

# **Growth Trends and Determinants of Crop Area Responsiveness in Haryana**

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Received: 24-03-2021

Revised: 29-05-2021

Accepted: 14-06-2021

#### ABSTRACT

The study has been done on the determinants of accountability of 6 major crops of the State of Haryana from the year 1980-2018. These major crops have been selected as they cover about 85% of the gross cropped area of the state. It has been observed that the two crops, wheat and paddy, have been growing in rotation as the main crop during this period. The study has validated the results of Narlovion model of area responsiveness. It has been identified that the lagged area, lagged price, and the volatility in price and yield shows the main determinants of area allocation. Furthermore, the study shows the growth trends of area, production and yield of wheat and paddy crop has been positive due to stability in yield, price and insured marketing. The promotion of a more diversified cropping pattern has a prequest condition for the state to achieve sustainable growth. But farmers will not move towards diversification unless they are encouraged by economically attractive alternatives.

Keywords: Agriculture, growth trend, acreage response, price risk, yield risk, area effect, yield effect

Agriculture sector is dominant sector in Indian economy which has contribution of 44.14 per of the workforce employed (PLFS, 2019) and this sector contributes 17.2 per cent to the country's gross value added (NAS, 2019). At the time of independence, the country was not able to produce enough food for the population. With the number of steps taken by the government, the country adopted the Green Revolution in 1965-66 which resulted in the dramatic increase in agricultural production and productivity (Singh et al. 2013). But the growth rate of agricultural production and productivity is not same in all the states (Dreze et al. 2006; Singh and Kaur, 2018; Singh et al. 2018). This has been due to the impact of the Green Revolution which was limited in those states where availability of land levelling was smooth &

non-sloppy, existence of high fertility, chances of availability of artificial irrigation facilities, and the tendency of farmers to the adoption of new farming techniques. The impact of Green Revolution on agricultural production has been confined in Punjab, Haryana, and some parts of Uttar Pradesh.

Another aspect of this inter-regional disparity in growth performance is seen among crops. Because the existing mode of production was born from food shortage, the priority of government, policymakers, researchers and agricultural scientist was to fulfill

How to cite this article: Singh, J., Singh, J., Singh, N. and Kapoor, S. (2021). Growth Trends and Determinants of Crop Area Responsiveness in Haryana. *Agro Economist - An International Journal*, **08**(01): 15-21. Source of Support: None; Conflict of Interest: None



the food demand of the nation. Consequently, research focused on a few geographical areas and selected crops. Therefore, wheat and paddy crops became the centre pivot of research. As a result, the area, production, and productivity of these crops increased over time. Due to the natural advantage of resources endowment, the responses of the new agricultural technology have been very impressive in Punjab, Harvana and western Uttar Pradesh. Harvana is the state where the successful impact of the Green Revolution has been recorded and the performance of the agriculture sector has shown impressive improvement. Haryana state achieved high growth in production and productivity of food crops during the green revolution era with the grace of natural resource endowment especially artificial irrigation facilities and plain land.

Haryana has been a predominantly agrarian economy and this sector contributes 19.2 per cent to the state's gross income with 27.41 per cent of employment (Singh et al. 2020). The state plays its role as a slight bigger state; slight in terms of an occupied area which is mere about 1.4 percent of the total geographical area of the country (DES, 2019); bigger in terms of contribution of wheat which is about 27 per cent and rice about 8.2 per cent of the centre pool. In Haryana, the area under wheat and paddy has increased in recent times and the area under other crops has decreased. It is important to understand the growth trends and different factors of crop responsiveness in Haryana. The state, like Punjab, has been under a tendency of cropping pattern following towards mono-cropping (Singh & Singh, 2018). This paper explores the growth performance of the agriculture sector in Harvana and the factors identifying the responding area allocation.

According to Narlovion model, factors like yield risk and price risk have a negative effect; on the other hand lagged area, yield and farm harvest price have a positive effect on area allocation. The present study revisits area allocation debate in six major crops (wheat, paddy, bajra, rapeseed and mustard, cotton and gram) cultivation in Haryana state. The paper examines the growth performance of these crops with respect to area, production and yield in Haryana. The study, furthermore, decomposes the change in production in area, yield and interaction effects. Furthermore, the factors responsible for increasing area under some crops have been identified.

