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Trend and Instability in Area, Production and Productivity of Food Grains in Haryana Vis-A-Vis India

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Authors' contributions

This work was carried out in collaboration among all authors. Authors Nisha and DRA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors Baishali and MN managed the analyses of the study. Author Sanjeev managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The Presented study is an attempt to examine the trend and instability in area, production and productivity of food grain crops in Haryana and India during period 1966-67 to 2012-13 and five sub periods i.e. P-I (1966-67 to 1975-76), P-II (1976-77 to 1985-86), P-III (1986-87 to 1995-96), P-IV (1996-97 to 2005-06) and P-V (2006-07 to 2012-13). The study is based on secondary data. The study reveals positive trends in area, production and yield of food grains for both Haryana and India. Production in Haryana and India increased mainly due to increase in yield. Similar results have been obtained on triennium bases. In Haryana, area, production and yield have shown positive growth rates in all the periods and the overall period except for area in Period-III, IV and V. In the case of India positive growth rates has obtained for production and yield of food grains while area has shown negative trend in Periods III, IV, V and entire period under study. The coefficient of variation (C.V.) in respect of the three components i.e. area, production and productivity of total food grains found to be higher in Haryana as compared to India in all the periods and the overall period except for yield in period-III, yield and production in period-IV and yield in Period-V. Similar results have been obtained for the instability indices.

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Keywords: Food grain; area; production; productivity; linear growth rate; compound growth rate; coefficient of variation; instability index.

1. INTRODUCTION

The agricultural sector is the backbone of India's development. Within agriculture, food grain production is the major activity covering most of the cropped area in India and provides the main staple source of food. Haryana is the state which has large amount of fertile land, in India. It has achieved a remarkable growth in its agricultural sector, which has made it self-sufficient in food grains production. Hence Indian economy in general and Haryana economy in particular, witnessed a distinctive change since mid-sixties with the development of High Yielding Varieties (HYVs) of wheat and rice. There are many studies like Bera, et al. [1] who analysed growth and instability of food grains production in India and West Bengal. Singh, et al. [2] studied instability in rice production in Gujarat. Similarly, Charya, et al. [3] studied growth in area, production and productivity of major crops in Karnataka, while Kumar and Jain [4] analysed growth and instability in agricultural productivity at district levels.

India has achieved self-sufficiency in the food grains production but its requirement is continuously growing up with increase in the population of the country. Sharma, et al. [5] estimated crop wise and state wise variability in production and yield and found that production of food grains became more stable during 1990s compared with 1980s at all India levels and in most of the states. Analysis of growth and fluctuations of the agricultural sector, apart from increasing production, is of paramount importance for the planners and policy makers for a better understanding of the prevailing trend and to frame a sound agricultural development strategy. It is worth stressing that recently, Nimbrayan, et al. [6] studied growth and instability in area, production and productivity of barley in Haryana vis-à-vis India. Similarly, Pavithra, et al. [7] studied growth in area, production and productivity in food grains in Karnataka state and Sekhara [8] who studied trends in area, production and productivity of paddy crop in India. Keeping in view the importance of food grains, the present paper is an attempt to examine the trend and instability in area, production and productivity of food grains in Haryana and India.

2. METHODOLOGY

The study is based on secondary data for 47 years period i.e. from 1966-67 to 2012-13. Data on area, production and yield under food grains cultivation was collected from various governmental source (Statistical Abstract of Haryana) and web sites [9,10]. To have a period-wise investigation of growth and variability patterns of area, production and productivity of food grains the analysis was carried out by dividing time period into five sub periods: Period I, 1966-67to 1975-76; Period II, 1976-77 to 1985-86; Period III, 1986-87 to 1995-96; Period IV, 1996-97 to 2005-06; Period V, 2006-07 to 2012-13.

Linear and compound growth rates were computed to determine the growth in area, production and yield of food grains.

