Indian J. Agric. Res., 50 (5) 2016 : 461-465
Print ISSN:0367-8245 / Online ISSN:0976-058X

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
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Decomposition analysis and acreage response of pigeonpea in western Vidarbha

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Received: 12-01-2016 Accepted: 06-04-2016 DOI:10.18805/ijare.v0iOF.11007

ABSTRACT

In the present investigation, an attempt was made to study the decomposition and acreage response of pigeonpea in western Vidarbha. The study was based on time series secondary data on the rainfall, farm harvest prices and other data, which were obtained from various Government publications. Nerlovian lagged adjustment model (1958) was used in acreage response analysis based on time series data. The study revealed that the compound growth rate for area and production under pigeon pea was recorded high during period I in all the districts. During period II, the area, production and productivity of pigeonpea registered mostly negative growth rates in all the districts. During period III, the compound growth rate for area, production and productivity under pigeonpea has increased in all the districts of western Vidarbha region. At overall period, the coefficient of variation and Coppock's instability index for area, production and productivity were high for pigeonpea in Akola district compared to other districts and coefficient of variation and Coppock's instability index for production and productivity were lowest for pigeonpea in Amravati district. At overall period, in pigeonpea, the area effect (56.61%) was most responsible factor for increasing production in Amravati division with positive yield and interaction effect i.e. 18.91 per cent and 23.75 per cent respectively.

Key words: Acreage response, Decomposition, Growth rate, Pigeonpea, Vidarbha.

INTRODUCTION

Pigeonpea is an very important *kharif* pulse crop in world named *Cajanus cajan* L in the Fabaceae family. It is also known as red gram, tur and arhar. This crop is widely grown in India. It is a protein rich staple food. In India, major states growing pigeonpea are Maharashtra, Madhya Pradesh, Uttar Pradesh, Karnataka and Gujarat etc. Among these states Maharashtra ranks first in acreage under pigeonpea. Pigeonpea occupied 24.42 per cent share to the gross cropped area of Amravati division.

The acreage response of agricultural crop is one of the important tools used for predicting the crop production. Agriculture is the most important sector in the economy of nation. In India, the increase in population during the last two decades has been more pronounced than agricultural production, thereby creating a lag in the availability and requirement of food crop. It is a matter of paramount importance to study the behavior of farmer's attitude towards area allocation to different crops.

MATERIALS AND METHODS

The study was undertaken to examine the extent of deviation from planned acreage while making ultimate acreage allocation.

Collection of data: The study was based on secondary data collected from western Vidarbha. The data pertain to the period 1983-84 to 2012-13 and the period was divided into breakup of 10 years with overall as: (a) Period I –1983-84 to 1992-93, (b) Period II –1993-94 to 2002-03, (c) Period III –2003-04 to 2012-13 and (c) Overall III –1983-84 to 2012-13.Time series secondary data on area, production and productivity of pigeonpea, data on rainfall, farm harvest price and other relevant data were obtained from many published sources *viz.*, Agricultural Statistical Information of Maharashtra Part II (published form the Office of the Agriculture Commissioner, Pune), Season and crop report (from Government of Maharashtra) , Epitome of Agriculture and Agricultural Situation in India.

Analytical techniques employed for analyzing the data: The present study was based on time series secondary data of pigeonpea in Western Vidarbha.

Growth rate analysis: The compound growth rate of area, production and yield for pigeonpea were estimated for three sub periods. The first period was 1983-84 to 1992-93, second period 1993-94 to 2002-03 and third period 2003-2004 to 2012-13. The district-wise compound growth rates were estimated to study the growth. These were estimated with the following exponential model:

$Y = ab^t$

$\log Y = \log a + t \log b$

CGR = (Antilog (logb) -1) x 100

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Where, CGR = Compound growth rate, t = time period in year, y = area/ production / productivity, a & b = Regression parameters

Instability analysis: To measure the instability in area, production and productivity, an index of instability was used as a measure of variability. The coefficient of variation (CV) was calculated by the formula:

$$\textbf{CV (\%)} = \frac{\text{Standard deviation}}{\text{Mean}} \times 100$$

The simple coefficient of variation (CV) often contains the trend component and thus over estimates the level of instability in time series data characterized by long-term trends. To overcome this problems, we used the instability index (II) given by Coppock's instability index of variation. Coppock's instability index is a close approximation of the average year to year per cent variation adjusted for trend. The algebraic form of equation is:

$$\textbf{CII} = [(\text{Antilog}\sqrt{\log V} - 1) \times 100)]$$

$$\textbf{log V} = \sum \frac{[\log \frac{X_{t+1}}{X_t} - m]^2}{N-1}$$

Where, X_t = Area/ production/ productivity in the year 't', N = Number of year, CII = Coppock's instability index, m = Arithmetic mean of difference, log V = Logarithmic variance of the series

