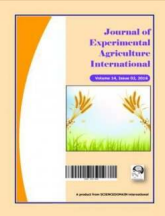

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Diversification towards Vegetable Crops: A Good Option for Doubling the Farmer's Income

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study was conducted to analyze the reason for which diversification towards vegetable production is taken as a pathway for increasing farmer's income as well as employment. In this study the trends in area, production and productivity of the vegetables in India and Punjab along with their compound annual growth rate have been calculated. The study was undertaken on a macro framework based on data collected from secondary source like www.indiastat.com. The results indicated that production of vegetables in total as well as the major cultivated vegetables i.e., potato, tomato and peas in Punjab and India had increased over the last 26 years due to increase in area and yield of the respective crops. Due to such notified increment, the vegetables can be taken as a very good option for the diversification from the culturally practiced crops and thereby will definitely promote the increase in income of farmers. But some factors like increasing rate of post harvest losses, poor conditions of contract farming and others have been forming limiting factors for the actual amount of arrival of vegetables to the consumer. Hence in order to continue the increase in availability of these vegetables there is a need to improvise several post harvest practices and motivate the contract farming to spread among vegetable cultivators so that a better platform could be placed for helping the farmers in increasing their income.

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Keywords: Diversification; vegetables; growth rate; post-harvest losses.

1. INTRODUCTION

Indian Agriculture has gone through lots of changes made possible by adoption of improved technology by farmers, investment in agricultural research and development and huge production and well distribution of the produce [1]. The period of green revolution (1965-85), the era of food self-sufficiency, led an increase in food grain production in many states of India especially Punjab, Haryana and Uttar Pradesh which was only be placed due to the decisive role of Indian farmers [2]. Intensification of agriculture by introduction of high yielding varieties, subsidy schemes on fertilizer, electricity, diesel and construction of large scale irrigation projects gave rise to increase in the wage rate and employment opportunity generation in rural areas which resulted in to increase in profitability among the farmers. However for certain period of time the economy of the country started prospering based on the food gain crops, pulses and cash crops only which was in the later period culminating to agrarian crisis of stagnating productivity, growing indebtedness, falling income and farmers' suicides and it gave rise to urgent need of diversification. Diversification from grain crops to vegetable crops can be an important strategy for agricultural growth to provide gainful employment, improve income and save natural resources from further degradation [3]. The extent of diversification of vegetables among farmers in Ghana's Cocoa belt and found that it offered great potential for improving livelihoods of cocoa-based farm households of that area [4]. Vegetable crops with their shorter growth periods and wider ecological amplitude than other crops can be a source of incremental per capita income, urbanization, health awareness and transformation of farmers' profit to certain higher level as there is a detectable change seen in the consumption pattern characterized by decreasing share of food grains and increasing share of non-food grains in particular vegetables and fruits in the consumption baskets [5].

Vegetables, the main source of vitamins and minerals, are very utilitarian in the rotational system of farming for maintenance of soil fertility and also providing better crop intensification as well as diversification. Being more labour intensive than the cereal crops, vegetable crops resulted more employment opportunities for hired labour as well as family labour thereby solving the disguised unemployment problem. From the point of view of profitability, vegetables like potato, tomato, cauliflower, peas have proved themselves in obtaining higher return in comparison to other crops and also having higher Benefit-Cost ratio (B:C ratio). Several studies have been conducted portraying the B:C ratio of cultivation of respective vegetables. Potato was cultivated in Jammu with a B:C ratio 1.73 [6]. Tomato was cultivated in Maharashtra with a B:C ratio of 1.83 [7] where as tomato was cultivated in Haryana with a B:C ratio of 0.32 [8]. Cauliflower was cultivated in Punjab with a B:C ratio of 2.09 [9]. Peas was cultivated in Punjab with a B:C ratio of 0.98 [10]. Here the studied profitability of the above vegetables has shown that adoption of these vegetables cultivation can be a form of diversification in order to increase the income as well as profit of farmers.