By taking area/production/yield as dependent variable (Y_t) and year number (t) as independent variable, the following functions were fitted for computing various growth rates:

1. Linear function, $Y_t = a + bt$ (1)

Where,

Y_t = area, production and yield of food grain crops in t^{th} year
a = constant
b = regression coefficient / simple growth rate
t = time variable (t = 1, 2… 47)

The compound growth rates of area, production and productivity of food grain crops were worked out using exponential function of the form,

$$Y = AB^t \quad (2)$$

By taking logarithm of both sides, the equation takes the linear form:

$$\text{Log } Y = \text{Log } A + X \text{ Log } B \quad (3)$$

On writing Log A = a, Log B = b and Log Y = y,

The equation becomes

$$y = a + bt \quad (4)$$

The compound growth rate (r) is = (B-1) x100

The Coefficient of determination (R^2) was also computed to examine whether or not the linear and exponential functions adequately fit the available data.

To measure the relative contribution of area and yield towards the total production change of food grain crops the technique of decomposition was adopted. As per this technique the change in the production between any time periods can be expressed as –

$$\Delta Q = A_0 \Delta Y + Y_0 \Delta Q + \Delta A \Delta \quad (5)$$

Thus, "the total change in production can be decomposed into three effects viz. yield effect, area effect and the interaction effect due to change in yield and area"(Kalamkar, [11]).

To measure the magnitude of variability in area, production and productivity in Haryana and India, the coefficient of variation was computed using the formula:

$$\text{Coefficient of Variation (C.V.)} = \frac{S.D}{\bar{x}} \times 100 \quad (6)$$

Where,

S.D = Standard Deviation of area/production/yield
$\bar{X}$ = Mean value of area/production/yield of the crop under consideration.

Instability in the area, production and productivity of food grains was measured by Cuddy-Della Valle Index (CDI), [12] given as:

$$CDI = C.V. \sqrt{1 - R^2} \quad (7)$$

Where,

C.V. = Coefficient of Variation
R^2 = ESS/TSS i.e. ratio of explained variation to total variation.
ESS = Variation explained by explanatory variable.
TSS = Total Variation

3. RESULTS AND DISCUSSION

Changes in Area, Production and Yield of food grains in Haryana from 1966-67 to 2012-13 and on triennium basis are shown in Tables 1 and 2.

In Haryana, a net increase 879 thousand hectares in the area has been noticed in food grains i.e. from 3520 thousand hectares in 1966-67 to 4399 thousand hectares in 2012-13. The total area under food grains in India increased by 5.48 million hectares i.e. from 115.3 million hectares to 120.78 million hectares during the same period (Table 1). Its production has increased from 2592 thousand tonnes to 16226 thousand tonnes in Haryana whereas it has increased from 74.23 million tonnes to 257.13 million tonnes in India. Food grains production has increased more rapidly in Haryana as compared to India. Similarly the yield of food grains in Haryana increased from 736 kg/ha to 3689 kg/ha during this period while it shot up from 644 kg/ha to 2129 kg/ha at country level. So the yield of food grain crops increased at a faster rate in Haryana is than in India.

On triennium basis net increase of 1053.0 thousand hectares in average area was recorded in Haryana which is 29.84% whereas there was net increase in area of 5.02 million hectares which amounts to 4.23% increase for India (Table 2). Further the production in Haryana inflated from 3108.33 thousand tonnes to 16938.33 thousand tonnes (444.93%) and at the country level from 87.76 million tonnes to 253.64 million tonnes (165.88%). Per cent change in the production of food grains in Haryana was more than two and a half time the % change at the country level.

Changes in area, production and yield of food grains in India from 1966-67 to 2012-13 and on triennium basis is given in Table 2.

Contribution of different factors in the production of food grains in Haryana and India is given in Table 3.

