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Factors Affecting Acreage Response of Pulses in the State of Rajasthan

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ABSTRACT

Background: Pulses are rich in protein, fiber and vital vitamins and minerals however, since the start of the so-called "green revolution" in 1966-1967, their cultivation has experienced a notable decrease. This declining trend in the area under pulses shows that farmers have been changing their crop selections in response to changing techno-economic circumstances. Thus, there is a strong need to study acreage reactions, which will provide important insights for developing efficient policy directives for pulse development.

Methods: The objective of this research is to examine the factors that impact the production of pulse crops in the state of Rajasthan. The study is totally dependent on secondary data that was obtained from state government publications for the years 2000–01 and 2019-20. In order to achieve its goals, the study uses backward an elimination regression method.

Result: The findings indicate that current-year irrigation significantly improved chickpea farming, while positive effects on pigeon pea acreage were linked to current-year rainfall, lagged irrigated area and pigeon pea yield variability. However, pigeon pea acreage was negatively affected by current-year irrigation and lagged production. Additionally, positive correlations were found between the lagged price of a rival crop (Bajra), current-year rainfall and moong bean acreage response. Urd bean acreage benefited from one-year lagged rainfall, lagged area and yield of pulse crops and lagged pricing of a rival crop (linseed). Therefore, investing in research and development, promoting rainfed techniques and establishing supportive pricing systems are crucial for boosting pulse production and meeting future demand efficiently.

Key words: Acreage response, Backward elimination regression, Elasticities, Pulses.

INTRODUCTION

Pulses are important source of protein, high in fiber content and provide ample quantity of vitamins and minerals. Keeping in view large benefits of pulses for human health, the United Nations has proclaimed 2016 as the International Year of Pulses with the objectives of increasing production and consumption of pulses by 10% by 2020 (Mohre and Mitra, 2022). Pulses are important component to sustain the agriculture production as the pulse crops possess wide adaptability to fit into various cropping systems, improve the soil fertility being leguminous in nature and physical health of soil while making soil more porous due to tap root system (Sood *et al.,* 2018). India is a premier pulse growing country and hence largest producer and consumer of pulses in world. In India, the major pulses cultivated during *kharif* season are pigeon pea, green gram and black gram. The common pulses grown in *rabi* season are chickpea, lentil, field pea, lathyrus and rajmah.

In India, the pulses production has virtually stagnated over the last 40 years. There are mainly two reasons for this. Firstly, 87% of the area under pulses is rainfed. Because the state of Rajasthan mostly depends on the unpredictable and frequently insufficient monsoon rains, rainfed circumstances have the potential to stall the production of pulses. This causes crops to run out of water and increases agriculture's reliance on the whims of the monsoon. In actuality, irregular rainfall patterns, water stress and a lack of adequate irrigation facilities provide difficulties for Rajasthan farmers that together make it difficult to cultivate pulses consistently and with significant yields. The second reason is that pulses are mainly grown as a residual crop on marginal lands, after diverting the better-irrigated lands

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for higher yield-higher input crops like rice and wheat (IIPR, 2015). Farmers are not motivated to grow pulses because of yield and price risk probably due to lack of effective procurement. Also pulses faces various abiotic (climate related) and biotic (insect and pest related) stresses. Pulses are more susceptible to pest and insect attacks than cereals like maize, rice and wheat, because of their higher protein content, which draws pests and their open pod structure, which gives insects easier access and increases vulnerability and yield losses (Sood *et al.* 2020). Therefore, India is not only one of the largest producers as well as consumers of pulses, but is also one of the largest importers in the world. This is because the demand for pulses far outweighs their domestic production. Even a liberal import of pulses has not been able to supplement the widening gap between their demand and supply. To meet the demand of pulses, India is at present importing about 4-5 million tons of variety of pulses (Tiwari and Shivhare, 2016).

The continual declining trend in relative pulses acreage in several regions of India has witnessed and caused growing concern of research and extension systems only during the last decade. Displacement of acreage under pulses has been especially marked in areas which have witnessed the introduction of new agriculture technology. The acreage under pulses has declined most markedly since 1966-67, the starting period of so called green revolution (Singh 1979). The declining trend in acreage under pulses definitely indicates that farmer have adjusted their crop acreages in accordance with shift in techno-economic conditions. Therefore, it was worthwhile to examine acreage response to provide current evidence on temporal and spatial dimensions of the pulse development and for devising appropriate policy directions.

