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Chanchal
Ph.D. Scholar; Department of Agricultural Economics, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Damor Joyal Rupsinh
Ph.D. Scholar; Department of Agricultural Economics, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Krishna
Ph.D. Scholar; Department of Agricultural Economics, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Tripti Verma
Ph.D. Scholar; Department of Agricultural Economics, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Corresponding Author:
Chanchal
Ph.D. Scholar; Department of Agricultural Economics, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Decomposition analysis and acreage response of linseed in Chhattisgarh

Chanchal, Damor Joyal Rupsinh, Krishna and Tripti Verma

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Abstract
Linseed is the first non-edible oilseed crops of Chhattisgarh. In present investigates is based on the decomposition analysis and acreage response of linseed in Chhattisgarh. The study was based on time series secondary data on area, production, productivity, the rainfall, farm harvest prices, which were obtained various government records and websites. The study period was from 2001-02 to 2022-23 and it had divided into three periods 2001 to 2011, 2012 to 2022 and 2001 to 2022. The decomposition analysis suggested that percent contribution of area effect was more responsible of linseed production followed by interaction and yield effect in all three periods for all selected district of Chhattisgarh, including India. The current year linseed acreage was influenced neither by farm harvest price in Sarguja and Surajpur district nor by annual rainfall in Sarguja district. Decreasing in yield gap and adoption of new technology can improve Chhattisgarh as well as India's Linseed production and increase linseed production and consumption.

Keywords: Linseed, area, production, productivity, decomposition, acreage

1. Introduction
Oilseed occupies for 14 percent of area and 8.5 percent of production of all the crops. India is ideally suited for growing all the major oilseed crops. Among the nine oilseed crops grown in the country, seven are of edible oils (Soybean, Groundnut, Rapeseed-Mustard, Sunflower, Sesame, Safflower and Niger) and two are of non-edible oils (Castor and Linseed). About 107.52 lakh ha area coverage has been reported compared to 99.65 lakh ha during the corresponding period of last year. Thus 7.87 lakh ha more area has been covered compared to last year. (A/C to Ministry of Agriculture and Farmers Welfare)**.** Linseed or seed flax (*Linum usitatissimum* L., 2n = 30, X = 15) belong to the order Malpighiales, the family Lineceae and the tribe Lineae is one of the oldest cultivated crops grown for seed and fiber. In India linseed is predominantly grown under rainfed (63%) and utera (25%) conditions (Netam *et al*.) [9].

2. Objectives
1. Decomposition analysis of linseed for selected districts of Chhattisgarh, India.
2. Acreage response analysis of linseed for selected districts of Chhattisgarh based on nerlovian model.

3. Materials and Methods
3.1 Selection of study area
Chhattisgarh state is made up of a total 33 district, which out of 5 districts Balrampur, Sarguja, Surajpur (Northern Hill Zone), Rajnandgaon (Chhattisgarh Plain Zone) and Kanker (Bastar Plateau Zone) district were selected for the study purpose.

3.2 Collection of data
Analysis was based on secondary data. Time series secondary data on area, production and productivity of linseed were collected from various source. District Statistical Book Directorate of Agriculture and Statistical Abstract of Chhattisgarh State, Indiastat website etc. For area, production and productivity data collected for the last 22 years that is from the year 2001-02 to

2022-23 for all the selected district. We had divided into three periods; 2001 to 2011, 2012 to 2022 and 2001 to 2022, because Balrampur and Surajpur district was separated from Sarguja district in 2012.

3.3 Analytical tools

3.3.1 Decomposition of total agricultural output growth

The contribution of area and productivity or the interaction of area and yield of the production was estimate by using the decomposition profounded by Dr. Minhas 1964, which is used to estimate the contribution of area and yield to production change (positive/negative).

Yield effect: Shows percentage share of average yield in total production.

$$YE = \frac{(Y_n - Y_0) A_0}{P_n - P_0} X\ 100$$

Area effect: Show percentage share of total area in total production.

$$AE = \frac{(A_n - A_0) Y_0}{P_n - P_0} X\ 100$$

Interaction effect: Shows percentage share of area and yield (simultaneous variation) interaction towards total production.

$$IE = \frac{(Y_n - Y_0)(A_n - A_0)}{P_n - P_0} X\ 100$$

Where,
A0 = Triennium average of area in base year
P0 = Triennium average of production in base year
An = Triennium average of area in current year
Pn = Triennium average of production in current year
Yn = Pn / An
Y0 =P0 / A0

