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GROWTH PATTERN OF HORTICULTURAL CROPS IN HIMACHAL PRADESH

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ABSTRACT

The present study deals with district wise growth performance of major fruit and vegetable crops in the State of Himachal Pradesh. Growth was analyzed in terms of compound annual growth rate in area, production and productivity of fruit and vegetable crops, which was carried out for the period 1980-81 to 2012-13 in case of fruits and 1995-96 to 2016-17 in case of vegetables. It was found that the area under different fruit and vegetable crops has increased but the productivity of fruits was found declining due to age old plantation in most of the districts. At state level, the area under total fruits and apple increased at the rate of 2.20% p.a. & 2.80% p.a. and production at the rate of 3.10% p.a. & 2.70% p.a., while, the productivity for the same was not found significant. However, the area, production and productivity of total vegetables in the state of Himachal Pradesh increased at the rate of 6.20% p.a., 7.30% p.a. and 1.10% p.a., respectively.

Keywords: Area, Growth rates, Exponential production function, Production, Productivity

India started putting greater thrust on the development of horticultural sector after sixties in order to exploit the country's vast potential and to generate the much needed value addition. In 2010-11, horticultural crops put together covered approximately 11.35% of the total cropped area with an annual production of about 114 million tons accounting for more than 18% of agricultural output of India (Gogoi and Borah, 2013). The importance of horticulture in improving the productivity of the land, generating employment, improving economic conditions of the farmers and entrepreneurs, enhancing exports and above all, providing nutritional security to the desert dwellers, can hardly be overemphasized (Bhandari *et al*., 2014). Growth of horticulture sector has been one of the driving forces of overall agricultural development in India (Dev, 2012; Mehta, 2009). Horticulture sector encompasses a wide range of crops for example fruit crops, vegetable crops, ornamental crops, medicinal and aromatic crops, spices and plantation crops (Government of India [GoI], 2001). Growth in area was the major source of production growth until early 1960s (Bhalla and Singh, 2009; Vaidyanathan, 2010) but with the growth of technology, modernization and changes in food habits, agricultural cropping pattern of the country has undergone a major shift in the recent past, moving away from the cereal to non-cereal crops cultivation, especially toward the horticulture crops. With the growth of urbanization, modernization, and increase in disposable income of the individuals, food consumption pattern gets changed greatly, shifted proportionately more toward the non-cereal crops (Popkin, 1998). As a result, in the recent past, change in cropping pattern from conventional/traditional to high-value cash crops has also been experienced in the Indian agriculture (Singha and Chakravorty, 2013) and at the same time, farmers are attracted by the higher market prices of the high-value cash crops. Evidence by Singh (2004) showed that one hectare under horticultural crops can generate an annual income up to Rs.20,000, compared to hardly Rs.10000 and Rs.4000 by rice and ragi, respectively. Also, growth of the horticulture sectors is not only enthused by the domestic needs but also by a large quantity of export requirements (Bhattacharyya, 2008; Mittal, 2007). Birthal *et al*. (2013) found that agricultural diversification towards HVCs in India occurred largely by replacing low value coarse grains and not rice and wheat.

Himachal Pradesh accounts for 1.39 per cent of the total area in the country and about 0.39 per cent of the net cultivated area in 2011-12 (Statistical Abstract of Himachal Pradesh, 2017-18). This implies that the agricultural growth performance in the state has lagged behind the average for the country as a whole. The agricultural productivity per hectare is less than national average. The state has made tremendous progress in agriculture through fruits, vegetables and off-season vegetables cultivation. Himachal Pradesh is reported to be the progressive among thirteen hill states and regions in the country and is considered to be a 'model' for development of other hilly areas of the Himalayan region. The reasons for such a diverse record may be varied but the regional heterogeneity; peculiar agro-climatic conditions in the state, low use of non-conventional inputs, subsistence farming and relatively small irrigation potential are the most important factors limiting the growth in output and productivity.

However, as noted above, hills have inherent potential for agriculture because they have comparative advantage in production of many location specific commodities of high value and suitable climate.

Agriculture is the main occupation of the people of Himachal Pradesh and has an important place in the economy of the state. Himachal Pradesh is the only state in the country

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whose 89.96 percent of population (2011 census) lives in rural areas. Therefore dependency on agriculture/ horticulture is much higher as compared to other states. It is the main source of income for people of state and about 10% domestic product of state comes from agriculture and related areas.

MATERIALS AND METHODS

Compound annual growth rates of the area, production and productivity of major fruit crops were worked out from 1980-81 to 2012-13 and from 1995-96 to 2015-16 in case of vegetable crops. Data were taken from Directorate of Agriculture, Shimla (HP). The data was available for this time period only.

In order to examine the trends in area, production and productivity of different crops, the compound growth rates were estimated by using exponential production function of the following type.

$$Y = a\, b^t$$

Where, Y = Area/production/productivity of crop

a = Constant

b= Regression coefficient

t= Time

CGR (%) = (Antilog b-1) x 100

RESULTS AND DISCUSSION

District wise compound annual growth rates of area, production and productivity of different fruits

At state level, the area under apple (2.80 % p.a.), other temperate fruits (0.60 % p.a.), nuts and dry fruits (0.70 % p.a.), sub-tropical fruits (5.10 % p.a.) and total fruits (2.20 % p.a..), recorded significant positive growth rates (Table 1).

