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Lalasab Allasab Nadaf
Department of Agricultural Economics and Management, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Latika Sharma
Department of Agricultural Economics and Management, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Hari Singh
Department of Agricultural Economics and Management, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Giridhar Lal Meena
Department of Agricultural Economics and Management, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Shalini Pilania
Department of Agricultural Economics and Management, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Corresponding Author
Lalasab Allasab Nadaf
Department of Agricultural Economics and Management, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Acreage response function of oilseed crops in Rajasthan

Lalasab Allasab Nadaf, Latika Sharma, Hari Singh, Giridhar Lal Meena and Shalini Pilania

Abstract
For analysis of the acreage response function of the oilseed crops in Rajasthan, the current study was conducted from 2000-01 to 2019-20. Four major oilseed crops mainly Groundnut, Sesamum, Soybean and Rapeseed & Mustard were considered for the analysis. Acreage response function revealed that area under irrigation and better price in the previous year were the deciding factors for current acreage under groundnut while area under cultivation in the previous year was the major deciding factor for Sesamum. In Soybean, better price and yield in previous year were the deciding factors while the area under cultivation in previous year, area under irrigation and price were the major deciding factors for current acreage of Rapeseed and Mustard in Rajasthan.

Keywords: acreage response function, elasticity

Introduction
India is the largest producer of oilseeds in the world and oilseed sector occupies an important position in the agricultural economy of the country. Oilseeds are among the major crops that are grown in our country apart from cereals. Oilseed cultivation is undertaken across the country in about 26.00 million ha, largely under rainfed areas covering 72 percent of marginal land and producing around 30.00 million ton of oilseeds in 2019-20 as per the data of Directorate of Economics and Statistics, Ministry of Agriculture, Cooperation and Farmers Welfare, Government of India. Nine oilseeds are the major source of vegetable oil in the country i.e. Groundnut, Soybean, Rapeseed and Mustard, Sunflower, Sesamum, Safflower, Niger, Castor and Linseed. Among nine major oilseeds Soybean (39%), Groundnut (26%) and Rapeseed &Mustard (24%), contribute to more than 88 percent of total oilseeds production in the country However in terms of vegetable oil production Rapeseed and Mustard, Soybean and Groundnut contribute 31 percent, 26 percent and 25 percent respectively. Madhya Pradesh, Rajasthan, Maharashtra and Gujarat are the major oilseeds producing states contributing more than 78 percent of oilseeds production in the country. Oilseed cakes with 40-60 per cent protein is good for animal feed and green manure and direct export of these oilseed cakes earned foreign exchange of INR 2,200 crore in 2016-17. Oilseed crops contains energy rich elements in equation 1 Kg of oil = 1.66 g of protein =2.37 g of carbohydrates (Laxminarayan, 2018) [4].

Rajasthan is currently the largest state of India covering 10.41 percent of total geographical area of the country. Rajasthan has total cultivable land of 17.90 million hectare (Department of Agriculture, Government of Rajasthan). Rajasthan state occupies a prominent place i.e. second place after Madhya Pradesh in the oilseeds production of India. Among total cultivable land of 17.90 million hectare, 5.80 million hectare land is under oilseed production with 7.33 million ton of oilseed production in 2019-20 (4th Advance estimates, Department of Agriculture, Government of Rajasthan). The important oilseed crops of Rajasthan state are Groundnut, Soybean, Rapeseed & Mustard, Sesamum and Taramira. Rajasthan is the leading producer of Rapeseed and Mustard with production of 4.30 million ton and second largest producer of Groundnut and third largest producer of Soybean with production of 1.61 million ton and 0.52 million ton respectively (Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare).

Regardless of the fact that India is the world's largest producer of oilseeds, it is unable to meet domestic demand for edible vegetable oils because edible oil is such a vital element of our everyday diet. Consumption of edible oils in India has increased steadily throughout the years and reached to 36.7 million tonnes in 2019-20. (GAIN Report, 2020) [3]. The rise in domestic edible oil production (30 million tonnes in 2019-20) has not kept up with the increase in

consumption demand and the gap between production and consumption is being bridged with imports.

Materials and Methods

Among all oilseed crops being produced in the state of Rajasthan, four oilseed crops which contributes major share in area were selected thus Groundnut, Sesamum, Soybean, Rapeseed and Mustard were selected. The analysis of acreage response function of selected major oilseed crops was done from 2000-01 to 2019-20 as whole period.

