



## Profitability and resource use efficiency in vegetable cultivation in Haryana: Application of Cobb-Douglas production model

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### ABSTRACT

Vegetable cultivation plays an important role in the agricultural economy of India. Small and marginal farmers of India grow vegetable for generating income and increasing nutrient in the diet of people. But limited research was done on profitability and resource use efficiency of potato and tomato which are the major vegetable crops grown by farmers in Haryana. Study was carried out in 2014-15 on the basis of primary data to know costs, returns and resource use efficiency of potato and tomato cultivation. The purposive sampling was used to select districts and villages on the basis of highest area under these crops. Probability proportion to size method was used to select the 60 farmers and categorized under small, medium and large farmers. Study concluded that rupee investment in potato and tomato cultivation was 1.40 and 2.09, respectively which was highest to medium farm category in both the vegetable crops and indicated that medium farms are more efficient and have more economies of scale due to better management practices, sound financial position and efficient use of resources. Farm yard manure (FYM) resource has significantly positive impact whereas irrigation was significantly negative impact on yield of potato. However, seeds, machine labour and weeding have positive impact whereas human labour was significantly negative impact on yield of tomato.

**Key words:** Economies of scale, Profitability, Purposive sampling, Resource use efficiency

India is the second largest producer of vegetables in the world next to China with a production of 162.90 million tonnes and it share 14.04% of the total production in the world and occupies 9.40 million ha area with 15.88 per cent of the total area under vegetables in the world in the year 2013-14 (Anonymous 2014). The vegetable cultivation is preponderance of small and marginal farmers and also family labours were done all the operation of vegetable cultivation. Vegetables are the most important component of a balanced diet and provide health security to people by supplying nutrition through it. Now-a-days consumer's preferences have also shifted away from cereals and moved towards vegetables for balanced diet (Mittal, 2006). While, vegetable cultivation is facing the challenge of profitability and economical use of resources. These problems are more serious when farmers showed that inability to manage the problems involved in supply value chain to a market oriented supply chain (Narappanavar *et al.* 1998, Viswanadham, 2006, Baba *et al.* 2010 and Sidhu *et al.* 2010). Though, vegetable crops hold a great promise for fostering the economic growth and improving the diet of the people

in Haryana. Keeping in view the above facts study was conducted to find out the profitability and resource use efficiency in vegetable cultivation in Haryana.

### MATERIALS AND METHODS

The purposive sampling was used to select the Yamunanagar and Karnal district of Haryana on the basis of their highest area under potato and tomato crops respectively. One tehsil from each district and two villages from each tehsil were selected. Radaur and Nilokheri tehsil was selected from respective district on the basis of highest area. Further, two villages were selected from each selected tehsil such as Kherki, Brahmana and Topra Kalan villages from Radaur, and Padhana and Ganger villages from Nilokheri. Thus, complete list of all the vegetable growers of selected villages were prepared on the basis of area under the selected crop. The farmers were categorized as small, medium and large on the basis of area under these crops. Thereafter, a sample of 15 farmers from each selected village was selected by probability proportion to size and making a sample of 60 vegetable growers. Primary data for analysis was collected from selected vegetable farmers through personal interview method for the year 2014-15.

To calculate cost for major vegetable CACP (Commission for Agricultural Costs and Prices) cost concept was used and returns over these cost (Bala *et al.* 2011, Sunny *et al.* 2013, Bajkani *et al.* 2013 and Anandaraj 2015).