Decomposition analysis: To measure the relative contribution of area, yield to the total output change for the major crops, Minhas (1964), the decomposition analysis model as given below was used. Sharma (1977) redeveloped the model and several research workers (Kalamkar *et al*., 2002) used this model and studied growth performance of crops on state. The method states that if A_0, P_0 and Y_0 respectively are area, production and productivity in base year and A_n, P_n and Y_n are values of the respective variable in n^{th} year then.

$$P_o = A_0 \times Y_0 \text{ and}$$

$$P_n = A_n \times Y_n \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, A_o and A_n represent the area and Y_o and Y_n represents the yield in the base year and n^{th} year respectively.

$$P_n - P_o = \Delta P,$$
$$A_n - A_o = \Delta A$$
$$Y_n - Y_o = \Delta Y \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

From equation (1) and (2) we can write

$$P_o + \Delta P = (A_o + \Delta A)(Y_o + \Delta Y)$$

Hence,

$$\textbf{P} = \frac{A_0 \Delta Y}{\Delta P} \times 100 + \frac{Y_0 \Delta A}{\Delta P} \times 100 + \frac{\Delta Y \Delta A}{\Delta P} \times 100$$

Production = Yield effect + area effect + interaction effect

Thus, the total change in production can be decomposed into three components *viz.* yield effect, area effect and the interaction effect due to change in yield and area.

Acreage response analysis: The model which generally used in supply response analysis based on time series data has been used adaptive expectations or Distributed Lagged model. In the present study the regression model of the Nerlovian lagged adjustment model (1958) was used. The acreage response means the change in acreage with the unit change in the variables affecting on during the period of study.

$$\textbf{At} = a + b_1 A_{t-1} + b_2 FHP_{t-1} + b_3 Y_{t-1+} b_4 W_t + b_5 P_r + b_6 Y_r$$

Where,

a = Intercept
A_t = Area under crop at time 't' ('00' ha)
A_{t-1} = One year lagged area under the crop ('00' ha)
FHP_{t-1} = Lagged year farm harvest price of the crop (Rs/kg)
Y_{t-1} = One year lagged yield
W_t = Weather variable as rainfall data per year.
P_r =Price risk (coefficient of variation of last three years)
Y_r = Yield risk (coefficient of variation of last three years)
$b_1 \ldots\ldots b_6$ = Parameters of multiple linear regression

Short run and long run elasticity: The elasticity's of variables show that the influence of unit change in variable on acreage decisions of crop. In the present study, variable elasticity was estimated for short run as well as for long run period. Moreover, the short run and long run elasticity were estimated as:

$$\textbf{Short run} = \text{Regression coefficient of price} \times \frac{\text{Mean of price}}{\text{Mean of area}} \text{ x Elasticity (SRE)}$$

$$\text{Long run elasticity (LRE)} = \frac{\text{SRE}}{\text{Coefficient of area adjustment (r)}}$$

Where, r = 1 – (coefficient of lagged area)

RESULTS AND DISCUSSION

Growth performance of pigeonpea: The growth performance of pigeonpea pertaining to three period and overall was presented in the Table 1. Devraj and Kumar (2005) studied the growth and instability in pulses production in Uttar Pradesh. The time series data on area, production and productivity of pulses for Western, Eastern, Bundelkhand and Central regions as well as for the whole state with reference to the period, 1989-90 to 1998-99 was considered for analysis. During period I, the growth rate of area, production was recorded positive and the productivity of Buldhana district was positive, the productivity was negative in Amravati, Akola and Yavatmal districts (-3.49, -3.07 and -0.97% per annum). The highest increasing trend in area was recorded in Akola district i.e. 8.00 per cent per annum and highest increasing trend in production was recorded in Yavatmal district i.e. 5.65 per cent per annum respectively and highest productivity was recorded in Buldhana district i.e. 0.34 per cent per annum. During period II, picture has been drastically changed, the compound growth rates of area, production and productivity of pigeonpea registered mostly negative growth rates in all the districts of Amravati division. During period III, there was negative growth rate in the area, production of Yavatmal district i.e. -2.10 and -0.51 per cent per annum respectively. In the Amravati division as a whole,

