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Decomposition of growth model to identify different factors contributing to increased vegetable output in India

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Abstract

During 1990s, both area and production of vegetables registered highest growth rate of 4.28% and 5.46% respectively. There was a stagnant growth in productivity of vegetables, but area expansion took place due to shifting of farmers from growing traditional low value crops to high value crops like vegetables influencing the growth of production over the later years. The study used secondary data from 1991-92 to 2011-12 breaking it into two periods (period I from 1991-92 to 2000-01and period II from 2001-02 to 2011-12). The results showed that the effect of diversification was found to be the largest contributor to the growth in vegetable output. But the rate of contribution declined from 86.5 % during Period I to 42.6% in Period II. During period II, the changes in area under vegetable cultivation and real prices of vegetables had a positive and increased extent of contribution on the growth.

Keywords: Diversification, Growth rate, Sources of growth, Vegetable production

Introduction

Horticulture sector in India gained importance in 1990's. During late 1940's, India imported large amount of food grains from other countries. During 1960's as a result of green revolution, India became self-sufficient in producing food grains and started to export the excess produced. Horticulture development had not been a priority until recent years in India. During the period 1948-80, the main focus of the country was on cereals (Dastagiri *et al* 2013). During 1990s, horticulture sector gained momentum. Increasing health consciousness, increase in per-capita income and living standards of the people increased demand for high value nutritional food like fruits, vegetables, meat, dairy in place of traditional cereal and pulse diet. This created a huge demand for horticulture sector especially fruits and vegetables in the country.

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Vegetables being important constituent of human diet are rich in vitamins, minerals, fibres and anti-oxidants. They constitute around 60% of the horticulture production. They provide early economic returns to the farmers and can be best fitted in any small farm production systems. Around 90% of vegetable growers belonged to landless, marginal and small farmers (Khan *et al* 2009). In addition, ecology and economics supported the transition from cereals to vegetables. On an average, a farmer needs 1 cubic meter of water to produce 330 g of grains. The same quantity of water is sufficient to grow 18 kg of vegetables. Due to increase in demand for nutritious food like fruits and vegetables, farmers started to shift their traditional cereal based cropping systems to high value crops like fruits and vegetables which fetch them higher and early economic returns. The reason for decline in area under food grains were high value crops mainly fruits and vegetables (Sharma and Jain 2011 and Kannan and Sunderam 2011).

India is the second largest producer of vegetables in the world after China. India ranks first in the production of okra in the world and second in the production of potato, onion, cauliflower, brinjal and cabbage. India contributed around 14% to vegetable production and around 15% of world area under vegetable cultivation during 2011-12 (NHB 2012). In India, vegetables are grown in 8.9 million ha (39% of horticulture area) producing 156.3 million t (61% of horticulture production) with a productivity of 17.4 t/ha during 2011-12. The average productivity of vegetables in India is less than the world's average productivity (19.6 t/ha). This shows the potential gap in the productivity that need to be harnessed by increasing the yield of many vegetable crops (Table 1).

India is bestowed with varied agro-climatic conditions which allow it to grow different types of vegetables (arid, temperate and tropical). Global diversity in vegetable crops is estimated at about 400 species with around 80 species of major vegetables reported to have originated in India (Sangeetha, 2013). Major vegetables grown in India are potato (27% of total vegetable production in

India), tomato (12%), onion (11%), brinjal (8%), tapioca (6%), cabbage (5%), cauliflower (5%), okra (4%), peas (2%) and other vegetables (20%) like radish, carrot, pumpkin, bottle gourd, bitter gourd, capsicum, chilly, beans, cowpea, cucumber and other leafy vegetables. The important states growing vegetables are West Bengal, Uttar Pradesh, Bihar, Andhra Pradesh, Maharashtra, Gujarat, Odisha, Karnataka, Madhya Pradesh and Tamil Nadu which account for around 80% of vegetable production and 75 % of area under vegetable cultivation in the country. With growing population, urbanization and demand for nutritional security of the people in the country, it is required to accelerate growth in vegetable production. Hence, an attempt was made in this study to identify different sources of growth contributing to the growth in vegetable production.