Among the apple producing districts, acreage of apple significantly increased in Lahaul-Spiti (10.80 % p.a.), Chamba (6.60% p.a.), Kinnaur (4.8% p.a.), Mandi (2.90%

Table 1. District-wise compound annual growth rates of area under different fruits in Himachal Pradesh from 1980-81 to 2012-13.
(Percent per annum)

District	Crops and crop groups					
	Apple	Other temperate fruits	Nuts and Dry Fruits	Citrus Fruits	Other sub-tropical Fruits	All Fruits
Shimla	1.90***	1.30***	2.40***	-0.20	6.20***	1.80***
	(0.20)	(0.00)	(0.30)	(0.30)	(0.30)	(0.20)
Kullu	2.80***	0.30	-1.40***	-4.80***	6.50***	2.20***
	(0.10)	(0.30)	(0.50)	(0.90)	(0.40)	(0.10)
Mandi	2.90***	1.80***	2.40***	1.30***	4.10***	2.50***
	(0.10)	(0.20)	(0.30)	(0.40)	(0.10)	(0.20)
Chamba	6.60***	1.30***	2.90***	-0.80	2.40***	4.50***
	(0.30)	(0.40)	(0.50)	(0.60)	(0.40)	(0.30)
Kinnaur	4.80***	1.60***	1.20***	-	-	4.00***
	(0.10)	(0.10)	(0.20)			(0.10)
Lahaul & Spiti	10.80***	0.01	-1.20	-	-	8.70***
	(0.30)	(0.70)	(0.90)			(0.30)
Kangra	-0.50*	-4.70***	-2.60***	0.20	5.40***	2.20***
	(0.30)	(0.80)	(0.70)	(0.60)	(0.30)	(0.40)
Solan	-6.70***	-1.50***	-3.60***	-4.20***	3.50***	-1.30***
	(0.90)	(0.40)	(0.80)	(0.90)	(0.20)	(0.50)
Sirmour	0.10	3.30***	-0.30	-1.20**	5.50***	1.60***
	(0.20)	(0.20)	(0.40)	(0.60)	(0.40)	(0.30)
Bilaspur	-	1.30***	0.40	-3.30***	4.90***	1.60***
		(0.40)	(1.30)	(0.80)	(0.30)	(0.40)
Una	-	3.00***	0.01	1.70***	5.70***	3.40***
		(0.60)	(0.50)	(0.50)	(0.30)	(0.40)
Hamirpur	-	3.20***	-0.60	0.20	6.40***	3.10***
		(0.40)	(0.60)	(0.60)	(0.20)	(0.30)
HP	2.80***	0.60***	0.70*	-0.30	5.10***	2.20***
	(0.10)	(0.30)	(0.40)	(0.60)	(0.20)	(0.20)

Source: Directorate of Horticulture, Shimla, Himachal Pradesh
Note: *** denotes the significance at 1% level of probability, ** at 5% and *at 10%
Figures in the parentheses are standard errors of growth rates

p.a.), Kullu (2.80% p.a.) and Shimla (1.90% p.a.). The area under other sub tropical fruits and all fruits increased in all the districts with highest increase in growth rate having been observed in Kullu (6.50% p.a.) in case of subtropical fruits and in Lahaul-Spiti (8.70% p.a.) in case of all fruits except Solan which had negative growth of 1.30% p.a. In case of other temperate fruits also area increased in most of the districts (eight); the maximum increase was observed in Sirmour (3.30% p.a.) and declined in the districts of Kangra (4.70% p.a.) and Solan (1.50% p.a.). If we see the area growth under nuts and dry fruits it grew up in Shimla (2.40% p.a.), Mandi (2.40% p.a.) and Kinnaur (1.20% p.a.) and declined in Kullu (1.40% p.a.), Kangra (2.60% p.a.) and Solan (3.60% p.a.). The area under citrus fruits increased only in two districts i.e. Una (1.70% p.a.) and Mandi (1.30% p.a.) and declined in Bilaspur (3.30% p.a.), Solan (4.20% p.a.), Kullu (4.80% p.a.) and Sirmour (1.20% p.a.) while non conspicuous ups or downs were observed in other districts.

If we see the growth rate in fruit production at state level, fruit production recorded positive growth rates of 2.70% p.a. in apple, 3.90% p.a. in other temperate fruits, 4.90% p.a. in citrus fruits, 6.90% p.a. in other sub- tropical fruits and 3.10% p.a. in all fruits (Table 2).