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Different CACP cost concept is given below:

Cost  $A_1$  = Value of hired human labour + Value of hired and owned bullock labour + Value of hired and owned machine labour + Value of seed (both farm or purchased seed) + Value of manures and fertilizers (owned and purchased) + Depreciation + Irrigation charges + Land revenue + Interest on working capital + Miscellaneous expenses

Cost  $A_2$  = Cost  $A_1$  + rent paid for leased in land

Cost  $B_1$  = Cost  $A_1$  + interest on working capital (excluding land)

Cost  $B_2$  = Cost  $B_1$  + rental value of owned land + rent for leased in land

Cost  $C_1$  = Cost  $B_1$  + imputed value of family labour

Cost  $C_2$  = Cost  $B_2$  + imputed value of family labour

Cost  $C_3$  = Cost  $C_2$  + 10 per cent of Cost  $C_2$  as management cost

Non linear Cobb-Douglas production model was fitted to analyze the resource use efficiency in potato and tomato crops (Ayoola *et al.* 2009, Patil *et al.* 2012 and Devi and Singh 2015). The production function and variables used are given below:

$$Y = a.X_1^{b_1}.X_2^{b_2}.X_3^{b_3}.X_4^{b_4}.X_5^{b_5}.X_6^{b_6}.X_7^{b_7}.X_8^{b_8}.X_9^{b_9}.U_i$$

For solving this model with help of Microsoft excel taking logarithm on both sides and converted non linear form of this model into linear form.

$$\text{Log}Y = \text{Log}a + b_1\text{Log}X_1 + b_2\text{Log}X_2 + b_3\text{Log}X_3 + b_4\text{Log}X_4 + b_5\text{Log}X_5 + b_6\text{Log}X_6 + b_7\text{Log}X_7 + b_8\text{Log}X_8 + b_9\text{Log}X_9$$

where, Y= Yield (Q/ha), X1=Seeds used (Kg/ha), X2=FYM used (Kg/ha), X3= Nitrogen used (Kg/ha), X4=Phosphorus used (Kg/ha), X5=Human labor used, X6= Machine labor (Hour/ha) (man-days/ha), X7=Irrigation (No.), X8=Spray (No.), X9=Weeding (No.)

## RESULTS AND DISCUSSION

Expenditure incurred on different items in growing potato and tomato crop on different farm size is presented in Table 1. Total variable cost accounted 51.69 and 53.49 per cent of total cost in potato and tomato crop. The major part of total cost was rental value of land, seed and human labor with 38.33 per cent, 18.57 per cent and 18.10 per cent in potato whereas in tomato crop it was 29.97, 2.48 and 37.11 per cent, respectively. The small farmers used more family labours per hectare for cultivation of both the vegetable crops, while hired labour use were more on large farms followed by medium. Study also indicated that small farmers were dependent on agriculture and farming was only source of income. Whereas, total cost was highest on large farms than followed by medium and small farms. It increased with the increase in size of holding because of better resource base and more use of hired labour in both the vegetable crops.

### Costs and returns from potato and tomato cultivation

A comparison of various CACP costs and returns of

Table 1 Distribution of expenditure on different items in potato and tomato crop (% of TC)

Items	Potato				Tomato			
	Small (%)	Medium (%)	Large (%)	Total (%)	Small (%)	Medium (%)	Large (%)	Total (%)
<i>Human labour</i>								
a. Family	16.73	9.12	2.18	9.01	34.99	11.38	4.18	15.91
b. Hired	0.00	9.00	17.09	9.09	0.00	26.11	34.36	21.20
Seeds	18.08	18.56	19.02	18.57	2.55	2.42	2.47	2.48
FYM	4.91	4.85	4.97	4.91	4.82	4.63	4.90	4.79
Fertilizers	0.79	0.77	0.76	0.77	2.98	2.81	2.93	2.90
Machinery	9.02	9.21	9.48	9.25	5.59	5.73	6.18	5.85
PP chemical	2.12	2.27	2.22	2.21	10.17	9.77	9.56	9.81
Weedicides	0.28	0.29	0.30	0.29	0.38	0.45	0.47	0.44
Irrigation charges	2.47	2.45	2.40	2.44	2.18	2.05	2.04	2.08
Land revenue	0.09	0.09	0.08	0.09	0.08	0.07	0.06	0.07
Depreciation	1.02	0.96	0.95	0.98	0.72	0.64	0.65	0.67
Miscellaneous	0.82	0.86	0.93	0.87	0.77	0.94	0.97	0.90
Interest on WC @ 4.5%	1.78	2.22	2.62	2.23	1.36	2.50	2.91	2.30
TVC	41.38	51.53	60.82	51.69	31.59	58.12	67.49	53.49
IFC	0.73	0.99	1.17	0.97	0.41	0.61	0.81	0.62
Rental value of land	41.15	38.37	35.83	38.33	33.01	29.89	27.52	29.97
Total cost (TC)	157947 (100)	169419 (100)	181408 (100)	169592 (100)	196914 (100)	217458 (100)	236194 (100)	216855 (100)

