$\text{Log } X_t = \text{Log } a + t\text{Log } b$$

Where,

log a = intercept

log b = regression coefficient

C) For Quadratic trend

$$X_t = ax^2 + bx + c$$

Where,

b= x-intercept

c= y-intercept

D) For cubic trend

$$X_t = ax^3 + bx^2 + cx + d$$

Where,

a, b, c, and d represent the parameters to be estimated.

The optimal trend model was chosen based on the highest R-squared value and the significance of its variables, ensuring the most accurate representation of the data.

Decomposition Analysis

The decomposition model developed by Minhas and Vaidyanathan (1965) was employed to examine the sources of output growth. This model facilitated the calculation of the relative contributions of area, yield, and their interaction effect to the overall output change in Groundnut and Rapeseed & Mustard.

$$P = \frac{Ao\,\Delta Y \times 100}{\Delta P} + \frac{Yo\,\Delta A \times 100}{\Delta P} + \frac{Yo\,\Delta A \times 100}{\Delta P}$$

Production = Yield effect + Area effect + Interaction effect

Where,

P = Production of Groundnut and Rapeseed & Mustard

ΔP = Change in production

ΔA = Change in area ($A_n - A_0$)

ΔY = Change in yield ($Y_n - Y_0$)

Results and Discussion

Estimation of Growth Rate in Area, Production and Yield of Major Oilseeds in Rajasthan

Compound Growth rate in Area, Production and Yield of Groundnut

Groundnut is a kharif oilseed crop in Rajasthan, the Compound Annual Growth Rate (CAGR) of area, production, and yield depicted in Table-1. During Period-I (2001-11), a positive and noteworthy growth rate of area (5.28%) and production (10.85%) of groundnut was observed.

In Period-II (2012-22), there was a positive but non-significant growth rate in area (7.85%) and production (10.52%), while yield showed a positive and significant growth (2.47%). Overall, spanning from 2001 to 2022, a positive albeit non-significant growth rate was observed in the area (6.82%) and production (10.47%) of groundnut, with yield recording a positive and significant growth (3.42%). The rise in groundnut area can be attributed to the increase in Minimum Support Price (MSP) at a CAGR of 6.7% from 2010-11 to 2022-23. A study by Ashwini and Khobarkar (2022) found that while the growth rate of groundnut production in Rajasthan was non-significant during the period 1988-89 to 2017-18, productivity witnessed significance during this time frame.

Compound Growth rate in Area, Production and Yield of Rapeseed & Mustard

Rapeseed & mustard, a rabi oilseed crop in Rajasthan, exhibits Compound Annual Growth Rates (CAGR) in area, production, and yield as presented in Table-1. During Period-I (2001-11), rapeseed & mustard experienced positive and significant growth in production (5.94%) and yield (2.10%). However, in Period-II (2012-2022), there was non-significant growth observed in the area, production, and yield of rapeseed & mustard. Across the Overall Period (2001-2022), rapeseed & mustard's production saw a significant increase (3.64%). The area dedicated to rapeseed & mustard showed positive growth throughout all periods, which can be attributed to the rise in Minimum Support Price (MSP) from ≠1850 in 2010-11 to ≠5450 in 2022-23.

Table 1: Compound Growth Rates in Area, Production and Yield of Groundnut and Rapeseed & Mustard

(In Per cent)

Crops	Area	Production	Yield
Groundnut			
Period-I (2001-2011)	5.28*	10.85*	5.29 ^{NS}
Period-II (2012-2022)	7.85^{NS}	10.52^{NS}	2.47**
Overall Period (2001-2022)	6.82 ^{NS}	10.47 ^{NS}	3.42*
RAPESEED & MUSTARD	**Area**	**Production**	**Yield**
Period-I (2001-2011)	3.76^{NS}	5.94*	2.10*
Period-II (2012-2022)	10.85*	4.78 ^{NS}	3.44 ^{NS}
Overall Period (2001-2022)	10.52^{NS}	3.64*	2.25^{NS}

Note: * Significant at 1 per cent level of significance, ** Significant at 5 per cent level of significance, and NS- Non-significant

Estimation of Instability in the Area, Production and Yield of Major Agricultural Commodities in Rajasthan

This section examined the variations observed in the area, production, and yield of groundnut and rapeseed & mustard crops specifically in Rajasthan. In terms of the instability index, values exceeding 30 are classified as high instability, while values below 30 are regarded as low instability.