The growth analysis of compound annual growth rates of production under major fruit crops/groups at the district level revealed that production of different fruits depicted the positive growth in apple, ranged from 2.10% p.a. in Kullu to 9.60% p.a. in Lahaul-Spiti while

Solan (7.40% p.a.) and Sirmour (3.70% p.a.) clocked negative growth rate. Growth trend of other temperate fruits showed that its production increased in nine districts ranging from 2.20% p.a. in Bilaspur to 6.50% p.a. in Sirmour. In case of other subtropical fruits production increased in eight districts with the growth rate ranging from 2.80% p.a. in Chamba to 8.50% p.a. in Solan and declined in Kullu (3.50% p.a.) only. The growth analysis of the production of citrus

Table 2. District-wise compound annual growth rates of production of different fruits in Himachal Pradesh from 1980-81 to 2012-13 (Percent per annum)

District	Crops and crop groups					
	Apple	Other temperate fruits	Nuts and Dry Fruits	Citrus Fruits	Other Sub-Tropical Fruits	All Fruits
Shimla	2.50**	4.80***	3.70***	-4.10***	-1.40	2.50**
	(1.00)	(0.90)	(0.90)	(1.60)	(1.90)	(1.00)
Kullu	2.10*	4.80***	-3.30***	-4.62***	-3.50***	2.40**
	(1.10)	(1.10)	(0.10)	(1.80)	(1.40)	(1.00)
Mandi	2.50**	0.40	0.20	5.20***	5.00***	2.40***
	(1.10)	(0.90)	(0.70)	(1.40)	(1.40)	(0.80)
Chamba	2.90***	3.00***	4.60***	3.30	2.80*	3.10***
	(1.10)	(1.10)	(1.10)	(2.10)	(1.50)	(0.90)
Kinnaur	7.20***	4.20***	-1.80**	-	-	6.90***
	(0.40)	(1.50)	(0.80)			(0.40)
Lahaul & Spiti	9.60***	5.50***	-0.90	-	-	7.80***
	(1.10)	(1.30)	(1.30)			(0.90)
Kangra	3.80***	4.60***	4.20***	6.30***	7.60***	6.50***
	(1.50)	(0.80)	(1.00)	(0.80)	(1.10)	(0.80)
Solan	-7.40***	0.01	-1.90**	4.20**	8.50***	0.80***
	(1.00)	(1.20)	(0.90)	(1.70)	(2.40)	(0.10)
Sirmour	-3.70***	6.50***	4.80***	-1.10	5.30***	3.90***
	(1.10)	(1.70)	(0.90)	(0.90)	(0.80)	(0.90)
Bilaspur	-	2.20*	10.20***	-3.00***	7.00***	4.30***
		(1.20)	(3.00)	(1.20)	(1.20)	(1.00)
Una	-	5.80***	-3.50	5.40***	6.70***	5.90***
		(1.20)	(3.00)	(1.00)	(1.30)	(0.80)
Hamirpur	-	5.00***	10.00***	3.20**	6.90***	5.50***
		(1.40)	(4.00)	(1.60)	(1.60)	(1.20)
HP	2.70***	3.90***	1.70***	4.90***	6.90***	3.10***
	(1.60)	(0.60)	(0.40)	(0.70)	(1.00)	(0.80)

Source: Directorate of Horticulture, Shimla, Himachal Pradesh
Note: *** denotes the significance at 1% level of probability, ** at 5% and * at 10%
Figures in the parentheses are standard errors of growth rates

fruits recorded the positive growth in Kangra (6.30% p.a.), Una (5.40% p.a.), Mandi (5.20% p.a.), Solan (4.20% p.a.) and Hamirpur (3.20% p.a.) and declined in the districts of Shimla (4.10% p.a.), Kullu (4.62% p.a.) and Bilaspur (3.00% p.a.). As far as growth in production under all fruits is concerned, trend was found more interesting when almost all the districts except Solan (non significant change) experienced an upward trend with annual growth rates ranging from 2.40% p.a. in Mandi & Kullu to 7.80% p.a. in Lahaul-Spiti.

Analysis of the growth performance of productivity during study period demonstrated that it increased significantly for other temperate fruits (3.30% p.a.), nuts and dry fruits (1.00% p.a.). and citrus fruits (5.10% p.a.) while no change was observed in case of apple (Table3).

It was found that the area under apple was increasing significantly in most of the districts but, the production and productivity of this crop was not increasing at the same rate. This may be due to that most of the apple orchards had aged plantation. In case of other temperate fruits, productivity trend depicted that the increasing growth rates were significant in seven districts only ranging from 2.60 per cent per annum in Kinnaur to 9.40 per cent per annum in Lahaul-Spiti. The growth analysis of the productivity of nuts and dry fruits increased only in Lahaul-Spiti (6.40% p.a.), Kangra (7.00% p.a.) and Sirmour (5.20% p.a.) while it declined in five districts. In case of citrus fruits, increase was observed only in five districts namely Mandi (3.90% p.a.), Chamba (4.10% p.a.), Kangra (6.10% p.a.), Solan (8.30% p.a.) and Una (3.80% p.a.). By looking at the complete trend of the productivity of all fruits it increased in only seven districts viz. Kangra (4.30% p.a.), Lahaul-Spiti (3.40% p.a.), Kinnaur (2.90% p.a.), Bilaspur (2.70% p.a.), Una (2.50% p.a.), Hamirpur (2.40% p.a.) and Sirmour (2.40% p.a.).

