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RESEARCH ARTICLE :

Decomposition analysis and acreage response of chickpea in western Vidarbha

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SUMMARY : In the present investigation, an attempt was made to study the decomposition and acreage response of chickpea in western Vidarbha. The study was based on time series secondary data on the rainfall, farm harvest price 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 chickpea was recorded high during period I in all the districts. During period II, the area, production and productivity of chickpea registered mostly negative growth rates in all the districts. During period III, the compound growth rate for area, production and productivity under chickpea has increased in all the districts of western Vidarbha region. During overall period, the co-efficient of variation and Coppock's instability index for area, production were high in Yavatmal district compared to other districts. At overall period, the area effect (37.44%) was most responsible factor for increasing production in Amravati division with positive yield and interaction effect *i.e.*, 6.78 per cent and 55.69 per cent, respectively.

KEY WORDS :
Acreage response, Chickpea, Decomposition, Growth rate

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BACKGROUND AND OBJECTIVES

Agriculture in India continue to hold the important place in Indian economy, where about 90 per cent of population leaving in rural area out of which 65 per cent of total population depends on agriculture. Agriculture sector employees around 50 per cent of labour force on total of 163 million hectare out of 328.7 mha of land. It contributes about 40 per cent to the national income and its developments. Therefore, is indispensable to feed the increasing demand of vast population.

Chickpea (or) gram is very important *Rabi* pulse crop in the world after peas and beans named *Cicer arietinum* L. in the Fabaceae family. Indian name 'channa' has most probably derived from the Sanskrit world 'chahakam'. Gram is commonly known by various names in different state of India such as, 'channa', 'harbhara', 'chhole', 'Bengal gram' etc. The light brown colored pulse is considered to be a good source of protein (25 to 29 %) and is also called by name 'Garbanzo beans'. Channa is used as an edible seed and is also used for marketing flour throughout the globe. In India, major states growing chickpea are Madhya Pradesh, Rajasthan, Maharashtra and Andhra Pradesh etc. Among these states

Maharashtra ranks third in acreage under chickpea after Madhya Pradesh and Rajasthan. Chickpea occupied 17.36 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 behaviour of farmer's attitude towards area allocation to different crops.

RESOURCES 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 chickpea, 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 chickpea in Western Vidarbha.

Growth rate analysis :

The compound growth rate of area, production and yield for chickpea were estimated for three sub periods. The period I was 1983-84 to 1992-93, period II - 1993-94 to 2002-03 and period III - 2003-2004 to 2012-13. The district-wise compound growth rates was estimated to study the growth. It was estimated with the following exponential model:

$$Y = ab^t$$

$$\text{Log } Y = \log a + t \log b$$

$$\text{CGR} = [\text{Antilog (logb) -1}] \times 100$$

where, CGR = Compound growth rate, t = time period in year, y = area/ production / productivity, a and 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 co-efficient of variation (CV) will be calculated by the formula:

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

The simple co-efficient of variation (CV) often contains the trend component and thus overestimates 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:

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

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

where, X_t = Area/ production/ productivity in the year 't', N = Number of year, m = Arithmetic mean of difference, V log = Logarithmic variation of the series.

Decomposition of output growth:

To measure the relative contribution of area, yield to the total output change for the major crops (Minhas, 1964 and Minhas and Vidhyanathan, 1965). 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 state that if A_0, P_0 and Y_0, respectively 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 item.

$$P_o = A_o \times Y_o \text{ and}$$

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

where, Ao and A_n represent the area and Yo and Y_n

represents the yield in the base year and n^{th} year, respectively.

$$P_n - Po = a\,P,$$
$$A_n - Ao = a\,A$$
$$Y_n - Yo = a\,Y \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

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

$$Po + a\,P = (Ao + a\,A)\,(Yo + a\,Y)$$

hence,

$$P = \frac{A_0 \Delta Y}{\Delta P} x\,100 + \frac{Y_0 \Delta A}{\Delta P} x\,100 + \frac{\Delta Y \Delta A}{\Delta P} x\,100$$

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 (Nerlov, 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.

$$At = a + b_1 A_{t-1} + b_2 FHP_{t-1} + b_3 Y_{t-1+} b_4 W_t + b_5 P_R + b_6 Y_R$$

where,

a = Area

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 (kg/ha)

Y_{t-1} = One year lagged yield

W_t = Weather variable as rainfall data per year.

