Trends of Agricultural Productivity and Its Determinants in South-western Haryana: A Spatio-temporal Study

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Abstract

Haryana is well known for its development in the field of agriculture among state and union territories of India. Infusion of green revolution played an important role in such an agricultural development. Agricultural productivity is one of the most efficient and important indicators of agricultural development. It is the ratio of output to input in relation to land, labour, capital, and overall resources employed in agricultural. However, due to difference in physiography and other factors, South-western Haryana is far behind the rest of Haryana in terms of such a development. The present study tries to analyze the levels of agricultural productivity in this region. To fulfill the need of study secondary data of post economic reform period has been analyzed with the help of Bhalla and Tyagi method, linear regression equations, trend lines, and index value. Annual compound growth rate has been used to monitor the difference in the level of agricultural productivity in South-western Haryana as well as rest of Haryana during the two phases of study i.e. 1990-93 and 2013-16. Correlation and step-wise regression analysis has been used to depicts the effect of independents variables on agricultural productivity. The findings of the study revealed that the study region lacks behind the rest of Haryana in terms of agricultural productivity. It is interested to note that index value and compound growth rate of South-western Haryana shows faster growth in agricultural productivity than rest of Haryana. It indicates that annual compound growth rate of study region was one percent more than rest of Haryana. Except consumption of pesticides all independent variables are positively correlated with agricultural productivity in both regions of Haryana. Step-wise regression model suggest that consumption of chemical fertilizer is the major determinants of agricultural productivity in South-western Haryana as well as rest of Haryana.

Key Words: Trends Line, Regression Equation, Agricultural Productivity, Compound Growth Rate, Correlation and Step-wise Regression

Introduction

The level of agricultural productivity is a key to denote the prosperity of an area. There are various factors which affect the agricultural productivity i.e., soil fertility, cropping intensity, net sown area, irrigation, rainfall, mechanization, human labour, use of bio-chemical fertilizers and pesticides, capital, farm management etc. It is a dynamic concept and keep on changes with respect to space and time. In order to improve the economic condition of farmers development in agricultural productivity is compulsory. Such a development can be increased by either increasing the net sown area or by increasing production. However, there are little scope of increasing net sown area, so the most effective tool to increase the productivity is increasing production or farm harvest price. The spatial and temporal change in the level of agricultural productivity

presents a sound picture of an area. Such a picture helps us in the demarcation of weaker and prosperous areas. It also helps us in the formulation of agricultural policies.

There is a various study which has been performed in this field by geographer and economist. Buck 91937) evolved a method to measure agricultural productivity under it the output is expressed in terms of grain equivalent. Clark and Haswell (1976) expressed agricultural output in terms of wheat equivalent per person. Bhatia (1976) designed a new method of weight average of yield efficiency of all crops in a component regional unit, where the weights are proportionate to the share of cropland devoted to each crop. Singh (1972) adopted a new technique using crop yield and concentration indices for measuring the level of agricultural productivity. The present study has been performed on the basis of Bhalla and Tyagi method.

Profile of Study Area

Haryana is an agricultural developed state which lies in the north-western part of India. It spread from 27 degree 39 minutes N to 29 degree 4 minutes N latitude and 75 degree 28 minutes E to 77 degree 20 minutes E longitude. It is bounded by Himachal Pradesh and Punjab in north and north-west, Uttar Pradesh and NCT of Delhi in the east and Rajasthan in the south and south-west. The present study covers the south-western part of the state which include districts i.e. Gurugram (Gurgaon), Nuh (Mewat), Rewari, Mahendragarh, and Bhiwani (Includes Charkhi Dadri District) (Fig. 1). The study area covers 11036 Sq. Km area, which is about 25 percent of the total land area of state. Due the presence of Aravalli hills and sand dunes, the physiography of this region is distinct from the rest of Haryana. South-western Haryana receives less rainfall in comparison to northern part of the state. Sahibi, Indori, Kasonti, and Dohan are the major seasonal rivers which remains dry during the most of time except monsoon. Due to the water scarcity, xerophyte vegetation is the common vegetation of this region.