Instability in Area, Production and Yield of Groundnut

The variability in the area, production and yield of groundnut crop is mentioned in Table 2.

(i) Area

Area: During Period-I and Period-II, groundnut area exhibited lower variation in terms of CDVI which was 8.86 per cent and 5.89 per cent, respectively. Over the Overall-Period, groundnut area displayed lower variability as per CDVI (12.69%).

(ii) Production

In Period-I and Period-II, groundnut production showed lower variations according to CDVI with values of 21.97 per cent and 9.44 per cent, respectively. In the Overall-Period, lower variability was observed by CDVI (19.02 %) measure.

(iii) Yield

In the Period-I, lower variations were observed in the groundnut production with respect to CDVI (20.07%). This trend persisted in Period-II and the Overall-Period. CDVI values indicated lower variability of 5.69 per cent and 12.71 per cent, respectively. The results are in consonance with Kumar *et al.* (2019) who analysed variability in area, production and yield of soybean crop in India and reported that in the Overall-Period (1996-97 to 2015-16), highest variability was found in production (21.47%) followed by yield (14.01%) and area (6.61%).

2. Instability in Area, Production and Yield of Rapeseed & Mustard

The variability in the area, production and yield of rapeseed & Mustard crop is mentioned in Table 2.

(i) Area

During Period-I, Period-II and Overall-Period, lower variations were observed in the crop area concerning CDVI which were 26.31 per cent, 9.91 per cent and 19.28 per cent, respectively.

(ii) Production

Similar to area, during Period-I, Period-II and Overall-Period, lower variations were observed in the crop production concerning CDVI which were 28.59 per cent, 11.96 per cent and 20.30 per cent, respectively.

(iii) Yield

Similar to area and production, during Period-I, Period-II and Overall-Period, lower variations were observed in the crop production concerning CDVI which were 11.78 per cent, 6.87 per cent and 9.61 per cent, respectively.

The results are in line with Pandey and Rai (2018) who attempted to study variability of rapeseed & mustard production in Eastern Uttar Pradesh and reported that high variability was found in case of area (22.87%), production (23.24%) and yield (22.69%) in Vindhyan Zone.

Table 2 : Measure of Variability in Area, Production and Yield of Groundnut and Rapeseed & Mustard

(In Per cent)

Crops Variability Index	Period-I (2001-2011)			Period-II (2012-2022)			Overall-Period (2001-2022)		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
GROUNDNUT									
CDVI	8.86	21.97	20.07	5.89	9.44	5.69	12.69	19.02	12.71
RAPESEED AND MUSTARD									
CDVI	26.31	28.59	11.78	26.31	28.59	11.78	19.28	20.30	9.61

3. Analysis of Trend in Area, Production and Yield of Major Oilseeds in Rajasthan

The analysis investigated the trends in the area, production, and yield of major oilseeds in Rajasthan from 2000-01 to 2021-22. The significance of the trend equation was evaluated using the 'P value'. This portion presented trends observed for the selected major oilseeds.

Trend in Area, Production and Yield of Groundnut

Groundnut's area and production showed exceptionally strong quadratic fit, with R^2 values of 0.974 and 0.955, respectively (both significant at $p < 0.05$), indicating significant increase, based on quadratic models. Yield displayed a moderately strong quadratic fit with an R^2 value of 0.714 (significant at $p < 0.05$), indicating a slight decrease in 2022.

Trend in Area, Production and Yield of Rapeseed & Mustard

Rapeseed & mustard's area and production showed moderate cubic fit, with R^2 values of 0.450 and 0.669, respectively (both significant at $p < 0.05$), indicating significant increase. Yield showed a relatively moderate exponential fit with an R^2 value of 0.674 (significant at $p < 0.05$).