In India the per capita availability of vegetables is much lower than the recommended level of consumption because the present production level of India is not sufficient to meet the requirement. Hence this target can be fulfilled by using improved agro techniques with hybrid seeds, bringing the additional area under vegetable crops and perfecting as well as promoting the protected cultivation of vegetables [11]. High-tech production of vegetables has become the solution of unwillingness of farmers for leaving the paddy-wheat rotation due to the insect and pests problems and others. Protected cultivation being capital intensive has the capacity to increment the productivity of vegetables as well as improving quality of vegetables [12].

Keeping in view of the importance of vegetables in increasing the income as well as profit of farmers, this study estimates the trend, Compound Growth Rate (CGR) of area, production and productivity of major vegetables cultivated in India as well as Punjab.

2. MATERIALS AND METHODS

In perspective of specific objectives of the present study, the time series data from 1990-91 to 2015-16 (26 years) regarding the area, production and productivity of selected vegetables was collected from the secondary source that is www.indiastat.com.

2.1 Analytical Techniques

2.1.1 Linear trend

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

$$Y = a + bt$$

Where,

Y = Area/ Production/Yield
a = Constant
t = Time variable
b = Regression coefficient

2.1.2 Growth analysis

The growth rates refer to the percentage change of a specific variable within a specific period of time, given a certain context. The compound annual growth rates (CAGR's) of area, production and productivity of vegetables were estimated for Punjab and India from 1990-91 to 2015-16. The growth model used is as under:

$$Y_t = AB^t$$

Where,

Y_t = Area / production / productivity of vegetables for the year't'.
t = Time variable (1, 2…... n) for each period.
A = Constant
B = Growth coefficient

Log transformation of above function is:

$$\ln Y_t = \ln A + t (\ln B)$$

Where,

$\ln B = \ln (1+ r)$, and
$t = [\text{antilog} (\ln B) – 1]$
CAGR's (%) = $[\text{antilog} (\ln B) – 1] \times 100$

Student's t- test was used to test the significance CAGR.

3. RESULTS AND DISCUSSION

A comprehensive view on the area, production and productivity of vegetables in India and Punjab has been presented in Table 1. The compound annual growth rate (CAGR) with respect to these variables is depicted in Table 2. During the study period (1990-91 to 2015-16) the area under vegetables in India increased significantly with CAGR of 3.10 per cent and in Punjab with 5.71 per cent.

The data presented in the Table 1 depicts that the production of vegetables in India has increased approximately 3.40 times and that of Punjab was 3.13 times which was due to the increase in area as well as productivity of vegetables in India and Punjab throughout the study period.

Productivity of vegetables in India increased with significant CAGR of 1.64 per cent and in Punjab with a CAGR of 0.96 per cent which was the result of technological changes in production technology occurred over this period.

Table 1. Area, production and productivity of vegetables in India and Punjab, 1990-91 to 2015-16

Year	Area (000 ha)		Production (000 tonnes)		Productivity (kg/ha)	
	India	Punjab	India	Punjab	India	Punjab
1990-1991	4120.00	78.20	48927.00	1331.00	11875	17000
1995-1996	5335.00	105.00	71594.00	1774.10	13420	16900
2000-2001	6250.00	131.00	93849.00	2310.00	15016	17600
2005-2006	7047.00	152.10	110270.00	2816.70	15648	18500
2010-2011	8495.00	174.10	146555.00	3585.80	17252	20600
2011-2012	8990.00	178.20	156326.00	3674.50	17389	20600
2012-2013	9205.00	184.10	162187.00	3782.60	17619	20500
2013-2014	9396.00	191.00	162897.00	3936.20	17337	20600
2014-2015	9494.00	208.00	167058.00	4167.70	17596	20000
2015-2016	9575.00	208.00	166608.00	4167.60	17400	20010