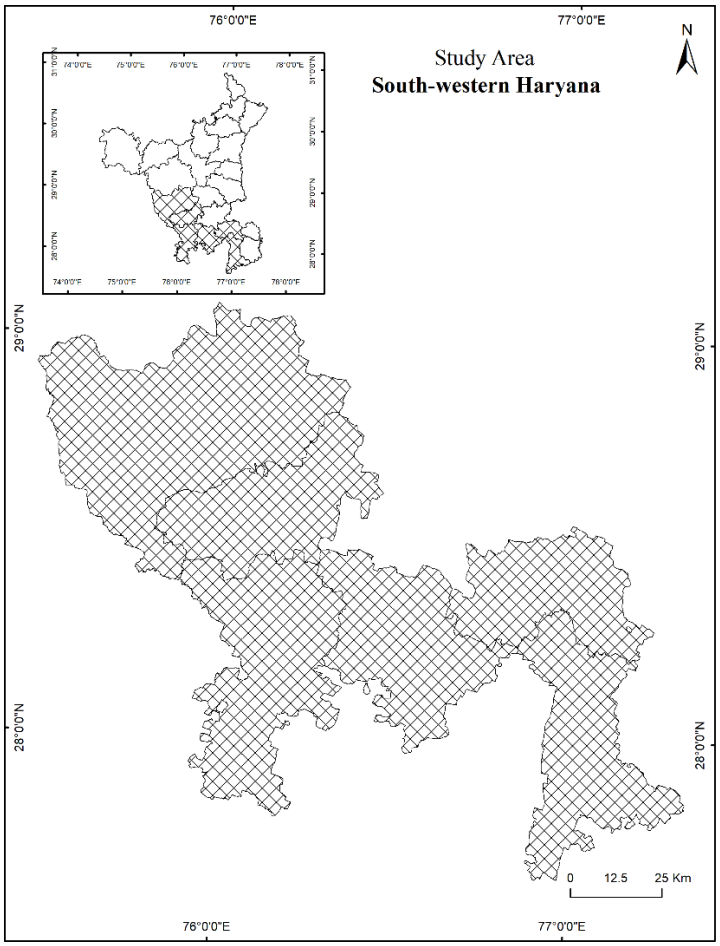


Fig. 1

Objective of the Study

The present study attempts to evaluate the levels of agricultural productivity and its determinants in the South-western Haryana viz-a-viz rest of Haryana during post-economic reform period.

Research Question

1. What is the level of agricultural productivity in South-western Haryana viz-a-viz rest of Haryana?
2. What are the major determinants which affect the level of agricultural productivity in South-western Haryana and rest of Haryana?

Period of the Study

The present study covers a period of two and half decades which coincide with post economic reform period. The period of agricultural development covers time series data from 1990-91 to 2015-16. The comparison between pre and post economic reform period is made by taking triennium average of two points of time i.e., 1990-93 (initial phase of study) and 2013-16 (final phase of study).

Material and Methodology

The present study is based on the secondary sources of data which has been collected from statistical abstract of Haryana (from 1990-91 to 2015-16). Bhalla and Tyagi method (1989) has been used to determine

the agricultural productivity. To compute agricultural productivity eight major crops (Wheat, Bajra, Rice, Cotton (both desi & American), Sugarcane, Rape Seeds & Mustard, Barley, and Gram) has been taken.

It is mathematically expressed as below.

$Y = \sum_{i=1}^{n}(C_1P_1 + C_2P_2 + C_3P_3 + \cdots C_nP_n)$*GSA/NSA

Here, Y = Agricultural Productivity

C = Crop Production

P = Farm Harvest Price (2015-16)

GSA= Gross Sown Area

NSA = Net Sown Area

An attempt has been made to analyze region-wise temporal and spatial development of agricultural productivity with the help of time series data using linear regression equation. Tables, graphs and trend lines have been used to represent the change in agricultural productivity. Index value has been used to check the comparative growth of agricultural productivity in South-western Haryana viz-a viz rest of Haryana.

To compute the compound growth rate following equation has been used.

$R = [\{\text{Anti Log } (\text{Log } X_2 - \text{Log } X_1)/i\} - 1]*100$

Here, R= Compound Growth Rate

X_2= Agricultural Productivity of later period (2015-16)

X_1=Agricultural Productivity of initial period (1990-91)

i= Interval between two period

To study the influence of various factors on agricultural productivity correlation and step-wise regression analysis has been used. For this following set of dependent and independent variables has been used:

Dependent Variable

Y=Agricultural Productivity (Rs./ha)

Independent Variables

X_1=Cropping Intensity (Percent)

X_2=Proportion of Net Sown Area (Percent)

X_3=Proportion of Irrigated Area (Percent)

X_4=Irrigation Intensity (Percent)

X_5=Tubewell Density(/000'ha)

X_6= Annual Rainfall(cm)

X_7= Consumption of Chemical Fertilizers (Kg/ha)

X_8=Consumption of Pesticides (Kg/ha)

X_9= Tractorization Index(/000'ha)

Results and Discussion

Trends of Agricultural Productivity

Agricultural productivity is a key to denote the prosperity of an area. It is the ratio of output to input in relation to land, labour, capital, and overall resources employed in agricultural (Shafi, 1960 and Singh, 1972).