In conclusion, the analysis of growth performance of the area of fruits and fruit groups revealed that most of districts witnessed increase while production and productivity of

Table 3. District-wise compound annual growth rates of productivity of different fruits in Himachal Pradesh from 1980-81 to 2012-13

(Percent per annum)

District	Crops and crop groups					
	Apple	Other Temperate fruits	Nuts and Dry Fruits	Citrus Fruits	Other sub-tropical Fruits	All Fruits
Shimla	0.60	3.50***	1.30	-3.90**	-7.60***	0.70
	(1.10)	(0.90)	(0.90)	(1.60)	(1.90)	(1.10)
Kullu	- 0.80	4.40***	-1.90*	1.40	-8.00***	0.20
	(1.20)	(1.10)	(1.00)	(1.80)	(2.50)	(1.00)
Mandi	- 0.40	-1.40	-2.30***	3.90**	0.90	-0.10
	(1.10)	(0.90)	(0.60)	(1.60)	(1.40)	(0.90)
Chamba	-3.70***	1.80	1.70	4.10*	0.40	-1.40
	(1.10)	(1.30)	(1.30)	(2.20)	(1.60)	(1.00)
Kinnaur	2.30***	2.60*	-3.00***	-	-	2.90***
	(0.40)	(1.40)	(0.80)			(0.40)
Lahaul & Spiti	2.30	9.40***	6.40***	-	-	3.40**
	(1.70)	(1.60)	(1.90)			(1.60)
Kangra	4.30***	9.30***	7.00***	6.10***	2.20*	4.30***
	(1.60)	(1.30)	(1.00)	(1.10)	(1.20)	(1.00)
Solan	-0.80	1.50	1.70	8.30***	5.00*	2.10
	(1.40)	(1.40)	(1.00)	(2.20)	(2.50)	(1.40)
Sirmour	-3.80***	3.10*	5.20***	0.20	-0.20	2.40**
	(1.20)	(1.80)	(1.00)	(1.00)	(1.10)	(1.10)
Bilaspur	-	1.00	-2.10*	0.20	2.20	2.70**
		(1.30)	(1.20)	(1.70)	(1.40)	(1.30)
Una	-	2.80***	-14.10***	3.80***	0.90	2.50***
		(1.00)	(1.70)	(1.30)	(1.30)	(0.90)
Hamirpur	-	1.80	0.20	3.00	0.60	2.40*
		(1.70)	(1.80)	(1.90)	(1.70)	(1.40)
HP	0.00	3.30***	1.00**	5.10***	1.80	0.90
	(1.00)	(0.80)	(0.50)	(1.10)	(1.10)	(0.90)

Source: Directorate of Horticulture, Shimla, Himachal Pradesh
Note: *** denotes the significance at 1% level of probability, ** at 5% and * at 10%
Figures in the parentheses are standard errors of growth rates

these was found declining in most of the districts of Himachal Pradesh.

District wise compound annual growth rates of area, production and productivity of different vegetables

The area under most of the high value crops increased continuously during the study period. At state level (Table 4) the area under peas, tomato and beans which are the main cash crops expanded at the rate of 7.00% p.a., 5.80% p.a. and 3.60% p.a., respectively. Likewise, area allotted to vegetables like onion/garlic (8.30% p.a.), cabbage (6.30% p.a.), cauliflower (9.70% p.a.), radish (6.70% p.a.), bhindi (10.40% p.a.), capsicum (6.00% p.a.), brinjal (8.40% p.a.) and total vegetables (6.20% p.a.) increased at varying rates. It can be inferred that, cropping pattern has shifted in favour of vegetables other than potato, partly major cereals i.e. maize and wheat; and fodder crops. Thus, relative profit and food security concerns could be the main motives behind this shift in acreage allocation in the State (Mehta, 2009).

An analysis of compound annual growth rates of area under vegetables at the district level revealed that among the vegetable producing districts, acreage of peas increased in eleven out of twelve districts with highest increase observed in Kinnaur (12.40% p.a.). Five out of twelve districts reported higher growth rates in area of peas than the state average. In the same manner, area allocated to tomato recorded the increasing growth in the acreage in eleven districts except Lahaul-Spiti (-1.60% p.a.) with highest growth in Chamba district (12.80% p.a.). In case of beans, nine districts recorded increasing growth rate ranging from 1.70% p.a. in Hamirpur to 6.40% p.a. in Kinnaur. In cauliflower, all (twelve) the districts registered the positive growth rate in acreage ranging from 3.50% p.a. in Una to 18.70% p.a. in Hamirpur. However, Bilaspur (1.60% p.a.) registered the declining growth in the acreage under radish, turnip and carrot. Area allocated to capsicum and chillies also went up in seven districts with yearly growth rates varying from 3.30 per cent in Shimla to 10.20 per cent in Hamirpur, but it declined in Chamba (5.30% p.a.). As far as growth in area under total vegetables is concerned, all the districts experienced an upward trend with annual growth rates ranging from 3.40 per cent in Una to 10.40 per cent in Kinnaur.

Table 5 displays compound annual growth rates of production of major vegetables crops computed for the period from 1995-96 to 2015-16. Growth analysis of production of vegetables for the state revealed that the area expansion as well as productivity increase caused the output to grow. A significant change of 8.20% p.a. was observed in pea production. Tomato and beans, registered a significant growth of 7.70 per cent and 4.90 per cent per annum, respectively. The production of onion/ garlic (11.10% p.a.), cabbage (7.50% p.a.), cauliflower (10.70% p.a.), radish turnip & carrot (7.60% p.a.), bhindi (12.50% p.a.), capsicum & chillies (10.30% p.a.), brinjal (10.00% p.a.) and total vegetables exhibited growth rates (7.30% p.a.) which were significant. Contrarily, production of cucurbits (-0.80% p.a.) registered the negative growth.

