



Growth and trend in area, production and productivity of vegetables in Haryana vis-à-vis India

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ABSTRACT

Vegetable farming plays an important role in the country's agricultural economy. Between the actual harvested yield and the potential yield of vegetable crops in Haryana state, there is a notable discrepancy. As a result, potential has yet to be fully realized. Numerous other industries, like processing, seeds industry, fertilizer, pesticides and farm machinery industry are supported by vegetables. The present study was carried out to analyze the trend in area, production and productivity of overall vegetables in Haryana and India. Area, production and productivity of overall vegetables shows a significant increase and positive trend from 1990–91 to 2020–21 with a compound annual growth rate (CAGR) of 7.00, 8.13 and 1.06% in Haryana and 3.18, 4.65 and 1.43% in India. Potato, onion, tomato, radish, carrot, cauliflower and bottle gourd are the major vegetables grown, amongst which highest production, viz. 0.81 and 54.75 million tonnes was recorded under potato during 2020–21 in Haryana and India, respectively.

Keywords: Compound annual growth rate, Production, Productivity, Trend

Vegetable cultivation occupies an important place in the agricultural economy of the country (Bidyasagar *et al.* 2017). The majority of the world's population consumes a vegetarian diet, and vegetables are a necessary part of every vegetarian meal (Kumar 2017). The varied climate of India ensures that all kinds of fresh vegetables are readily available in the country (Jha *et al.* 2019). Some of the most significant vegetables grown in India include tomato, onion, brinjal, cabbage, cauliflower, okra and pea. In terms of global vegetable production, it comes in second place to China, with a production of 204.84 million metric tonnes from 11.34 million hectare of land area in the year 2021–22 (Anonymous 2021–22).

The enormous production base provides India with fantastic export opportunities. India exported fresh vegetables worth ₹6,965.83 crores/\$865.24 million in 2022–2023. Pulses and processed vegetables totaled ₹12,146.32 crore (\$1,511.14) in exports. The majority of vegetables exported from the nation are onions, mixed

vegetables, potatoes, tomatoes and green chillies. The UAE, Bangladesh, Nepal, Malaysia, Netherland, Sri Lanka, UK, Qatar, Oman, Iraq, USA, China and Saudi Arabia are major markets for Indian fresh and processed vegetables (APEDA 2021–22)

Actual harvested yield and potential yield of vegetable crops in the state of Haryana are significantly different. Therefore, there is still room to fully realize its potential. In the State, vegetable production totaled 5.87 million metric tonnes during 2021–22, covering 0.34 million hectare, which accounted 2.93 and 3.11% over the national figures (Anonymous 2022).

In terms of vegetable production, the State still has a long way to go. Vegetables have been found to have higher economic returns than a number of other crops (Tegar *et al.* 2016). A number of other industries, such as those involved in processing, seeds, fertilizer, pesticides, and farm machinery are supported by vegetables (Mishra *et al.* 2023). In light of the significance of vegetables, this study calculates the area, production, and productivity trends, as well as the compound annual growth rate (CAGR), of the vegetables grown in India and Haryana.

MATERIALS AND METHODS

In consideration of the study's specific objectives, the time series data from 1990–1991 to 2021–2022 (31 years) regarding the area, production, and productivity of vegetables was obtained from secondary source, i.e.

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Horticulture Department of Haryana, GoI (Statistical data) and Statistical Abstract of Haryana (Anonymous 2018)

Analytical techniques

Linear trend: The linear trends (per year contribution) of area, production and productivity of vegetables were observed by fitting the linear trend equations in the form of linear regression as:

$$Y = a + bt$$

Where Y, Area/production/yield; a, Constant; t, Time variable; b, Regression coefficient.