To work out the acreage response pattern of major oilseed crops to find out effects of several factors on the change of acreage in cultivation, the following acreage response function has been estimated:

$$A_t = f\ (A_{t-1}, Y_{t-1}, P_{t-1}, Y_{ct-1}, P_{ct-1}, R_t, R_{t-1}, I_t, I_{t-1}, Sp_{t-1}, Sy_{t-1}, e_t)$$

Where,

A_t = Current year area of the oilseed crops

A_{t-1} = One year lagged area of the oilseed crops

Y_{t-1} = One year lagged yield (average) of the oilseed crops

P_{t-1} = One year lagged price (average) of the oilseed crops

Y_{ct-1} = One year lagged yield (average) of competing crop

P_{ct-1} = One year lagged price (average) of the competing crop

R_t = Rainfall in the t^{th} year

R_{t-1} = One year lagged rainfall

I_t = Total irrigated area in t^{th} year

I_{t-1} = Total irrigated area in $(t-1)^{th}$ year

Sp_{t-1} = Standard deviation of prices for preceding 3 years

Sy_{t-1} = Standard deviation of yield for the preceding 3 years

e_t = Error term

Keeping in mind the likely multicollinearity between explanatory variables backward elimination method has adopted to retain the significant variables after eliminating the problems of multicollinearity.

Selection of Competing Crops

Selection of competing crop will be made based on correlation coefficient between areas under different crops for the period 2000-01 to 2019-20. Those crops having highest negative correlation coefficient between these areas under these crops will be chosen as competing crops.

Elasticities from Estimated Acreage Response Function

When, Y = f(X) is a function, the elasticity of Y with respect to X is given by:

$$e_{yx} = \frac{\%\ \text{Change in Y}}{\%\ \text{Change in X}}$$

$$= \frac{\Delta Y / Y}{\Delta X / X}$$

$$= \frac{\Delta Y}{Y} \cdot \frac{X}{\Delta x}$$

$$= \frac{\Delta Y}{\Delta X} \cdot \frac{X}{Y}$$

$$= \frac{dY}{dX} \cdot \frac{\overline{X}}{\overline{Y}}$$ for the average situation

When $Y = \hat{a} + \hat{b}$ X is the estimated equation

$$e_{yx} = b\frac{\overline{X}}{Y}$$

Test of Significance

i. To test the significance of estimated coefficients, 't' test was used.

Where; Calculated 't'= $\frac{b}{Se(b)}$

b = Estimated coefficient of the model

Se (b) = Standard error of the estimated coefficient

ii. To test the overall significance of estimated model 'F' test was used:

$$\text{Calculated 'F'} = \frac{\text{Sum of squares due to model / d.f}}{\text{Error sum of squares / d.f.}}$$

Results and Discussion

Acreage Response Function of Groundnut in Rajasthan

The parameters of estimated acreage response function of Groundnut using backward elimination method and the elasticity coefficient of Groundnut with respect to significant variables in the acreage response function were given in table 4.38. These parameters revealed that explanatory variable like total irrigated area in current year had significantly positive influence on acreage of groundnut in current year. The positive sign of coefficient of total irrigated area in current area (I_t) indicates that as the irrigation potential increases, farmers tend to cultivate Groundnut in more land. The explanatory variable like one year lagged price of the competing crop (Arhar) had significantly negative effect on current year acreage of Groundnut. The elasticity coefficients of significant variables of Groundnut for acreage response function revealed that acreage under Groundnut was positively elastic to total irrigated area in current year (0.64) and negatively elastic to one year lagged price of the competing crop (-0.09). Other variables like price and yield of Sesamum in previous year had positive effect and rainfall in lagged year had negative effect on current year acreage of Sesamum in Rajasthan.

Table 1: Parameters of Estimated Acreage Response Function of Groundnut Using Backward Elimination Method

Sl. No	Variables	Parameter estimates		
		'b' value	Standard error	Elasticity coefficients
1.	Acreage (A_t)	125838.42*	19570.01	-
2.	Total irrigated area in current year (I_t)	0.857*	0.092	0.647
3.	One year lagged yield (Y_{t-1})	26682.697	19441.31	-
4.	One year lagged price (P_{t-1})	20.004	15.804	-
5.	One year lagged price of the competing crop Arhar (P_{ct-1})	-12.168*	5.365	-0.099
6.	One year lagged rainfall (R_{t-1})	-606.903	424.061	-
7.	SD price (Sp_{t-1})	-54.084	30.679	-
R^2 value = 0.994 F (1,11) = 1.583				

(*Significant at 5 per cent level of significance)

Acreage Response Function of Sesamum in Rajasthan

The parameters of estimated acreage response function of Sesamum using backward elimination method and the elasticity coefficient of Sesamum with respect to significant variables in the acreage response function were given in table 4.40. The analysis revealed that explanatory variable like one year lagged area was found to have significantly positive influence on acreage of Sesamum in current year. Positive influence of one year lagged area (A_{t-1}) indicates that if more area of cultivation in previous year made farmers to cultivate in same or more area under known crop. The elasticity coefficients of significant variables of Sesamum for acreage response function revealed that acreage under Sesamum was positively elastic (0.61) to one year lagged area. Other explanatory variables like One year lagged yield of Sesamum, rainfall in current year had positive influence on current year acreage of sesamum while variables like one year lagged yield of competing crop Urad and rainfall in previous year had negative influence on current year acreage of Sesamum in Rajasthan.