An analysis of compound annual growth rates of production under vegetables at the district level revealed that among the vegetable producing districts, production of pea was observed highest in Kinnaur (12.40% p.a.) and minimum in Solan (2.30% p.a.) during the study period. Tomato is an important cash crop in the state and is grown throughout the state. Time trends in tomato output were observed to be positive and significant in eleven districts recording per annum growth rates ranging from 6.00 per cent in Sirmour to 16.40 per cent in Kinnaur. Eight out of twelve districts reported the higher growth rates in output of tomato than the state average. Investigation of beans production depicted that it grew up in most of the districts (eight) registering growth rates varying from 1.20 per cent per annum in Mandi to 7.50 per cent per annum in Kinnaur but it declined in Lahaul & Spiti (6.40% p.a.).

In relation to the assessment of the growth behaviour of production under cauliflower, it was evident that all the districts sustained increasing trend by securing growth rate between 3.00 per cent per annum in Kinnaur to 17.80% p.a. in Hamirpur. Cucurbits production declined at varying rate in the districts of Chamba (12.00% p.a.), Solan (6.70% p.a.), Sirmour (5.00% p.a.), Kullu (3.20% p.a.) and Shimla (1.70% p.a.) while it increased in districts of Kinnaur (6.20% p.a.), Kangra (3.30% p.a.) and Una (1.20% p.a.). Time trends in capsicum and chillies output were observed to be positive and significant in eight out of twelve districts ranging from 6.50% p.a. in Shimla to 15.00% p.a. in Solan during the study period. Brinjal production exhibited the positive growth in all the districts barring Lahaul & Spiti (no change). The analysis of total vegetables production demonstrated that it grew up in all the districts with highest rate of increase recorded in Kinnaur (11.10% p.a.) and minimum in Una (3.30% p.a.).

By looking at the Table 6 for the state, it was observed that all the crops registered the significant increasing growth rate in productivity except cucurbits and onion/garlic. An assessment of the growth of crop productivity at disaggregated level of districts revealed that productivity of peas declined significantly only in Hamirpur (1.50% p.a.) and increased in nine districts of the state with growth rate ranging from 4.00% p.a. in Bilaspur to 0.60% p.a. in Una and Shimla. The trend was good for most of the districts (ten) depicting perceptible growth in the productivity of tomato ranging from 1.30 per cent per annum in Chamba to 5.50 per cent per annum in Kangra. Lahaul-Spiti exhibited decreasing growth rate of 2.60% p.a. Productivity of onion/garlic increased only in one district i.e. Bilaspur (1.30% p.a.).By looking at the trend of the productivity of cauliflower, it was evident that it increased in half of the districts with the range of 1.30% p.a. in Shimla to 2.40% p.a. in Solan and declined in Sirmour (0.70% p.a.), Hamirpur (0.80% p.a.) and Kinnaur (6.30% p.a.). Moreover, productivity trend of radish, turnip & carrot declined in Lahaul-Spiti (1.00% p.a.) and Shimla (2.00%

Table 4. District-wise compound annual growth rates of area under different vegetables in Himachal Pradesh from 1995-96 to 2015-16

(Percent per annum)

