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Decomposition analysis and acreage response of cotton in western Vidarbha

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ABSTRACT : The study revealed that compound growth rates for area and production of cotton was recorded near about equal. The growth rate for area and production was recorded high during period III, whereas productivity in period I. The coefficient of variation and Coppock's Instability Index with regards to area (3.44 and 3.20) productivity (2.39 and 2.32) were lowest in Amravati and Buldhana district, respectively, whereas production was recorded negative in Amravati district (-2.82 and -2.44). At overall period, the area effect was stronger factor for increasing production of cotton in all districts and division as a whole, except Akola district. At overall period, the results clearly indicate that the price effect was responsible for production of cotton in all the districts of Amravati division as a whole except Buldhana district. Short run price elasticity are comparatively higher than the long run price elasticity in cotton, which indicated that the farmers were relatively market oriented in their decision in short run than in the long turn.

Key words : Cotton, decomposition, growth rate, instability

Agriculture in India continue to hold the important place in Indian economy, where about 50 per cent of population leaving in rural area out of which 60 per cent of total population depends on agriculture. Agriculture sector employees around 50 per cent of labour force on total of 163 million ha out of 328.7 mha of land. It contributes about 40 per cent to the national income and its developments. This process is accelerated by the rapid growth of population accompanied by rising levels of income. Does supply of agricultural products respond to rising demand for them?. This question becomes critical and assumes central importance and hence calls for the efficient utilization of resources.

This is a major problem covering finding resources for agriculture to produce larger output and improving the institutional frame leading to a shift of the supply function. The second and equally important aspect deals with the shape of the supply curve or response of the supply of agricultural products to changing level of prices.

The supply response of crop or acreage response of agricultural crop is one of the important procedure tools predicting crop production. Agriculture is the most important sector in the economy of nation. In India during the last two decades increase in population has been morepronounced then increase in agricultural production, creating a lag in the availability and requirement of food crop. Thus to feed and cloth the teaming millions of India, the pace of agricultural productionhas been increased for proper planning andpolicy formulating. It is a matter of paramount importance of study the behaviour of farmer's attitude towards area allocation to different crops.

MATERIALS AND METHODS

Selection of crops: For the present study, major selected crop of Amravati division *i.e.*, cotton, was selected purposively.

Selection of period: For the growth rate and decomposition analysis, the period was divided into breakup of 10 years and overall as

shown below:
Period I - 1982-1983 to 1991-1992.
Period II - 1992-1993 to 2001-2002.
Period III - 2002-2003 to 2011-2012.
Overall period - 1982-1983 to 2011-2012.

Nature and source of data: Data used for present study were collected from various Governments and published source. The time series secondary data on area, production and productivity of selected crop were obtained from various Governments published sources.

Analysis technique employed for analysing the data: The present study is based on time series secondary data of selected crop in Amravati division.

Growth rate analysis : The compound growth rate of area, production and yield for major crop will estimated fortwo sub periods. The first period was 1982-83 to 1992-93 and second 1992-93 to 2013-14.

$Y = ab^t$

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

$\text{CGR} = (\text{Antilog}(\log b\text{-}1) \times 100$

Where,

CGR = Compound growth rate
t = time period in year
y = area/ production / productivity
aand b = Regression *par*ameters

Instability analysis : To measure the instability in area, production and productivity, an index of instability will be used as a measure of variability.

The coefficient of variation (cv) will be calculated by the formula

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

The simple coefficient 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, this study will be 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 –

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

$$V \log = \sum \frac{[\log \frac{(x_{t+1})}{x_t} - m]^2}{N - 1}$$

Where;

x_t = Area/ production/ productivity in the year 't'
N = Number of year
m = Arithmatic mean of difference
Vlog = Logarithmic variation of the series

Decomposition analysis : To measure the relative contribution of area and yield to the total output change for the major crops, Minhas (1964). The decomposition analysis model as given below will be used. 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.

$Po = Ao \times Yo$ and

$Pn = A_n \times Y_n$ ..... (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.