P_R =Price risk (co-efficient of variation of last three years)

Y_R = Yield risk (co-efficient of variation of last three years)

b_1……. 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's were estimated for short run as well as for long run period. Moreover, the short run and long run elasticity were estimated as:

$$\text{Short run elasticity (SRE)} = \text{Regression co-efficient of price} \times \frac{\text{Mean of price}}{\text{Mean of area}}$$

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

where, r = 1 – (co-efficient of lagged area)

OBSERVATIONS AND ANALYSIS

The results obtained from the present investigation have been presented in the following sub heads:

Growth performance of chickpea:

The growth performance of chickpea pertaining to three period and overall is presented in the Table 1. During period I, the growth rate of area, production and productivity was recorded positive in all the districts. The highest increasing trend in area and production was recorded in Yavatmal district *i.e.* 17.17 per cent and 22.39 per cent per annum, respectively and highest productivity was recorded in Amravati district *i.e.* 6.66 per cent per annum. The lowest increase in area and production was recorded in Akola district *i.e.* 6.32 per cent per annum and 12.72 per cent per annum, respectively.

During period II, picture has been drastically changed, the growth rate has been decreased in area, production and productivity. During period III, the growth rate has been increased in area, production and productivity. In the Amravati division as a whole, in this period growth rate of area, production and yield was registered positive with area increasing in a decreasing rate and shows significance in 5 per cent level.

The growth rate was also worked for the overall period (pooled period of 30 years) for chickpea where almost all found to be positive. Statistically compound growth rate in area, production and productivity all districts shows significance in 1 per cent level. In the Amravati division as a whole, in this period growth rate of area, production and yield was registered positive with area increasing in a decreasing rate.

Instability in chickpea:

In order to know the instability in area, production and yield of chickpea, the fluctuation measured with the help of co-efficient of variation as well as Coppock's index as a co-efficient of instability. During period I, co-efficient of variation for the area was less as compared to production but more as compared to yield. Co-efficient of variation for area and production was found to be

similar for all districts during first period (Table 2). The co-efficient of instability for area and production for all districts was found to be within the limited range *viz.*, 19.12 to 50.73 per cent. However, for Amravati division as a whole, co-efficient of variation for area, production and yield was 40.39, 61.97 and 24.93 per cent, respectively (Devraj and Kumar, 2005; Ramarao, 2004 and Shende *et al*., 2010).

During period II, co-efficient of variation for the area, productivity was less in compared to production. Highest co-efficient of variation was recorded in the productivity of Akola *i.e.*, 30.49 per cent per annum. CII has been seen almost increased in productivity in all the district and in whole Amravati Division in this period CII has been decreased in the area and production in all the districts. The co-efficient of instability for area and production for all districts was found to be within the limited range *viz.*, 16.90 to 39.37 per cent. The instability in the area was found to be increased in period III in all the districts. Similarly instability in production and yield has been recorded increased in all the districts and as a whole Amravati Division except Amravati district which decreased from co-efficient of variation 30.18 per cent to 23.29 per cent per annum in yield. The co-efficient of instability for area and production for all districts was found to be within the limited range *viz.*, 22.49 to 56.33

Table 1 : District wise compound growth rate for chickpea

Particulars		Amravati	Akola	Buldhana	Yavatmal	Amravati Division
Period I	Area	8.70**	6.32	10.98**	17.17***	9.33**
	Production	16.02***	12.72**	16.00**	22.39***	15.79***
	Yield	6.66**	5.82**	4.52	4.50**	5.31**
Period II	Area	-2.92	-3.22	-1.69	3.71**	-0.99
	Production	-5.80*	-6.56*	-5.87	2.86	-4.75
	Yield	-2.97	-3.44	-4.25*	-0.81	-1.93
Period III	Area	9.40***	9.94**	4.96	7.05	8.42**
	Production	15.45***	15.79**	14.56**	16.07**	15.81**
	Yield	5.51**	5.41	9.13**	8.42***	6.81**
Overall	Area	6.02***	8.05***	6.58***	8.59***	7.21***
Period	Production	9.66***	11.47***	9.28***	12.12***	10.55***
	yield	3.43***	6.25***	2.53***	3.25***	3.08***

