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GROWTH, INSTABILITY AND ACREAGE RESPONSE FUNCTION IN PRODUCTION OF CUMIN IN RAJASTHAN

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ABSTRACT

The study was conducted to find out the compound growth rates, instability and acreage response functions of cumin crop in selected districts and for the state as a whole for the period I (1991-92 to 2000- 01), period II (2001-02 to 2010-11) and overall period (1991-92 to 2010-11).The production of coriander crop increased significantly in Kota (6.18per cent), Jhalawar (9.65per cent), Baran (11.10per cent) districts and state as a whole (9.10per cent) and Production of cumin spice decreased in Jalore district (-7.66per cent), Jodhpur district (-7.78per cent) and state as a whole (-1.03per cent) during period I which was due to negative growth in productivity under the crop by (-) 2.16,(-) 12.68 and (-) 3.19 per cent per annum similarly, Production of fenugreek crop increased significantly in Kota (64.50per cent) and Jhunjhunu (36.22per cent) districts. The magnitude of instability in cumin crop was higher in production as compared to productivity and area except Barmer district (in context of I_3 measure) during period I, where the variation in productivity was more. Cumin spice was found to have both pushing and pulling factors, almost equal in number. The lagged area and price, current and lagged year rainfall, current irrigated area and variability in yield responded in positive direction to boost up area under cumin.

INTRODUCTION

India is the world's largest producers, consumers and exporter of seed spices. Among all the states of India, Gujarat and Rajasthan together contribute more than 80 per cent of the total seed spices production in the country and thus, both the states together are known as "seed spices bowl" of India. Coriander (*Coriandrum sativum* L.) is an annual herb from *umbelliferae* family with 90 to 120 days growth period. Coriander leaves are being used in cooking, flavouring, beverages *etc.* and seeds are being used for preparing value added products such as coriander powder, dhana dal, curry powder, oleoresin and essential oil. So, it is known as low volume but high value crop of arid and semi arid regions (Patel *et al.*, 2013)

In Rajasthan, area under seed spices was 720.6 thousand hectares and production was 860.9 thousand MT and in Gujrat, area under seed spices was 551.7 thousand hectares and production was 882.1thousand MT in the year 2012-13 (Indian Horticulture Database-2012-13, NHB, GOI). The measurement of magnitude of instability helps policy makers, as it plays a crucial role in policy issues like feasibility of crop insurance and planning scheme and level of buffer stock, pattern of marketing, storage and export and so on. Further it helps to assess the causes and estimate the level of investment in various crop enterprises. The magnitude and sources of instability are guiding factors for the farmers in streamlining the policy package benefiting different agro climatic situation. Thus, apart from growth, it is the stability which is equally important for the better health of the economy. The controversy still persists over the relationship between the growth and instability. The acreage response for various spices crops of the state to identify the factors responsible for it and to estimate the relative elastic behaviour of such factors are of paramount importance streamline proper action for future strategy, as apart of meeting the challenges emerging out of new economic environment.

MATERIALS AND METHODS

The study is based on secondary data. These secondary data of past years were collected from Directorate of Economics and Statistics, Jaipur, Rajasthan, Department of Agriculture, Government of Rajasthan, Jaipur and Revenue records. To analyse the growth, instability and acreage response functions of cumin in Rajasthan, district wise data were collected for the period from 1991-92 to 2010-11.

Three districts viz. Barmer, Jalore and Jodhpur for cumin crop were selected on the basis of highest average production of five years *i.e.* 2006-07 to 2010-11. To estimate the trends of growth in area, production and productivity of cumin crop in the state and major producing districts of the state, exponential function of the form $Y_t = ab^t. U_t$ was used. Where Y_t is area/ production/productivity of cumin in time period t, t is time element that takes the values 1, 2, 3, n, a and b are parameters to be estimated, and U_t is the error term. b = (1 + r), Where 'r' is compound growth rate. The above equation can be rewritten as $Y_t = a (1 + r)^t. U_t$ and logarithmic transformation of this equation we get Log Y_t = log a + t log (1 + r) + log U_t. The compound growth rate was obtained as r = [(Antilog of b) – 1] × 100. Student's't' test was used to test the significance of the estimated compound growth rates.

The instability in area, production and productivity of cumin in the state and major producing districts of the state for the period of 20 years *i.e.* from 1991-92 to 2010-11 was worked out through following measures (Purbia, 2002). Instability index 1 (I_1) = $\frac{SD}{AM}\times100$ or $\frac{\sigma}{\bar{X}}\times100$. Where SD and AM are standard deviation and arithmetic mean of area, production and productivity of the crop, respectively, for specified period.