Table 2: Parameters of Estimated Acreage Response Function of Sesamum Using Backward Elimination Method

Sl. No	Variables	Parameter estimates		
		'b' value	Standard Error	Elasticity coefficients
1.	Acreage (A_t)	139385.575	154769.592	-
2.	One year lagged area (A_{t-1})	0.622*	0.215	0.61
3.	One year lagged yield (Y_{t-1})	537407.535	315618.521	-
4.	One year lagged yield of competing crop Urad (Y_{ct-1})	-147205.836	190707.935	-
5.	Rainfall (Rt)	1582.023	2134.644	-
6.	One year lagged rainfall (Rt-1)	-3151.553	2510.660	-
R^2 value = 0.592 F (1, 12) = 0.695				

(*Significant at 5 per cent level of significance)

Acreage Response Function of Soybean in Rajasthan

The parameters of estimated acreage response function of Soybean using backward elimination method and the elasticity coefficient of Sesamum with respect to significant variables in the acreage response function were given in table 4.42. The analysis revealed that explanatory variables like one year lagged yield and one year lagged price of the competing crop Maize were found to have coefficient which were found to have significantly positive influence on current year acreage of Soybean. Positive sign of both variables indicates that better yield of Soybean in previous years might cause the increase in area in current year and low price for the competing crop like Maize in previous year may leads to shift to cultivation of soybean. The elasticity coefficients of significant variables of Soybean for acreage response function revealed that acreage under Sesamum was positively elastic to one year lagged yield (0.286) and one year lagged price of the competing crop Maize (0.545).

Table 3: Parameters of Estimated Acreage Response Function of Soybean Using Backward Elimination Method

Sl. No	Variables	Parameter estimates		
		'b' value	Standard error	Elasticity coefficients
1.	Acreage (A_t)	147233.957	126479.629	-
2.	One year lagged yield (Y_{t-1})	210883.91*	89364.267	0.286
3.	One year lagged price of the competing crop Maize (P_{ct-1})	491.933*	73.305	0.545
R^2 value = 0.752 F (1, 15) = 1.226				

(*Significant at 5 per cent level of significance)

Acreage Response Function of Rapeseed and Mustard in Rajasthan

The parameters of estimated acreage response function of Rapeseed and Mustard using backward elimination method and the elasticity coefficient of Rapeseed and Mustard with respect to significant variables in the acreage response function were given in table 4.44. The explanatory variables like total irrigated area in current year, one year lagged irrigated area, variability of yield were held to have significantly positive influence on current year acreage while one year lagged area, one year lagged price of the competing crop Wheat were found to have significantly negative influence on current year acreage of Rapeseed and Mustard. This indicates that due to increased irrigated area in the lagged year and current year increases the yield of Rapeseed and Mustard. These increased yield and better price for the produce had an positive effect on increasing the area under cultivation. The elasticity coefficients of significant variables of Rapeseed and Mustard for acreage response function revealed that acreage under Rapeseed and Mustard was

positively elastic to irrigated area in current year (0.98), lagged irrigated area (0.57) and variability in yield (0.10) of Rapeseed and Mustard. Apparently, it showed negative elasticity for acreage under Rapeseed and Mustard to one year lagged area (-0.53) and one year lagged price of the competing crop Wheat (-0.31).

Table 4: Parameters of Estimated Acreage Response Function of Rapeseed and Mustard Using Backward Elimination Method

Sl. No	Variables	Parameter estimates		
		'b' value	Standard error	Elasticity coefficients
1.	Acreage (A_t)	498783.731*	136756.650	-
2.	One year lagged area (At-1)	-0.533*	0.199	-0.53
3.	One year lagged price of the competing crop Wheat (Pct-1)	-690.527*	118.405	-0.31
4.	Total irrigated area in current year (It)	1.152*	0.072	0.98
5.	One year lagged irrigated area (It-1)	0.679*	0.269	0.57
6.	SD yield (Syt-1)	1957009.044*	505216.346	0.10
7.	SD price (Spt-1)	319.237	151.818	-
R^2 value = 0.982 F (1, 11) = 110.240				

(*Significant at 5 per cent level of significance)

Conclusion

Area under irrigation and better price in the previous year were the deciding factors for current acreage under groundnut. Area under cultivation in the previous year was the major deciding factor for present acreage for Sesamum. In case of Soybean, better price and yield of soybean in previous year were the crucial factors for deciding current acreage while the area under cultivation in previous year, area under irrigation and price were the major deciding factors for current acreage of Rapeseed and Mustard.

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