Original Research Article

Supply Response Functions of Major Food Grain Crops in Rajasthan

Abstract

The present study was carried out in Rajasthan state as a whole aiming to study acreage response analysis. Nerlovian acreage response function was employed in the time series data of major food grain crops from 1997-98 to 2020-21. It is concluded that acreage of wheat, paddy, bajra, and gram were mainly controlled by the gross cropped area in current year (t), while the price of last year (t-1) also appeared to be the key determination of acreage allocation analysis. In case of wheat, if the gross irrigated area is increase by one per cent then the percentage of acreage will be increased by 1.04 per cent of the area, while in paddy and bajra, farm harvest price and irrigated area were important factors and influencing acreage response, but their influence was non-significant. In case of gram, if the price is increase by one per cent then the percentage of acreage will be increased by the farmers by 1.02 per cent.

Keywords: *acreage response function, Rajasthan, food grains*

Introduction

India is primarily an agrarian economy which provides employment of more than 50% of the population. The food grain production was estimated at record level of 316.06 million tonnes during 2021-22 (2nd Advance estimate, MoA&FW, 2022). Out of which paddy production is estimated at record 127.93 million tonnes during 2021-22. It is higher by 11.49 million tonnes than the last five years' average production of 116.44 million tonnes. Production of wheat during 2021-22 is estimated at record 111.32 million tonnes. It is higher by 7.44 million tonnes than the average wheat production of 103.88 million tonnes. Production of gram is 13.12 million tonnes and production of Bajra 9.62 million tonnes. The government of India formulates policies like procurement, distribution, imports and support prices of crops, on the basis of advance estimates of crop production. Therefore, the empirical and factual knowledge of supply response of crops is necessary for formulation of effective agricultural policy. By applying the production decision to prices, the individual farmer not only improves his policy decision but also maximizes the income by adjusting his production to crop prices. Improved knowledge of the future supply structure is needed in rapidly changing technology and product prices. The communication of this knowledge to farmers

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could help them to use their resources more efficiently and take better decisions on investment and planning. The production imbalances in Indian agriculture continue to stress the need for policy oriented research. The important policy-decisions in agriculture production such as how to produce and how much to produce depend on price elasticities of own price and competing crop price on acreage response. The degree of farmers' responsiveness to prices varies with crops and districts/ regions of a State because of differences in agro-climatic conditions, cropping pattern and level of technology adoption. In such a situation no unique proposition can be built for the country or State as a whole. Also, the studies undertaken on supply response are at regional or state level and have not taken into account the variations among districts of a state. The present study aims at studying the supply response of major agricultural commodities to changing price levels and other factors affecting the acreage allocation in selected districts of Rajasthan for the period from 1997-98 to 2020-21. The study assumes that farmers behave rationally and act in a way that maximizes income/ expectations within the available opportunities, uncertainties and risks prevailed.

Material and methods

The study is based on the secondary data. Data were collected from the Directorate of Economics and Statistics, Rajasthan. Time series data from 1997-98 to 2020-21 were collected. Four major food grain crops i.e. wheat , paddy, , *bajra* and gram were selected on the basis of highest production. Four districts were selected purposively on the basis of highest production of selected major food grain crops in Rajasthan. This method was used by Ahmed, 1991; Bapna, 1980; Devi, 1964; Jakhade et al, 1964 in various supply response model.

Nerlovian lagged adjustment function was employed to estimate the degree of acreage / supply responsiveness analyse of selected crops. In the study it was assumed that input costs are either the same or move uniformly overtime 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:

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

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

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

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

The first equation is a behaviourable equation, stating that desired acreage (At*) depends upon following 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 preceding three years price
CVY_t	=	coefficient of variation of 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:

$C_0 = b_0B$, $C_1 = b_1\ B$, $C_2 = b_2\ B$, $C_3 = b_3\ B$, $C_4 = b_4\ B$,

$C_5 = b_5\ B$, $C_6 = b_6\ B$, $C_7 = (1\text{-}B)$, $V_t = BV_t$

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 least squares method. The magnitude of the regression coefficients of different variables explicitly shows how much dependent variable (acreage in period t) depends upon independent variables. The value of coefficient of determination (R^2) shows per cent of variation in the dependent variables which is explained by the independent variables. Long-run elasticities were computed by dividing short-run elasticities by coefficient of adjustment. Coefficient of adjustment is equivalent to 1-C_7 *i.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 decisions of farmers are approximated in terms of area under the crops rather than its yield. Because the area allotted to crop is a better barometer of the

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farmers 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 (1956) himself pointed out that acreage seems to be more appropriate measure of supply since 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 which 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 condition, 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' decision in 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 previous year's price whether it be absolute post-harvest price, relative price or relative profitability to make decision for current year production. This study has utilized farm harvest prices with the assumption that the major portion of their produce will be sold in the market within two months after harvest.