Growth analysis: The growth rates refer to the percentage change of a particular variable over a certain period of time in a particular situation. Compound growth rates were calculated by fitting the time-series data in an exponential function in the form given below to the data, in order to quantify the growth in area, production and productivity of crops for Haryana and India from 1990–1991 to 2020–21 (Muhammed 2018):

$$Y_t = AB^t (1)$$

Where, Y_t , Index number of area/production/productivity of vegetables for the year 't' as dependent variable; t, Time variable as independent variable; A, Intercept; B, Regression coefficient. Equation (1) can be expressed in logarithmic form as follows:

$$\log y = \log a + t \log b$$

$$\log y = A + Bt$$

Where, A, $\log a$ and; B, $\log b$. Student's t- test was used to test the significance of CAGR. Per cent annual compound growth rate "r" can be computed as:

$$r = (\text{Antilog of } b-1) \times 100.$$

Co-efficient of variation (CV): The co-efficient of variation was estimated using the expression (Udhayan *et al.* 2023):

$$CV = \frac{SD}{\text{Mean}} \times 100$$

Where SD, Standard deviation.

RESULTS AND DISCUSSION

Trend in the area under vegetables: The data provided by the Horticulture Department of Haryana indicates that the area under vegetable crops in Haryana has grown at the rate of 7.00% per year during 1990–91 to 2020–21, to reach an overall value of 450.43 thousand hectare as on 2020–21 and in India it has grown at the rate of 3.18% per annum during the study period to reach the overall area of 10859 thousand hectare (Table 1 and 2, Fig 1). The mean area under vegetables was observed to be 240.36 thousand hectares for Haryana and 7447.484 thousand hectares for India, respectively (Anonymous 2018, Anonymous 2021, Anonymous 2022). The coefficient of variation shows

55.79% of variation in areas under vegetables in Haryana and 26.80% variation in India, respectively. The percentage change for the area and production of vegetables was calculated to be positive for most of the years, suggesting that there was an upward trend in the area and production of vegetables in Haryana and India during the period 1990–1991 to 2020–2021. Similar results were reported by Chaudhari *et al.* (2018) for Gujarat state.

Production: In terms of production, the compound growth rate during the period 1990–91 to 2020–21 was observed to be 8.13% in Haryana and 4.65% per annum was observed for the country as a whole. During this period, the mean production under vegetables was found to be 3548.26 thousand tonnes in Haryana and the corresponding figure for India was found to be 118739.00 thousand tonnes, respectively. The coefficient of variation shows 62.15% variation in production of vegetables in Haryana and 38.87% variation in India. In India and Haryana, the per cent change in production of vegetables during the study period revealed an increasing trend which is favoured by Chaudhari *et al.* (2018) for the states of Gujarat.

Productivity: The overall compound growth rate in productivity of vegetables was seen to be 1.06% in the State and 1.43% was found in the country as a whole, respectively. The mean productivity of vegetables in Haryana was observed to be 14.59 t/ha and for India it was found to be 15.43 t/ha. The coefficient of variation shows 10.38% variation in productivity of vegetables in Haryana and 13.89% variation in India in terms of productivity of vegetables.

Due to advancements in production technology over this time period, the area, production, and productivity of vegetables increased significantly in India with CAGRs of 7.00, 8.13, and 1.43% and in Haryana with CAGRs of 3.18, 4.65, and 1.06%. Similar results were reported by Mohapatra *et al.* (2017) indicated an increasing trend in area, production and productivity of major vegetables in India and Punjab with CAGR of 3.10, 3.40 and 1.64% for India and the corresponding figures for Punjab were 5.71, 3.13 and 0.96%.

Area, production and productivity of selected vegetables in India and Haryana: The data on area, production, and productivity of selected vegetables in Haryana and India are shown in Supplementary Table 1. From 1990–91 to 2020–21, the area under the following crops grew significantly in Haryana: potato, onion, tomato, radish, carrot, cauliflower, and bottle gourd with a significant CAGR of 28.27, 60.20, 43.75, 75.21, 67.82, 53.70, and 31.37% (Table 3). In India, over the same time period, the area planted with the corresponding vegetables increased significantly at a CAGR of 24.38, 52.91, 35.72, 31.04, 55.95, 32.43 and 75.92%. In Haryana, the area planted with bottle gourd varies the most (101.00%) and the potato crop the least (41.76%), according to the coefficient of variation. In India, a variant of the same trend was observed with variation of 96.02 and 38.03%.