Objective

- To estimate the acreage response function of pulse crops in the state of Rajasthan.
- To identify factors affecting acreage under pulses in the Rajasthan.

MATERIALS AND METHODS

The study was based on the secondary data i.e. time series data on different pulses namely chickpea, pigeonpea, urd bean and moong bean in the state of Rajasthan. The study was conducted in Maharana Pratap University of Agriculture and Technology, Udaipur in the year 2022-23. The data for a period of 20 years from the year 2000-01 to 2019-20 were collected from various published sources like Rajasthan Agricultural Statistics at Glance etc. To study the different factors affecting acreage under pulses in Rajasthan following acreage response function was employed:

Estimation of acreage response function

To work out the acreage response pattern of major pulse crops, the following acreage response function was 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 pulse crops
A_{t-1} = One year lagged area of the pulse crops
Y_{t-1} = One year lagged yield (average) of the pulse crops
P_{t-1} = One year lagged price (average) of the pulse 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 view the likely multicollinearity between explanatory variables backward elimination method was adopted to retain the significant variables after eliminating the problems of multicollinearity.

Selection of competing crops

Selection of competing crops was made based on correlation coefficient between areas under different selected pulse crops with other crops for the period 2000-01 to 2019-20. Those crops having highest negative correlation coefficient between areas under these crops were chosen as competing crops (Appendix I).

Elasticities from estimated acreage response function

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

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

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

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

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

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

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

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

Test of significance

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

$$\frac{\hat{b}}{Se\,(\hat{b})} \quad \text{Calculated 't'}$$

Where;
$\hat{b}$ = Estimated coefficient of the model.
$Se\,(\hat{b})$ = Standard error of the estimated coefficient.

Appendix 1: Correlation matrix of acreage between crops (2000-01 to 2019-20).

	Rice	Jowar	Bajra	Maize	Wheat	Barley	Arhar	Gram	Ground nut	Sesa-mum	Castor	Soy-bean	R and M	Lin-seed	Urd	Moong
Rice	1.000															
Jowar	0.270	1.000														
Bajra	0.084	0.469	1.000													
Maize	-0.334	0.399	0.730	1.000												
Wheat	0.584	0.234	-0.065	-0.322	1.000											
Barley	0.411	-0.065	0.212	-0.039	0.383	1.000										
Arhar	0.135	0.214	0.486	0.397	-0.392	-0.156	1.000									
Gram	0.326	0.105	0.256	-0.046	0.807	0.509	-0.361	1.000								
Groundnut	0.387	-0.107	-0.261	-0.452	0.837	0.386	-0.679	0.740	1.000							
Sesamum	0.186	0.137	0.432	0.493	0.246	0.180	-0.036	0.438	0.379	1.000						
Castor	0.489	-0.027	-0.119	-0.339	0.818	0.255	-0.372	0.670	0.845	0.439	1.000					
Soybean	0.535	-0.113	-0.138	-0.417	0.832	0.233	-0.412	0.741	0.848	0.399	0.870	1.000				
R and M	-0.185	-0.103	0.220	0.044	0.222	0.037	-0.320	0.470	0.437	0.448	0.369	0.366	1.000			
Linseed	0.555	0.222	0.092	-0.149	-0.187	0.023	0.603	-0.328	-0.384	-0.185	-0.139	-0.195	-0.423	1.000		
Urd	-0.261	-0.297	-0.380	-0.261	0.095	-0.190	-0.372	0.056	0.213	-0.235	0.185	0.112	-0.330	-0.377	1.000	
Moong	0.187	0.004	0.405	0.263	0.602	0.459	-0.322	0.767	0.606	0.631	0.621	0.621	0.410	-0.515	0.130	1.000

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

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

Acreage response function

The area under any crop at farm, district, state, country level is determined by a number of factors. In the present study, current year area (A_t) is assumed to be influenced by the following factors:

(i) One year lagged area (A_{t-1})

Normally farmers do not abruptly change area under any crop. The acreage under any crop changes gradually. In order to ascertain the positive or negative change in area under crops over the years one year lagged area of selected pulse crop was included in the model.

(ii) One year lagged yield (Y_{t-1})

It is one of the important non-price factor which affect decrease or increase in area under the crop. One year lagged average yield of a crop obtained by dividing total production by area under the crop in that year. Besides, lagged yield indicates the influence of agricultural technology on acreage under crop. A positive correlation is expected between current year acreage (A_t) and one year lagged yield (Y_{t-1}).