3.3.2 Acreage response analysis

The model which generally used in supply response analysis based on time series data has been used adaptive expectations or distributed lagged model. In the present study the regression model of the Nerlovian lagged adjustment model (1958) was used. The acreage response means the change in acreage with the unit change in the variables affecting on during the period of study (Sandeep *et al.*) [13] SPSS software used for acreage response analysis.

$$At\ a = a + b_1 A_{t-1} + b_2 FHP_{t-1} + b_3 Y_{t-1} + b_4 W_t + b_5 PR + b_6 YR$$

Where,
a = Area
At= Area under crop at time `t' (`00' ha)
At-1 = One year lagged area under the crop (`00' ha)
FHPt-1 = Lagged year farm harvest price of the crop (kg/ha)
Yt-1 = One year lagged yield
Wt = Weather variable as rainfall data per year.
PR =Price risk (coefficient of variation of last three years)
YR = Yield Risk (coefficient of variation of last three years)
b1... b6 = Parameters of multiple linear regression

4. Results and Discussion

4.1 Decomposition Analysis of Linseed for Selected Districts of Chhattisgarh, India

The decomposition analysis does not evaluate the contribution of area and yield towards the production growth. So, it is necessary to examine the sources of output growth. To appraise the sources of output growth for linseed, the change in production is divided in to three effects i.e., area effect, yield effect and interaction effect. The relative contribution of area, yield and their interaction to changes in production of linseed. The decomposition analysis of linseed production in area, yield and interaction effect presented in below Table.

Table 1: Decomposition analysis of area, yield and their interaction towards increasing production of linseed crop in India and Chhattisgarh

Particular's	Criteria	Period- I (2001-2011)	Period – II (2012-2022)	Overall (2001-2022)
India	AE	135.15	148.16	153.76
	YE	-50.31	-60.60	-113.38
	IE	15.16	12.44	59.62
Chhattisgarh	AE	110.96	91.83	102.50
	YE	-21.00	19.05	-14.84
	IE	10.04	-10.88	12.34

AE – Area effect, YE – Yield effect, IE – Interaction effect

In Table 1, The overall period in year 2001-2022 shows that the positive area effect was 153.76 per cent in India, suggests that the increase in the cultivated area with a favorable impact on linseed production. Expanding the cultivation area contributes positively to overall output. The negative yield effect was -113.38 per cent implies that change in yield per unit area was a detrimental impact on linseed production. This could be indicative of a decrease in efficiency in term of output per unit area. The positive interaction effect was 59.62 per cent signifies that there is a synergistic effect between the area and yield components. This suggests that the combined influence of changes in both area a yield contributes positively to linseed production beyond the sum of their individual effect.

During the period I in year 2001-2011, the results clearly indicates that the area effect 110.96 per cent was most responsible for increasing the production of linseed in Chhattisgarh with yield effect was -21.00 per cent and interaction effect was 10.04 per cent. The interaction effect was positive for all the districts and the Sarguja district was recorded highest area effect i.e. 542.05 per cent. Overall, the districts yield effect in districts was found negative effect.

Table 2: Decomposition analysis of area, yield and their interaction towards increasing production of linseed crop in selected district of Chhattisgarh

District	Criteria	Period- I (2001-2011)	Period – II (2012-2022)	Overall (2001-2022)
Rajnandgaon	AE	104.36	107.76	104.85
	YE	-12.94	-145.83	-68.04
	IE	8.58	100.00	63.19
Kanker	AE	135.28	92.20	98.79
	YE	-449.45	-124.62	10.28
	IE	100	100.00	-9.08
Sarguja	AE	542.05	678.51	124.74
	YE	-467.60	-749.43	-105.50
	IE	25.55	170.92	80.76
Balrampur	AE	-	89.76	-
	YE	-	18.25	-
	IE	-	-8.00	-
Surajpur	AE	-	99.04	-
	YE	-	1.74	-
	IE	-	-0.78	-

AE – Area effect, YE – Yield effect, IE – Interaction effect

In the contrary during period II (2012-2022), it was noticed that the yield effect 19.05 per cent was responsible for increasing production of linseed in Chhattisgarh, where area and interaction effect was 91.83 and -10.88 per cent respectively. The area and interaction effect of Sarguja district i.e. 678.51 per cent and 170.92 per cent respectively were highest among all the districts, whereas yield effect was negative for all the selected districts except Balrampur and Surajpur district.