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

There has been a considerable variation in yields of crops over time. The crops of wheat, paddy, *bajra* and gram are exposed to variation in yield due to introduction of high-yielding varieties, attack 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 during season was taken as one of the independent variable. The yield and production of crop is influenced by the distribution of rainfall. It is an independent variable and has strong impact as prices for some crops e.g. *bajra* and gram. The

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

Results and discussions

Sri Ganganagar is one of the maximum wheat producing districts of Rajasthan. In allocation of acreage under wheat crop, the significant factors influencing the area allocation and the results of response equation for wheat for the period 1997-98 to 2020-21 are summarized in table1. The regression coefficient for lag year acreage showed positive and lag yield showed negative impact in the case of wheat in Sri Ganganagar district. The regression coefficient for lag year price of wheat portrayed positive and its impact was non-significant. The regression coefficient for gross irrigated area during the year depicted positive and significant impact at 1 per cent level in selected district. The regression coefficient of rainfall exhibited negative but non-significant impact on current year area of wheat. The regression coefficients for yield risk on area allocation for wheat was significant. Impact of price was found insignificant. However, wheat acreage has been almost stabilized in the district with minor alterations. Therefore, the only factor, *i.e.* irrigation was found most important of all other factors. The above study concludes that the acreage of wheat crop is mainly

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controlled by gross irrigated area in current year. Coefficient of determination is very high (R^2 = 0.88).

Table 1: Acreage response for wheat in Sri Ganganagar district of Rajasthan (1997-98 to 2020-21)

Regression coefficient	Estimates	Standard Error
1. Constant	-1.7653	1.1945
2. Lagged area of wheat	0.1719	0.1396
3. Lagged yield of wheat	-0.1212	0.1523
4. Lagged farm harvest price of wheat	0.0004	0.1215
5. Gross irrigated area of district	1.0387***	0.2715
6. Rainfall	-0.0051	0.0536
7. Yield risk	0.0803**	0.0348
8. Price risk	0.0148	0.0297
Adjusted R^2 (B)	0.90	

*** indicate at 1%, ** at 5% and * at 10% level of significance

Hanumangarh is one of the leading paddy growing districts of Rajasthan. The results of the response equation for paddy are summarized in table 2. The results showed that regression coefficient for lagged area of paddy showed positive and significant impact, while one year lagged yield showed negative and insignificant impact for area allocation for paddy in Hanumangarh district. The regression coefficient for lagged price of paddy depicted non-significant impact. The regression coefficients for gross irrigated area under the crop also showed non-significant impact in selected district. The regression coefficient of rainfall exhibited negative but non-significant impact on area of paddy. (Bingxin, 2012; Kanwar, 2006 and Yu. B., 2006)

Table 2: Acreage response for paddy in Hanumangarh district of Rajasthan (1997-98 to 2020-21)

Regression coefficient	Estimates	Standard Error
1. Constant	-4.6459	3.4701
2. Lagged area of paddy	0.8187***	0.2469
3. Lagged yield of paddy	-0.0041	0.1660
4. Lagged farm harvest price of paddy	0.0256	0.2031
5. Gross irrigated area of district	0.9821*	0.5289
6. Rainfall	-0.1288	0.1060

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7. Yield risk	0.0110	0.10.39
8. Price risk	-0.0363	0.0416
Adjusted R^2 (B)	0.76	

*** indicate significance at 1 per cent and * indicate significance at 10 per cent level of probability

Bajra is one of the major crops in Jaipur district of Rajasthan. The regression results of acreage response model are presented in table 3. The regression coefficients for lagged area and lagged farm harvest pries were positive, though insignificants. The regression coefficients for lagged yield of *bajra* and irrigated area under *bajra* were negative and also insignificants. Although the regression coefficient of rainfall was positive, however, the model could not establish the significant influence of increase in area (Ashok, 2004 and Bhattarai et al.2013).

Table 3: Acreage response for *bajra* in Jaipur district of Rajasthan (1997-98 to 2020-21)

Regression coefficient	**Estimates**	**Standard Error**
1. Constant	5.2227	4.3544
2. Lagged area of *bajra*	0.3677	0.3281
3. Lagged yield of *bajra*	-0.1482	0.1026
4. Lagged farm harvest price of *bajra*	0.03576	0.1118
5. Gross irrigated area of district	-0.3730	0.5779
6. Rainfall	0.1098	0.0719
7. Yield risk	-0.0013	0.0558
8. Price risk	-0.0568	0.0318
Adjusted R^2 (B)	0.63	

In Rajasthan, Ajmer is one of the major districts producing gram. The results of the response equation for gram from 1997-98 to 2020-21 are summarized along with value of coefficient of adjustment, and short-run and long-run elasticities in table 4. Regression coefficients for lagged acreage, lagged yield, lagged farm harvest prices, irrigated area and rainfall were found positive but their influence on area allocation was insignificant. Similar type of results also found by the Rao et al, 1974; Ram et al 1973 and Parhi et al, 1997.

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Table 4: Acreage response for gram in Ajmer district of Rajasthan (1997-98 to 2020-21)

Regression coefficient	Estimates	Standard Error
1. Constant	-2.0128	3.7641
2. Lagged area of gram	0.09155	0.6219
3. Lagged yield of gram	0.15007	0.7145
4. Lagged farm harvest price of gram	1.21075	1.3863
5. Gross irrigated area of district	0.02930	0.6235
6. Rainfall	0.57835	0.8575
7. Yield risk	0.38957	0.9105
8. Price risk	-0.0803	0.2554
Adjusted R^2 (B)	0.58	

Summary and Conclusions

In the acreage response analysis, it is concluded that acreage of wheat, paddy, bajra and gram 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 determination of acreage allocation analysis. In case of wheat, if the irrigated area is increased by one per cent then the percentage of acreage will be increased by the farmers by 1.0387 per cent of the area. In case of paddy and 81 *bajra*, lagged area and lagged farm harvest prices were the important factors towards acreage allocation by the farmers. In case of gram, if the price increases by one per cent then the percentage of acreage will be increased by the farmers by 1.21 per cent of the area. In case of *Bajra* in Jaipur for yield risk, and Hanumangarh in paddy for yield lagged year.

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