Instability index 2 (I_2) = $\frac{SD^*}{AM^*}\times100$ or $\frac{\sigma'}{\bar{X}'}\times100$. Where SD* and MD* are standard deviation and arithmetic mean of detrended area, production and productivity of the crop, respectively, for specified period. Detrended values were worked out by assuming multiplicative model of the form of Y_{dt} = TSCR/T. Where Y_{dt} is detrended value of area, production and productivity, T is trend, S is seasonal variation, C is cyclical variation and R is random variation. Instability index 3 (I_3) = $CV\sqrt{(1-R^2)}$. Where CV is coefficient of variance of area, production and productivity of the crop and R^2 is coefficient of multiple determination of the trend equation for original time series data on area, production and productivity.

To work out the acreage response pattern of cumin crop, the following acreage response function was estimated as $A_t = f(A_{t-1}, Y_{t-1}, P_{t-1}, Y_{ct-1}, P_{ct-1}, R_t, R_{t-1}, I_t, I_{t-1}, Sp_{t-1}, Sy_{t-1})$.Where A_t is current year area of the crop, $A_{t-1}$is one year lagged area of the crop, Y_{t-1} is one year lagged yield (average) of the crop, $P_{t-1}$is one year lagged price (average) of the crop, Y_{ct-1} is one year lagged yield (average) of the competing crop, P_{ct-1} is one year lagged price (average) of the competing crop, R_t is Rainfall in the t^{th} year, R_{t-1} is one year lagged rainfall, I_t is total irrigated area in t^{th} year, I_{t-1} is total irrigated area in $(t-1)^{th}$ year, Sp_{t-1} is standard deviation of prices for preceding 3 year and Sy_{t-1} is standard deviation of yield for preceding 3 year of the crop. Multiple linear regression function was fitted for estimating the coefficient of acreage response function between explanatory variables. Backward elimination method was adopted to retain the variables after eliminating the problem of multicollinearity for cumin over the period 1991-92 to 2010-11 for Rajasthan.

RESULTS AND DISCUSSION

Compound growth rate

The compound growth rates of area, production and productivity of cumin crop in selected districts and for the state as a whole for the period I (1991-92 to 2000- 01), period II (2001-02 to 2010-11) and overall period (1991-92 to 2010-11) were worked out and depicted in Table 1.There was no significant growth in production and productivity of cumin spice in all the selected districts and state as a whole during period I, period II and overall period. However, significant increase in production of cumin crop was found only in Barmer (20.03 per cent) district during the period I which was due to positive and significant growth in area of 11.85 per cent per annum. Production of cumin spice decrease in Jalore district (-7.66 per cent), Jodhpur district (-7.78 per cent) and state as a whole (-1.03 per cent) during period I which was due to negative growth in productivity under the crop by (-) 2.16, (-) 12.68 and (-) 3.19 per cent per annum, respectively. Production growth was also negative during period II in Barmer (-10.50 per cent) district and state as a whole (-4.31 per cent) which was due to negative growth in area of (-) 2.34 and (-) 2.95 per cent per annum, respectively. During overall period, production growth rate was negative in Jalore district by (-) 0.37 per cent due to negative growth in area by (-) 0.69 per cent per annum. The area under cumin crop increased significantly in Barmer and Jodhpur districts during period I by 11.85 per cent and 5.73 per cent as well as during overall period by 4.93 and 6.51 per cent per annum, respectively.Similar results were observed for coriander by Kumawat and Meena (2005) and Chaudhary (2011).

Instability in area of cumin in selected districts of Rajasthan

The instability estimated through different measures in area of cumin in the major producing districts of the state and for the Rajasthan state as a whole is given in Table 2. During period I,

Table 1: Compound growth rate of area, production and productivity for cumin crop (Per cent per annum)

Districts	Period I			Period II			Overall period		
	Area	Prodn	Yield	Area	Prodn	Yield	Area	Prodn	Yield
Barmer	11.85*	20.03***	7.31	-2.34	-10.05	-7.88	4.93*	4.85	-0.07
Jalore	-5.62	-7.66	-2.16	1.05	0.21	-0.82	-0.69	-0.37	0.33
Jodhpur	5.73**	-7.78	-12.68	3.79	4.57	0.75	6.51*	4.93	-1.49
Rajasthan	2.23	-1.03	-3.19	-2.95	-4.31	-1.40	2.22	0.80	-1.39