$P_n - Po = \Delta P$,

$A_n - Ao = \Delta P$

$Y_n - Yo = \Delta Y$ ..... (2)

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

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

Hence,

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

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 will be adaptive expectations (or distributed lag) model. In the present study 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.

The model used in the present study is as follows :

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

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 three month average pre sowing rainfall (mm)

Y_R = Yield risk (coefficient of variation of last three years)

P_R = Price risk (coefficient of variation of last three years)

b_1..... b_6 = Parameters of multiple linear regression

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

Moreover, the short run and long run elasticity have been estimated as –

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

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

Where;

r = 1 – (coefficient of lagged area)

RESULTS AND DISCUSSION

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

Growth performance of cotton : In this study, the growth in area, production and productivity of selected crop was estimated using compound growth rates as indicated in the methodology chapter. In this analysis, the general growth performance of the crop in western Vidarbha zone (*i.e.* Amravati division) were examined by fitting exponential growth function with time normalization on area, production and productivity. The growth performance of the crop pertaining to three periods and overall is discussed separately for each district as under.

The growth performance of cotton pertaining to three periods and overall was presented in the Table 1, which revealed that during period I, the growth rate of area, production and productivity was positive for cotton. The highest increasing trend in area and production was recorded in Yavatmal and

Amravati district *i.e.* 1.65 and 6.90 per cent/ annum, respectively and highest productivity was recorded In Amravati district *i.e.* 6.46 per cent/ annum. The lowest increase in area was recorded in Amravati district *i.e.* 0.36 per cent/ annum and production in Yavatmal *i.e.* 0.90 per cent/annum. Statistically area of Akola, Buldhana districts and Amravati division as a whole shows significance in 5 per cent level and Yavatmal district shows the significance at 1 per cent level.

The result revealed that during period II picture has been drastically changed, the growth rate has been decreased in area, production and productivity. In Yavatmal district and whole Amravati division, it has been found significant in area with 5 per cent level of significance. There was negative growth in production and productivity in all districts.

The result in the period III, revealed that there was positive growth in the area, production and productivity in all districts. The lowest increase in area was recorded in Akola district *i.e.*, 2.44 per cent/annum and highest in Amravati district *i.e.*, 5.99 per cent/annum . Statistically compound growth rate area of Buldhana and a whole Amravati division shows significance with 5 per cent level and in production Buldhana, Yavatmal and a whole Amravati division shows significance with 10 per cent level. In productivity Akola and a whole Amravati division shows significance with 5 per cent level and 1 per cent level in Yavatmal district.

The growth rate in area was also worked for the overall period (pooled period of 30 years) for cotton where almost all found to be negative. Statistically Compound growth rate in production of Buldhana, Yavatmal and whole Amravati division shows significance in 10 per cent level and 5 per cent level in Akola. In productivity all district and whole Amravati division shows significance in 10 per cent level

In Buldhana and Yavatmal district shows highest increase in production and productivity in cotton.

Instability in cotton : In order to know the instability in area, production and yield of cotton, the fluctuation measured with the help of coefficient of variation as well as Coppock's index as a coefficient of instability. The results are presented in Table 2 and discussed as under for the period with 10 years breakage and overall also. Fluctuation in area, production and productivity due to the uncontrollable factors like climatic conditions can cause upward bios in coefficient of variation (Shende *et al.,* 2011).

Table 1. District wise compound growth rate for cotton

Particular		Amravati	Akola	Buldhana	Yavatmal	Amravati division
Period I	Area	0.36	0.75**	0.90**	1.65***	0.91**
	Production	6.90	5.22	4.93	0.90	4.48
	Yield	6.46	6.45	3.59	0.68	4.29
Period II	Area	-0.72	0.96	0.92	1.29**	-0.97**
	Production	-7.19	-7.68	-0.60	-3.81	-4.82
	Yield	-4.46	-2.38	-0.61	-1.56	-2.25
Period III	Area	5.99	2.44	2.93**	4.40	3.94**
	Production	9.09	4.71	10.48*	11.34*	8.90*
	Yield	0.22	8.40**	2.10	1.97***	3.17**
Overall Period	**Area**	**-1.21**	**-2.61**	**-0.40**	**-0.29**	**-4.51**
	Production	**1.68**	**2.07****	**5.43***	**4.49***	**3.41***
	yield	**2.87***	**5.71***	**4.48***	**3.61***	**4.16***