The data presented in the Table 3 depicted that the production of potato, onion, tomato, radish, carrot,

Table 1 Area, production and productivity of vegetables in India and Haryana, 1990–91 to 2020–21

Year	Haryana			India		
	Area (ha)	Production (t)	Productivity (t/ha)	Area (ha)	Production (t)	Productivity (t/ha)
1990–91	55.36	802.24	14.49	4120	48927	11.88
1991–92	60.80	877.00	14.42	5593	58532	10.47
1992–93	69.59	1029.43	14.79	5322	62335	11.71
1993–94	75.26	1155.00	15.35	4876	65787	13.49
1994–95	85.00	1275.00	15.00	5013	67286	13.42
1995–96	94.00	1420.00	15.11	5335	71594	13.42
1996–97	98.00	1455.00	14.85	5515	75074	13.61
1997–98	102.00	1350.00	13.24	5607	72683	12.96
1998–99	120.00	1850.00	15.42	5866	87536	14.92
1999–2000	135.00	2094.50	15.51	5993	90831	15.16
2000–01	133.00	2100.00	15.79	6250	93850	15.02
2001–02	150.20	2150.00	14.31	6156	88622	14.40
2002–03	163.00	2245.20	13.77	6092	84815	13.92
2003–04	203.74	2701.30	13.26	6309	93165	14.77
2004–05	207.75	2980.40	14.35	6744	101246	15.01
2005–06	232.66	2984.80	12.83	7213	111399	15.44
2006–07	280.87	3366.86	11.99	7581	114993	15.17
2007–08	274.58	3277.10	11.93	7848	128449	16.37
2008–09	298.43	3893.43	13.05	7981	129077	16.17
2009–10	300.86	4020.72	13.36	7985	133738	16.75
2010–11	346.40	4649.28	13.42	8495	146554	17.25
2011–12	356.77	5068.43	14.21	8990	156326	17.39
2012–13	360.34	5011.31	13.91	9205	162187	17.62
2013–14	373.17	5565.90	14.92	9396	162897	17.34
2014–15	359.40	5285.59	14.71	9542	169478	17.76
2015–16	410.74	6156.88	14.99	10106	169064	16.73
2016–17	379.20	5684.46	14.99	10238	178172	17.40
2017–18	446.99	7140.70	15.97	10259	184394	17.97
2018–19	443.60	7305.01	16.47	10073	183170	18.18
2019–20	384.09	6052.87	15.76	10310	188284	18.26
2020–21	450.43	9047.71	20.09	10859	200445	18.46

Source: Anonymous (2018); Anonymous (2022); Mohapatra *et al.* (2017) and Vikash and Meena (2022).

Table 2 Growth in area, production, and productivity of overall vegetables in Haryana and India (1990–1991 to 2020–21)

	Mean area (ha)	CV (%)	CAGR (%)	Mean production (t)	CV (%)	CAGR (%)	Mean productivity (t/ha)	CV (%)	CAGR (%)
Haryana	240.36	55.79	7.00	3548.26	62.15	8.13	14.59	10.38	1.06
India	7447.48	26.80	3.18	118739.03	38.87	4.65	15.43	13.89	1.43

CAGR, Compound annual growth rate.

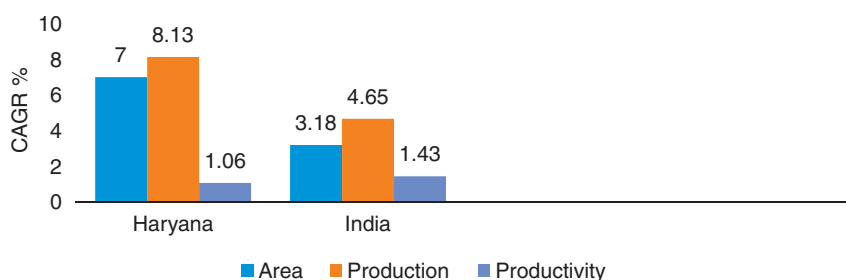


Fig 1 CAGR in area, production and productivity of overall vegetables in Haryana and India from 1990–91 to 2020–21. CAGR, Compound annual growth rate.

cauliflower and bottle gourd in Haryana has increased with a CAGR of 47.74, 86.12, 49.53, 76.02, 70.75, 70.39 and 43.88% from 1990–91 and 2020–21, respectively (Fig 2). During the same period in India, it has increased with a CAGR of 37.41, 69.77, 57.18, 71.14, 77.59, 35.35 and 69.95% for the respective crops (Fig 3). In terms of production the coefficient of variation was found to be highest for onion (81.98%) and lowest for tomato crop (59.30%) in Haryana. In India, it was highest for onion (85.75%) and lowest for cauliflower crop (46.64%).