During 1966-67 to 1976-77, the production of food grains in Haryana has increased due to yield and area by 66.8 and 20.2% respectively (Table 3) whereas their interaction has only 13% contribution. Similar pattern was observed at the country level. In both Haryana and India, yield has shown maximum contribution towards the increase in the production of food grains during the decade from 1966-67 to 1975-76. Akshu and Sharma [13] revealed that area and productivity played a key role in the production of food grain crops in Haryana for the period 2005-06 to 2014-15. In Period-II, its production in Haryana has increased mainly due to yield, while area and its interaction with yield have shown the negative and small contributions. Similar trends in the contribution towards production were observed at the country level. So both at state and the national level, for the increase in the production of food grains, yield was a major contributor in

Period-II. Sharma, et al. [14] found that in both Haryana and India yield has played a key role in increasing the production of food grains.

In Haryana during Period-III, food grains production has increased mainly due to yield effect; area and its interaction with yield have negative and small effects i.e. 8.5% and 3% respectively. Similar pattern was observed at the country level where area and its interaction with yield having negative effects (18 and 6% respectively) and the increase was mainly due to yield. During Period-IV, the production has increased by 44.6 and 51.9% due to yield and area respectively whereas their interaction has 3.5% effect in Haryana. In India, food grains production has inflated due to yield while area and its interaction with yield had negative effects to the extent of i.e. 34% and 21% respectively. During this period the production increased due to mainly productivity at the national level, whereas for the state of Haryana, area and yield both contributed towards the food grains production. Both Bhatnagar, et al. [15] and Bhatt, et al. [16] found that yield and its interaction with area was the major factors responsible for the production of food grains during period 1979 to 2009 and 1966-67 to 2007-08 respectively in Haryana.

In Period-V, yield has 88% effect whereas area and its interaction with yield have 11.3% and 0.97% respectively in the production of food grains in Haryana. However, at the national level, area and its interaction with yield have negative contribution towards production to the extent of 12.9% and 2.9% respectively and the yield only responsible for the increased production. Production of food grains in Haryana, for the overall period from 1966-67 to 2012-13, increased by 76.2% 4.8% and 19% due to yield, area and their interaction respectively while at national level, these have increased the production by 93.5%, 2% and 4.5% in the same order respectively. So, similar type of pattern was observed both at state and national level thus yield has played a major role in improving the production of food grains in Haryana as well as in India. Similar results were obtained by Maji and Bera [17] for the food grains in West Bengal during period 1950-51 to 2007-08.

Growth rates of area, production and yield of food grains in Haryana and India is given in Table 4.

During Period-I positive trend coefficients have been observed for area, production and yield of food grains crops i.e. 1.37, 3.69 and 2.30% respectively in Haryana while highly significant rate of growth of 0.65, 3.19 and 2.52%, respectively were observed in India (Table 4) during this period. In Haryana rate of growth in production and productivity of food grain crops have appreciably went to the peaks of 4.29 and 4.66% respectively in Period-II while its area has decelerated with growth rate of 0.35%. For India, its production and productivity have achieved highly significant growth rates of 3.05 and 2.86% respectively and 0.19% growth rate has been observed in its area during this period.

Trends in production and productivity of food grain crops during Period-III revealed a highly significant growth of 4.50 and 3.95% respectively also its area has increased with growth rate of 0.53% in Haryana and in case of India, its production and productivity have grown with highly significant growth rates of 2.92 and 3.25% respectively while area has decelerated by 0.32%. Yield increased per year was more in the Haryana (88.47 kg/ha) than at the country level (42.75 kg/ha) during this period.

During Period-IV area under the food grains of Haryana increased with growth rate of 0.13% giving an increase of 4.99 thousand hectares per year. Production and yield have also increased with highly significant growth rates of 1.46 and 1.34% respectively showing rise of 177.86 thousand tonnes and 38.6 kg/ha every year in Haryana. The growth rate of 0.23 and 0.63 were observed in production and yield of food grain crops in India. Though its area has decreased with growth rate of 0.40% showing a decrease of 0.48 million hectares every year. Similarly Sihmar [18] have registered negative growth rate in production for the crops like Gram, Massar, Maize, Sesamum, groundnut over the three periods (1980-81 to 1989-90, 1990-91 to 1999-2000 and 2000-01 to 2006-07) and Kumar and Singh [19] found negative growth rates in the area of sugarcane in most of the district of the Haryana. In Haryana, during Period-V area of food grain crops has increased with growth rate of 0.44% i.e. 20 thousand hectares more area was acquired by this crop every year in Haryana. While its production and productivity have increased with significant growth rates of 2.41 and 1.96% showing an increase of 382.39 thousand tonnes and 69.36 kg/ha each year. For India, its production and productivity have sharply rose with striking rates of 2.82 and 2.94% respectively whereas its area has decreased with growth rate of 0.11%.