(Note: ***,** and * denotes significances at 1%,5% and 10% level of significances)

The data in Table 2 revealed that during period I, coefficient of variation for the area was more in compared to production but less in compared to yield. In Buldhana coefficient of variation for the area is 21.64 per cent/annum whereas coefficient of variation for the yield is 2.39 per cent/annum . Highest coefficient of variation for area was found in Amravati district *i.e.* 38.00 per cent/annum . For the production and yield Yavatmal district has got the highest coefficient of variation *i.e.* 3.37 and 3.33 per cent/annum respectively. As a whole Amravati division has got coefficient of variation of 25.73, 1.80 and 2.85 per cent/annum, respectively for the area, production and productivity. In the same way CII was found highest for area in the Amravati district *i.e.* 34.45 per cent/annum and for in production and yield Yavatmal district recorded highest as 3.36 and 3.65 per cent/annum, respectively. In the other hand it shows CII in the range of 5 to 20 per cent/annum which indicate inconsistent in the area, production and productivity of cotton in all the districts of Amravati division. On the other hand high production instability than area and yield instability was estimated for all the districts of western Vidarbha zone as well as zone as a whole contributed towards production fluctuation in the period I.

The instability in the area was found to be decreased in period III. Similarly instability in production and yield has been recorded decreased in all the districts and as a whole Amravati division except Akola district witch increased from coefficient of variation 2.60 per

Table 2. District wise instability indices of Cotton

Name of district	Particulars	Period I		Period II		Period III		**Overall**	
		CV	CII	CV	CII	CV	CII	**CV**	**CII**
Amravati	Area	38.00	34.45	15.34	14.44	3.44	3.20	**18.92**	**17.3**
	Production	-2.82	-2.44	2.64	2.18	2.86	2.41	**0.82**	**0.71**
	Yield	2.85	2.50	2.90	2.71	33.34	32.49	**13.03**	**12.5**
Akola	Area	27.55	21.17	12.89	12.01	4.09	4.00	**14.84**	**12.3**
	Production	2.60	2.41	2.52	2.14	2.97	2.70	**2.69**	**2.41**
	Yield	2.85	2.50	3.35	3.26	3.07	2.41	**3.09**	**2.72**
Buldhana	Area	21.64	17.42	12.65	11.92	7.24	5.50	**13.84**	**11.6**
	Production	2.26	2.14	3.23	3.84	2.59	1.74	**2.69**	**2.57**
	Yield	2.39	2.32	3.41	3.93	5.39	5.11	**3.73**	**3.60**
Yavatmal	Area	15.74	10.42	16.40	12.64	5.23	4.37	**12.45**	**9.14**
	Production	3.37	3.36	3.15	2.93	2.45	1.51	**2.99**	**2.6**
	Yield	3.33	3.65	3.46	3.41	13.06	8.66	**6.61**	**5.24**
Amravati division	Area	25.73	20.86	14.32	12.75	5.09	4.26	**15.01**	**12.5**
	Production	1.80	1.36	2.88	2.77	2.71	2.09	**2.30**	**1.93**
	Yield	2.85	2.74	3.28	3.32	13.71	12.16	**6.61**	**6.01**

cent to 2.70 per cent/annum in production and coefficient of variation from 2.85 to 3.09 per cent per annual the yield. Similarly CII has been recorded increasing in almost all the districts and Amravati division as a whole for area, yield and production except area .Yield of all four districts has been increased at increasing level. In a whole in this period least CV and CII were obtained is in the whole western Vidarbha *i.e.* 2.45 and 1.51 per cent/annum, respectively in production of Yavatmal district it shows from 5 to 35 per cent/annum which shows least consistency (Jahagirdar *et al.,* 2014).