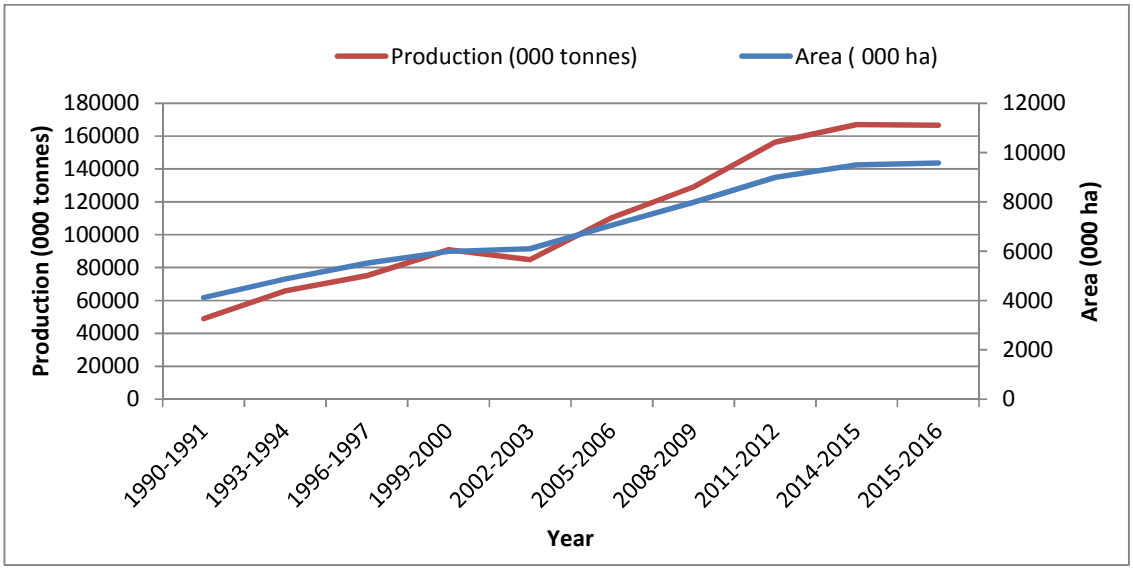

Fig. 1. Trends in area and production of vegetables in India

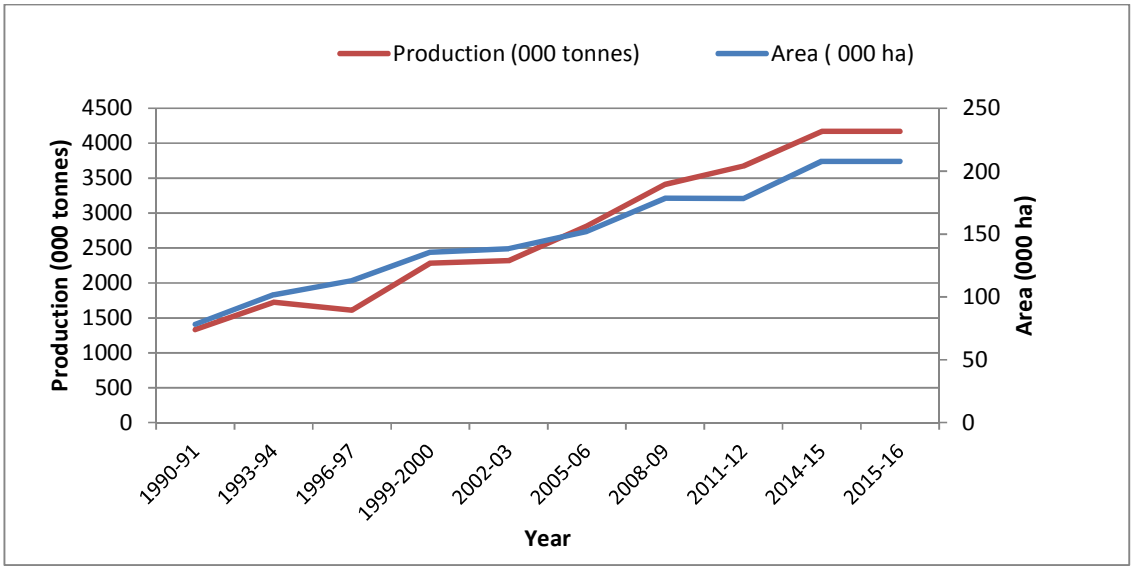

Fig. 2. Trends in area and production of vegetables in Punjab

Table 2. Compound annual growth rate of area, production and productivity of vegetables in India and Punjab, 1990-2000 to 2015-16 (Per cent)

Year	CAGR (%)					
	Area		Production		Productivity	
	India	Punjab	India	Punjab	India	Punjab
1990-2000	2.87***	5.78*	5.92***	4.46***	2.97***	-1.34
2000-2010	3.63***	3.87***	5.29***	4.64***	1.59***	0.73
2010-16	2.26***	4.05***	2.44***	3.39***	0.18	-0.58
1990-2016	3.10***	5.71***	4.78***	6.67***	1.64***	0.96***

