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RESEARCH PAPER

Economic surplus estimates of improved vegetable production technology in Maharashtra

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Abstract : The paper envisages the detailed analysis of assessment of improved vegetable production technologies on production, resource use economic surplus estimates of vegetable growers in Maharashtra. Among the adopters, maximum share of total cropped area was observed under cereals crops (34.15 %) followed by vegetable crops (25.61 %). Among the non adopters, cereals crops contributed maximum area (38.25 %) followed by vegetable crops (28.85 %). The net present value of cultivation of major vegetables was estimated to Rs. 4849 crores and in case of chilli, okra, brinjal, onion and tomato it was Rs. 1521, Rs. 672, Rs. 46, Rs. 1134 and Rs. 1476 crores, respectively. The benefit –cost ratio of an investment made in vegetable research was observed 1:89 for major vegetables in Maharashtra. Among the vegetables, the highest (Rs. 873 crores) consumers surplus was recorded in case of tomato and it was followed by chilli (Rs.621 crores), onion (Rs. 524 crores), okra (Rs. 299 crores) and brinjal (Rs.26 crores). The total surplus in vegetable cultivation especially of five major vegetables due to adoption of improved vegetable production technology was to the tune of Rs. 3168.48 crores and it was Rs. 988.57, Rs. 961.42, Rs. 741.53, Rs. 439.68 and Rs. 37.28 crores in case of chilli, tomato, onion, okra and brinjal, respectively.

Key Words : Vegetable production technologies, Adopters and Non-adopters, Economic surplus

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INTRODUCTION

Technological change implies a downward shift in the cost function/ rightward shift in the supply function with consequent increased consumption at a lower cost. A new technology may have important direct implications for the economy and society. Since technological innovations, by definition, have both resource saving and resource augmenting effects, it is expected to influence the distribution of income. The new production technologies through intensive research may result in increased real income to the consumers through decline in prices, relative of crops as a result of reduction in unit cost. The decline in food prices as a result of technological change would redistribute income in favour of consumers, especially poorer ones since their spending on food is relatively more and real income is less.

Considering the importance of vegetable crops, four agricultural universities of Maharashtra *viz.*, Mahatma Phule Krishi Vidyapeeth, Rahuri, Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharthwawa Krishi Vidhyalaya, Parbhani and Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli are engaged in vegetable research pertaining to the development of high yielding and disease resistant varieties /F_1 hybrids, standardization of agro-techniques, plant protection measures, seed production technology, post harvest management, processing, "transfer of technology, etc. for more than three decades. Since the inception of these agricultural universities, 65 high yielding varieties / F_1 hybrids in 22 vegetable crops have been developed and released. These include 10 in chilli.

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9 in tomato. 8 in brinjal. 6 in onion, 4 each in bitter gourd, snake gourd and sweet potato and 1 each in amaranthus, bottle gourd, drumstick, french bean, radish, yard long bean, ghorkand, lesser yam, sponge gourd and xanthosoma. About 244 vegetable production technologies (related to production technologies-125. protection technologies - 79 and post harvest management and processing - 40) have been standardized and passed on to the farmers of the state. Therefore, it was felt necessary to assess the overall impact of these technologies in terms of economic surplus estimates in Maharashtra and accordingly the present investigation has been under taken with the following objectives :

- To assess the level of adoption of improved vegetable production technologies .
- To examine the impact of improved technologies on resource use structure of the major vegetable *viz.*, onion, tomato, chili, brinjal and okra grown on different sized farms.
- To estimate the economic surplus of improved vegetable technologies adoption.

MATERIAL AND METHODS

The paper envisages the detailed analysis of assessment of improved vegetable production technologies on production, resource use economic surplus estimates of vegetable growers in Maharashtra. The details of methodological aspects of the present study are outlined as below.

Data collection :

The data were collected on various aspects, *viz.*, Agricultural economy of Maharashtra, structure of the sample farms, physical quantity of inputs and outputs, prices of inputs and outputs, technological adoption index, technology impact assessment, etc. The farm level data were obtained by the survey method from sample farms of different categories through the specially designed schedule.