Materials and Methods

This study used secondary data collected from Food and Agriculture Organization (FAO), National Horticulture Board (NHB) and Office of the economic advisor, Government of India. The compound growth rate (r) was calculated using exponential growth functions separately for Area, Production and productivity of major vegetable crops considering two periods. Period I is from 1991-92 to 2000-01 and Period II is from 2001-02 to 2010-11. These two decades were considered for the two study periods, as horticulture gained importance during this period. The effect and the extent of contribution made by different sources of growth on growth of vegetable production were assessed. The growth rate was calculated using $Yt = Y_0 (1+r)^t$

After logarithmic transformation,

$\ln Y_t = A + Bt + e$

Where, A (=$\ln A_0$) and B (=ln (1+r)) are the parameters to be estimated

t = time in years.

And finally, growth rate is given by, r = exp (B) -1

Decomposition of growth was done by using the methodology described by (Minot, 2003) and (Joshi, et al, 2006)

Considering the above equation, $R = [\sum_{i=1}^{n} a_i Y_i P_i] \sum_{i=1}^{n} A_i$

Where, R = Gross income/revenue/value of output

Ai = the area under crop

Yi = the production per unit area

Pi = the real price per unit of production

$ai = (A_i/\Sigma_i A_i)$

Now, taking total derivatives on both sides,

$$dR = [\sum_{i=1}^{n} a_i Y_i P_i] d[\sum_{i=1}^{n} A_i] + \sum_{i=1}^{n} A_i \sum_{i=1}^{n} (a_i Y_i dP_i) + \sum_{i=1}^{n} A_i \sum_{i=1}^{n} (a_i P_i dY_i) + \sum_{i=1}^{n} A_i \sum_{i=1}^{n} (Y_i P_i da_i)$$

Where, $[\sum_{i=1}^{n} a_i Y_i P_i] d[\sum_{i=1}^{n} A_i]$ gave the effect from area expansion which is the product of

$\sum_{i=1}^{n} A_i \sum_{i=1}^{n} (a_i P_i dY_i)$ change in area, yield, real price and area share.

$\sum_{i=1}^{n} A_i \sum_{i=1}^{n} (a_i P_i dY_i)$ gave the effect from change in real prices

$\sum_{i=1}^{n} A_i \sum_{i=1}^{n} (Y_i P_i da_i)$ gave the effect from change in yield/productivity of vegetables

$\sum_{i=1}^{n} A_i \sum_{i=1}^{n} (Y_i P_i da_i)$ gave the effect from diversification from low-value crops to high-value crops.

And finally the interaction effect of these was got from subtracting all this effect from the final change in gross income/value of output.

Results and discussion

Decadal growth of area, production and productivity of vegetables in India: The production of vegetables from 16.5 million tonnes during 1951-52 to 156.33 million tonnes in 2011-12 had a varied growth influenced by area and productivity of vegetables in the country. The vegetable production registered a growth rate of 1.13 % during 1950's reached highest at 5.46 % during 1990's with the range of productivity growth rate of 1.12 % to 2.12 % over last 6 decades (Fig. 1). This shows that the growth in the production of vegetables was solely moved by the influence of growth in area

under cultivation of vegetables. There was a highly positive correlation found between area and production of vegetables in India (Kundu 2012).The growth rate of vegetable area in India started from a negative growth of -0.21% during 1950s to a positive growth trend from 1970s at 1.45% and registered highest growth rate during 1990s at 4.28%. The increase in production of fruits and vegetables was primarily driven by area expansion rather than productivity enhancement (Sharma 2011). The area under vegetables increased at the rate of 3.15% in 1995-2000 which later declined and the same period also observed high production growth (Mittal, 2007). During 1990s both area and production of vegetables registered a highest growth rate of 4.28% and 5.46% respectively (Figure 1). This trend shows a stagnant growth in productivity. The increase in area under cultivation of vegetables during this period can be attributed to the diversification of farmers from traditional cereal based cropping system to high value crops like vegetables which mainly led to the growth in vegetable production over these years (Figure 1). From 1951-52 to 2011-12, vegetable area, production, productivity and per-capita availability in India was increased by 3.2, 9.5, 3.0 and 2.8 folds respectively (Figure 2).

Effect of different sources of growth on vegetable output in India: The contribution of different sources of growth namely area, yield, Real prices, crop diversification and interaction effect on the growth of vegetable output in the country were assessed. These were the parameters considered responsible for the growth trend observed in vegetable output for the two periods. The rate of growth in productivity of vegetables has declined from 2 % to 1.22 % from period I to period II (Table 2), whereas the rate of growth in area has been increased from 3.6 % during period I to 5.18 % in period II (Table 2). The contribution of change in yield or productivity of vegetable crops leads to the increased growth in vegetable production in period I, whereas, the change in area under vegetable cultivation mainly contributed to the growth of vegetable production during period II. From 1980s to 1990s over the 2 decades, the share of fruits and vegetables in the total cropped area has increased from 2.8% to 5.1% (Joshi *et al* 2006).