#### MATERIALS AND METHODS

The study is based on the secondary data collected for the period of 1980-81 to 2018-19 of Haryana state. For this 6 major crops have been studied. Three major crops (Paddy, Bajra, and Cotton) have been selected for the Kharif season and similarly for the Rabi season, three major crops (Wheat, Gram, and Rapeseed & mustard) have been selected. These major crops cover 85% of the total cropped area. We compiled data on area, production and yield of selected crops. For this, various statistics have been obtained from published sources like Statistical Abstract of Haryana, Economics and Statistics Director (DES of Haryana State); Area, Production and Yield Statistics, Directorate of economics and statistics India; cost of cultivation data of Haryana state for estimating farm harvest prices. The study period has been divided into two parts viz., period-I 1982-83 to 2002-2003, period-II 2002-2003 to 2017-18.



Fig. 1: Map of Study area

Area of study has been highlighted in Fig. 1. The Haryana state is located in the north-west part of the county. Haryana bifurcated from Punjab state in 1966, now it occupied about 1.34 per cent (about 4421 thousand hectors) of the total geographical area of the nation.

## **Growth Rate Analysis**

The compound growth rate of area, production and yield for selected crops are estimated for selected periods of time. The crop-wise compound growth rates are estimated to study the growth with the following exponential model.

Print ISSN : 2350-0786

$$Y = ab^t$$

Log  $Y = \log a + t \log b$  (by taking the log of both sides)

$$CGR = (Antilog b - 1) \times 100$$

Where,

*t* = time period in year

*Y* = area/production/productivity

a & b = Regression parameters and

*CGR* = Compound growth rate.

## **Instability Analysis**

To measure the instability in area, production and productivity, coefficient of variation (CV) has been used as a measure of variability. The CV is calculated by the following formula;

$$CV = \frac{\sigma}{Mean} \times 100$$

where

CV is stated as coefficient of variation and  $\sigma$  stands for standard deviation (SD)

## Decomposition of change in production

The Component Analysis Model has been used to calculate the relative contribution of area and productivity in the total output changes for cotton, bajra, wheat, paddy, rapeseed & mustard and gram crops as used by other scholars (Minhas, 1964; Minhas, 1965; Sharma, 1977; Shende *et al.* 2011; Kalamkar *et al.* 2002; Singh, *et al.* 2018). The method states that if  $A_0$ ,  $P_0$  and  $Y_0$  are respectively area, production and productivity in base year and  $A_{n'}$ ,  $P_n$  and  $Y_n$  are values of the respective variables in  $n^{\text{th}}$  year then

# $\Delta P = A_0 \,\Delta Y + Y_0 \,\Delta A + \Delta Y \Delta A$

The first, second and third terms of the above equation represent productivity, area and interaction effect respectively. Hence is usual difference operator showing change is

$$\Delta A = An - A0; \Delta Y = Yn - Y0; and \Delta P = Pn - P0$$

## Area Responsiveness Analysis

To examine the area responsiveness, Nerlovian lagged adjustment model (1958) has been applied in the study. The area responsiveness means the change in acreage due to the unit change in the variables under consideration during the period of study. The area responsiveness function has been fitted for the state of Haryana. The general specification of the model is given below:

$$Areat = a + \beta_1 Area_{t-1} + \beta_2 Price_{t-1} + \beta_3 Yield_{t-1} + \beta_4$$
  
Pricerisk +  $\beta_5 Yieldrisk + Trend + \mu_t$ 

where,

 $Area_t$  = Area under crop at *t* time

 $Area_{t-1}$  = Area under crop at t-1<sup>th</sup> time

 $Yield_{t-1}$  = Lag yield crop at t-1<sup>th</sup> time

*Yieldrisk* = Yield volatility in last three year

*Pricerisk* = Price volatility in last three year

 $\alpha,\beta_1$  to  $\beta_5$  are regression coefficients and  $\mu$  is random error term.