Sampling technique :

From the nine agro-climatic zones of Maharashtra, two tahsils from each of the zones having the highest area under vegetable were selected purposively. From each of the tahsils, three villages from different eco-units having highest area under vegetable were selected purposively. The total sample comprised of 486 farmers growing major vegetables like onion, potato, tomato, brinjal and okra from 54 villages of 18 tahsils in Maharashtra were studied. Besides adopters, 162 non-adopters were also considered for the study. The data used referred to the year 2006-07.The major vegetables like onion, potato, tomato, brinjal and okra were studied.

Analytical procedure :

A brief description on analytical procedure deployed in the present paper is as under :

Technological adoption index :

In order to measure the extent of use of vegetable production technology on area basis in terms of use of high yielding varieties, application of farm yard manures, use of plant protection measures and chemical fertilizers, the area under particular item under consideration was converted in percentage. Further, technology adoption score for individual farm for the important vegetables *viz.*, onion, tomato, chilli, brinjal, okra, was computed by using the simple method.

Under this method six key inputs like area, variety, FYM, fertilizers and plant protection measures like 4 points for 75 to 99 per cent, 3 points for 50 to 74 per cent area, 2 points for 25 to 49 per cent were assigned for area under a given crop. For variety, if high yielding variety is used, 1 point was assigned otherwise, 0 point. In the case of FYM, fertilizers and plant protection measures 3 points for 75 to 99 per cent, 2 points for 50 to 74 per cent, 1 point for 25 to 49 per cent and 0 point for less than 25 per cent of the recommended dose were assigned. For seed rate for recommended level 2 points for more/less than the recommended level, 1 point was assigned. Thus, points obtained for all the crops for all the above inputs together were assigned and they were equated to 100 and the technology adoption index in terms of percentages was worked out.

Per hectare input use levels and output produced of major vegetables and farm as a whole were estimated to know the differential in costs and returns for local and improved technology. The costs and returns of aggregate crop production activities as per hectare basis and farm as a whole were estimated. The simple method of tabular analysis was followed in estimation of costs and returns of individual farms. Cost A, Cost B and Cost C were estimated by following the standard cost concepts.

Economic surplus approach :

Economic surplus underlines most of the methods used by economists to estimate the benefits and cost of agricultural research or to assess agricultural priorities The basic economic surplus model was used that consider a single market in a closed economy. The basic model of research benefits in a closed economy should be used is shown in the following Figure. In his model D represents the demand for a homogeneous product and S_0 and S_1 represents supply, respectively. The supply of the product before and after a research induced technical change. All curves are defined as flows per unit time, typically annually, as are economic surplus measures.

The initial equilibrium price and quantity are P_0 and Q_0, after the supply shift they are P_1 and Q_1. The total annual benefit from the research induced supply shift is equal to the area beneath the demand curve and between the two supply

curves ΔTS = area (l_0abl_1). This area can be viewed as the sum of the two parts:(a) the cost saving on the original quantity (the area between the two supply curves to the left of Q_0- area $loacl_1$), and (b) the economic surplus due to production and consumption (the triangular area abc, the total value of the increment to production and consumption (the triangular area abc, the total value of the increment to consumption area Q_0abQ_1 less the total cost of the increment to the production - area Q_0cbQ_1. Alternatively, we can partition the total benefit in to benefits to consumers surplus in the form the change in producers surplus (ΔCS = area P_0abP_1) and benefits surplus in the form the change in producers surplus ΔPS = area P_1bl_1 minus area P_0al_0. Under the special assumption of a parallel supply shift (Where the vertical distance between the two curves is constant, area dcl_1 = area P_0al_0 and change in producer surplus is equal to the net benefit on current production (area P_1ecd) plus the gain on the increment to production from Q_0 to Q_1 (area bce) for a total producer surplus gain of area P_1bcd.