District	Crops and crop groups												
	Peas (green)	Tomato	Beans	Onion/ garlic	Cabbage	Cauliflower	Radish, Turnip & carrot	Bhindi	Cucurbits	Capsicum & chillies	Brinjal	Other vegetables	Total vegetables
Bilaspur	-0.70 (0.90)	10.60*** (1.60)	0.70 (0.60)	4.90*** (0.70)	-0.90 (0.90)	5.20*** (0.80)	-1.60* (0.80)	7.20*** (0.50)	-0.60 (0.50)	-1.10 (1.60)	-1.80 (1.10)	5.80*** (0.70)	3.50*** (0.30)
Chamba	12.50*** (1.10)	12.80*** (1.40)	3.30** (1.30)	0.90 (1.20)	1.40 (1.10)	4.80*** (1.20)	7.30*** (0.80)	10.30*** (1.00)	-10.60*** (2.00)	-5.30*** (1.50)	5.20*** (1.20)	-2.00** (0.80)	6.20*** (0.40)
Hamirpur	6.50*** (0.40)	7.60*** (1.20)	1.70** (0.70)	12.10*** (0.70)	13.30*** (1.60)	18.70*** (1.10)	11.50*** (0.70)	13.70*** (1.10)	5.40*** (1.10)	10.20*** (1.70)	13.00*** (1.20)	11.90*** (1.40)	10.30*** (0.60)
Kangra	6.40*** (0.40)	8.00*** (0.70)	3.00*** (0.50)	7.50*** (0.50)	11.90*** (1.30)	12.90*** (1.00)	14.00*** (1.40)	10.90*** (1.40)	3.10*** (0.40)	8.60*** (0.70)	11.90*** (1.40)	7.40*** (1.60)	7.70*** (0.80)
Kinnaur	12.40*** (1.20)	12.30*** (1.20)	6.40*** (0.50)	-1.40 (1.70)	8.70*** (1.00)	9.30*** (1.50)	9.00*** (1.00)	6.60*** (1.40)	7.10*** (1.00)	-	9.00*** (1.00)	11.80*** (2.10)	10.40*** (0.80)
Kullu	10.20*** (0.60)	2.80*** (0.60)	-0.50 (0.60)	10.80*** (1.90)	5.60*** (0.60)	5.90*** (0.60)	7.70*** (1.40)	7.70*** (2.20)	-1.60 (0.90)	0.00 (1.30)	6.10*** (0.90)	-6.10* (3.00)	5.20*** (0.20)
Lahaul & Spiti	8.60*** (1.40)	-1.60 (1.60)	-4.70*** (1.00)	-19.70*** (1.60)	8.40*** (1.20)	14.20*** (2.30)	11.10*** (1.70)	-	-0.50 (2.00)	-	-	12.10*** (1.50)	8.50*** (1.10)
Mandi	8.30*** (0.60)	9.60*** (2.10)	1.50*** (0.50)	8.10*** (1.20)	17.30*** (1.30)	15.70*** (0.80)	13.70*** (0.90)	14.70*** (2.60)	1.60 (2.20)	6.10*** (0.40)	10.60*** (0.90)	4.30*** (1.30)	7.80*** (0.40)
Shimla	6.90*** (0.60)	6.40*** (1.70)	6.00*** (0.20)	-1.50 (1.30)	4.10*** (0.60)	9.70*** (1.20)	7.30*** (0.60)	10.50*** (2.00)	0.30 (0.30)	3.30*** (0.70)	7.50*** (0.90)	2.60*** (0.80)	5.90*** (0.30)
Sirmour	3.30*** (0.60)	4.30*** (0.60)	5.00*** (0.60)	16.60*** (1.30)	5.20*** (0.40)	4.90*** (0.40)	3.10*** (0.50)	8.40*** (0.30)	-5.10*** (0.90)	8.40*** (0.50)	6.60*** (0.50)	-5.40** (2.40)	4.90*** (0.10)
Solan	1.60*** (0.50)	5.70*** (0.60)	3.90*** (1.10)	2.30*** (0.80)	0.10 (0.40)	7.50*** (0.40)	-1.80 (1.10)	12.20*** (1.80)	-4.70*** (1.50)	7.90*** (0.80)	10.50*** (2.40)	8.00** (3.00)	4.50*** (0.30)
Una	4.70*** (0.80)	10.80*** (0.80)	0.80 (0.50)	6.80*** (0.60)	3.00*** (0.30)	3.50*** (0.30)	3.10*** (0.30)	3.70*** (0.70)	3.80*** (0.40)	6.20*** (0.40)	5.30*** (0.70)	-4.80** (1.90)	3.40*** (0.20)
HP	7.00*** (0.40)	5.80*** (0.80)	3.60*** (0.20)	8.30*** (0.60)	6.30*** (0.40)	9.70*** (0.30)	6.70*** (0.30)	10.40*** (0.60)	0.60* (0.30)	6.00*** (0.30)	8.40*** (0.50)	4.50*** (0.90)	6.20*** (0.20)

Source: Directorate of Agriculture, Shimla, Himachal Pradesh
Note: *** denotes the significance at 1% level of probability, ** at 5% and * at 10%
Figures in the parentheses are standard errors of growth rates

Table 5. District-wise compound annual growth rates of production of different vegetables in Himachal Pradesh from 1995-96 to 2015-16 **(Percent per annum)**