Table 1 shows that the agricultural productivity of South-western Haryana and rest of Haryana was Rs. 44773 and 68483 per hectare during initial period of study (1990-91) which goes up to Rs. 82025 and 101033 per hectare in the final period of study (2015-16). The trend lines of both regions show positive slope for the agricultural productivity development (fig. 2). The findings of the study shows that regression coefficient of South-western Haryana and rest of Haryana is 1611 and 1723 per hectare per year respectively. It indicates that per unit change in study region lower than rest of Haryana. The intercept value reveals that in the beginning of study South-western Haryana was lagging behind the rest of Haryana, however slope of trend lines indicates a study and continuous growth in the levels of agricultural productivity for the both regions. It is important to note that about 81 percent in the change in agricultural productivity of South-western Haryana is explained by time period, whereas in case of rest of Haryana such an explanation is about 88 percent, which is much higher than study region.

Table 1
Agricultural Productivity (Rs./ha)
1990-91 to 2015-16

Year	SW Haryana	Rest of Haryana	Haryana
1990-91	44773	68483	62271
1991-92	42119	70267	63362
1992-93	46124	70409	64568
1993-94	53968	72609	68224
1994-95	61380	75791	72334
1995-96	54073	68282	64880
1996-97	58742	77301	72585
1997-98	48589	70252	64813
1998-99	59485	73841	70359
1999-00	56987	81496	75437
2000-01	58352	84017	77678
2001-02	65492	83383	79009
2002-03	58681	82306	76959
2003-04	74084	86493	83460
2004-05	64884	87618	82261
2005-06	57095	86986	79258
2006-07	69250	96435	89708
2007-08	65731	97605	89764
2008-09	81227	102437	97375
2009-10	75413	96305	91432
2010-11	88583	102584	99289
2011-12	80263	115336	106935
2012-13	85723	104914	100310
2013-14	87913	109757	104580
2014-15	74180	98478	92790
2015-16	82025	101033	96677