(iii) One year lagged price (P_{t-1})

The farm harvest prices were used because the bulk of the crop output is marketed soon after the harvest. The farm harvest price provides the appropriate price realized by the farmers. One year lagged farm harvest price was included as an explanatory variable for current year acreage (A_t), as acreage decision are expected to be governed by the price level of the crop during previous year. A positive coefficient is expected for this variable.

(iv) One year lagged yield of the competing crop (Y_{ct-1})

Average yield of the competing crop lagged by one year is also an important non-price factor which affects average allocation decision of farmers between current year acreage and one year lagged yield of the competing crop (Y_{ct-1}). A negative correlation is expected in normal situation.

(v) One year lagged price of competing crop (P_{ct-1})

For this one year lagged farm harvest price was used, which is based on the above logic. It is likely that the price of competing crop affects the acreage decision of farmers for a particular crop. A negative sign is expected for the coefficient of this variable.

(vi) Current year rainfall (R_t)

In the acreage decision of farmers weather plays a major role in rainfed areas. The annual rainfall of that agricultural year is used as a variable for estimating the acreage response function. It can have a positive or negative sign depending on crops yield water relationship for *kharif* crops and positive sign for *rabi* pulse crops.

(vii) Lagged rainfall (R_{t-1})

The previous year's rainfall supplements the current year irrigation facilities. It is expected to influence the acreage response of the farmers particularly in well irrigated areas. A positive sign is expected for irrigated crops.

(viii) Current year irrigated area (I_t)

The irrigation is expected to have positive effect on both yield and area for most of the crops. Here, the total irrigated area which stands for the irrigation potential of that year was considered as explanatory variables to decide on the current year acreage under the crop.

(ix) One year lagged irrigated area (I_{t-1})

The previous year irrigation supplements the expected current year acreage under the crop. One year lagged irrigated area is used as an explanatory variable for estimating the acreage response function.

(x) Variability in lagged price (S_{pt-1})

To capture the influence of risk aversion attitude of the farmers, variability in prices was included in the model. Variability was measured as the standard deviation of absolute prices of preceding three years of the crops. As perceived by other researchers, logic behind inclusion of past three years price in the calculation of standard deviation was that the farmers do not look more longer past than previous three years for fluctuations of prices.

(xi) Variability in yield (S_{yt-1})

Variability in yield represents the yield risk of the farmers. It is calculated as the standard deviation of yield for preceding three years. The logic for using three years was that the farmers do not consider more longer past than three years fluctuations in yield.

Selection of competing crops

The selection of competing crops was made based on correlation coefficients between areas under selected pulse crops with other crops for the period 2000-01-2019-20. That crop having maximum negative correlation with acreage under selected crops was considered as the competing crop of the selected pulse crop. The competing crops for the selected pulse crop are given in Table 1.

All selected pulse crop initially the acreage response function was estimated keeping all the variables in the model. Since multicollinearity existed between explanatory variables in most of the cases, the acreage response function using backward elimination method was tried to get the final acreage response functions, with only statistically significant variables in the model.

RESULTS AND DISCUSSION

Acreage response function of chickpea

The estimated acreage response function for chickpea keeping all the explanatory variables in the model is given in the equation 1 (a):

Eqn. 1 (a) Estimated acreage response function of chickpea

$$A_t = \underset{(1235.088)}{-1221.757} - \underset{(0.585)}{0.418\,A_{t-1}} - \underset{(0.582)}{0.443Y_{t-1}} - \underset{(0.499)}{0.173\,P_{t-1}} + \underset{(0.616)}{0.064\,Y_{ct-1}} + \underset{(0.270)}{0.010\,P_{ct-1}} + \underset{(11.857)}{4.174\,R_t} - \underset{(11.060)}{6.443\,R_{t-1}} + \underset{(0.282)}{0.334\,I_t} + \underset{(0.437)}{0.048\,I_{t-1}} - \underset{(1.430)}{0.552\,Sp_{t-1}} + \underset{(2.982)}{0.067\,Sy_{t-1}}$$

R^2 = 0.9025.

F (11,3) = 2.53(NS).

The estimated acreage response function using the backward elimination method is given in equation 1 (b):

Eqn 1 (b) Estimated Acreage response function of chickpea

$$A_t = \underset{(325.938)}{-1026.189^{**}} - \underset{(0.188)}{0.486^{*}\,A_{t-1}} + \underset{(0.043)}{0.439^{**}\,I_t}$$

R^2 = 0.7966.