During the overall period *i.e.* 30 years as a whole, Yavatmal district recorded lowest degree of instability in area *i.e.* CV 12.45 per cent and CII 9.14 per cent/annum . Similarly in production and yield Amravati district was recorded with lowest

Table 3. Per cent contribution of area, yield and their interaction for increasing production of cotton

Period	Particulars	Amravati	Akola	Buldhana	Yavatmal	Amravati division
Period I	Area effect	43.23	45.83	55.09	-72.08	18.01
	Yield effect	56.50	137.10	51.52	140.76	96.47
	Interaction effect	0.25	8.72	6.62	31.33	11.73
Period II	Area effect	57.42	1.01	7.57	11.78	19.44
	Yield effect	48.70	99.58	111.21	83.86	85.83
	Interaction effect	-6.13	-0.60	3.62	4.37	1.26
Period III	Area effect	88.69	-479.30	26.77	-3.71	-91.88
	Yield effect	10.39	117.47	59.66	108.35	73.96
	Interaction effect	0.87	-598.09	13.54	-4.64	-47.08
Overall Period	**Area effect**	**-7.82**	**-60.90**	**7.44**	**11.44**	**-12.46**
	Yield effect	**112.82**	**331.26**	**76.35**	**73.63**	**148.51**
	Interaction effect	**-4.98**	**-170.33**	**16.19**	**14.92**	**-36.05**

which shows CV 0.82 per cent and CII 0.71 per cent/annum and CV 13.03 per cent and CII 12.5 per cent/annum respectively and highest instability in area *i.e.* CV 18.92 and 17.3 per cent CII/annum . Yavatmal in the production as well *i.e.* 2.99 per cent and CII 2.6 per cent/annum and in the yield Amravati shows highest CV *i.e.*, 13.03 per cent/annum but through CII Amravati district came highest by 12.5 per cent/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 cotton : The decomposition of cotton production in area, yield and interaction effect is presented in Table 3 and results demonstrate that per cent contribution of area, yield and their interaction for increasing production of cotton in western Vidarbha (*i.e.* Amravati division) and overall also.

During period I , the result clearly indicate that the area effect 43.23 per cent was most responsible for increasing the production of cotton in Amravati division with yield effect 56.5 per cent and interaction effect 0.25 per cent. Area effect was positive for all the districts except Yavatmal which shows area effect of -72.08 per cent. The Buldhana district has recorded highest area effect *i.e.* 55.09 per cent. In all the districts yield effect was also shown positive. Buldhana district showed all the effect nearer to be proportional and in other area effect has played a driving force in the differential production of cotton in Amravati division during I 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 19.44 per cent whereas yield effect was 85.83 per cent and interaction effect was only 1.26 per cent. Lowest area effect was found in the Akola district *i.e.* 1.01 per cent and highest yield effect was found in Buldhana district with 111.21 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 positive in all the districts and in whole over Amravati division too.

Period III was also recorded as like the period II but area effect has been shown increased somehow. In whole Amravati division area effect and interaction effect was recorded negative *i.e.*, -91.88, -47.08 per cent and yield effect recorded 73.96 per cent, respectively. Highest area effect was shown in Amravati district *i.e.* 88.69 and negative interaction effect was also shown in Akola and Yavatmal district *i.e.* -598.09 and -4.64 per cent respectively. Highest yield effect and lowest area effect was recorded in Akola district *i.e.* 117.47 and -479.09

per cent, respectively. So we can conclude that in this period also yield effect was responsible for increasing production of cotton in the western Vidarbha region of Maharashtra.

During overall period, though area effect decreasing but yield effect increasing. Highest area effect was recorded in Yavatmal district *i.e.* 11.44 per cent and interaction effect recorded in Buldhana *i.e.*, and 16.19 per cent respectively. All four districts and whole Amravati division recorded positive yield effect in this overall 30 years period. And it is also recorded that highest yield effect was found in Akola district *i.e.* 331.26 per cent.

Acreage response of cotton : The regression coefficient of these explanatory variables are presented in Table 4 revealed that the lagged area was found to be positively influential factors in the farmer's decision regarding area allocation to cotton and found insignificant in all district with whole Amravati division (Chahal *et al.,* 2003).