Source: Computed by Author

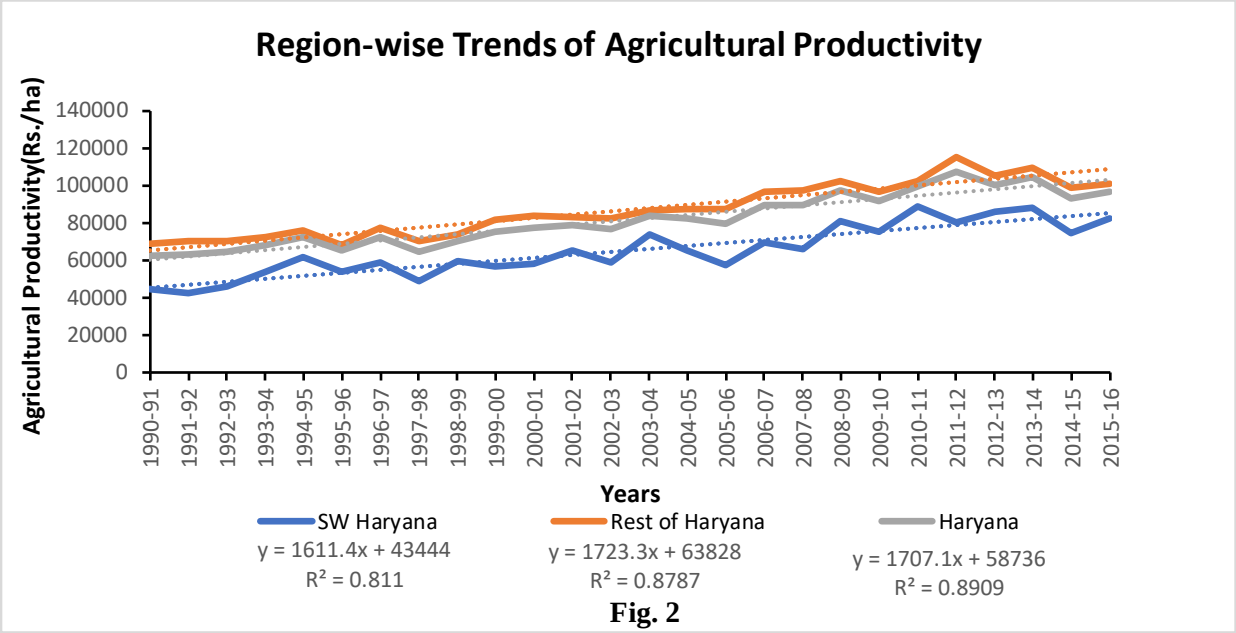
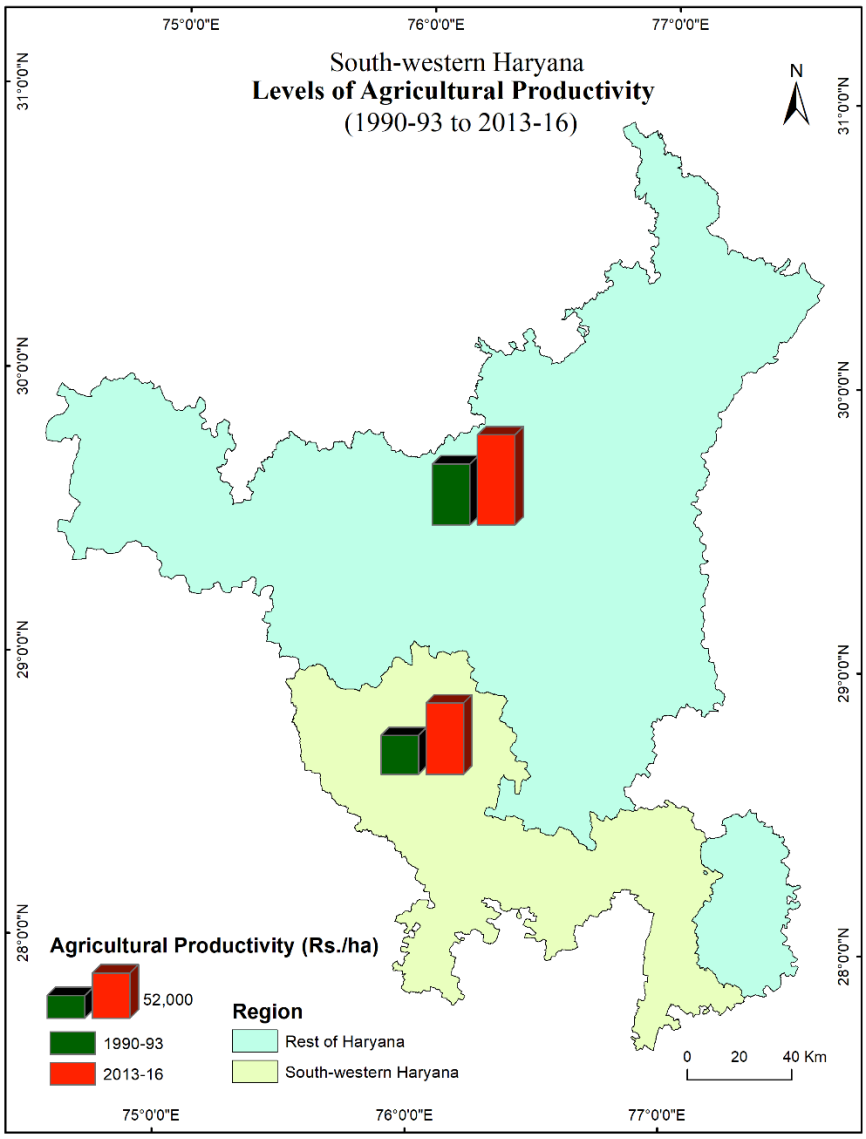


Fig. 2

Spatial Patterns of Agricultural Productivity

Spatial pattern of agricultural productivity has been shown by fig. 3. The findings of the study depict that during the initial phase of study agricultural productivity of south-western Haryana was much lower than rest of Haryana. It may be due to various factors, however one of the important factors which control agricultural production is irrigation. Various study shows that South-western Haryana lacks in the levels of irrigation facilities than rest of Haryana.



Index Value of Agricultural Productivity

Table 2 denotes that during 1990-93 index value of South-western Haryana was 0.70 in comparison to 1.10 for rest of Haryana. It meant that South-western Haryana lagged far behind the rest of Haryana. On the other hand, in 2013-16 the gap between these two regions gets reduced. It shows that there is a faster increase in agricultural productivity in the study region than its counterpart.

Table 2

Index Value of Agricultural Productivity

Region	Index Value	
	1990-93	2013-16
South-western Haryana	0.70	0.83
Rest of Haryana	1.10	1.05
Haryana	1.00	1.00

Source: Computed by Author

Compound Growth Rate of Agricultural Productivity

Table 3 reveals the compound growth rate of agricultural productivity. It is evident from the findings of the study that annual compound growth rate of South-western Haryana is more than rest of Haryana during the post-economic reform period. The agricultural productivity of South-western Haryana has increased at three percent annually whereas, agricultural productivity of rest of Haryana has increased at two percent annually. It indicates that agricultural productivity in South-western Haryana has increased at faster rate than rest of Haryana.