***,** and * indicate significant of values at P=0.01, 0.05 and 0.10, respectively

Table 2 : District wise instability indices in chickpea

Name of district	Particulars	Period I		Period II		Period III		Overall	
		CV	CII	CV	CII	CV	CII	CV	CII
Amravati	Area	37.08	27.78	23.54	22.07	32.81	22.49	56.64	28.85
	Production	62.03	41.44	34.00	29.73	47.10	30.35	85.53	42.36
	Yield	30.38	23.68	30.18	28.59	23.29	17.44	37.69	24.85
Akola	Area	44.33	41.30	32.45	31.02	34.14	24.41	78.63	41.25
	Production	62.59	50.73	44.27	39.37	56.25	44.21	111.89	57.12
	Yield	27.47	21.56	30.49	28.72	37.80	34.46	70.98	38.73
Buldhana	Area	45.98	35.19	28.73	28.33	36.45	33.71	60.33	34.08
	Production	65.19	47.42	38.38	34.79	60.57	49.72	90.50	53.80
	Yield	25.75	23.22	27.44	23.59	34.34	24.21	36.50	29.44
Yavatmal	Area	55.50	36.24	20.41	16.90	60.66	56.33	91.60	45.00
	Production	75.30	49.01	28.61	27.34	66.57	53.81	121.85	56.45
	Yield	23.35	19.12	26.47	26.34	30.50	18.17	40.48	26.27
Amravati	Area	40.39	31.94	23.67	23.47	34.87	27.41	67.42	31.34
Division	Production	61.97	42.73	34.53	31.38	50.69	37.07	96.24	46.36
	Yield	24.93	19.66	26.90	26.23	27.91	20.67	36.39	24.72

CV,CII : Co-efficient of variation and Coppocks instability index.

per cent.

During the overall period *i.e.* 30 years as a whole, Amravati district recorded lowest degree of instability in area *i.e.* CV 56.64 per cent and Yavatmal district recorded highest degree of instability in area *i.e.* CV 91.60 per cent and CII 45.00 per cent per annum. Similarly in production Amravati district recorded with lowest which shows CV 85.83 per cent and Yavatmal district recorded highest degree of instability CV 121.85 per cent and in yield, Buldhana district recorded lowest degree of instability CV 36.50 per cent per annum and Akola district recorded highest degree of instability CV 70.98 per cent and CII 38.73 per cent per annum, but through CII Yavatmal district came highest by 45.00 per cent per annum in the 30 years overall period. This all indicates least consistency in terms of area, production and productivity during overall period of 30 years.

Decomposition analysis of chickpea:

The decomposition of chickpea 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 chickpea in Western Vidarbha (*i.e.* Amravati division) and overall also. During period I , the result clearly indicate that the area effect 65.00 per cent was most responsible for increasing the production of chickpea in Amravati division with yield effect 12.57 per cent and interaction effect 21.99 per cent. Interaction effect was positive for all the districts and Amravati division. The Yavatmal district has recorded highest area effect *i.e.* 72.48 per cent. Akola district showed all the effect nearer to be proportional and in other area effect has played a driving force in the differential production of chickpea in Amravati Division during first period.

In the contrary during period II, it was noticed that yield effect has got domination over the area effect. In Amravati division as a whole area effect was found only 1.79 per cent whereas yield effect was 98.42 per cent and negative interaction effect was -0.35 per cent. Lowest area effect was found in the Yavatmal district *i.e.* -151.3 per cent and highest yield effect was also

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

Period	Particulars	Amravati	Akola	Buldhana	Yavatmal	Amravati Division
Period I	Area effect	62.22	54.81	86.54	72.48	65.00
	Yield effect	12.09	21.07	4.25	10.94	12.57
	Interaction effect	25.12	24.72	9.1	17.46	21.99
Period II	Area effect	-13.31	35.33	11.07	-151.3	1.79
	Yield effect	108.06	76.62	94.18	193.5	98.42
	Interaction effect	5.04	-12.19	-5.16	58	-0.35
Period III	Area effect	46.3	83.81	24.99	41.89	48.46
	Yield effect	24.9	5.24	55.92	27.48	24.56
	Interaction effect	28.7	10.84	18.92	30.53	26.83
Overall Period	Area effect	30.67	43.6	58.25	28.09	37.44
	Yield effect	10.00	7.28	6.88	6.61	6.78
	Interaction effect	59.26	49.03	34.87	65.24	55.69