The findings showed that the productivity of bottle gourd, potato, onion, tomato, radish, carrot, and cauliflower increased significantly with a CAGR of 7.24, 14.76, 13.72, 2.90, 0.61, 0.93 and 8.32% respectively. Similarly in case of India it has increased with significant CAGR of 10.47, 11.02, 15.81, 30.62, 13.87 and 2.2% for vegetables like potato, onion, tomato, radish, carrot and cauliflower, but in case of bottle gourd it has decreased with CAGR of -3.39%. In terms of productivity, the coefficient of variation was found to be

highest for onion (30.92%) and lowest for carrot crop (3.47%) in Haryana. In India, it was highest for radish (49.02%) and lowest for cauliflower crop (3.94%).

It is encouraging to see that despite the country's flourishing urbanization, India's area planted with vegetables increased from 4120–10859 thousand hectares, from 1990–1991 to 2020–2021 and production has increased from 48.93–200.45 million metric tonnes

(Table 1). In Haryana the area under vegetables has increased from 55.36–450.43 thousand hectares from 1990–91 to 2020–21 and production has increased from 0.80–9.05 million metric tonnes. At the same time, it is upsetting to see that post-harvest losses have also increased. With an unprecedented increase in area, production, and productivity, India entered the golden revolution during the 11th Five Year Plan of the Indian Planning Commission. India produced 162.19 million tonnes of vegetables on 9205 thousand hectares, which was made possible by ongoing research efforts and numerous advancements in the production and protection technologies developed by scientists and adopted by farmers.

The paradoxical reason for the rising amount of loss of these perishable products after harvest has been the inadequate post production infrastructure as well as improper marketing and handling system. In India, the post-harvest management system did not improve in a way that was consistent with the significant increase

Table 3 Growth in area, production, and productivity of major vegetables in Haryana and India (1990–1991 to 2020–21)

	Mean area (000'ha)	CV (%)	CAGR (%)	Mean production (mt)	CV (%)	CAGR (%)	Mean productivity (t/ha)	CV (%)	CAGR (%)
<i>Haryana</i>									
Potato	21.39	41.76	28.27	0.46	64.76	47.74	19.80	27.50	14.76
Onion	15.42	60.85	60.20	0.31	81.98	86.12	18.42	30.92	13.72
Tomato	15.68	66.09	43.75	0.29	59.30	49.53	18.90	17.30	2.90
Radish	15.62	73.32	75.21	0.27	72.39	76.02	17.78	12.89	0.61
Carrot	12.49	68.93	67.82	0.21	68.54	70.75	16.74	3.47	0.93
Cauliflower	19.14	65.11	53.70	0.35	71.52	70.39	17.53	12.95	8.32
Bottle gourd	30.47	101.00	31.37	0.35	81.86	43.88	12.55	20.68	7.24
<i>India</i>									
Potato	1567.50	38.03	24.38	33.57	53.39	37.41	20.37	18.14	10.47
Onion	874.95	69.06	52.91	12.61	85.75	69.77	12.98	21.57	11.02
Tomato	610.84	49.94	35.72	12.20	66.75	57.18	18.41	25.21	15.81
Radish	126.46	47.19	31.04	1.54	85.45	71.14	10.52	49.02	30.62
Carrot	53.89	73.05	55.95	0.90	81.83	77.59	15.37	21.63	13.87
Cauliflower	316.43	43.14	32.43	5.91	46.64	35.35	18.45	3.94	2.21
Bottle gourd	81.24	96.02	75.92	1.44	84.43	69.95	19.26	16.62	-3.39

CAGR, Compound annual growth rate. *Source:* Anonymous (2013); Anonymous (2018); Anonymous (2021).