Table 3

Compound Growth Rate of Agricultural Productivity

Region	Compound Growth Rate (Percent) (2013-16 over 1990-93)
South-western Haryana	3.00
Rest of Haryana	2.00
Haryana	2.20

Source: Computed by Author

Determinants of Agricultural Productivity

There are numerous factors which determine the agricultural productivity. Such a factors can be classified under the heading of physical, social, economic, technological etc. To capture the difference an attempt has been made using statistical tools like correlation and stepwise regression analysis.

Correlation Analysis

Table 4 shows that consumption of fertilizers, tubewells density, cropping intensity and tractorization index are significantly and positively correlated with agricultural productivity. Whereas, rest of Haryana shows a minor difference from South-western Haryana. For the rest of Haryana proportion of net sown area is negatively correlated with agricultural productivity. It is interesting to note that values of correlation coefficients are more for rest of Haryana than the study region. It shows that determinants of agricultural productivity in study region are less effective than the rest of Haryana. On the other hand, it is important to note that consumption of pesticides is significant and negatively correlated with agricultural productivity for both regions in Haryana.

Table 4

Correlation Matrix

Region	Variables	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
South-western Haryana	Y	0.746**	0.204	0.364	0.584*	0.767**	-0.073	0.886**	-0.630**	0.705**
Rest of Haryana	Y	0.924**	-0.615**	0.823**	0.823**	0.832**	-0.151	0.937**	-0.901**	0.910**
Haryana	Y	0.903**	-0.319	0.810**	0.698**	0.878**	-0.118	0.942**	-0.937**	0.922**

*Significant at 0.05 level (Two-tailed), ** Significant at 0.01 level (Two-tailed)

Source: Computed by Author

Regression Analysis

Table 5 shows that consumption of chemical fertilizers is the leading explanatory variable of agricultural productivity in South-western Haryana. It enters at step one and explains about 78 percent variation in agricultural productivity. However, in case of rest of Haryana step-wise regression goes upto two steps. In this region consumption of chemical fertilizers and cropping intensity both explain about 94 percent variation in agricultural productivity alone. The R-value indicate a strong positive correlation of these two variables with agricultural productivity. Whereas, in case of Haryana consumption of chemical fertilizers is also the most important explanatory variable and enters at step one in step-wise regression analysis. The regression analysis of Haryana goes upto three steps and along with consumption of chemical fertilizers and consumption of pesticides, net sown area is the most significant independent variable which affect agricultural productivity of Haryana.

Table 5

Step-wise Regression Matrix

Region	Steps	Variables	R	R^2*100	Increased in R^2*100	F	Regression Coefficient	S.E of Regression Coefficient	T	Intercept
South-western Haryana	Step I	X_7	0.88	78.50	0.00	87.67	27.34	27.34	9.36	4387
Rest of Haryana	Step I	X_7	0.93	87.70	0.00	171.22	150.31	11.48	13.08	37624
	Step II	X_7	0.94	89.70	0.02	4.47	91.68	29.73	3.08	-82350
		X_1					780.92	369.37	2.11	
Haryana	Step I	X_7	0.94	88.70	0.00	187.70	169.95	12.40	13.70	33017
	Step II	X_7	0.95	90.80	2.10	114.11	93.98	34.39	2.73	121135
		X_1					-50111.95	21407.85	-2.341	
	Step III	X_7	0.96	92.60	1.80	91.29	66.19	34.00	1.947	308578
		X_1					-64123.23	20680.22	-3.101	
		X_2					-2003.34	889.29	-2.256	

Source: Computed by Author

Conclusion

It may be summarized that there has been improvement in the level of agricultural development in South-western Haryana over the period 1990-93 to 2013-16. But still there is huge gap between the study region and rest of Haryana in terms of level of agricultural productivity. This is despite the fact that South-western Haryana has recorded much higher growth rate in agricultural productivity in comparison to other part of Haryana. The annual compound growth rate of South-western Haryana is about one percent more than rest of Haryana during the triennium periods i.e. from 1990-93 to 2013-16. Correlation analysis reveals that consumption of chemical fertilizers, tractorization, proportion of irrigated area, tubewells density, and cropping intensity are positively correlated with agricultural productivity in both regions of Haryana. Step-wise regression model suggest that consumption of chemical fertilizer is the major determinants of agricultural productivity in South-western Haryana as well as rest of Haryana.

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