Table 1. Changes in area, production and yield of food grains in Haryana from 1966-67 to 2012-13 and on triennium basis

Variable	Yearly basis				Triennium basis			
	Base year (1966-67)	Current year (2012-13)	Net change	% change	Base triennium (1966-67 to 1968-69)	Current triennium (2010-11 to 2012-13)	Net change	% change
Area ('000 ha)	3520.00	4399.00	879.00	25.00	3528.67	4581.67	1053.00	29.84
Production ('000 tonnes)	2592.00	16226	13634	526.00	3108.33	16938.33	13830.00	444.93
Yield (kg/ha)	736.00	3689.00	2953.0	401.20	875.67	3698.00	2822.33	322.31

Table 2. Changes in area, production and yield of food grains in India from 1966-67 to 2012-13 and on triennium basis

Variable	Yearly basis				Triennium basis			
	Base year (1966-67)	Current year (2012-13)	Net change	% change	Base year (1966-67 to 1968-69)	Current year (2010-11 to 2012-13)	Net change	% change
Area (m ha)	115.30	120.78	5.48	4.75	119.05	124.07	5.02	4.23
Production (m tonnes)	74.23	257.13	182.90	246.40	87.76	253.64	165.88	189.01
Yield (kg/ha)	644.00	2129.00	1485.00	230.59	736.00	2045.67	1309.67	177.94

Table 3. Contribution of different factors in the production of food grains in Haryana and India

Period	Effect	Food grains	
		Haryana (%)	India (%)
I	Area	20.20	18.00
	Yield	66.80	74.00
	Yield × Area	13.00	8.00
II	Area	-5.05	8.00
	Yield	108.07	89.00
	Yield × Area	-3.02	3.00
III	Area	-8.50	-18.60
	Yield	111.60	124.80
	Yield × Area	-3.10	-6.20
IV	Area	51.90	-34.00
	Yield	44.60	136.00
	Yield × Area	3.50	-2.00
V	Area	11.30	-12.90
	Yield	88.00	115.80
	Yield × Area	0.97	-2.90
Overall	Area	4.80	2.00
	Yield	76.20	93.50
	Yield × Area	19.00	4.50

Table 4. Growth rates of area, production and yield of food grains in Haryana and India

Period	Variable	Haryana		India	
		Linear growth rate (b)	Compound growth rate (%)	Linear growth rate (b)	Compound growth rate (%)
I	Area	50.22	1.37	0.78*	0.65*
	Production	127.90	3.69	3.01**	3.19**
	Yield	20.96	2.30	19.56**	2.52**
II	Area	-14.40	-0.35	0.24	0.19
	Production	267.42**	4.29**	3.96**	3.05**
	Yield	71.45**	4.66**	29.22**	2.86**
III	Area	17.10	0.53	-0.41	-0.32
	Production	384.00**	4.50**	4.73**	2.92**
	Yield	-88.47**	-3.95**	42.75**	3.25**
IV	Area	4.99	0.13	-0.48	-0.40
	Production	177.86**	1.46**	0.51	0.23
	Yield	38.60**	1.34**	10.36	0.63
V	Area	20.00	0.44	-0.13	-0.11
	Production	382.39*	2.41*	6.66**	2.82**
	Yield	69.36*	1.96*	56.29**	2.94**
Overall	Area	15.91**	0.39**	-0.03	-0.02
	Production	306.69**	3.76**	3.51**	2.29**
	Yield	65.81**	3.35**	28.97**	2.31**

*significant at 5%; **significant at 1%

Highly significant growth rates were observed in area, production and yield of food grain crops i.e. 0.39, 3.76 and 3.35% respectively in Haryana and in India highly significant growth rates were observed for production and yield food grains i.e. 2.29 and 2.31%, though its area has decelerated with 0.02% growth rate. Yield increase in Haryana during the overall period was more than at the national level.