These effects can be expressed algebraically as follows:

$\Delta CS = P_0Q_0Z\ (1+ 0.5Zn)$

$\Delta PS = P_0Q_0\ (K-Z)(1+ 0.5Zn)$

$\Delta TS = \Delta\ CS + \Delta\ PS = P_oQ_0\ (1+ O.5\ Zn)$.

where K is the vertical shift of the supply function expressed as a proportion of tin: initial price, n is the absolute value of the elasticity of demand, e is the elasticity of supply and $Z= K\varepsilon\ I\ (\varepsilon + n\ )$ is the reduction in price, relative to its initial (*i.e*. pre-research) value, due to the supply shift. The basic economic surplus model that considers a single market in a closed economy however the model will be extended to consider various multi market settings, mainly to disaggregate the measures of benefits that are obtained from the basic model (to allocate the producer surplus" among individual productive factors as quasi-rents and to allocate consumer surplus among different group of consumers).

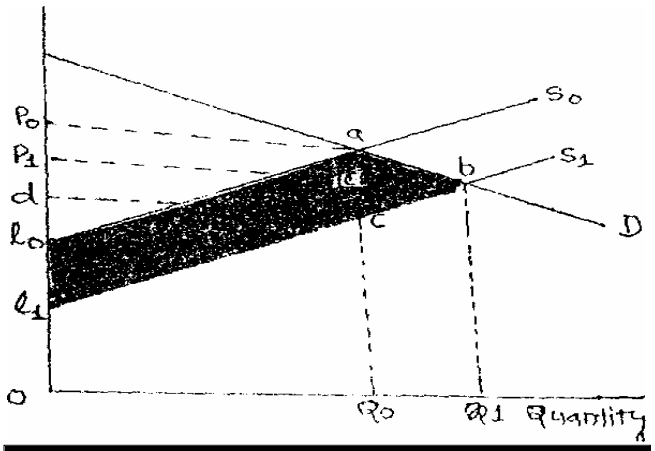

Fig. A : Surplus distribution in the basic model

Information of the study area and sample vegetable producers:

Agricultural economy of Maharashtra :

Total geographical area of Maharashtra is 308 thousand sq. Km. According to topography, rainfall and weather, the state is divided into 9 agro climatic zones. The cropping pattern of Maharashtra state is dominated by food grain crops (11456 thousand hectare). Among food grains, cereals well grown on 8364 thousand hectares pulses were grown on 3092 thousand hectare. The measure cereals grown in the state are Jowar, rice, Wheat and Bajra and Tur, Gram, Mung and Udid are the major pulses grown in the state. Among the cash crops the major crops grown are sugarcane, cotton and groundnut. The area under vegetables was 448.3 thousand hectare and the major vegetables cultivated in the state are onion, tomato, Brinjal, Okra and Chilli. The food grain production of Maharashtra was 11197 thousand tons in 2008-09. The production of vegetables was 6368 thousand tons and among vegetables, onion ranked first with the production 3932.5 thousand tons followed by tomato, chilli, brinjal and okra. The index number of agricultural production during the year 2008-09 was 161.9.

Structure of the sample farms :

In order to know the background information of sample farms, the data in respect of family size and its composition, literacy percentage, land use pattern, capital asset owned by the sample farms were collected.

Family size, its composition and level of literacy :

The information on family size, its composition and literacy percentage of adopters and non-adopters is presented in Table A.

The average size of family of the adopters was 5.58, while that of non-adopters was 5.27. The adopters constitute 1.82 males and 1.71 females, while non-adopters constitute 1.72 males and 1.70 females. Among the adopters, children accounts for 36.74 per cent while non-adopters it was 35.10 per cent. As regards the educational status, as expected the percentage of above higher secondary education of family members of adopters is high *i.e*. 3.76 per cent. Even the level of literacy up to higher secondary education level of adopters is high and it is 15.23 per cent as against 13.66 per cent of those of non-adopters.