District	Crops and crop groups												
	Peas (green)	Tomato	Beans	Onion/ garlic	Cabbage	Cauliflower	Radish, Turnip & carrot	Bhindi	Cucurbits	Capsicum &chillies	Brinjal	Other vegetables	Total vegetables
Bilaspur	3.30*** (1.00)	12.90*** (1.60)	4.20*** (0.70)	6.20*** (1.10)	2.30** (1.00)	7.30*** (0.80)	1.30 (0.80)	11.60*** (0.70)	2.40 (1.80)	6.70*** (1.60)	1.80* (1.10)	10.30*** (1.00)	7.20*** (0.30)
Chamba	16.50*** (1.80)	14.10*** (1.40)	5.00*** (1.20)	1.20 (1.60)	0.90 (1.60)	7.80*** (2.00)	11.50*** (0.90)	12.30*** (1.20)	-12.00*** (2.10)	-1.20 (1.40)	7.10*** (1.10)	1.40 (1.00)	7.30*** (0.80)
Hamirpur	5.00*** (0.60)	11.10*** (1.10)	2.10 (1.30)	12.50*** (0.70)	10.20*** (1.90)	17.80*** (1.20)	11.50*** (0.90)	17.00*** (2.00)	2.20 (1.60)	13.30*** (3.10)	13.30*** (1.10)	13.80*** (1.40)	9.70*** (0.50)
Kangra	8.00*** (0.60)	13.50*** (2.00)	5.30*** (0.70)	7.00*** (0.40)	14.70*** (1.30)	14.50*** (0.80)	15.90*** (1.70)	13.00*** (1.50)	3.30*** (0.90)	10.30*** (0.80)	14.60*** (1.20)	11.20*** (1.80)	9.40*** (0.70)
Kinnaur	12.40*** (1.20)	16.40*** (2.80)	7.50*** (0.60)	-3.90** (1.80)	6.90*** (1.30)	3.00** (2.30)	8.70*** (1.10)	7.30*** (1.40)	6.20*** (1.10)	-	7.90*** (1.00)	15.50*** (2.50)	11.10*** (0.90)
Kullu	12.30*** (0.90)	7.60*** (2.00)	-0.60 (1.20)	10.30*** (1.00)	6.10*** (0.90)	6.30*** (0.90)	7.50*** (1.40)	9.70*** (1.90)	-3.20* (1.70)	1.30 (1.20)	6.80*** (1.60)	-4.50 (3.10)	5.80*** (0.60)
Lahaul & Spiti	8.50*** (1.60)	-4.20** (1.90)	-6.40*** (0.70)	-22.70*** (2.40)	6.60*** (1.80)	16.50*** (2.60)	10.10*** (1.70)	-	3.00 (3.20)	-	-	16.40*** (1.80)	8.70*** (1.20)
Mandi	9.70*** (1.10)	11.40*** (1.50)	1.20 (0.80)	7.50*** (2.00)	17.90*** (2.10)	17.20*** (1.10)	14.10*** (1.20)	15.70*** (2.50)	0.30 (2.90)	9.20*** (0.50)	11.60*** (1.10)	8.70*** (1.70)	9.40*** (0.50)
Shimla	7.50*** (0.60)	7.90*** (1.60)	6.20** (1.90)	-0.20 (2.20)	6.00*** (0.70)	11.00*** (1.20)	5.30*** (0.60)	12.60*** (1.10)	-1.70*** (0.40)	6.50*** (1.00)	8.40*** (1.00)	4.90*** (0.80)	6.70*** (0.30)
Sirmour	4.10*** (0.60)	6.00*** (0.70)	5.90*** (0.60)	15.70*** (1.10)	7.60*** (0.30)	4.20*** (0.30)	3.20*** (0.40)	10.50*** (0.50)	-5.00*** (0.80)	12.10*** (0.70)	8.40*** (0.60)	-2.50 (2.30)	5.80*** (0.30)
Solan	2.30*** (0.70)	7.60*** (0.40)	6.80*** (1.60)	3.00*** (1.00)	1.70** (0.80)	9.90*** (0.80)	-0.50 (1.40)	15.60*** (2.00)	-6.70** (2.70)	15.00*** (2.10)	9.10*** (2.50)	13.50*** (3.60)	6.70*** (0.30)
Una	5.30*** (0.80)	12.60*** (1.30)	2.30*** (0.70)	5.40*** (0.60)	2.50*** (0.40)	3.90*** (0.30)	4.40*** (0.50)	6.50*** (0.50)	1.20*** (0.30)	8.70*** (0.70)	6.60*** (0.70)	-3.20* (1.70)	3.30*** (0.30)
HP	8.20*** (0.50)	7.70*** (0.50)	4.90*** (0.30)	11.10*** (1.70)	7.50*** (0.50)	10.70*** (0.40)	7.60*** (0.50)	12.50*** (0.80)	-0.80 (0.60)	10.30*** (0.40)	10.00*** (0.70)	8.10*** (1.00)	7.30*** (0.20)

Source: Directorate of Agriculture, Shimla, Himachal Pradesh
Note: *** denotes the significance at 1% level of probability, ** at 5% and * at 10%
Figures in the parentheses are standard errors of growth rates

Table 6. District-wise compound annual growth rates of productivity of different vegetables in Himachal Pradesh from 1995-96 to 2015-16 **(Percent per annum)**