The coefficient of farm harvest price were very less *i.e.* -1.17, -0.94, 0.24 and -1.79 in Amravati, Akola, Buldhana and Yavatmal districts, respectively.

It was insignificant in all districts with whole Amravati division of cotton. It implied that prices had not shown any impact in the increase on area of cotton in the study period. One year lagged yield was also included in the function but the coefficient turned out to be very small and negligible and non significant which implies that one year lagged yield had no impact or very less impact to area allocation of cotton in all the districts of western Vidarbha zone of Maharashtra.

The annual rainfall was employed as a proxy for combating the weather influence on the cotton hectare age allocation decisions. The coefficient of annual rainfall variable showed negative relations to Amravati, Akola, Buldhana and Yavatmal district and statistically insignificant in all the districts which showed annual rainfall favourably didn't influence the area allocation decision of the farmers in all the four district it produced the negative relationships (Maibangsa and Subramania, 2001).

The yield risk variable was incorporated in the model to gauge the impact of risk over the variation in the hectare age under cotton. The coefficient of variable had a negative and statistically insignificant response in all the districts of Amravati division which shows farmers are relatively marginal risk bearers.

It was also recorded that regression coefficient of price risk variable or factors were positive in all the districts except Buldhana district. In all these 3 districts cases, it indicate that farmers were relatively better risk bearers

Table 4. Estimated coefficient for acreage response function of cotton

Particulars	Variables	Coefficients				
		Amravati	Akola	Buldhana	Yavatmal	Amravati division
	Intercepts	222.06	147.57	136.02	317.34	580.93
One year lagged area	A_{t-1}	0.92	1.00	0.41	0.64	1.12
One year lagged farm harvest price	FHP_{t-1}	-1.17	-0.94	0.24	-1.79	-0.86
One year lagged yield	Y_{t-1}	-3.70	-0.31	-0.96	-0.99	-0.06
Annual rainfall	w_t	0.43	-0.45	0.18	0.11	-0.14
Yield risk	Y_r	-2.05	-0.93	-0.30	1.13	-0.69
Price risk	P_r	0.45	0.75	-0.29	2.32	0.66
Coefficient of determination	R^2	0.48	0.30	0.63	0.12	0.66

(Note: ***,** and * denotes significances at 1%,5% and 10% level of significances)

but are statistically non significant whereas in Buldhana negative relationship testified to the farmers risk aversion behaviour in cotton production.

The value of $R^{2,}$ the coefficient of multiple determinations ranged from 0.48to 0.66 for all the districts of Amravati division. 0.48 was found in Amravati districts and it was 0.30, 0.63, and 0.12 found in Akola, Buldhana and Yavatmal district respectively which indicates that variables included in the model explained most of the variations in area under cotton in the study period.

Short run and long run elasticity : The price elasticity shows the influence of unit change in price on acreage allocation of the crop. In the present study price elasticity were estimated for short run as well as for long run period.

District wise price elasticity of cotton : 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 elasticity of cotton showed positive price responsiveness of farmers in all the districts of Amravati division except Akola district which turned out to be surprisingly negative.

The short run price elasticity for different districts are 1.71, 1.23, 0.82and 0.98 for Amravati, Akola, Buldhana and Yavatmal, districts, respectively. The highest short run price elasticity was found in the Buldhana district.

The long run elasticity for Amravati, Akola, Buldhana and Yavatmal districts are 0.92, 0.89, 0.68 and 0.74, respectively. It is also recorded from the Table 5 that short run price elasticity are comparatively higher than the long run price elasticity indicated that the farmers were relatively market oriented in their decisions in the short run than in the long run in respect to the cotton in the western Vidarbha region of the Maharashtra.

Table 5. District wise price elasticity of cotton

Sr. No	Name of districts	SRE	LRE
1	Amravati	1.71	0.92
2	Akola	1.23	0.89
3	Buldhana	0.82	0.68
4	Yavatmal	0.98	0.74

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