****, * indicates significance at 1 and 10 per cent level*

3.1 Area, Production and Productivity of Selected Vegetables in India and Punjab

The data on area, production and productivity in Punjab and India has been presented in Table 1. The CAGR with respect to these variables are given in Table 3. The area under potato, tomato, cauliflower and peas in Punjab has increased with a significant CAGR of 3.75, 2.10, 8.49 and 2.7 per cent respectively from 1990-91 to 2015-16. During the same time period, in India the area under respective vegetables increased significantly at a CAGR of 3.09, 4.63, 6.74 and 4.19 per cent.

The results revealed that productivity of potato, tomato and peas in Punjab increased with significant CAGR of 1.36, 0.20 and 2.22 per cent respectively but in case of cauliflower it has decreased with CAGR of 1.25 percent. Similarly in case of India it has increased with significant CAGR of 1.37, 1.80, 1.24 and 0.1 per cent for vegetables like potato, tomato, cauliflower and peas.

The data presented in the Table 3 depicted that the production of potato, tomato, cauliflower and peas in Punjab and India has increased with a CAGR of 5.21, 2.32, 7.13 and 5.07 per cent from 1990-91 2015-16 respectively. During the same period in India it has increased with a CAGR of 4.44, 6.51, 8.07 and 3.87 per cent for the respective crops.

It is heartening to observe that despite the flourishing urbanization, the area under vegetables in India has increased from 4120 thousand ha in 1990 to 9575 thousand ha in 2015 [13]. At the same time it is depressing to notice that there is also increment occurred in post harvest losses. During 11th Five

Table 3. Area, production and productivity of selected vegetables in Punjab and India, 1990-91 to 2015-16

Vegetable crops	Year	Area (000 ha)			Production (000 tonnes)			Productivity (kg/ha)	
		Punjab	India	% share of Punjab	Punjab	India	% share of Punjab	Punjab	India
Potato	1990-91	25.60	935.50	2.74	499.50	15205.60	3.28	19512	16254
	1995-96	38.80	1109.00	3.50	795.70	18843.30	4.22	20508	16991
	2000-01	59.60	1211.30	4.92	1187.10	22142.70	5.36	19918	18280
	2005-06	71.40	1401.40	5.09	1164.60	23905.30	4.87	16311	17058
	2010-11	64.40	1863.20	3.46	1609.20	42339.40	3.80	24988	22724
	2015-16	92.35	2134.00	4.33	2385.20	43770.00	5.45	25828	20511
Tomato	1990-91	3.11	276.00	1.13	75.00	4015.00	1.87	24116	14547
	1995-96	5.80	356.00	1.63	139.00	5442.00	2.56	23966	15287
	2000-01	6.85	460.00	1.49	165.00	7242.00	2.28	24088	15743
	2005-06	8.02	546.00	1.47	194.00	9820.00	1.97	24190	17985
	2010-11	6.26	865.00	0.72	154.00	16826.00	0.92	24601	19452
	2015-16	7.63	760.00	1.00	191.00	18399.00	1.04	25033	24209
Cauliflower	1990-91	2.10	201.34	1.04	50.47	2987.65	1.69	24033	14839
	1995-96	2.31	220.00	1.05	56.87	2474.00	2.30	24619	11245
	2000-01	3.24	256.30	1.26	78.04	4695.80	1.66	24086	18321
	2005-06	5.60	288.60	1.94	131.40	5323.10	2.47	23464	18445
	2010-11	8.65	369.00	2.34	154.65	6745.00	2.29	17879	18279
	2015-16	14.85	426.00	3.49	273.51	8199.00	3.34	18418	19246
Peas	1990-91	12.50	138.70	9.01	75.52	1457.90	5.18	6000	7700
	1995-96	13.20	224.00	5.89	79.70	2341.30	3.40	6030	10500
	2000-01	13.40	319.30	4.20	80.60	3007.60	2.68	5990	9400
	2005-06	17.21	286.10	6.02	103.33	2270.00	4.55	6000	7900
	2010-11	19.66	370.00	5.31	200.55	3517.00	5.70	10190	9500
	2015-16	31.30	497.00	6.30	323.16	4814.00	6.71	10320	9700

