Supply responses to acreage of major oilseed crops in Rajasthan, India

Abstract

Oilseed crops are the second most important determinant of the agricultural economy, next only to cereals within the segment of field crops. Self-sufficiency in oilseeds was attained through "The Yellow Revolution" during the early 1990s and the major ones are soybean, groundnut, rapeseed-mustard, sesame, sunflower, castor, safflower, linseed and niger. Among the nine oilseed crops in India, the highest average contribution to total production of oilseeds is soybean followed by rapeseed & mustard and groundnut. Similarly, the highest average area contribution to the total oilseed area is of soybean (44%) followed by rapeseed & mustard (24%) and groundnut (20%). Against this backdrop, the present study attempts to employ the Nerlovian lagged adjustment function for significant oilseed crops in Rajasthan to estimate the degree of acreage/supply responsiveness analyses. For the study secondary data from 1997-98 to 2020-21 were collected to obtain the results of acreage responsiveness of oilseed crops like groundnut, rapeseed & mustard and soybean in Bikaner, Alwar and Baran districts respectively.

Keywords: oilseeds, acreage responsiveness, elasticity, Nerlovian lagged adjustment function

Introduction

India is the fourth largest oilseed producing country in the world, next only to USA, China and Brazil. Indian share in world production of oilseeds has been around 10 percent. It has 20.8% of the total area under cultivation globally, accounting for 10% of global production. The diverse agro-ecological conditions in the country are favourable for growing 9 annual oilseed crops, which include 7 edible oilseeds (groundnut, rapeseed & mustard, soybean, sunflower, sesame, safflower and niger) and two non-edible oilseeds (castor and linseed).

India's oilseed production increased from 94 million tons in 1980 to 376 million tons in 2021-22. The country recorded a productivity level of oilseeds yield of 1284 kg/ha during 2017-18 followed by 1254 kg/ha during 2020-21 due to favourable weather conditions and support given by the Govt of India to the Oilseeds production/developmental programmes and policies.

Different oilseeds are grown covering approximately 12 per cent of the total cropped area of the country. Nearly 72% of the oilseed area is restricted to rainfed farming done by small farmers which led to poor productivity. However, a breakthrough was realized in oilseed production by introducing the latest crop production technologies. The production of oilseeds in India has been growing for the last five years. In 2020-21, the production of the country was 365.65 lakh tonnes which was a 10% increase from that of the previous year. From the years 2015-16 to 2020-21, the compound annual growth rate (CAGR) of production was 7.7%. This was achieved due to the implementation of various programs like special programmes on mustard & rapeseed during Rabi and cluster demonstrations of improved technology by the Government of India (Anonymous, 2022). Among the seeds, soybean (34%), groundnut (27%), rapeseed & mustard (27%) contributes to more than 88% of total oilseeds production and more than 80% of vegetable oil with major share of mustard (35%), soybean (23%) and groundnut (25%).

The largest oilseed-producing states in India include Andhra Pradesh (groundnut), Gujarat (groundnut), Haryana (mustard), Karnataka (ground nut), Madhya Pradesh (soybean), Maharashtra (soybean), Rajasthan (rapeseed & mustard and soybean),, Tamil Nadu (groundnut), Uttar Pradesh (mustard) and West Bengal (mustard). Out of these states, Rajasthan, Gujarat, Madhya Pradesh and Maharashtra are the top producers with a share of about 20%, 20%, 19% and 16% of the total production, respectively (RBI Statistics, 2022).

Rajasthan state occupies a prominent place in the oilseeds production of India. The important oilseed crops of the Rajasthan state are groundnut, soybean, rapeseed & mustard, sesamum and taramira. The growth pattern of these crops in the state has been prone to risk over time and across the agro-climatic regions because of the rainfall behaviour, prolonged drought periods, and limited water resources and facilities available in the state (Jain et al. 2005). The present study describes the Nerlovian lagged adjustment function for major oilseed crops of the Rajasthan state.

Research Methodology

The present study is based on secondary data. The Time series data from 1997-98 to 2020-21 were obtained from the Directorate of Economics and Statistics, Rajasthan. Three major oilseed crops i.e. groundnut, rapeseed & mustard, and soybean were selected on the basis of highest production. Three districts namely Bikaner, Alwar and Baran were selected purposely on the basis of the highest production of selected major oilseed crops like groundnut, rapeseed & mustard and soybean in these districts respectively in Rajasthan.