F (2, 12) = 23.29 (1 per cent level of significance).

Where;

*5 per cent level of significance.

**1 per cent level of significance.

None of the coefficients in the original model using all explanatory variables was significant. The F value was also non-significant. The factors like rainfall and irrigated area in current year, irrigated area during lagged year, variability in prices were found to have coefficients with the expected sign. One year lagged area of selected pulse, one year lagged yield of selected pulse, one year lagged price of selected pulse, one year lagged yield of the competing crop, one year lagged price of competing crop, lagged rainfall and variability in yield were not on the expected line.

The estimated acreage response function using backward elimination method given in equation 1(b) revealed that the explanatory variables like lagged area under pulse crop and irrigated area during current year were statistically significant and explained 79.66 per cent variation, demonstrating their substantial influence on the decisions regarding area under chickpea. The lagged area under pulse crop may indicate the influence of crop rotation practices. While Current-year irrigated area's significance suggests that water availability has a substantial impact on chickpea cultivation. Adequate irrigation can boost chickpea production, making it an attractive choice for farmers. The estimated multiple acreage model was also statistically significant as evidenced from the F value. The negative sign of coefficient for A_{t-1} indicates that the acreage under chickpea has been declining over the years. However, the positive sign for I_t was on the expected lines. Birla (2014) worked on acreage response of chickpea and found that price factors were important in Madhya Pradesh and Rajasthan whereas non-price factors were important in Maharashtra.

The elasticity coefficient of chickpea with respect to significant variables in the acreage response function equation 1(b) is given in Table 2. The elasticity coefficients

Table 1: Competing crops for the selected pulse crops.

Major pulse crops	Competing crop
Chickpea (Gram)	Pigeonpea
Pigeonpea (Arhar)	Groundnut
Moong bean	Bajra
Urd bean	Linseed

of significant variables for acreage response function of chickpea revealed that acreage under chickpea was positively elastic to current year irrigated area and negatively elastic to one year lagged area. Apparently, it was not on the expected line to have negative elasticity for acreage under a particular crop to lagged area.

Acreage response function of pigeonpea

The estimated acreage response function for pigeonpea keeping all the explanatory variables in the model is given in the equation 2 (a):

Eqn. 2 (a) Estimated Acreage response function of pigeonpea

$$A_t = \underset{(12.450)}{15.235} - \underset{(0.479)}{0.269\,A_{t-1}} - \underset{(0.007)}{0.007\,Y_{t-1}} - \underset{(0.002)}{0.001\,P_{t-1}} + \underset{(0.004)}{0.0001\,Y_{ct-1}} + \underset{(0.002)}{0.001\,P_{ct-1}} + \underset{(0.120)}{0.241\,R_t} + \underset{(0.126)}{0.001\,R_{t-1}} - \underset{(0.004)}{0.007\,I_t} + \underset{(0.003)}{0.006^*\,I_{t-1}} + \underset{(0.007)}{0.004\,Sp_{t-1}} + \underset{(0.009)}{0.028^*\,Sy_{t-1}}$$

$R^2 = 0.9423$.

$F\ (11,3) = 4.452$ (NS).

The estimated acreage response function using the backward elimination method is given in equation 2 (b):

Eqn. 2 (b) Estimated Acreage response function of pigeonpea

$$A_t = \underset{(3.557)}{11.218^{**}} - \underset{(0.002)}{0.005^*\,Y_{t-1}} + \underset{(0.043)}{0.195^{**}\,R_t} - \underset{(0.001)}{0.005^{**}\,I_t} + \underset{(0.001)}{0.004^{**}\,I_{t-1}} + \underset{(0.003)}{0.021^{**}Sy_{t-1}}$$

$R^2 = 0.9097$.

$F\ (5, 9) = 18.15$ (1 per cent level of significance).

The estimated acreage response function of pigeonpea keeping all the 11 explanatory variables revealed that the coefficient of one year lagged irrigated area (I_{t-1}) and variation in yield (Sy_{t-1}) were significant. The F value was non-significant. The variables like rainfall in current year, rainfall in lagged year, one year lagged irrigated area were on the expected lines. However, the sign of coefficient of variables like lagged area, lagged yield, lagged prices, lagged yield and lagged prices of competing crop and irrigated area in current year, variation in prices and variation in yield were not on expected lines. The negative sign of coefficients of A_{t-1} is conformity with the negative growth of area under pigeonpea. Savadatti (2007) revealed that in rainfed areas farm harvest prices and good weather conditions positively influenced the area allocation decision of the farmers. Tuteja (2006) found that in allocating land to arhar, moong and urad, farmers considered lagged acreage and magnitude of pre-sowing rainfall as the most important factors.