Land use pattern :

The information regarding the size of holding, cultivable land, irrigated land and gross cropped area of the sample households is indicated in Table B. It was noticed that the larger size of holding (3.14 ha) was recorded in case of adopters than the non-adopters (1.92 ha). The proportion of holding uncultivable waste land was least compared with cultivable land. At the overall level, adopters having 95.86 per cent cultivable land and rest of land uncultivable.

When we compared with availability of irrigated Vs un-irrigated land holding, adopters recorded maximum per cent (50.00%) of un-irrigated land than irrigated (45.54%). Similar

trend of the respective proportion of irrigated and non irrigated land holding was reported among non adopters also. In case of gross cropped area, adopters having larger (4.10 ha) area as compared with the non-adopters (2.53 ha.).

Cropping pattern :

The area under different categories of crops especially of major crops and area under selected vegetables of the sample households is presented in Table C.

Table A : Average family size, its composition and level of literacy

Particulars	Adopters	Per cent	Non-adopters	Per cent
Family size :				
Male	1.82	32.62	1.72	32.64
Female	1.71	30.65	1.70	32.26
Children	2.05	36.74	1.85	35.10
Total	5.58	100	5.27	100
Level of literacy :				
Literate	0.47	8.42	0.45	8.84
Upto Primary	3.14	56.27	3.09	58.63
Upto SSC	0.91	16.31	0.96	18.22
Upto HSC	0.85	15.23	0.72	13.66
Above HSC	0.21	3.76	0.05	0.95
Total	5.58	100	5.27	100

Figures in the parentheses indicates percentages to the total

Table B : Average land use pattern **(Area in ha)**

Particulars	Adopters		Non – Adopters	
	Area	%	Area	%
Size of holding	3.14	100	1.92	100
Uncultivable waste land	0.13	4.14	0.07	3.65
Cultivable land	3.01	95.86	1.85	96.35
i) Irrigated	1.43	45.54	0.63	32.81
ii) Un-irrigated	1.57	50.00	1.22	63.54
Net cropped area	3.01	73.25	1.85	73.05
Area cropped more than once	1.10	26.75	0.68	26.95
Gross cropped area	4.10	100	2.53	100
Cropping intensity (%)	136.21		136.76	

Table C : Average cropping pattern **(Area in ha)**

Crops	Adopters		Non-adopters	
	Area	Per cent	Area	Per cent
Total cereals	1.40	34.15	0.95	38.25
Total pulses	0.32	7.80	0.17	6.22
Total oilseeds	0.48	11.71	0.31	12.25
Onion	0.72	17.51	0.53	20.95
Tomato	0.07	1.67	0.02	0.79
Chilli	0.1	2.40	0.07	2.77
Brinjal	0.05	1.17	0.03	1.19
Okra	0.03	0.71	0.02	0.79
Other vegetables	0.09	2.15	0.06	2.37
Total vegetables	1.06	25.61	0.73	28.85
Fruit crops	0.22	5.37	0.08	3.16
Cash crops	0.56	13.66	0.27	10.67
Other crops	0.07	1.71	0.02	0.79
Gross cropped area	4.1	100.00	2.53	100.00

It is revealed that among the adopters the 1.40 ha area was under cereals, 0.32 ha under pulses, 0.48 ha area allocated for oil seeds, 1.06 ha for vegetable crops, 0.22 ha for fruit crop and 0.56 ha. for cash crops. In case of non adopters, maximum area was found under cereal crop (0.95 ha) followed by 0.73 ha and 0.31 ha, under vegetable crop and oil seed crops, respectively. Higher area (0.56) was observed under cash crops of adopters as compared to non adopters.