Coefficient of Variation and Instability Index of Food grains crop in Haryana and India is given in Table 5.

The coefficient of variation and instability index in respect of the three components i.e. area, production and yield were higher in Haryana as compared to India for all the sub periods and the overall period except for yield in period-III, yield

Table 5. Coefficient of variation and instability index of food grain crops in Haryana and India

Period	Variable	Haryana			India		
		R^2 (%)	Coefficient of variation (%)	Instability index	R^2 (%)	Coefficient of variation (%)	Instability index
I	Area	23.50	13.29	7.06	41.44	3.01	2.30
	Production	23.12	23.74	18.60	56.70	12.01	7.90
	Yield	17.76	12.63	14.20	57.85	9.46	6.14
II	Area	4.24	4.86	4.92	11.99	1.67	1.57
	Production	74.79	16.69	7.51	65.70	11.05	6.47
	Yield	82.35	12.82	6.55	91.32	9.98	2.94
III	Area	3.78	3.85	7.65	16.72	2.39	2.18
	Production	64.83	12.34	8.97	74.35	9.76	4.94
	Yield	83.48	9.05	5.00	87.05	9.99	3.60
IV	Area	1.17	2.74	3.48	20.35	2.61	2.33
	Production	51.22	4.47	4.20	1.38	5.79	5.76
	Yield	50.69	3.38	3.86	19.10	4.31	3.88
V	Area	10.85	3.19	2.74	2.03	1.64	1.62
	Production	61.71	8.83	4.14	70.19	7.19	3.93
	Yield	62.36	5.79	3.33	77.48	7.17	3.40
Overall	Area	39.89	16.95	6.36	1.49	27.75	2.75
	Production	94.39	43.38	11.00	94.31	30.11	7.18
	Yield	94.39	30.53	9.80	96.47	30.49	5.73

and production in period-IV and yield in Period-V. Similarly, instability indices were also higher in Haryana as compared to the country in all the sub-periods and overall period except in production and yield in period IV, yield in period-V and the area in the overall period. As we move from Period-I to Period-V, coefficient of variation in area, production and productivity of food grains, generally, show a decreasing trend both in Haryana and all India level barring very few exceptions. Similar trends were observed for the instability indices of area, production and yield of food grains in Haryana as well as in India. This shows that the production system is going to stabilize with the passage of time. Comparable results were obtained by Sharma [20] for the area, production and productivity of food grain in the north-eastern states.

4. CONCLUSION

Results of the study showed positive trends in area, production and yield of food grains for both Haryana and India. Food grains production in Haryana and India increased mainly due to increase in yield. Similar results were obtained on triennium bases. In Haryana, area, production and yield have shown positive growth rates for the crop under study in all the periods and the overall period except for area in Period III, 1986-87 to 1995-96; Period IV, 1996-97 to 2005-06; Period V, 2006-07 to 2012-13 and the overall period. In case of India positive growth rates were obtained for production and yield of food grains while area has shown negative trend in Period III, 1986-87 to 1995-96; Period IV, 1996-97 to 2005-06; Period V, 2006-07 to 2012-13 and entire period under study. The coefficient of variation in respect of the three components i.e. area, production and productivity of total food grains were higher in Haryana as compared to India in all the periods and the overall period except for yield in Period III, 1986-87 to 1995-96; yield and production in Period IV, 1996-97 to 2005-06; and yield in Period V, 2006-07 to 2012-13. Similar results were obtained for the instability indices except for the production and yield in Period IV, 1996-97 to 2005-06; yield in Period V, 2006-07 to 2012-13 and area in the overall period.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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