Table 1: District wise compound growth rate for pigeonpea

Particulars	Amravati	Akola	Buldhana	Yavatmal	Amravati	Division
Period I	Area	7.45***	8.00***	4.18***	6.68***	6.70***
	Production	4.90*	4.67	4.54	5.65**	5.06*
	Yield	-3.49	-3.07	0.34	-0.97	-1.81
Period II	Area	-1.05	-6.38*	-1.84***	-2.89	-2.62
	Production	-2.59	-4.93	-6.53**	-0.91	-2.79
	Yield	-1.55	1.56	-4.78*	2.04	1.25
Period III	Area	3.88***	2.13**	3.32***	-2.10**	1.58*
	Production	4.04*	2.32	1.80	-0.51	2.06
	Yield	0.15	0.08	-1.48	1.60	0.53
Overall Period	Area	2.31***	2.61***	1.75***	1.95***	1.56***
	Production	2.41***	3.12***	1.51**	2.30***	1.83***
	Yield	-0.05	3.64***	-0.24	0.34	0.30

(Note: ***,** & * denotes significant at 1%, 5% & 10% level of significance)

in this period growth rate of area, production and yield was registered positive with area increasing in a decreasing rate and in production and productivity it is statistically insignificant.

The growth rate was also worked for the overall period (pooled period of 30 years) for pigeonpea where almost all found to be positive in all the districts, except Amravati and Buldhana districts there was negative growth rate in productivity i.e. -0.05 and -0.24 per cent per annum respectively.

Instability in pigeonpea: In order to know the instability in area, production and yield of pigeonpea, the fluctuation measured with the help of coefficient of variation as well as Coppock's index as a coefficient of instability. Chatterjee *et al*. (2014) studied the overall trend in area, production and productivity of kharif, rabi and total pulses as well as their respective growth rates and instability during the period 1986-87 to 2007-08 for the sixteen major pulse growing states of India. During period I, coefficient of variation for the area and productivity was less in comparison to production. Coefficient of variation for area and production was found to be similar for all districts during first period (Table 2). The coefficient of instability for area and production for all districts was found to be within the limited range *viz.*, 4.88 to 37.69 per cent. However, for Amravati division as a whole, coefficient of variation for area, production and yield was 19.27, 28.30 and 21.35 per cent. During period II, coefficient of variation for the area, productivity was less in comparison to production. Highest coefficient of variation for area was found in Akola district i.e. 27.73 per cent per annum and it has been increased in comparison to period I i.e. 23.53 per cent per annum. For the production, Akola district has got the highest coefficient of variation i.e. 39.29 per cent per annum. Highest coefficient of variation was recorded in the productivity of Buldhana district i.e. 28.04 per cent per annum. The coefficient of instability for area and production for all districts was found to be within the limited range *viz.*, 4.82 to 37.30 per cent.

The instability in the area was found to be decreased in period III except the area of Amravati and Buldhana

Table 2: District wise instability indices in pigeonpea

Name of District	Particulars	Period I		Period II		Period III		Overall	
		CV	CII	CV	CII	CV	CII	CV	CII
Amravati	Area	21.62	8.47	12.78	12.47	15.26	9.45	23.18	13.89
	Production	31.06	27.80	24.12	23.11	23.44	19.70	31.05	24.33
	Yield	22.53	20.34	18.28	17.69	18.61	18.60	19.21	19.20
Akola	Area	23.53	12.26	27.73	23.78	8.81	5.97	30.61	24.03
	Production	35.33	32.60	39.29	37.30	31.03	30.40	43.92	36.25
	Yield	25.87	24.45	22.95	22.50	29.28	29.27	47.31	46.94
Buldhana	Area	14.55	7.37	7.37	4.82	12.93	7.58	18.17	10.38
	Production	39.97	37.69	30.98	24.20	29.89	29.32	34.43	32.06
	Yield	33.31	33.29	28.04	24.36	32.33	31.94	30.20	30.12
Yavatmal	Area	19.35	4.88	20.74	19.74	9.39	6.77	23.52	18.49
	Production	22.94	16.30	29.66	29.57	20.49	20.44	34.01	28.43
	Yield	13.75	13.44	18.58	17.58	20.82	20.25	19.77	19.53
Amravati Division	Area	19.27	6.47	15.92	14.59	8.92	7.54	18.55	14.29
	Production	28.30	24.26	25.97	24.99	19.55	18.59	29.33	25.46
	Yield	21.35	20.69	16.23	15.82	19.37	19.30	19.41	19.24

CV,CII : Coefficient of variation and Coppocks instability index.

district which has been increased in terms of coefficient of variation from 12.78 per cent per annum to 15.26 per cent per annum and 7.37 per cent per annum to 12.93 per cent per annum. Similarly, instability in production has been recorded decreasing in all the districts and as a whole in Amravati Division. The coefficient of instability for area and production for all districts was found to be within the limited range *viz.*, 5.97 to 30.40 per cent.