Table 4 : Co-efficients for acreage response function of chickpea

Particulars	Variables	Co-efficients				
		Amravati	Akola	Buldhana	Yavatmal	Amravati Division
	Intercepts	-241.56	-366.39	-332.51	-146.45	-1660.28
One year lagged area	A_{t-1}	0.48***	0.65***	0.54***	0.39**	0.65***
One year lagged farm harvest price	FHP_{t-1}	0.14**	0.18**	0.12**	0.13**	0.62***
One year lagged yield	Y_{t-1}	0.15	0.08	0.04	0.05	-0.01
Annual rainfall	W_t	0.16*	0.43**	0.33***	0.17*	1.67***
Yield risk	Y_r	3.51*	-0.67	3.45*	-1.10	3.61
Price risk	P_r	0.18	-0.09	0.31	-0.55	5.31
Co-efficient of determination	R^2	0.82	0.85	0.73	0.53	0.84

***,** and * indicate significant of values at P=0.01, 0.05 and 0.10, respectively

found in this district with 193.5 per cent. In all the districts yield effect has got higher record *i.e.* more than 60 per cent. It is also recorded in this period that interaction effect is negative in all the districts and in whole over Amravati division except Amravati and Yavatmal districts. During period III, the area effect *i.e.* 48.46 per cent was most responsible for increasing the production of chickpea in Amravati division. In whole Amravati Division area effect, yield effect and interaction effect was recorded 48.46 per cent, 24.56 per cent and 26.83 per cent, respectively. Highest area effect was shown in Akola district *i.e.* 83.81 per cent. Highest yield effect and lowest area effect was recorded in Buldhana district *i.e.*, 55.92 per cent and 24.99 per cent, respectively. So we can conclude that in this period also area effect was responsible for increasing production of chickpea in the western Vidarbha region of Maharashtra (Chatterjee *et al.*, 2014).

During overall period, interaction effect was found most responsible factors for increasing chickpea production in Amravati division *i.e.* 55.69 per cent with positive yield and area effect *i.e.*, 6.78 per cent and 37.44 per cent, respectively. Highest area effect was recorded in Buldhana district *i.e.* 58.25 per cent with both yield and interaction effect *i.e.* 6.88 and 34.87 per cent, respectively. And it is also recorded that highest interaction effect and lowest yield effect was found in Yavatmal district *i.e.* 65.24 per cent and 6.61 per cent, respectively.

Acreage response of chickpea:

Acreage response functions were fitted to examine the effect of price and non price factors on farmer's decision in allocating the area chickpea. The value of R^2 *i.e.* the co-efficient of multiple determinations ranged from 0.53 to 0.85 for all the districts of Amravati Division, which indicates that variables included in the model explained most of the variations in area under chickpea in the study period (Table 4).

The regression co-efficients for lagged area were positively and statistically significant in almost all the districts, indicating lesser rigidity in the adjustment of area under chickpea. The co-efficient 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 chickpea (Birla, 2014 and Shende *et al.*, 2011).

Table 5 : District wise price elasticity of chickpea in Western Vidharba

Sr. No.	Name of districts	SRE	LRE
1.	Amravati	0.34	0.67
2.	Akola	0.35	1.02
3.	Buldhana	0.38	0.85
4.	Yavatmal	0.62	1.02
5.	Amravati division	0.39	1.14

The co-efficient of annual rainfall variable showed positive relationship for and all districts and statistically significant which showed annual rainfall favourably influenced the area allocation decision of the farmers. The co-efficient of yield risk had a positive response for Amravati and Buldhana districts and statistically significant at 10 per cent level in Amravati and Buldhana districts. On the other hand, the co-efficient of price risk had negative response for Akola and Yavatmal districts.

Short run and long run elasticity of chickpea:

In the present study price elasticity 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 the Table 5. The short run and long run price elasticities of chickpea 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 Yavatmal district *i.e.*, 0.62 followed by Buldhana, Akola and Amravati. The long run elasticity for all districts was found positive and highest in Akola and Yavatmal district *i.e.*, 1.02 followed by Buldhana and Amravati. Therefore, Yavatmal district recorded highest short run and long run elasticity.

In conclusion, the compound growth rate for area and production under chickpea was recorded high during period I in all the districts. During period II, the area, production and productivity of chickpea registered mostly negative growth rates in all the districts. During period III, the compound growth rate for area, production and productivity under chickpea has increased in all the districts of western Vidarbha region. Per cent contribution of area effect was more responsible for chickpea 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 chickpea in all the districts. Long run price elasticities were more than short run elasticities in chickpea indicating that farmers were relatively market oriented in their decisions.

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