Among the adopters, maximum share of total cropped area was observed under cereals crops (34.15 %) followed by vegetable crops (25.61 %). Among the adopters, the maximum share of cropped area was under cereal crops. Similar trend was noticed for vegetable crops. Among the non adopters, cereals crops contributed maximum area (38.25 %) followed by vegetable crops (28.85 %). Among the cereal crops, bajra, wheat and maize recorded maximum contribution in order of merit. Among the vegetable crops the contribution to total area was onion, chilli, tomato, brinjal and okra in order a merit. The area under onion of sample cultivators was 17.51 per cent in case of adopters and 20.95 per cent in case of non adopters of the gross cropped area. To sum up, the cropping pattern of both the adopters and non adopters was dominated by cereals, followed by vegetables, cash crops, oilseeds, pulses and fruit crops.

RESULTS AND DISCUSSION

The findings of the study are as below :

Adoption of improved vegetable production technology :

Awareness about improved production technology is a pre requisite for its adoption, but the only awareness is not sufficient for adoption. The next step to awareness is acceptance by the vegetable growers followed by acquisition of required inputs and actual use as per the recommendation. The information on level of adoption of improved vegetables production technology by the different size of farms is presented in Table 1.

The level of adoption of improved vegetable production technology with respect to variety, seed rate, FYM application, fertilizer use and plant protection measures of major vegetables *viz.*, onion, tomato, chilli, brinjal and okra grown in Maharashtra revealed that the adoption rate of improved variety above 75 per cent level was found in case of 79.80, 99.17, 59.36, 47.37 and 50.54 per cent for onion, tomato, chilli, brinjal and okra, respectively and the adoption level of remaining vegetable growers was below 25 per cent. As regards the seed rate used the adoption rate was above 75 per cent in case of 91.92, 89.26, 83.56, 83.33 and 53.76 per cent of onion, tomato, chilli, brinjal and okra growers, respectively and the adoption level of remaining vegetable growers was below 25 per cent. The level of adoption above 75 per cent in case of FYM use was found in case of 24.28, 46.28, 31.96, 27.20 and 17.20 per cent of onion, tomato, chilli, brinjal and okra growers. The maximum number of vegetable growers level of adoption of fertilizer application was in the range of 50 to 75 per cent *i.e.*58.25, 44.63, 60.27, 59.65 and 64.52 per cent of onion, tomato, chilli, brinjal and okra growers, respectively. Similar trend was observed in case of level of adoption of plant protection measures. These are in corroboration with the finding of Reddy and Tirkey (2004), Balai *et al.* (2013),

Resource use structure of selected vegetables of adopters and non-adopters :

The per hectare resource use structure of onion is presented in Table 2.The resource use structure of major vegetables revealed that the maximum utilization of total human labour was noticed in case of adopters as compared to non adopters. The utilization of female labour for farm operation was more in comparison with male labour in both the categories *i.e.* adopters and non-adopters. There was no much more difference in utilization of bullock pairs between adopters and non adopters. The seed rate used by adopters was more in comparison with the non adopters. The non adopters have used least manure than the adopters. The utilization of NPK/ ha was found more in case of adopters than the non adopters. These are in corroboration with the finding of Mubarak Ali.and Vu Thi Bich (2001).

Economic surplus :

The monetary benefits accrued for both to the producers and consumers of vegetables in Maharashtra due to adoption of recommended vegetable production technology were estimated in respect of major vegetables *viz.*, chilli, okra, brinjal, onion and tomato and are presented in Table 3.

The total surplus was estimated by using the software prepared by NCAP, New Delhi. The period considered was 21 years *i.e.* from 2000 to 2021 and the factors considered were price elasticity's of supply and demand, maximum yield change and reduction in cost due to adoption of technology, input cost change per hectare and per kg, adoption rate and probability of success, depreciation rate of technology, price and production quantity of vegetables, changes in consumer and producers surplus, research cost and net benefit. Also, vertical shift in supply function (K) and reduction in price relative to pre-research value (Z) were considered. Accordingly, net present value, Benefit-cost ratio, Net present benefit and cost and consumers, producers and total surplus were estimated for the selected five major vegetables grown in Maharashtra.