During the overall period, Buldhana district recorded lowest degree of instability in area i.e., coefficient of variation of 18.17 per cent and coppocks instabiliy index of 10.38 per cent per annum. Similarly in production and yield Amravati district was recorded with lowest which shows coefficient of variation of 31.05 per cent and coppocks instabiliy index of 24.33 per cent per annum and coefficient of variation of 19.21 per cent and coppocks instabiliy index of 19.20 per cent per annum respectively. This all indicates least consistency in terms of area, production and productivity during overall period of 30 years.

Decomposition analysis of pigeonpea: The decomposition of pigeonpea production in area, yield and interaction effect presented in Table 3. and results demonstrate that per cent contribution of area, yield and their interaction for increasing production of pigeon pea in Western Vidarbha (i.e. Amravati division) and overall also. Minhas and Vaidyanathan (1965) studied the decomposition of aggregate crop output into its component elements for the country as a whole. A seven factor additive model was employed to analyse the data for a period of eight years from 1951 to 1959. During period I, the result clearly indicate that the area effect 83.04 per cent was most responsible for increasing the production of pigeonpea in Amravati division with yield effect 9.24 per cent and interaction effect 7.91 per cent. Interaction effect was positive for all the districts except Akola which shows interaction effect of -24.19 per cent with yield effect -25.27 per cent and the district has recorded highest area effect i.e. 149.16 per cent. In all the districts yield effect was also found negative only in the Akola district. It indicated that area was a driving force in the differential production of pigeon pea in Amravati division during first period.

In the contrary during period II, it was noticed that yield effect (79.23%) was responsible for increasing production of pigeonpea, whereas area and interaction effect was 23.52 and -3.16 per cent respectively. The area effect of Yavatmal district i.e. 317.07 per cent was highest among all the districts, whereas yield and interaction effect were highest in Amravati district i.e. 144.7 and 6.14 per cnt respectively. On the contrary in period III, it was noticed that yield effect (54.59%) was responsible for increasing production of pigeonpea, whereas area and interaction effect was 38.18 and 7.32 per cent respectively. The area effect of Buldhana district (684.86%) was highest among all the districts, whereas yield effect was highest in Yavatmal district (246.87%) and interaction effect was highest in Akola district (14.76%).

During overall period, area effect (56.61%) was found most responsible factors for increasing pigeonpea production in Amravati division with positive yield and interaction effect i.e. 18.91 and 23.75 per cent respectively. Highest area effect was recorded in Buldhana district (103.02%). The highest interaction effect and yield effect was found in Akola district 28.24 and 42.93 per cent respectively.

Acreage response of pigeonpea: Acreage response functions were fitted to examine the effect of price and non price factors on farmer's decision in allocating the area of pigeonpea. Shende *et al.* (2011) studied the acreage response and decomposition analysis of soybean in western Vidarbha region. The study revealed that during overall period, the area effect (46.98%) was most responsible factor for increasing soybean production in Amravati division with positive yield and interaction effect i.e., 1.91 per cent and 51.41 per cent respectively. The value of R^2 i.e. the coefficient of multiple determinations ranged from 0.48 to 0.81 for all the districts of Amravati Division, which indicates that variables included in the model explained most of the variations in area under pigeonpea in the study period. The

Table 3: Per cent contribution of area, yield and their interaction for increasing production of pigeonpea

Period	Particulars	Amravati	Akola	Buldhana	Yavatmal	Amravati Division
Period I	Area Effect	90.60	149.16	44.42	80.9	83.04
	Yield Effect	5.04	-25.27	32.57	10.00	9.24
	Interaction Effect	4.29	-24.19	22.84	8.93	7.91
Period II	Area Effect	-50.8	85.65	22.94	317.07	23.52
	Yield Effect	144.7	23.25	84.58	-187.54	79.23
	Interaction Effect	6.14	-8.97	-7.27	-29.49	-3.16
Period III	Area Effect	49.73	19.77	684.86	-107.54	38.18
	Yield Effect	39.58	65.49	-414.12	246.87	54.59
	Interaction Effect	10.67	14.76	-171.21	-39.05	7.32
Overall Period	Area Effect	67.49	28.78	103.02	48.03	56.61
	Yield Effect	11.76	42.93	-1.29	25.39	18.91
	Interaction Effect	20.66	28.24	-1.74	26.53	23.75