The estimated acreage response function using backward elimination method given in equation 2(b) revealed that the explanatory variables like lagged yield, rainfall and irrigated area in current year, lagged irrigated area and variations in yield were statistically significant and explained 90.97 per cent variation in area under pigeonpea. This is because these factors have direct impact on crop performance and farmer decision-making, with each variable contributing to optimizing production and mitigating risks associated with weather and resource availability. The estimated multiple acreage model was also statistically significant as evidenced from the F value. The negative sign for I_t may be due to the fact that as the irrigation potential increases, the choice of the farmers may be for crop other than pigeonpea.

The elasticity coefficient of pigeon pea with respect to significant variables in the acreage response function equation 2(b) is given in Table 3. The elasticity coefficients of significant variables for acreage response function of pigeonpea revealed that acreage under pigeonpea was positively elastic to rainfall in current year, lagged irrigated area and variation in yield.

Apparently, it was not on the expected line to have negative elasticity for acreage under a particular crop to irrigated area and one year lagged yield.

Acreage response function of moong bean

The acreage response function for moong bean was estimated keeping only 9 explanatory variables in the model as the data on prices of moong bean for the period (2000-01 to 2005-06) were not available. Therefore, the variables

Table 2: Elasticity coefficients of significant variables in acreage response function of chickpea.

Variables	Parameter estimates	
	'b' value	Elasticity coefficients
One year lagged area of the chickpea (A_{t-1})	-0.486	-0.471
Total irrigated area in t^{th} year (I_t)	0.439	2.346

Table 3: Elasticity coefficients of significant variables in acreage response function of pigeonpea.

Explanatory variables	Parameter estimates	
	'b' value	Elasticity coefficients
One year lagged yield (average) of the pigeonpea (Y_{t-1})	-0.005	-0.167
Rainfall in the t^{th} year (R_t)	0.194	0.568
Total irrigated area in t^{th} year (I_t)	-0.005	-1.613
Total irrigated area in $(t-1)^{th}$ year (I_{t-1})	0.004	1.365
Standard deviation of yield for preceding three year (S_{yt-1})	0.021	0.248

P_{t-1} and Sp_{t-1} were excluded from the model. The estimated acreage response function for moong bean keeping all the 9 explanatory variables in the model is given in the equation 3 (a):

Eqn. 3 (a) Estimated Acreage response function of moong bean

$$A_t = \underset{(526.460)}{139.760} - \underset{(0.382)}{0.161}A_{t-1} + \underset{(0.570)}{0.005}Y_{t-1} + \underset{(0.185)}{0.048}Y_{ct-1} + \underset{(0.238)}{0.277}P_{ct-1} + \underset{(5.971)}{14.157}R_t + \underset{(11.438)}{13.039}R_{t-1} - \underset{(0.151)}{0.024}I_t - \underset{(0.202)}{0.174}I_{t-1} - \underset{(0.699)}{0.681}Sy_{t-1}$$

$R^2 = 0.8313$.

F (9, 5) = 2.74 (NS).

The estimated acreage response function using the backward elimination method is given in equation 3 (b):

Eqn. 3 (b) Estimated Acreage response function of moong bean

$$A_t = \underset{(178.141)}{42.329} + \underset{(0.041)}{0.129^{**}}P_{ct-1} + \underset{(2.946)}{9.391^{**}}R_t$$

$R^2 = 0.6593$.

F (5, 9) = 11.612 (1 per cent level of significance).

None of the coefficients in the original model using all explanatory variables is significant. The F value was also non-significant. The factors like one year lagged yield, rainfall in current year, rainfall in lagged year and variability in yield were found to have coefficients with the expected sign. The coefficients of one year lagged area of selected pulse, one year lagged yield and price of the competing crop, irrigated area in current year and lagged irrigated area were not on the expected line.