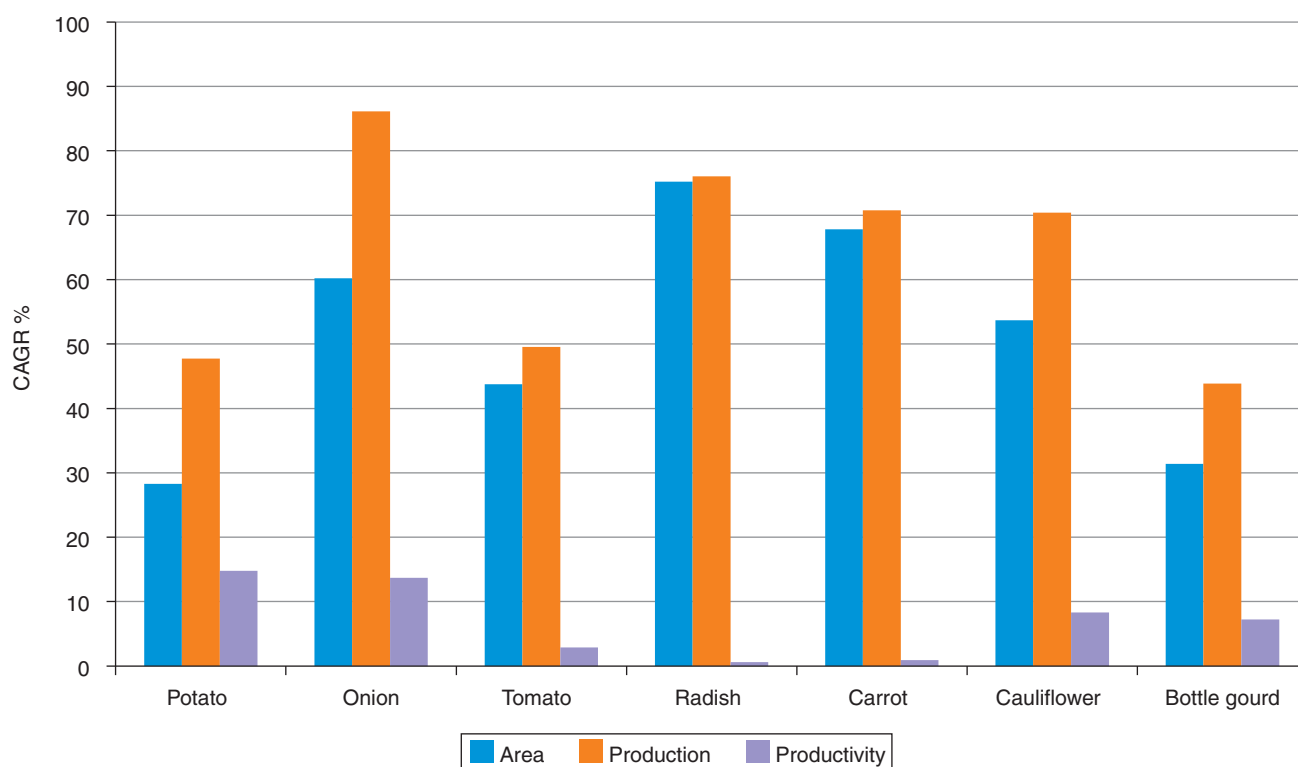


Fig 2 Compound annual growth rate (CAGR) of area, production and productivity of major vegetables in Haryana 1990–91 to 2020–21.

in production and productivity. Therefore, in order to reduce the percentage of losses currently experienced in vegetables, it is imperative to strengthen the post-harvest technologies used in the case of vegetables. Fruits

and vegetables, which have a short shelf life among horticultural products, account for 70% of the wasted food. The supply chain's postharvest stages are where this food wastage occurs most frequently as a result of inadequate