The net present value of cultivation of major vegetables was estimated to Rs. 4849 crores and in case of chilli, okra, brinjal, onion and tomato it was Rs. 1521, Rs. 672, Rs. 46, Rs. 1134 and Rs. 1476 crores, respectively. The internal rate of return in case of vegetable cultivation was assumed to 6 per cent per annum. The net present benefits of major five vegetables together were estimated to Rs. 4786 crores and the

Table 1 : Adoption of improved production technology of vegetables

Sr. No.	Technology	Level of adoption							
		Below 25%		25-49%		50-75%		Above 75%	
		No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
1.	**Onion**								
i	Variety	60	20.20	00	00	00	00	237	79.80
ii	Seed rate	24	8.08	00	00	00	00	273	91.92
iii	FYM	11	3.70	98	33.00	115	38.72	73	24.28
iv	Fertilizers	00	0.00	37	12.46	173	58.25	87	29.29
v	Plant protection	53	17.84	74	24.92	143	48.15	27	9.09
2.	**Tomato**								
i	Variety	1	0.83	0	0	0	0	120	99.17
ii	Seed rate	13	10.74	0	0	0	0	108	89.26
iii	FYM	14	11.57	17	14.05	34	28.10	56	46.28
iv	Fertilizers	0	00	5	4.13	54	44.63	62	51.24
v	Plant protection	0	00	23	19.01	64	52.89	34	28.10
3.	**Chilli**								
i	Variety	89	40.64	0	0	0	0	130	59.36
ii	Seed rate	36	16.44	0	0	0	0	183	83.56
iii	FYM	21	9.60	55	25.11	73	33.33	70	31.96
iv	Fertilizers	0	0	39	17.81	132	60.27	48	21.92
v	Plant protection	33	15.07	78	35.62	98	44.75	10	4.56
4.	**Brinjal**								
i	Variety	60	52.63	0	0	0	0	54	47.37
ii	Seed rate	19	16.67	0	0	0	0	95	83.33
iii	FYM	13	11.40	32	28.07	38	33.33	31	27.20
iv	Fertilizers	0	0	16	14.03	68	59.65	30	20.32
v	Plant protection	21	18.42	39	34.21	47	41.23	07	6.14
5.	**Okra**								
i	Variety	46	49.46	0	0	0	0	47	50.54
ii	Seed rate	43	46.24	0	0	0	0	50	53.76
iii	FYM	19	20.43	27	29.03	31	33.34	16	17.20
iv	Fertilizers	0	0	4	4.30	60	64.52	29	31.18
v	Plant protection	10	10.75	35	37.63	42	45.16	6	6.46

Table 2 : Average per hectare resource use structure of selected vegetables

Sr. No.	Technology	Vegetable crop									
		Onion		Tomato		Chilli		Brinjal		Okra	
		Adopters	Non adopters	Adopters	Non adopters	Adopters	Non adopters	Adopters	Non adopters	Adopters	Non adopters
1.	Total human labour (days) male	63.62	56.00	93.50	74.91	56.35	48.63	63.24	58.46	73.79	58.42
2.	Female	176.45	156.16	279.41	243.27	200.99	197.09	214.45	234.46	194.39	187.63
3.	Bullock labour (Pair days)	8.73	11.48	30.91	33.45	19.93	19.81	31.51	20.18	23.96	25.26
4.	Seed (kg)	11.41	10.85	0.66	0.49	1.12	0.89	0.64	0.45	12.32	9.89
5.	Manure (q)	49.59	11.62	70.13	23.27	54.49	24.79	51.55	21.59	38.75	48.16
	Fertilizer (kg) N	89.72	49.93	257.23	138.91	89.23	57.75	81.77	63.71	87.86	60.26
	P	40.22	23.40	116.29	78.55	40.66	27.23	41.48	32.21	43.70	32.10
	K	39.92	23.40	112.08	70.55	40.34	26.48	40.62	28.32	42.40	30.50