## **RESULTS AND DISCUSSION**

Adoption of new agricultural technology during mid-1960s in India has shown the growth of foodgrain production which has been very impressive. The changes are well known as the Green revolution of India. But the responsiveness of these technological changes has been recorded only in wheat and paddy crop. As a result, the area and production of these crops increased over time. In table 1, the changes in the cropping patterns are depicted. The biggest change in per cent area cultivation during 1980-81 to 2017-18 has been estimated in paddy crop which increased from 8.6 per cent to 21.7 per cent. The area under cotton, wheat, rapeseed & mustard crops has increased in the state but the area under bajra, gram and other crops has decreased.

Bajra, which occupied about 16.1 per cent of the gross cropped area of that state has been found to be the main kharif crop during 1980-81 in Haryana. But, the tendency of the area allocation to this crop has been decreasing. Area under paddy and wheat has been 35.7 percent during 1980-81 which increased to 59 percent in 2017-2018. The reason behind the increase in area under these crops is insured marketing,

Print ISSN : 2350-0786

*Online ISSN : 2394-8159* 



	Percentage change in Area Under Different Crops					
Crop	1980-81	1990-91	2000-01	2010-11	2017-18	
Paddy	8.6	11.2	17.2	19.1	21.7	
Cotton	5.8	8.3	9.1	7.6	10.2	
Bajra	16.1	10.3	9.9	10.2	6.9	
Wheat	27.1	31.3	38.5	38.7	37.3	
Gram	13.6	11.0	2.0	1.7	0.5	
R & M	5.5	8.0	6.6	7.7	8.4	
Other crops	23.3	20.0	16.6	15.0	15.1	
Gross cropped area (000 ha)	5462	5919	6115	6505	6549	

#### Table 1: Changing cropping pattern in Haryana over the time

Source: Authors' estimation using Agricultural Statistics at a glance, DES (Various issues).

Crop	Particular	1980-81 to 1990-91	1990-91 to 2000-01	2000-01 to 2010-11	2010-11 to 2017-18	1980-81 to 2017-18
Kharif						
Paddy	Area	2.71	5.76	2.26	2.26	3.06
-	Production	3.04	4.33	3.61	3.42	3.78
	Yield	0.31	-1.36	1.32	1.13	0.70
Cotton	Area	3.85	1.44	-1.97	2.06	1.41
	Production	5.47	-0.51	6.86	-5.31	3.14
	Yield	1.56	-1.92	9.01	-7.23	1.71
Bajra	Area	-3.77	0.23	0.94	-4.65	-1.39
-	Production	-1.60	4.42	6.17	-6.06	2.63
	Yield	2.25	4.18	5.17	-1.47	4.08
Rabi						
Wheat	Area	1.81	2.41	0.95	-0.01	1.41
	Production	5.93	4.02	2.00	-1.28	3.10
	Yield	4.05	1.58	1.03	-1.27	1.67
Gram	Area	-4.49	-11.43	-0.48	-14.48	-8.01
	Production	0.14	-12.29	0.98	-14.34	-6.69
	Yield	4.85	-0.96	1.46	0.17	1.44
R & M	Area	8.26	-2.42	-0.13	-0.04	2.10
	Production	15.96	-1.92	2.46	1.87	4.50
	Yield	7.11	0.52	2.60	1.91	2.36

Table 2: Growth rates of area, production and yield of selected crops in Haryana

Source: Authors' estimation using Agricultural Statistics at a glance, DES (Various issues).

insured prices (through implementation of MSP) and stable yield of the crop. But in areas where irrigation facilities are lacking, like that of cotton crop has increased. This is because the cotton crop needs lesser irrigation. Secondly, the crop has been available to the farmers at a fairly reasonable price. The reason for the decline in area under Bajra and Gram crops has been price uncertainty and market uncertainty.

The growth rate in area, production and yield of selected crops is presented in Table 2. During *kharif* 

season, area increased by 3.06 per cent, 1.41 per cent, and -1.39 per cent of paddy, cotton and bajra respectively between 1980-81 and 2017-18. The highest growth rate of area under production of paddy has been estimated to be 5.76 per cent and 4.33 per cent per annum during 1990-91 to 2000-01. Area under cotton crop had increased by 3.85 per cent during 1980-81 to 1990-91. The production of cotton grows by 5.47 per cent during this period, while the area under cultivation declined in the next decade which necessitated a decline in production. However, between 2000-01 and 2010-11, the area of cotton decreased by 1.97 per cent whereas production increased by 6.86 per cent per annum which has been due to high growth rate observed in yield (9.01 per cent) during the same period. Growth rate of area under Bajra (which was the highest occupied area share during 1980-81, table 1) was found to be negative during 1980-81 to 1990-91 and again 2010-11 to 2017-18, and a marginal increase during 1990-91 to 2000-01 and 2000-01 to 2010-11.