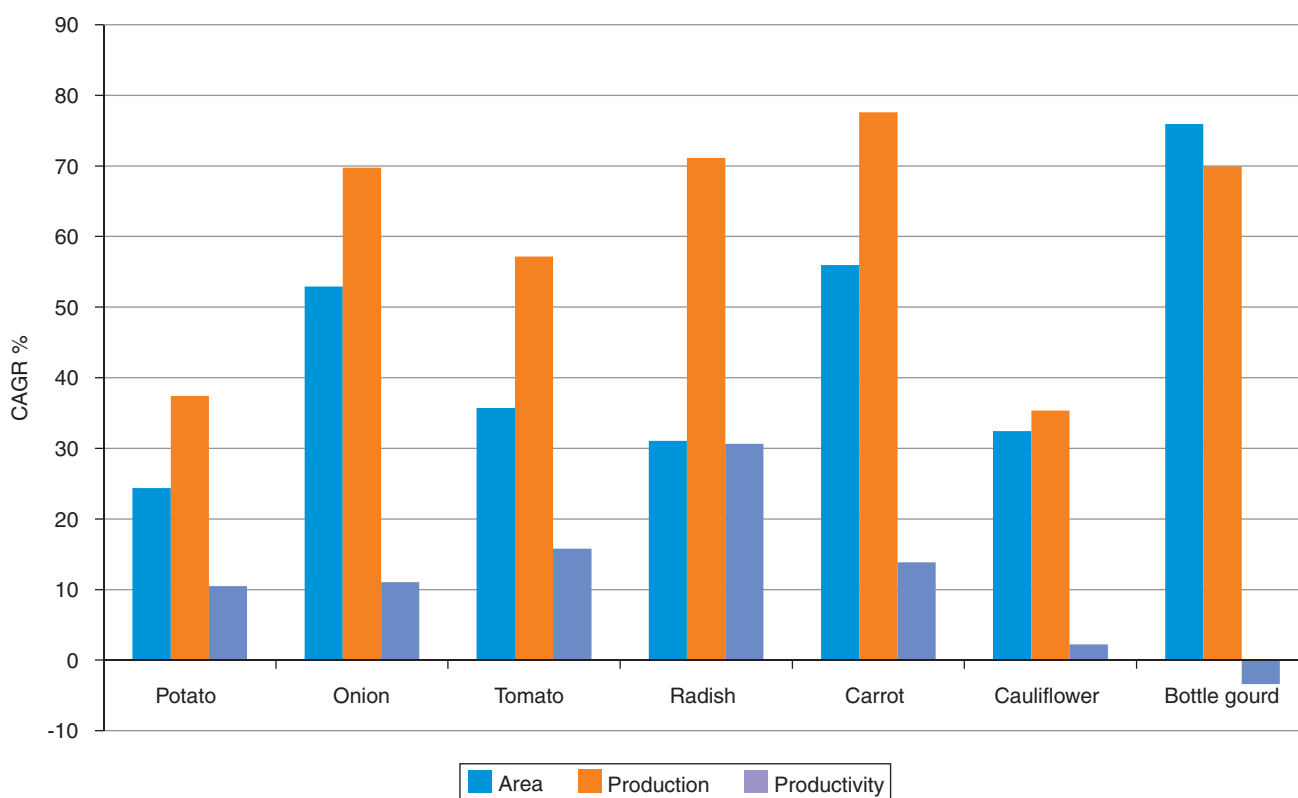


Fig 3 Compound annual growth rate (CAGR), production and productivity under major vegetables in India from 1990–91 to 2020–21.

infrastructure for storage and transportation facilities (Mohan *et al.* 2023).

Additionally, because they must travel over long distances and through a variety of climate zones, horticultural products are subject to a variety of environmental factors that affect their quality. Therefore, there is a critical need to enhance the technologies used for processing and storage so that farmers will be more interested in growing vegetables. Vegetable contract farming should be increased with a strong incentive in addition to post-harvest loss management. Contract farming generally bridges the gap by giving capital-strapped small farmers access to quality inputs, technical assistance and management skills. Since these farmers typically cannot afford to make significant investments in land improvement and modern inputs, they are encouraged to switch from traditional cultivation to vegetable farming, which boosts their income.

According to the study, vegetable crop production and area have increased both in India and Haryana. The minimal increase in productivity across the board in Haryana and the entire nation (1.06 and 1.43%, respectively) showed that the increase in vegetable production during the study period was primarily due to an increase in the area dedicated to vegetable cultivation. Therefore, there is a pressing need to increase productivity in order to meet the state's expanding population's increasing demand for vegetables. To do this, necessary investments must be made to provide farmers with access to high-quality seeds, production methods, irrigation, transportation, communication, and marketing facilities at the state and district levels.

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