Table 3 : Estimates of Economic Surplus due to adoption of recommended vegetable production technology in Maharashtra (Rs. in Crores)

Sr. No.	Particulars	Chilli	Okra	Brinjal	Onion	Tomato	Major vegetables
1.	Net present value	1521.29	672.25	45.73	1133.73	1476.08	4849.08
2.	Internal rate of return	6 per cent	6 per cent	6 per cent	6 per cent	6 per cent	6 per cent
3.	Benefit cost ratio	1 : 18	1 : 85	1 : 5	1 : 84	1 : 12	1 : 89
4.	Net present benefit	1412.79	680.22	57.69	1147.28	1488.03	4786.01
5.	Net present cost	7.96	7.96	11.95	13.54	11.95	53.36
6.	Consumers surplus	621.18	299.33	26.36	524.29	873.20	2344.36
7.	Producers surplus	116.47	74.83	7.32	145.63	382.02	726.27
8.	Total surplus	988.57	439.68	37.28	741.53	961.42	3168.48

highest net presents benefit was recorded in case of tomato (Rs. 1488 crores) and it was followed by chilli (Rs. 1413 crores) and onion (Rs. 1147 crores). The lowest net present benefit of Rs. 58 crores was noticed in case of brinjal as it was not grown on large scale in Maharashtra. As regards the net present cost, the present value of research expenditure on the selected major five vegetables was Rs. 53 crores and the same was Rs. 7.96 crores each in case of chilli and okra, Rs. 11.95 crores each in case of brinjal and tomato and Rs. 13.54 crores in case of onion. The highest research expenditure in Maharashtra was incurred for onion research.

The benefit –cost ratio of an investment made in vegetable research was observed 1:89 for major vegetables in Maharashtra. This has revealed that the producers of major five vegetables in Maharashtra were benefitted by Rs. 89 when one rupee investment made by the government to other agencies in vegetable research. The highest benefit- cost ratio was recorded in case of chilli (1:18)and it was followed by tomato (1:12), okra (1:85), onion (1:84) and lowest ratio was observed in case of brinjal (1:5). Thus the chilli and tomato growers in Maharashtra were largely benefitted due to adoption of technology and the research expenditure. Also the research expenditure on onion and okra showed a remarkable increase in the benefits occurred by the onion and okra growers. It was also noticed that there is no scope in case of further research on brinjal.

The supply of major vegetables grown in Maharashtra has been increased tremendously due to improvement in the productivities of these vegetables. The supply- demand balance determines the price so that producers as well as consumers surplus were estimated. The results of analysis revealed that the consumers were largely benefitted than producers of vegetables and it was three times more than producers. The estimated figure of consumers surplus was Rs. 2344 crores and as against to this producers surplus was only Rs. 726 crores. Among the vegetables, the highest (Rs. 873 crores) consumers surplus was recorded in case of tomato and it was followed by chilli (Rs.621 crores), onion (Rs. 524 crores), okra (Rs. 299 crores) and brinjal (Rs.26 crores). The producers surplus of major vegetables together was observed to be Rs. 726 crores and it was highest in case of tomato (Rs. 382 crores) and next to tomato were onion (Rs.) 146 crores and chilli (Rs. 116 crores). The chilli and onion consumers were largely benefitted than the producers of chilli and onion as compared to other three vegetables and the consumers surplus was five times more than the producers surplus. The total surplus in vegetable cultivation especially of five major vegetables due to adoption of improved vegetable production technology was to the tune of Rs. 3168.48 crores and it was Rs. 988.57, Rs. 961.42, Rs. 741.53, Rs. 439.68 and Rs. 37.28 crores in case of chilli, tomato, onion, okra and brinjal, respectively.

Conclusion :

The technologies evolved *i.e.* improved varieties, modern cultivation practices have largely benefitted to the society as a whole in Maharashtra which has indicated that there is wide potential for carrying out further research on vegetable crops as the benefit-cost ratio of investment in research was found at higher magnitude.

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