During overall period (2001-2022), area effect 102.50 per cent was found most responsible factors for increasing linseed production in Chhattisgarh with negative yield effect and positive interaction effect i.e. -14.84 and 12.34 per cent respectively. Highest area effect recorded in Sarguja district was 124.74 percent. The highest interaction effect was found in Sarguja district and yield effect was found in Kanker district 80.76 and 10.28 per cent respectively.

The positive area effect indicates that expanding the cultivated area with positively influences production. However, the negative yield effect suggests with challenges related to productivity. The positive interaction effect indicates that the optimizing both area and yield management together can lead to more substantial positive outcome in linseed production, potentially offsetting some of the negative yield impacts.

In Table 2 the Balrampur and Surajpur district were positive area and yield effect that both expanding the cultivated area and improving yield contribution positively for linseed production. However, the negative interaction effect implies that there might be some negative synergy when considering changes in both area and yield together, potentially limiting the overall positive impact on production for further analysis may be needed to understand the factors influencing this interaction effect and optimize production strategies accordingly.

This result inferred that the production of linseed was stunted due to the restriction of linseed cultivation to marginal land coupled or utera crop with poor management practices, climate change and incidence of pests and diseases and lower contribution of yield effect concluded that the technology was not made any positive impact on the linseed production during this period.

4.2 Acreage Response of Linseed for Selected District of Chhattisgarh

Acreage response function was fitted to examine the effect of price and non-price factors on farmer's decision in allocating the area of linseed. In Table 3 the value of R^2, representing the coefficient of multiple determinations ranged from 0.97 to 0.99 for all the districts of Chhattisgarh, indicating that the variables included in the model explained most of the variations in area under linseed during the study period. The regression coefficients for the lagged area were positively and statistically non-significant in all the districts except Rajnandgaon district, indicating lesser rigidity in the adjustment of area under linseed. The coefficient of farm harvest price was positive and significant for Sarguja and Surajpur district in the study, indicating that prices was an impact on one year lag prices for increasing the area of linseed. The coefficient of annual rainfall variable showed a positive relationship for all district except Rajnandgaon district and statistically significant in Sarguja district at 10 per cent level, indicating that annual rainfall favorably influenced the area allocation decision of the farmers. The coefficient of yield risk was a positive response for all district except Sarguja district. On the other hand, the coefficient of price risk was negative response for Sarguja and Balrampur district.

Table 3: Coefficient of acreage response function of linseed for selected district of Chhattisgarh

Particulars	Variable's	Coefficients			
		Rajnandgaon	Sarguja	Balrampur	Surajpur
	Intercept	4.294	-6.42608	-10.8427	-12.0341
One year lagged area	A_{t-1}	-0.00074	0.000572	8.58E-05	0.002869
One year lagged farm harvest price	FHP_{t-1}	0.00128	0.002127**	0.00357	0.003158**
One year lagged yield	Y_{t-1}	0.00493	-0.0109	0.001726	-0.01116
Annual rainfall	W_t	-0.0033	0.00443*	6.22E-05	0.00013
Yield risk	Y_r	0.00185	-0.04213	0.00191	0.012171
Price risk	P_r	0.028909	-0.01341	-0.0058	0.092712
Coefficient of determination	R^2	0.97	0.99	0.99	0.99

** and * denotes significant at 5% and 10% level of significance

5. Conclusion and Suggestion

Area and interaction effect observed positive but yield effect observed negative except Surajpur district. The highest interaction effect was found in Sarguja district and yield effect was found in Balrampur district. The positive area effect indicates that expanding the cultivated area positively influences production. However, the negative yield effect suggests challenges related to productivity. The positive interaction effect indicates that optimizing both area and yield management together can lead to more substantial positive outcome in linseed production.

In the acreage response analysis, it is concluded that acreage a linseed was predominantly influenced by the lagged yield and gross irrigated area during the year, while the lagged farm harvest prices emerge as significant determinant in acreage response analysis. If prices increase by one per cent than the percentage of acreage will be increased but negligible by the farmers. It is concluded that Nerlovian acreage response function is very well explained by the various contributing factors and supply response is according to price and lagged price. The regression coefficients for the lagged area were positively and statistically non-significant in all the districts except Rajnandgaon district, indicating lesser rigidity in the adjustment of area under linseed. The coefficient of farm harvest price was positive and significant for Sarguja and Surajpur district in the study, indicating that prices was an impact on one year lag prices for increasing the area of linseed.

The study findings suggest the need for research efforts to concentrate on production techniques, improve productivity, and developing varieties with higher productivity potential, wider adaptability, application of improved crop protection techniques, and capacity building for expertise in agronomic practices will have vital role in providing modern linseed production systems in India.

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