The wheat crop has been observed as the main *rabi* crop in Haryana due to the staple-food crop of the state. It occupied about 27 per cent (during 1980s) and about 37 per cent (during 2020s) of the gross cropped area. The growth rate of the area, production, and yield of wheat and rapeseed, and mustard has been positive in the overall time period (between 1980-81 and 2017-18). As a result, the area under gram cultivation has been found to be decreasing during the study period although the growth rate of yield is estimated to be positive.

The effect of both area and yield on changes in

production of major crops is presented in Table 3. The highest change in production in period one has been in paddy crop in kharif season with 1193 thousand tonnes and in rabi season wheat production was changed by 4840.99 thousand tonnes. Paddy crop production changed 91.14 per cent by area effect. While the impact of technology has been less, on the contrary, the effect of acreage on wheat production estimated as 28.42 and the effect of yield shows 54.37. Technology for the wheat crop improved during this time. As a result, production increased. Similar results can be observed during the second period. The overall production of paddy had increased by 3248'000 tonnes. The impact of the area effect to increase this production is 74.89 while the impact of technology is 8.14. Wheat production increased by 6418.28 thousand tonnes Technology has been affected by 50.64 per cent more than the area effect (28.24) to increase this production. The increase in production in cotton crop (133.79 thousand tonnes) is due to increase in area. There is not much impact of technology in the present case. The reason for the increase in production in millet crop is due to changes in technology, because the effect of acreage on the

Crop		Change in productio	n	In percent			
	Particular	(in thousand ton)	Area effect	Yield effect	Interaction effect		
Kharif							
Paddy	TE 1982-83 to TE 2002-03	1193.00	91.14	4.78	4.08		
	TE 2002-03 to TE 2017-18	2055.38	68.39	20.14	11.47		
	TE 1982-83 to TE 2017-18	3248.38	74.89	8.64	16.48		
Cotton	TE 1982-83 to TE 2002-03	33.66	129.30	-22.46	-6.84		
	TE 2002-03 to TE 2017-18	100.12	50.01	38.94	11.05		
	TE 1982-83 to TE 2017-18	133.79	72.06	16.68	11.26		
Bajra	TE 1982-83 to TE 2002-03	-48.00	360.37	-395.62	135.25		
	TE 2002-03 to TE 2017-18	262.90	-21.69	139.00	-17.31		
	TE 1982-83 to TE 2017-18	214.90	-99.79	346.75	-146.96		
Rabi							
Wheat	TE 1982-83 to TE 2002-03	4840.99	28.42	54.37	17.21		
	TE 2002-03 to TE 2017-18	1577.29	44.45	51.61	3.94		
	TE 1982-83 to TE 2017-18	6418.28	28.24	50.64	21.12		
Gram	TE 1982-83 to TE 2002-03	-241.00	104.34	-40.12	35.78		
	TE 2002-03 to TE 2017-18	-5.00	342.92	-417.53	174.60		
	TE 1982-83 to TE 2017-18	-246.00	107.41	-117.68	110.27		
R & M	TE 1982-83 to TE 2002-03	586.00	50.74	13.39	35.87		
	TE 2002-03 to TE 2017-18	410.88	-16.21	128.49	-12.28		
	TE 1982-83 to TE 2017-18	996.88	25.91	22.27	51.82		

Table 3: Estimation of area, yield, and interaction effect on production of different crops

Source: Authors' estimation using Agricultural Statistics at a glance, DES (Various issues).



Singi *et ut*.