District	Crops and crop groups												
	Peas (green)	Tomato	Beans	Onion/garlic	Cabbage	Cauliflower	Radish, Turnip & carrot	Bhindi	Cucurbits	Capsicum &chillies	Brinjal	Other vegetables	Total vegetables
Bilaspur	4.00*** (0.90)	2.30*** (0.40)	3.50*** (0.30)	1.30*** (0.40)	3.10*** (0.40)	2.20*** (0.50)	2.80*** (0.30)	4.40*** (0.60)	3.00* (1.80)	7.80*** (0.60)	3.60*** (0.20)	4.50*** (0.50)	3.70*** (0.30)
Chamba	3.90*** (1.00)	1.30*** (0.40)	1.70*** (0.50)	0.30 (0.50)	-0.50 (0.80)	3.10 (2.00)	4.10*** (0.70)	2.00*** (0.60)	-1.30** (0.60)	4.10*** (0.40)	1.90*** (0.30)	3.50*** (0.60)	1.10* (0.60)
Hamirpur	-1.50*** (0.50)	3.60*** (1.00)	0.40 (0.70)	0.40 (0.30)	-3.20*** (0.60)	-0.80*** (0.30)	0.00 (0.40)	0.30* (1.90)	-3.20*** (0.70)	3.00** (1.40)	0.30 (0.50)	1.90 (1.30)	-0.60 (0.40)
Kangra	1.60*** (0.50)	5.50*** (1.70)	0.30*** (0.50)	-0.50 (0.40)	2.80 (0.40)	1.70** (0.70)	1.90*** (0.70)	2.10*** (0.50)	0.20 (0.80)	1.60** (0.70)	2.70*** (0.30)	3.80*** (0.50)	1.70*** (0.30)
Kinnaur	0.00 (0.50)	4.10* (2.40)	1.20*** (0.30)	-2.40*** (0.30)	-1.80*** (0.70)	-6.30** (2.70)	-0.20 (0.40)	3.40** (1.60)	-1.00** (0.40)	19.00*** (2.90)	-1.00*** (0.30)	3.70*** (0.50)	0.60** (0.30)
Kullu	2.10*** (0.50)	4.90*** (1.80)	0.00 (0.60)	-0.50 (1.40)	0.60 (0.50)	0.30 (0.50)	-0.10 (0.40)	2.00** (0.90)	-1.70 (2.00)	1.20*** (0.40)	0.70 (1.00)	1.60*** (0.50)	0.70 (0.60)
Lahaul & Spiti	-0.10 (0.30)	-2.60*** (0.90)	-1.70*** (0.60)	-3.10*** (1.10)	-1.80 (1.50)	2.30** (1.00)	-1.00*** (0.20)	-	-2.20 (2.60)	-	-	4.30*** (0.90)	0.30 (0.30)
Mandi	1.40** (0.60)	1.80 (1.10)	-0.30 (0.50)	0.60 (1.70)	0.60 (1.50)	1.50** (0.70)	0.40 (0.60)	1.00 (1.10)	-1.30 (0.90)	3.20*** (0.50)	1.00* (0.60)	4.50*** (0.70)	1.60*** (0.40)
Shimla	0.60*** (0.10)	1.50*** (0.30)	0.20 (1.90)	1.30 (1.80)	1.90*** (0.30)	1.30*** (0.10)	-2.00*** (0.40)	2.20* (1.20)	-2.00*** (0.30)	3.20*** (0.50)	1.00*** (0.10)	2.30*** (0.50)	0.80*** (0.20)
Sirmour	0.90*** (0.20)	1.70*** (0.30)	0.90*** (0.20)	-0.80 (0.60)	2.50*** (0.40)	-0.70** (0.30)	0.00 (0.30)	2.10*** (0.40)	0.10 (0.40)	3.70*** (0.50)	1.70*** (0.20)	2.90*** (0.50)	0.90*** (0.20)
Solan	0.70** (0.30)	1.90*** (0.30)	2.90*** (0.60)	0.70 (0.60)	1.70* (0.90)	2.40*** (0.80)	1.30* (0.70)	3.40*** (0.80)	-2.10 (1.50)	7.20*** (1.90)	-1.40** (0.70)	5.50*** (0.70)	2.20*** (0.20)
Una	0.60*** (0.20)	1.80* (1.00)	1.50*** (0.40)	-1.40*** (0.50)	-0.50* (0.30)	0.30 (0.30)	1.30*** (0.30)	2.90*** (0.50)	-2.60*** (0.40)	2.50*** (0.40)	1.30*** (0.20)	1.60*** (0.40)	0.00 (0.20)
HP	1.20*** (0.10)	1.90*** (0.40)	1.30*** (0.20)	2.80 (2.00)	1.20*** (0.20)	1.10*** (0.20)	0.90*** (0.30)	2.20*** (0.40)	-1.30*** (0.40)	4.30*** (0.40)	1.50*** (0.50)	3.60*** (0.40)	1.10*** (0.10)

Source: Directorate of Agriculture, Shimla, Himachal Pradesh
Note: *** denotes the significance at 1% level of probability, ** at 5% and * at 10%
Figures in the parentheses are standard errors of growth rates

p.a.) and increased considerably in five districts. Likewise, in case of cucurbits, productivity increased only in Bilaspur (3.00% p.a.). The trend was better for the productivity of capsicum/chillies, as it increased in most of the districts (eleven) with highest growth observed in Kinnaur (19.00% p.a.) and minimum in Kullu (1.20% p.a.) barring Lahaul & Spiti which observed non significant change. Productivity of total vegetables grew up in only eight districts of Himachal Pradesh with the growth rate range from 0.60 per cent per annum in Kinnaur to 3.70 per cent per annum in Bilaspur. The increases or decreases were, however, not significant in the districts of Hamirpur, Kullu, Lahaul & Spiti and Una.

In conclusion, the analysis of growth performance of the productivity of vegetables revealed that a large number of districts experienced increase in the area, production and productivity of majority of the vegetables. It may be attributable to better utilization of the existing infrastructure in addition to growing importance and a wider spread of productivity-raising technology in the recent period. Policy suggestions from the study are that though the area and production of fruits in the state is increasing at a significant rate, yet the productivity of these fruits is still low as compared to national and international standards. So realizing the contribution of fruits in the state's economy, more efforts are needed to rejuvenate and replace the old fruit plants with appropriate improved and regular bearing varieties. Productivity of vegetables is still low in the state, so besides enhancing the productivity of vegetables by using high yielding varieties, investment should also be made to further improve the market infrastructure, road network and post–harvest infrastructure like processing units.

Authors' contribution

Conceptualization of research work and designing of experiments (ND and RSP); Execution of field/lab experiments and data collection (ND); Analysis of data and interpretation (ND and RSP); Preparation of manuscript (ND)

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