Crops like tomato, onion, okra and tapioca had an increasing trend in the growth rates of area, production and productivity compared to other crops like potato, brinjal, cabbage, cauliflower, peas and sweet potato (Table 2). The decomposition of growth model showed that the effect of different sources of growth on vegetable output production shifted during the two study periods.

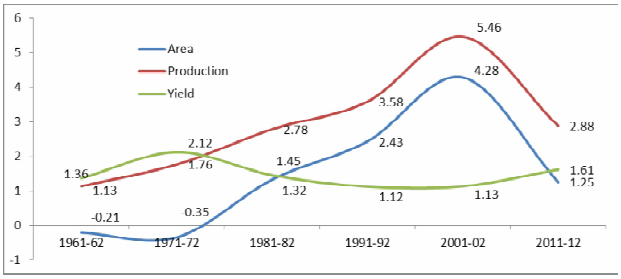

Fig. 1: The growth trend of area, production and yield of vegetables in India

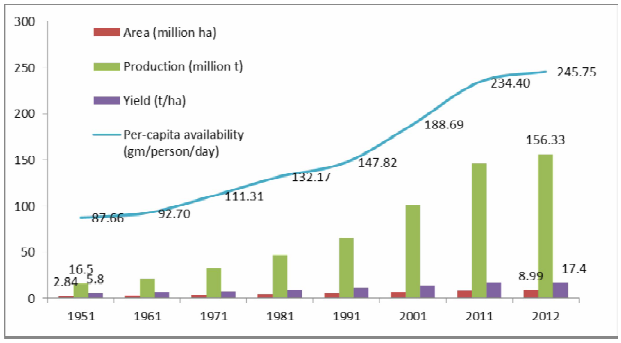

Fig. 2: Trends in Area, Production, Yield and per-capita availability of vegetables in India

Table 1: Productivity scenario of different vegetable crops (2011-12)

Crop	Avg. World Productivity (t/ha)	Avg. Productivity in India (t/ha)	Highest productivity in the world (t/ha)
Potato	19.5	22.7	50.1(Belgium)
Onion	19.9	14.4	66.2 (Korea)
Tomato	33.6	19.5	478.9 (Netherlands)
Brinjal	25.8	17.5	455.5 (Netherlands)
Cabbage	29.0	21.5	118.1 (Cyprus)
Cauliflower	17.3	18.3	60.5 (Cyprus)
Okra	7.4	11.6	24.5 (Cyprus)
Peas	7.6	9.7	22.0 (Jordan)
Sweet Potato	13.1	9.3	32.6 (Israel)
Cassava	12.8	36.5	36.5 (India)

Source: faostat.fao.org

Table 2: The growth rate of area, production, yield and real prices of major vegetable crops during the two periods (%)

Crops	Area		Production		Yield		Real prices	
	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II
Potato	2.98	4.57	4.99	6.07	3.04	2.30	-6.20	1.23
Tomato	5.65	5.60	7.13	8.08	1.36	2.34	2.93	5.74
Onion	4.19	9.64	3.48	14.89	-0.66	4.86	-0.49	10.89
Brinjal	6.96	3.07	12.11	4.02	4.83	0.94	4.33	0.62
Cabbage	3.33	3.94	8.52	3.73	5.04	-0.20	3.26	5.98
Cauliflower	2.84	4.44	6.02	4.84	3.08	0.39	2.93	1.24
Okra	2.83	4.26	3.92	5.85	0.97	1.49	2.06	2.40
Peas	6.67	2.73	9.36	6.60	2.71	3.76	-0.94	3.75
Sweet potato	-2.31	-0.43	-1.31	0.07	0.98	0.49	2.71	1.56
Tapioca	0.09	0.99	1.80	4.80	1.73	3.77	-4.33	10.80
Total	3.60	5.18	5.67	6.47	2.00	1.22	-	-

During both the periods, considered in the study, diversification was found to be the largest contributor to the growth in vegetable output. But the actual contribution declined from 86.5% during period I to 42.6% during period II. This showed that diversification from low value to high value crops had more importance during period I but, in period II it was dominated by vegetable prices. Vegetable prices contributed to the extent of -66.3% in period I to 34.4% in period II. Vegetable prices especially potato, onion, peas and tapioca (Table 2) showed an increased growth in their prices from period I to period II which led to the positive contribution of vegetable prices in the value of output in period II. The food price inflation in the country was seen to be driven by high-value commodities, with vegetables playing a major role (Chand *et al* 2011). Contribution of yield/productivity to the growth in vegetable production has decreased from 47.9% to 12.5% and that of prices and area have increased from negative contribution to positive in the two periods considered. This shows that the productivity of many vegetable crops can be enhanced which have potential to increase the growth in vegetable output in future (Table 3).