Particulars	Paddy	Cotton	Bajra	Wheat	R&M	Gram		
Dependent variable= Area under crop								
Log Lag Area	0.55608***	0.5187***	0.4634**	0.5933***	0.5257***	0.0481		
	(0.12500)	(0.1152)	(0.1842)	(0.1495)	(0.1106)	(0.1645)		
Log Lag Price	0.14942***	0.3524***	0.0826	0.1482**	0.1732	0.5259		
	(0.0509)	(0.0813)	(0.1534)	(0.0607)	(0.2255)	(0.4201)		
Log Lag Yield	0.23129*	0.2201***	-0.2117**	0.04705	0.3629**	0.2893		
0 0	(0.1310)	(0.0637)	(0.1030)	(0.06716)	(0.1678)	(0.228)		
Log Price Risk	-0.02000	-0.0197	-0.0058	0.0032	-0.0085	-0.0030*		
	(0.0180)	(0.0244)	(0.0221)	(0.0076)	(0.0339)	(0.0171)		
Log Yield Risk	-0.0513***	0.0474**	-0.0411*	0.00023	0.1192**	-0.0212**		
	(0.0178)	(0.0213)	(0.0213)	(0.0062)	(0.0607)	(0.0099)		
Trend	_	-0.0247***	-0.0048	-0.0068	-0.0114	-0.1253***		
		(0.0058)	(0.0132)	(0.0044)	(0.0150)	(0.0394)		
Constant	0.21284	-0.4688	4.615***	1.9564**	-0.9177	1.9104		
	(1.2917)	(0.7767)	(1.6168)	(0.9897)	(1.6480)	(3.3949)		
Adj. R <sup>2</sup>	0.9576	0.8564	0.61857	0.9687	0.7537	0.8800		
F Statistics	168.33***	37.788***	11.00***	191.87***	19.8759***	46.2536***		
DW Statistics	2.2411	1.7540	2.0943	1.6075	1.5543	2.0528		
Number of Observation	38	38	38	38	38	38		

Table 4: Determinants of crop area responsiveness in Haryana (Results of regression analysis)

**Source:** Authors' estimation using Agricultural Statistics at a glance, DES (Various issues).

**Note:** \*\*\*, \*\*, \* significant at 1, 5 and 10% levels, respectively.

production of this crop has been negative. Gram crop has increased production due to acreage but due to increase in production of rapeseed mustard crop (996.88) both acreage and new technology.

The decision of the farmers to area allocation under six major crops has been determined by different price and non-price factors per acre accountability function. The results of the regression model are presented in Table 4. Table shows that yield and price risk adversely affect whereas in the previous year under area, yield areas have had a positive effect on area allocation. It has been noted that lag area, price, yield on *kharif* crops have a positive effect in determining the area allocation of paddy and cotton crops, because the corresponding coefficients are found to be significant at the level of 1.5, and 10 percent, respectively. In case of paddy, the yield risk is not significant as the minimum support price (MSP) of the paddy crop has been assured. The lag area under bajra crop has been significant, but lag yield and price risks shows negative significant results. These results show that farmers are price conscious in their divisional decisions.

## CONCLUSION

This paper explores the growth performance of the agriculture sector in Haryana and the factors identifying the responding area allocation. The area under wheat and paddy has increased during the study period and the area under other crops has decreased. The state, like Punjab, has a tendency of cropping pattern towards mono-cropping. The reason for the increase in area under these crops was observed in stability of yield and ensured marketing at minimum support prices. The area under cash crop cotton has doubled during this period.

The contribution of area effect has been very strong which increase paddy production to about 91 per cent, 68 per cent, and 74 per cent during period first, second, and overall period respectively. On

the other hand, in the case of wheat, the increase in production mainly contributed due to technological improvement which has been reported around 54 per cent, 51 per cent and 52 per cent during the same time period. The area allocation for the cultivation of paddy and cotton crops have a positive and significant effect on the lag area, lag price, and lag yield. While the lag area and lag price found to have positive and significant relation with area allocation in the case of wheat crop. As we know, the uncertainty in price and yield shows a negative effect on crop area allocation in most cases. The study reveals that the area under paddy is increasing in Haryana as in Punjab state. This may push the state in such issues as seen in Punjab, such as depletion in the level of groundwater, excessive use of fertilizer and pesticides, etc. which may have more adverse effects in the future. The promotion of a more diversified cropping pattern has a prequest condition for the state to achieve sustainable growth. But farmers will not move towards diversification unless they are encouraged by economically attractive alternatives.

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