* Significant at 1per cent level of significance*** Significant at 5 per cent level of significance

Table 2: Instability in area of cumin in selected districts of Rajasthan (In per cent)

Districts	Instability measures								
	Period I			Period II			Overall period		
	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3
Barmer	32.92	18.01	13.77	30.05	29.96	29.09	39.04	30.29	30.76
Jalore	38.20	18.02	15.98	43.12	43.20	43.12	39.73	39.68	39.59
Jodhpur	37.32	37.63	35.42	35.38	32.95	32.54	49.22	36.41	34.70
Rajasthan	30.16	26.61	30.01	37.45	36.69	35.77	38.34	36.64	36.48

Table 3: Instability in production of cumin in selected districts of Rajasthan (In per cent)

Districts	Instability measures								
	Period I			Period II			Overall period		
	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3
Barmer	67.66	51.78	44.42	52.58	52.64	43.41	60.55	57.79	57.70
Jalore	47.68	37.45	40.80	60.08	58.70	59.87	54.25	54.27	54.25
Jodhpur	52.88	51.22	50.55	47.25	44.82	43.04	59.13	44.82	50.10
Rajasthan	38.30	37.10	37.89	48.03	47.49	45.74	45.54	45.01	45.17

Table 4: Instability in productivity of cumin in selected districts of Rajasthan (In per cent)

Districts	Instability measures								
	Period I			Period II			Overall period		
	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3
Barmer	49.15	47.65	45.45	45.45	36.82	38.54	46.27	46.01	46.15
Jalore	25.46	24.46	24.53	38.06	37.28	37.70	33.12	32.74	32.97
Jodhpur	43.67	36.26	30.91	30.88	30.80	30.76	37.28	36.21	36.05
Rajasthan	16.70	14.52	13.70	32.16	31.15	31.66	24.71	24.46	23.74

Table 5: Estimated acreage response function of cumin in Rajasthan

S. No.	Variables	Parameter estimates Coefficients	Elasticity coefficients
	Intercept(a)	-95311	-
1.	One year lagged area of the cumin(A_{t-1})	0.17	0.16
2.	One year lagged yield (average) of the cumin(Y_{t-1})	-84.63	-0.15
3.	One year lagged price (average) of the cumin(P_{t-1})	69.39*	2.31
4.	One year lagged yield (average) of the competing crop (Y_{ct-1})	-81.16	-0.41
5.	One year lagged price (average) of the competing crop (P_{ct-1})	-161.70	-1.17
6.	Rainfall in the t^{th} year (R_t)	778.73	0.22
7.	One year lagged rainfall (R_{t-1})	2771.51**	0.77
8.	Total irrigated area in t^{th} year(I_t)	0.06	1.57
9.	Total irrigated area in $(t-1)^{th}$ year (I_{t-1})	-0.08	-2.01
10.	Standard deviation of prices for preceding three year (S_{pt-1})	-28.84	-0.15
11.	Standard deviation of yield for preceding three year (S_{yt-1})	787.18**	0.31
R^2 = 0.9120			

*Significant at 1 per cent levelof significance**Significant at 5 per cent levelof significance

Jodhpur district emerged as highly unstable district in context of I_2 (37.63 per cent) and I_3 (35.42 per cent) measures, while Jalore district was found highly unstable district in context of I_1(38.20 per cent) measure. In the same period Barmer district was found lowest instable district with 32.92, 18.01 and 13.77 per cent instability in context of I_1, I_2 and I_3 measures, respectively. During period II, Jalore showed highest instability with 43.12, 43.20 and 43.12 per cent, while Barmer district had lowest instability with 30.05, 29.96 and 29.09 per cent with respect to I_1, I_2 and I_3 measures, respectively. Similar results were observed by Chand and Raju (2008) in Andhra Pradesh.

During overall period, instability analysis revealed that Jodhpur district was found highly unstable district with 49.22 per cent instability in context of I_1measure, while Jalore district was highly unstable district with 39.68 and 39.59 per cent instability in context of I_2 and I_3 measures. Barmer district had lowest instability with 39.04, 30.29 and 30.76 per cent in context of I_1, I_2 and I_3 measures, respectively.