Table 4: Coefficients for acreage response function of pigeonpea

Particulars	Variables	Coefficients				
		Amravati	Akola	Buldhana	Yavatmal	Amravati Division
	Intercepts	462.27	418.18	199.52	457.58	1821.42
One year lagged area	A_{t-1}	0.26*	0.39***	0.50***	0.41**	0.25*
One year lagged farm harvest price	FHP_{t-1}	0.11***	0.05**	0.04**	0.07*	0.38***
One year lagged yield	Y_{t-1}	0.08	0.09*	0.05	-0.14	0.42
Annual rainfall	W_t	-0.13*	-0.13	0.005	0.12	-0.50
Yield risk	Y_r	5.75**	8.74***	0.95	3.49	26.14***
Price risk	P_r	-2.64	-7.24***	-1.42	-1.27	-17.26**
Coefficient of determination	R^2	0.80	0.81	0.78	0.48	0.76

(Note: ***,** & * denotes significant at 1%, 5% & 10% level of significance)

regression coefficients for lagged area were positively and statistically significant in almost all the districts, indicating lesser rigidity in the adjustment of area under pigeonpea. The coefficients of farm harvest price were positive and significant for all districts in the study. It was implied that prices show impact on one year lag prices for increasing the area of pigeonpea. The coefficient of annual rainfall variable showed positive relationship for Buldhana and Yavatmal districts and statistically significant in Amravati district at 10 per cent level which showed annual rainfall favourably influenced the area allocation decision of the farmers. The coefficient of yield risk had a positive response for all districts and statistically significant at 1 per cent level in Amravati and Akola districts. On the other hand, the coefficient of price risk had negative response for all districts and statistically significant for Akola i.e. -7.24 (Table 4).

Short run and long run elasticity of pigeonpea: In the present study price elasticities were estimated for short run as well as for long run period. The variations in the magnitude of short run and long run price elasticity factors between different districts of western Vidarbha zone were evident from Table 5. The short run and long run price elasticities of pigeonpea showed positive price responsiveness of farmers in all the districts of Amravati division.

The short run price elasticity for all districts was found positive and the highest short run price elasticity was found in the Amravati district i.e., 0.22 followed by Yavatmal, Buldhana and Akola. The long run elasticity for all districts was found positive and highest in Amravati i.e., 0.31 followed by Buldhana, Yavatmal and Akola. Therefore, Amravati district recorded highest short run and long run elasticity.

Table 5. District wise price elasticity of pigeonpea in western Vidharba

Name of Districts	SRE	LRE
Amravati	0.22	0.31
Akola	0.11	0.19
Buldhana	0.12	0.26
Yavatmal	0.13	0.22
Amravati division	0.19	0.26

In conclusion, the compound growth rate for area and production under pigeonpea was recorded high during period I in all the districts. During period II, the area, production and productivity of pigeonpea registered mostly negative growth rates in all the districts. During period III, the compound growth rate for area, production and productivity under pigeonpea has increased in all the districts of western Vidarbha region. Percent contribution of area effect was more responsible for pigeon pea production in the initial period but later yield effect was more pronounced. The current year acreage was influenced neither by farm harvest price nor by one year lagged yield of the pigeonpea in all the districts.

REFERENCES

Anonymous (2012). Annual report 2012-13. *http//www.mahaagri.com*

Chatterjee, S., R. Nath., J. Ray., M. Ray., S.K Gunri and P. Bandopadhyay. (2014). Analysis of pulse production in major states of India. *Journal of Food Legume*s **27:** 140-145.

Devraj and Hemanth Kumar. (2005). Growth and instability in pulses production in Uttar Pradesh. *Indian Journal of Pulses Research* **18:** 100-101.

Kalamkar, S.S, Atkare, V.G. and Shende, N.V. (2002). An analysis of growth trends of prinicipal crops in India. *Agricultural Science Digest*, **22:** 153-156.

Minhas B. S. (1964). Analysis of Crop Output Growth by Component Analysis (Mimeo.)

Minhas, B.S. and Vidhyanathan A. (1965). Growth of crop output in India. *Journal of Indian Society of Agricultural Statistics* **28:** 230-252.

Sharma, K.L. (1977). Measurement of the effects to Area, yield and prices in the increase of value of crop output in India. *Agricultural Situation in India* **32:** 348-350.

Shende, N.V., Thakare, S.S. and Roundhal, P. S. (2011). Acreage response and decomposition analysis of soybean in Western vidarbha. *Journal of Food Legumes*. **24:** 133-137.