Nerlovian lagged adjustment function was employed to estimate the degree of acreage/supply responsiveness analyse of selected crops. This method was used by Ahmed and Bhowmick (1991), Bapna, (1980), Devi, (1964), Jakhade and Mujumdar (1964) in various supply response models. In the study, it was assumed that input costs are either the same or move uniformly over time for different crops. The model was fitted on the data for the period 1997-98 to 2020-21. For estimating the parameters, double logarithmic models have been used. This has been preferred since it provides direct estimate of short-run elasticities and yield a better estimate of the coefficients. Nerlovian type model depicting the farmer's behaviour in its simplest form is given below:

$A_t^* = b_0 + b_1 P_{t-1} + b_2 Z_{t-1} + b_3 R_t + b_4 GI_t + b_5 CVY_t + b_6 CVP_t + U_t$ ---------- (1)

$A_t - A_{t-1} = B(A_t^* - A_{t-1})$ (Nerlovian adjustment equation) -------------------- (2)

As expected variables are not observable, for estimation purposes, a reduced form containing only observable variables be written after substituting the value of At* from equation (2) into equation(1), as follows:

$A_t = C_0 + C_1 P_{t-1} + C_2 Z_{t-1} + C_3 R_t + C_4 GI_t + C_5 CVY_t + C_6 CVP_t + C_7 A_{t-1} + V_t$.....(3)

The first equation is a behavioural equation, stating that desired acreage (At*) depends upon thefollowing independent variables.

A_{t-I}	=	one year lagged area
P_{t-I}	=	one year lagged price
Z_{t-I}	=	one year lagged yield
R_t	=	average rainfall for pre-sowing three month
GI_t	=	current year gross irrigated area
CVP_t	=	coefficient of variation of the preceding three years' price
CVY_t	=	coefficient of variation of the preceding three years' yield

Equation (1) includes variables for all the crops considered. Equation (3) is the reduced form of the previous two equations, which estimates the unobserved variable (A_t^*) by an observed variable (A_t). The coefficients and error terms of ~~the~~ equation (III) are related to those of equation (I) and to the coefficient of adjustment as follows:

$C_0 = b_0 B$, $C_1 = b_1 B$, $C_2 = b_2 B$, $C_3 = b_3 B$, $C_4 = b_4 B$,

$C_5 = b_5 B$, $C_6 = b_6 B$, $C_7 = (1-B)$, $V_t = BV_t$

These parameters of the above computational equation can be estimated using the time-series data on related variables included in the supply/acreage response model by the least squares method. The magnitude of the regression coefficients of different variables explicitly shows how much the dependent variable (acreage in period t) depends upon independent variables. The value of the coefficient of determination (R^2) shows per cent of the variation in the dependent variables which is explained by the independent variables. Long-run elasticities were computed by dividing short-run elasticities by the coefficient of adjustment. Tha coefficient of adjustment is equivalent to 1-C_7i.e. 1-(1-B).

Specifications of the variables used

1. Current year acreage (A_t)

The acreage response model study related changes in total planned production to changes in various economic and environmental factors, but Singh et.al. (1974) pointed out that the decisions of farmers are approximated in terms of the area under the crops rather than its yield. Because the area allotted to the crop is a better barometer of the farmer's land allocation decisions. Further, the area under a crop is a function of several endogenous variables/ factors, whereas the yield is greatly influenced by several exogenous factors. Moreover, since time–series estimates of planned output cannot be available, some proxy must be used. Thus area planted under the crop concerned has been taken as the dependent variable in the regression model. Nerlove (1958) himself pointed out that acreage seems to be a more appropriate measure of supply since the cultivator has a larger degree of control over area.

2. Lagged area (A_{t-1})

The inclusion of lagged acreage as an independent variable in the acreage response function serves as a vehicle to reach the coefficient of adjustment, which is assumed to be constant and is always between zero and one. This variable also takes into account the effect of all non-price factors such as quasi-fixed factors, risk and uncertainties and such technological changes, which are difficult to measure but have a specific influence on the change of output. It is also assumed that under normal conditions, the cultivator keeps at least his lag year's acreage by keeping in view his family requirements and other needs.

3. Lagged Price (P_{t-1})

The use of price formulation has much significance in farmers' decisions in the acreage response model. Alternate price specifications are said to be most relevant in the producer's expectational behaviour with regard to resource allocation decisions. Farmers see the previous year's price whether it be absolute post-harvest price, relative price or relative profitability to make decisions for the current year's production. This study has utilized farm harvest prices with the assumption that the major portion of their products will be sold in the market within two months after harvest.

4. **Lagged Yield (Y_{t-1})**

There has been a considerable variation in the yields of crops over time. The crops of wheat, paddy, bajra and gram are exposed to variation in yield due to the introduction of high-yielding varieties, attacks of pests

& diseases and vagaries of nature. Therefore, lag year yield, as an independent variable was included in the model.