In conclusion, horticultural crops like fruits and vegetables gained importance during 1990s. This study analyzed the effect of different growth sources and its contribution to the growth of vegetable output in the country. The results showed that diversification from low value to high value crops played a major role in contributing to the growth in vegetable output in both the study periods. But the extent of contribution decreased from period I to period II and took over by change in area and vegetable prices in period II. The change in yield/productivity of vegetable crops was also one of the main factors contributing in the growth of vegetable output. Increase in vegetable productivity played a major role in the growth of vegetable production. But, India has low average productivity in many vegetable crops even less than the world average productivity. Hence, there is potential to increase the yield of many vegetable crops that can contribute in the growth of vegetable output of the country in the coming years.

Table 3: Contribution of different growth sources in vegetable production during the two periods (%t)

Crops	Area	Yield	Real Prices	Diversification	Interaction	All
Period I (1991-92 to 2000-01)						
Potato	-0.1	-47.6	157.7	-22.8	12.8	100.0
Tomato	-3.8	42.1	-864.4	626.1	300.0	100.0
Onion	5.9	65.7	293.2	-67.4	-197.4	100.0
Brinjal	-1.6	29.6	23.4	38.5	10.1	100.0
Cabbage	-0.9	32.8	39.2	30.7	-1.8	100.0
Cauliflower	-2.6	19.8	32.8	21.7	28.3	100.0
Okra	1.5	15.3	11.1	66.1	6.0	100.0
Peas	0.0	44.7	-92.4	122.1	25.6	100.0
Sweet potato	66.6	933.7	811.9	-1678.9	-33.3	100.0
Tapioca	204.7	1464.2	-1557.1	-270.7	258.9	100.0
Total	-0.6	47.9	-66.3	86.4	32.6	100.0
Period II (2001-02 to 2010-11)						
Potato	3.3	18.8	18.8	36.9	22.2	100.0
Tomato	1.6	12.6	28.8	55.1	1.9	100.0
Onion	0.4	6.1	37.2	50.6	5.7	100.0
Brinjal	14.1	27.9	-61.7	130.5	-10.8	100.0
Cabbage	3.3	-5.2	36.9	67.4	-2.4	100.0
Cauliflower	3.9	-2.9	19.9	73.1	6.0	100.0
Okra	3.6	18.1	38.3	29.7	10.3	100.0
Peas	4.4	13.6	55.2	27.6	-0.8	100.0
Sweet potato	27.1	-18.0	115.0	-0.6	-23.4	100.0
Tapioca	3.1	30.5	98.0	-30.2	-1.4	100.0
Total	2.9	12.5	34.4	42.6	7.6	100.0

सारांश

वर्ष 1990 के दौरान सब्जियों के क्षेत्रफल एवं उत्पादन दोनों में उच्चतम वृद्धि दर 4.28 प्रतिशत एवं 5.46 प्रतिशत क्रमशः दर्ज की गयी। सब्जियों की गतिहीन उत्पादकता में वृद्धि रही लेकिन किसानों के परंपरागत कम मूल्य वाली फसलों को खिसकाकर उच्च मूल्य वाली फसलें जैसे सब्जियों को अपनाकर बाद वाली वर्षों की तुलना में उत्पादन वृद्धि की। अध्ययन में 1991–92 से 2011–12 के द्वितीयक ऑकड़ों का प्रयोग कर दो समयावधि (अवधि–I वर्ष 1991–92 से 2000–01 एवं अवधि II 2001–02 से 2011–12) में विभक्त किया गया। परिणाम से स्पष्ट हुआ कि विविधिकरण के प्रभाव का योगदान सब्जी उत्पादन में सबसे ज्यादा है। लेकिन योगदान दर का पतन 86.5 प्रतिशत समयावधि–I से 42.6 प्रतिशत समयावधि–II रहा। समयावधि–II के दौरान सब्जी की खेती में क्षेत्रफल परिवर्तन तथा सब्जियों का वास्तविक मूल्य धनात्मक एवं बढ़ते स्तर का योगदान वृद्धि देखा गया।

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