WC=Working capital; TVC=Total variable cost; IFC=Interest on working capital

Table 2 Costs and returns of potato and tomato crop on the basis on different size holdings

Particulars	Potato				Tomato			
	Costs (in % of Cost C <sub>3</sub> )							
	Small	Medium	Large	Total	Small	Medium	Large	Total
Cost A <sub>1</sub>	37.62	46.84	55.29	46.99	28.72	52.83	61.35	48.63
Cost A <sub>2</sub>	37.62	46.84	55.29	46.99	28.72	52.83	61.35	48.63
Cost B <sub>1</sub>	38.28	47.74	56.35	47.88	29.09	53.39	62.09	49.19
Cost B <sub>2</sub>	75.70	82.62	88.92	82.72	59.10	80.56	87.11	76.44
Cost C <sub>1</sub>	53.50	56.03	58.34	56.07	60.90	63.74	65.89	63.66
Cost C <sub>2</sub>	90.91	90.91	90.91	90.91	90.91	90.91	90.91	90.91
Cost C <sub>3</sub>	173742	186361	199549	186551	216605	239204	259814	238541
(₹ ha)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
Yield (q/ha)	288	312	304	301	520	582	562	555
<i>Return (in % of gross return)</i>								
Gross return	218304	236496	230432	228411	405600	453960	438360	432640
(₹/ha)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
Net return	27.65	28.36	21.27	25.75	51.45	52.10	46.12	49.88
Return over variable cost	70.06	63.09	52.12	61.62	84.66	72.16	63.64	73.19
FBI	70.06	63.09	52.12	61.62	84.66	72.16	63.64	73.19
FLI	39.76	34.90	22.99	32.44	68.44	57.55	48.37	57.85
Return to management	20.41	21.20	13.40	18.33	46.60	47.31	40.73	44.86
<i>Return per rupee investment (in ratio)</i>								
Return	1.38	1.40	1.27	1.35	2.06	2.09	1.86	2.00

FBI=Farm business income; FLI= Family labour income

potato and tomato is presented in Table 2. The yield of potato and tomato crops were 312 and 582 quintals per hectare on medium farmers which was highest and followed by large and small farmers. It may be due to better management practices and efficient use of resources by medium farmers. The net return was found highest in medium with 28.36 and 52.10 per cent of gross return in potato and tomato crops respectively. Net return from potato and tomato cultivation was 26.0 and 50.0 per cent, respectively which indicated that cost of cultivation of potato was higher than tomato but net

returns from both the vegetable crop cultivation were found highest on medium farm followed by small and large size of the holding. But returns over variable cost and family labour income were highest about small farmers in both vegetables and decreased with increase in the size of land holding. Farm business income which represents returns over variable cost A<sub>2</sub> were same as returns over variable cost and it was found that there was no difference between cost A<sub>1</sub> and cost A<sub>2</sub> because the leasing in land for vegetable production was not in practice in the study area. The per

Table 3 Regression coefficients of different production variables of potato and tomato

Input variable	Regression coefficient		Standard errors		t-value	
	Potato	Tomato	Potato	Tomato	Potato	Tomato
Seeds	2.8059	0.1120*	1.9343	0.0282	1.4506	3.9724
FYM	9.7490*	0.0262	3.7191	0.3678	2.6213	0.0713
Nitrogen	0.0362	0.0967	1.0197	0.1786	0.0355	0.5416
Phosphorus	-0.2970	-0.3041	0.3516	0.1839	-0.8445	-1.6534
Human labour	-0.4742	-0.0863*	0.3746	0.0218	-1.2660	-3.9654
Machine labour	-0.0192	0.0202*	0.1235	0.0083	-0.1552	2.4364
Irrigations	-0.3754*	0.0473	0.1340	0.0433	-2.8015	1.0924
Sprays	-0.0883	-0.0075	0.1332	0.0134	-0.6627	-0.5622
Weedings	0.0072	0.0243*	0.1019	0.0119	0.0708	2.0422
R <sup>2</sup>	0.75		0.89			

\* Significant at 5%.