5. Rainfall (R_t)

The rainfall duringthe season was taken as one of the independent variables. The yield and production of the crop is influenced by the distribution of rainfall. It is an independent variable and has a strong impact on prices for some crops e.g. bajra and gram. The pattern of relationship between these crops and rainfall appears to be reasonable in view of soil and moisture conditions under which these crops are grown in Rajasthan.

6. Irrigation (GI_t)

To examine the impact of irrigation facilities on acreage allocation, i. e. on the area that a farmer is willing to put under each crop, gross irrigated area during the growing season of each crop was included as an independent variable, since such facilities increase the yield and flexibility of land use. Generally, a positive correlation is observed between the current year's gross irrigated area and the current year's acreage. Therefore, for irrigated crops, current year gross irrigated area has been incorporated as an independent variable.

7. Risk

The risk factors are a crucial element in the farmer's decisions, particularly in the agricultural sector with changing technology. Generally, two types of risks are accounted for in the agriculture, i. e, yield risks and price risks. Yield risks (Y) enter into agricultural production due to the vagaries of nature, attacks of insects and pests, whereas price risks (p) are due to uncertainties of demand and supply. Yield variability is accounted for by three year preceding the coefficient of variation of yield and price variability by three years preceding the coefficient of variation of price.

Results and Discussion

Bikaner district has a significant area under groundnut cultivation and is the highest groundnut-producing district of Rajasthan. The regression results of the acreage response model for groundnut are given in table 1 Regression coefficient for the lagged area, lagged yield, lagged farm harvest prices, and irrigated area under groundnut were all non-significant in determining the area under groundnut cultivation.

Table 1: Acreage response for groundnut in the Bikaner district of Rajasthan (1997-98 to 2020-21)

Regression coefficient	Estimates	Standard Error
1. Constant	-0.6685	1.2109

2. Lagged area of groundnut	0.8620***	0.1522
3. Lagged yield of groundnut	0.0285	0.1006
4. Lagged farm harvest price of groundnut	0.1401	0.2032
5. Gross irrigated area of the district	0.2063	0.3893
6. Rainfall	-0.0989	0.0907
7. Yield risk	0.02444	0.0532
8. Price risk	-0.0387	0.0554
Adjusted R^2 (B)	0.96	

***indicate significance at 1 per cent level of probability

Alwar has asignificant area under rapeseed & mustard and produces the maximum mustard in Rajasthan. The regression results obtained from the model are presented in table 2. The regression coefficients for the lagged area, lagged yield, lagged farm harvest prices, and irrigated area under groundnut were found non-significant in their influence in determining area under groundnut cultivation.

Table 2: Acreage response for rapeseed & mustard in Alwar district of 1997-98 to 2020-21)

Regression coefficient	Estimates	Standard Error
1. Constant	-1.3555	2.8507
2 .Lagged area of rapeseed & mustard	0.269	0.2639
3. Lagged yield of rapeseed & mustard	0.0808	0.1840
4. Lagged harvest price of rapeseed & mustard	0.0476	0.0855
5. Gross irrigated area of the district	0.8224	0.5272
6. Rainfall	0.1541	0.1250
7. Yield risk	0.0223	0.0674
8. Price risk	-0.0008	0.0533
Adjusted R^2 (B)	0.31	

Baran district of Rajasthan has significant share in the area under soybean cultivation and produces highest production among districts of Rajasthan. The coefficients for variables viz. lagged yield, lagged farm harvest price and gross irrigated area were positive and significant at 5 per cent is given in the table 3.

Table 3: Acreage response for soybean in Baran district of Rajasthan (1997-98 to2020-21)

Regression coefficient	Estimates	Standard Error
1. Constant	0.7002	1.7794
2. Lagged area of soybean	0.3603	0.2590
3. Lagged yield of soybean	0.5681*	0.2659
4.Lagged farm harvest price of soybean	0.3353*	0.1515
5. Gross irrigated area of the district	0.9629**	0.3632
6. Rainfall	-0.1008	0.2334
7. Yield risk	-0.2509**	0.1068
8. Price risk	-0.0023	0.0788
Adjusted R^2 (B)	0.66	

** &* indicate significance at 5 per cent and 10 per cent level of probability

Conclusions

In the acreage response analysis, it is concluded that acreage a groundnut, rapeseed & mustard, and soybean were mainly controlled by the lagged yield and gross irrigated area during the year, while the lagged farm harvest prices also appeared to be the key determinant of acreage allocation analysis. In the case of oilseeds like rapeseed& mustard, groundnut and soybean, if the price increases by one per cent then the percentage of acreage will be increased by the farmers by 0.2 per cent in groundnut and 0.33 per cent under soybean.

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