Table 4. Compound annual growth rate of area, production and productivity of selected vegetables in Punjab and India, 1990-91 to 2015-16 (Per cent)

Vegetable crops	Year	Area		Production		Productivity	
		Punjab	India	Punjab	India	Punjab	India
Potato	1990-2000	4.97**	3.90***	7.73***	5.42***	2.65***	1.52***
	2000-2010	3.31*	2.03**	4.33***	3.82**	1.02***	1.32***
	2010-2016	2.64***	2.31***	3.25***	3.51*	0.32**	1.20***
	1990-2016	3.75**	3.09***	5.21**	4.44**	1.36***	1.37***
Tomato	1990-2000	7.64***	6.09***	6.32**	7.71***	-1.18	1.47**
	2000-2010	-0.58	3.82***	-1.01	6.20***	-0.44	2.29***
	2010-16	4.41***	-3.23**	4.56***	0.24	0.07	3.54***
	1990-2016	2.10***	4.63***	2.32***	6.51***	0.20	1.80***
Cauli flower	1990-2000	6.41***	27.28**	6.59***	30.16**	0.17*	2.19**
	2000-2010	9.94***	3.78***	9.79***	4.25***	-0.14	0.46**
	2010-16	12.83***	2.74***	13.37***	3.74**	0.49**	0.94**
	1990-2016	8.49***	6.74***	7.13***	8.07***	-1.25	1.24**
Peas	1990-2000	1.49***	8.76***	1.42***	8.54***	-0.058**	2.64**
	2000-2010	4.07***	1.49**	4.15***	2.69*	0.11***	1.19
	2010-16	7.98**	5.78***	8.26**	6.44***	0.26***	0.65
	1990-2016	2.78***	4.19***	5.07***	3.87***	2.22***	0.17

****, **, * indicates significance at 1, 5 and 10 per cent level*

Year Plan of Indian Planning Comission, India entered in to an era of Golden Revolution with an unprecedented increment in area, production and productivity. India harvested 166608 thousand tones of vegetables from 9575 thousand hectares which was possible because of the constant research efforts along with lots of improvement in production and protection technologies developed by the scientists and adopted by farmers. Paradoxically the inadequate post production infrastructure as well as improper marketing and handling system have been the reason for the increasing amount of loss of these perishable products after harvest. India did not witness consonant improvement in post harvest management system matching with long strides made in increased production and productivity. Hence there is a strong need to strengthen post harvest technologies used in case of vegetables in order to minimize the percentage of losses occurred presently. The aggregate post harvest losses in vegetables like potato, tomato, cauliflower and peas are 8.99, 12.98, 6.88 and 10.28 per cent respectively [14]. Hence there is a strong need to improve the technologies carried out in processing and storage so that the farmers will give more interest for the vegetable cultivation. In addition to post harvest loss management, there should be a strong motivation for increment in contract farming of vegetables. Contract farming which generally bridges the gap by the provision of quality inputs, technical guidance and management skills to the capital starved small farmers, who generally cannot make major investments in land improvement and modern inputs, as a result of which they can get incentive for shifting the traditional cultivation to vegetable cultivation thereby increasing their income.

4. CONCLUSION

The present study has analyzed the trends in area, production and productivity of major vegetables cultivated in India as well as Punjab. The overall results have indicated that in case of vegetables in total as well as each of the selected vegetables the area, production and productivity have increased over period of time with an exception found in case of productivity of cauliflower in Punjab where it has shown that the productivity is declined. Despite of such huge increase in area, production and productivity of vegetables, the poor post harvest handling practices, inadequate infrastructure and lack of systematic marketing procedures make the actual profit which is very lower than the estimated one. Hence there is a strong need to focus on these lacking as a result of which farmers will pay more interest on vegetable cultivation as well as will get a very higher income.

5. POLICY IMPLICATION

The policy intervention calls for improving the post harvest practices like sorting and cleaning, packaging, transportation, storage and

processing. Contract farming needs to be given more attention so that the farmers could be well aware of its benefits as a result of which this practice will be promoted everywhere and the farmers by practicing this will be able to get more income in future.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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