Instability in production of cumin in selected districts of Rajasthan

The instability estimated through different measures in production of cumin in the major producing districts of the state and for the Rajasthan state as a whole are given in Table 3. Highest instability was noticed in Barmer district with 67.66 and 51.78 per cent in context of I_1 and I_2 measures while Jodhpur district with 50.55 per cent instability in context of I_3 measure during period I. In the same period Jalore district showed lowest instability with 47.68, 37.45 and 40.80 per cent instability in context of I_1, I_2 and I_3 measures, respectively. During period II, Jalore district was found maximum instable with 60.08, 58.70 and 59.87 per cent instability in context of I_1, I_2 and I_3 measures, respectively while Jodhpur district was found minimum instability with 47.25, 44.82 and 43.04 per cent instability in context of I_1, I_2 and I_3 measures, respectively. For the overall period, highest coefficient of variation in production was observed in Barmer district with 60.55, 57.79 and 57.70 per cent instability of I_1, I_2 and I_3 measures, respectively and lowest instability coefficient were found 44.82 and 50.10 per cent in context of I_2 and I_3 measures, respecting in Jodhpur district and 54.25 per cent in context of I_1 measure in Jalore district.Similar results were observed for cotton by Awaghad *et al.* (2010).

Instability in productivity of cumin in selected districts of Rajasthan

The estimated instability through different measures during different periods in productivity of cumin in the major producing districts of the state and for the Rajasthan state as a whole are given in Table 4. All the three measures of instability indicated that the productivity of cumin was maximum instable in Barmer district with respect to 49.15, 47.65 and 45.45 per cent and minimum in Jalore district with 25.46, 24.46 and 24.53 per cent in I_1, I_2 and I_3 measures, respectively, during period I. During period II, Barmer district was found high level of instability with 45.45 and 38.54 per cent in context of I_1 and I_3measures, respectively, while Jalore showed 37.28 per cent in context of I_1. Jodhpur district having low level of instability with 30.88, 30.80 and 30.76 per cent instability in context of I_1, I_2 and I_3 measures, respectively.

During the overall period, Barmer district showed highest productivity instability of 46.27, 46.01 and 46.15 per cent and Jalore district showed lowest instability 33.12, 32.74 and 32.97 per cent in context to I_1, I_2 and I_3 measures, respectively.

Acreage response function of cumin

The estimated acreage response function for cumin keeping all the explanatory variables in the model is given in Table 5. All variables included in the model to analyse the factors affecting area allocation decision under cumin. The value of R^2 was 0.9120 which indicated that 91.20 per cent variation in area under cumin crop was explained by all eleven variables included in this model.

The variables such as lagged area of crop, one year lagged price, current year rainfall, lagged rainfall, current year irrigated area and variability in yield were found to have positive impact and the variables such as lagged yield of selected spice, lagged yield of the competing crop, lagged price of competing crop, lagged irrigated area and variability in lagged price were found to have negative impact in determining acreage under cumin. Mineral nutrition is one of the main factors, which influences on growth, yield of chilli to a great extent (Khan and Pariari, 2013)

The coefficient of lagged area under crop was positive which in turn implied that the producer of the state not only considered preceding year's price rather than past experience in the area allocation decision under cumin. The coefficient of lagged price of cumin was positive and statistically significant at 1 per cent level which showed that higher the price more will be area under cumin in the state. Thus, Government's price support measures were in the right direction to attain desired goal of higher cumin production. The coefficient of lagged yield of competing crop was found to be negative which implied that higher the yield of competing crop in the preceding year, less will be the area under cumin in current year. The coefficient of lagged price of competing crop (rapeseed & mustered) was found to be negative which implied that higher price of competing crop affect area allocation decision under cumin adversely in the state. The current year rainfall was most important factor to explain area allocation under cumin which was positive. It revealed that higher the current year rainfall higher will be the area under cumin. It was quite obvious as high rainfall would affect the irrigation facilities and subsequently acreage under cumin.

The coefficient of lagged year rainfall was found to have positive and statistically significant at 5 per cent level. The coefficient of total area under irrigation in current year was found to be positive, indicating that expansion in area under irrigation leads to increase in area under cumin in the state. The coefficient representing price variability in cumin emerged with negative sign and coefficient representing yield variability in cumin emerged with positive sign and statistically significant at 5 per cent level, indicated that farmers are risk averters of price variability but risk takers of yield variability. The technology and price related variables of cumin were found to influence the acreage decision of farmers with respect to this crop. The acreage under cumin is positively elastic to the lagged area and price of crop, current year and lagged year rainfall, current year irrigated area and variability in yield. Lagged yield of crop, lagged yield and price of competing crop, lagged irrigated area and variability in prices of crop were found to have negative elasticity coefficients. Similar results were observed for wheat by Khan and Khair (2010).

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