The estimated acreage response function using backward elimination method given in equation 3(b) revealed that the explanatory variables like price of competing crop and rainfall in current year were statistically significant and explained 65.93 per cent variation in area under moong bean. These variables interact to influence the economic viability and environmental suitability of moong bean cultivation, ultimately affecting farmers' decisions regarding its cultivation area. The estimated multiple acreage model was also statistically significant as evidenced from the F value. The positive influence of price of competing crop for acreage under moong bean was may be due to the reason that the price of competing crop (Bajra) is fairly not good in the state. Tuteja (2006) found that that acreage allocation in *rabi* pulses, *i.e.* gram and massar got influenced by lagged acreage followed by relative price in most of the analyzed cases whereas in *kharif* pulses *i.e.* in allocating land to arhar, moong and urad, farmers considered lagged acreage and magnitude of pre-sowing rainfall as the most important factors.

The elasticity coefficient of moong bean with respect to significant variables in the acreage response function equation 3(b) is given in Table 4. The elasticity coefficients of significant variables for acreage response function of moong bean revealed that acreage under moong bean was positively elastic to price of competing crop and rainfall in current year. Apparently it was not on the expected line to have positive elasticity for acreage under particular crop to lagged prices of competing crop. It may be due to the fact that acreage under moong bean and prices of Bajra have been growing in the state in an inter-related manner during the study period.

Acreage response function of urd bean

The acreage response function for urd bean was estimated keeping only 9 explanatory variables in the model as the data on farm harvest prices of urd bean for the period (2000-01 to 2005-06) were not available. Therefore, the variables P_{t-1} and Sp_{t-1} were excluded from the model. The estimated acreage response function for urd bean keeping all the 9 explanatory variables in the model is given in the equation 4 (a)

Eqn 4 (a) Estimated Acreage response function of urd bean

$$A_t = \underset{(244.741)}{184.802} + \underset{(0.479)}{0.539}A_{t-1} + \underset{(0.287)}{0.399}Y_{t-1} - \underset{(0.218)}{0.175}Y_{ct-1} + \underset{(0.183)}{0.113}P_{ct-1} - \underset{(4.214)}{2.446}R_t + \underset{(3.489)}{3.042}R_{t-1} - \underset{(0.090)}{0.036}I_t - \underset{(0.073)}{0.072}I_{t-1} - \underset{(0.404)}{0.251}Sy_{t-1}$$

$R^2 = 0.5384$.

F (9, 5) = 0.65 (NS).

None of the coefficients in the original model using all the explanatory variables were significant. The F value was also non-significant. The signs of coefficients of price of competing crop, rainfall and irrigated area in current year, lagged irrigated area were not on expected lines. It may be due to the fact that acreage under urd bean is not systematically governed by these factors. And the factors like one year lagged area and yield of pulse crop, yield of competing crop, lagged rainfall and variation in yield found to have coefficients with expected signs. The positive sign of coefficient for A_{t-1} indicates that the acreage under urd bean has been increasing over the years.

The method using backward elimination method did not reveal any relationship for urd bean. This may be due to the reason that all variables that we have taken were not governed the acreage under urd bean.

Thus the acreage under different pulse crop is determined by different factors. The acreage under chickpea was found to be positively elastic to current year irrigated area and negatively elastic to one year lagged area under

Table 4: Elasticity coefficients of significant variables in acreage response function of moong bean.

Explanatory variables	Parameter Estimates: 'b' value	Parameter Estimates: Elasticity coefficients
One year lagged price (average) of the competing crop (P_{ct-1})	0.129	0.344
Rainfall in the t[th] year (R_t)	9.391	0.606

pulse crop, the acreage under pigeonpea was found to be positively elastic to the rainfall pattern, lagged irrigated area and variability in yield. As far as moong bean is concerned acreage was found to be positively elastic to one year lagged price of competing crop (Bajra) and rainfall in current year. The price policy, rainfall pattern, technological factors and irrigated area etc. affect the acreage under different pulses in the state.

CONCLUSION

The acreage response of pigeonpea is inversely associated to the yield of pulse crop indicating that yield stimulating technologies for pigeonpea is required to increase production of pigeonpea in the state. Considering the international scenario and practical realities of pulse production in India, it would be prudent to plan on the assumption that a large part of the expected demand in the future we may have to fill it with domestic production and the rest can be imported. There is a need to address the structural problems that hinder the growth of pulse production. The real need is to increase revenue through wider adoption of technology and by making critical inputs available, accessible and affordable. Therefore, investment in research and development of yield-enhancing technologies, promotion of rainfed techniques and supportive pricing system for boosting pulse production and to meet future pulse demand efficiently is need of the hour. However, an unfavorable pricing system can hinder technology transfer. Hence favorable price support to pulse growers is an extremely important to encourage farmers to adopt the technology.

Conflict of interest

Authors declare no conflict of interest.

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