Table 4 GM, MPP and MVP of different inputs for potato and tomato

Input variable expenditure	GM		MPP <sub>xi</sub> (q)		MVP <sub>xi</sub> (₹)		MPP <sub>xi</sub> /P <sub>xi</sub>	
	Potato	Tomato	Potato	Tomato	Potato	Tomato	Potato	Tomato
Yield (q)	300.89	555.36						
FYM (q)	474.69		6.18		4689		26.72	
Irrigations (no.)	10.11		-11.17		-8478		-20.91	
Seeds (kg)		0.21		296.19		230891		9.19
Human labour (man-days)		255.94		-0.19		-146		-0.47
Machine labour (hr)		25.08		0.45		349		0.70
Weedings (no.)		4.91		2.75		2143		2.68

GM = Geometric mean, MPP = Marginal physical product, MVP = Marginal value product.

rupee investment in potato and tomato crop was 1.40 and 2.09, respectively which was highest about medium farmers in both the vegetable crops such as tomato and potato, respectively. Present study also indicated that medium farmers were more efficient and has more economies of scale as compared to large and small farmers.

#### Resource use efficiency

Various production models were used to analysis of resource use efficiency but Cobb-Douglas production model was the best fit because of high  $R^2$  value than other model (Goni *et al.* 2013). This production model was used to determine the resource use efficiency in cultivation of potato and tomato with significance level are presented in the Table 3. The value of coefficient of multiple determinations ( $R^2$ ) was 0.75 and 0.89, respectively which indicates that 75.0 and 89.0 per cent yield of potato and tomato affected by independent variable included in the model. The only FYM resource was found significantly positive impact whereas irrigation was significantly negative impact on yield of potato. This indicated that FYM use was increased and number of irrigation was decreased for increasing yield of potato. Further, study showed that water was over utilized potato cultivation. However, seeds, machine labour and number of weeding had significantly positive impact whereas human labour had significantly negative impact on yield of tomato. This said that seeds used per unit area, machines and weeding activities were increased and human labour used was decreased for increasing the yield of tomato.

#### Marginal value productivity analysis of different inputs for potato and tomato cultivation

Marginal value productivity of different inputs used in the cultivation of potato and tomato showed in Table 4. The marginal value productivity for FYM and number of irrigation in potato production was ₹ 26.72 and ₹ -11.17. It indicated that FYM resource can be used more till their  $MVP_{xi} = P_{xi}$  and get more yield of potato because this is under utilization; whereas irrigations has to be decreased this resource was over utilization and unnecessarily increased the cost of cultivation of potato (Luis *et al.* 1998). The marginal value productivity for seeds, machine labour and weeding were ₹ 9.19, 0.70 and 2.68, respectively in

tomato cultivation. This indicated that these resources can be used further till their  $MVP_{xi} = P_{xi}$  and get more yield of tomato, whereas human labour has to be decreased to save expenditure on labour.

The cultivators of potato used more irrigation water more as required by crops and due to this ground water table is going down day by day in Haryana. The higher labour used in the cultivation of tomato indicated that disguised unemployment because vegetables are mostly grown by the small and medium category of farmers. However, seeds used per unit area and machines used were also very low in tomato crop.

#### Conclusion

Study concluded that farmers of medium category of land holding have good economic conditions due to better management practices and efficient use of resources. So, trainings should organize to impart technological know-how at door step through extension workers and agricultural research stations. It would be helpful for improvement of scientific knowledge of farmers for vegetables cultivation practices and efficient use of productive resources.

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