Table 3 : Estimated Trend Equations of Area, Production and Yield of Groundnut and Rapeseed & Mustard

Crops	Functional forms	Equations	R^2	P value
Groundnut				
Area	Quadratic	$Y= 1.3367x^2 -0.1215x+240.3$	0.974	0.001
Production	Quadratic	$Y= 3.3528x^2+2.984x+277.69$	0.955	0.001
Yield	Quadratic	$Y= -0.001x^2+0.080x+1.0421$	0.714	0.398
Rapeseed & Mustard				
Area	Cubic	$Y = 1.493x^3 - 53.34x^2 + 551.68x + 1087.6$	0.450	0.004
Production	Cubic	$Y = 2.0276x^3 - 67.602x^2 + 714.25x +1095.5$	0.669	0.008
Yield	Exponential	$Y= 1.0404e^{0.0222x}$	0.674	0.001

4. Assessment of the Relative Contribution of Area and Yield in the Growth of Production

The analysis was conducted for two distinct sub-periods (Period-I: 2000-01 to 2010-11, Period-II: 2011-12 to 2021-22) as well as for the Overall-Period from 2000-01 to 2021-22.

Sources of Output Growth in Groundnut

Table 4 displays decomposition analysis of the sources of output growth in groundnut production. In Period-I, groundnut production saw a significant boost from positive yield effect of 33.42 per cent, 42.41 per cent area effect and interaction effect of 24.17 per cent. This aligns with findings by Dupare *et al.* (2014) in soybean crop cultivation in India during the 2002-2007 period. During Period-II, groundnut production was fueled by a positive yield effect (21.79%), area effect (56.88%), and interaction effect (21.33%). Throughout the Overall-Period, groundnut production growth was sustained by a positive yield effect (15.70%), area effect (48.50%), and interaction effect (35.80%).

Sources of Output Growth in Rapeseed & Mustard

The Table 4 presents a decomposition analysis of the sources of output growth in rapeseed & mustard production. During Period-I, rapeseed & mustard production saw significant contributions from both a positive yield effect (21.01%) and area effect (70.86%), indicating expansion of cultivated land. The positive interaction effect (8.13%) signified those combined changes in yield and area contributed to production growth, consistent with findings by Dupare *et al.* (2014) in major oilseed crops during the 2003 to 2007 period in India.

In Period-II, rapeseed & mustard production continued to grow, driven by a positive yield effect (45.43%) and area effect (43.88%). The interaction effect (10.69%) also remained positive during this period.Throughout the Overall-Period, rapeseed & mustard production showed sustained growth, with a positive yield effect (28.75%), area effect (45.02%) and interaction effect (26.23%).

Table 4 : Sources of Output Growth in Groundnut and Rapeseed & Mustard Production

(In Per cent)

Crops			
Groundnut			
Periods	**Yield Effect**	**Area effect**	**Interaction Effect**
Period-I (2000-01 to 2010-11)	33.42	42.41	24.17
Period-II (2011-12 to 2021-22)	21.79	56.88	21.33
Overall-Period (2000-01 to 2021-22)	15.7	48.50	35.8
RAPESEED & MUSTARD	**Yield Effect**	**Area effect**	**Interaction Effect**
Period-I (2000-01 to 2010-11)	21.01	70.86	8.13
Period-II (2011-12 to 2021-22)	45.43	43.88	10.69
Overall-Period (2000-01 to 2021-22)	28.75	45.02	26.23

Conclusion

The study highlighted the critical role of agriculture in Rajasthan's economy, with substantial growth observed in groundnut and rapeseed & mustard production over the past two decades. However, significant variability in production poses challenges for farmers. Targeted support for low-income and vulnerable farmers through subsidies and financial assistance can help them adapt to variability and market changes. Effective agricultural policies and market strategies are essential to stabilize incomes and support sustainable growth. Emphasizing yield improvements and area expansion, coupled with price stabilization mechanisms, can enhance agricultural productivity and resilience.

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