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PROFITABILITY AND RESOURCE-USE EFFICIENCY IN VEGETABLE CULTIVATION IN HAMIRPUR DISTRICT OF HIMACHAL PRADESH

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ABSTRACT

Vegetable cultivation holds importance in Himachal Pradesh agriculture as it provides food, nutrition, and financial security. The present study examines the profitability and resource use efficiency in vegetable cultivation in Hamirpur district of Himachal Pradesh. The study was based on primary data collected during 2017-18 from 60 farmers selected randomly using three-stage sampling techniques. The study found that growing vegetables on sample farms was very profitable as the net returns over total cost were positive in all crops. Moreover, the return per rupee investment ratio was greater than one, demonstrating that vegetable growing is economically efficient. The outcomes of the production function indicated increasing returns to scale for all vegetables except garlic, implying that by increasing all production variables (area, seed, FYM & fertilizers, human labour, irrigation, and plant protection measures) by one per cent, the production will increase by more than one per cent. This shows that there is still the possibility of expanding output. The marginal value productivity analysis revealed that the farmers in the study area may improve their earnings by enhancing the use of variable inputs.

Keywords: Cobb-Douglas Model, Return to scale, Resource use efficiency, Vegetables production

Vegetable agriculture is quite significant in India (Kumar *et al.,* 2018). India is the second-largest producer of vegetables in the world. Although the productivity levels of vegetables have increased manifolds, it will not be enough to feed an increasing population (Sankaranarayanan *et al.,* 2012). Conversely, the demand for fruits and vegetables is continuously expanding as a result of increasing purchasing power and growing consumer awareness of health benefits. The exemplary growth of horticulture production is evident as it surpassed total food grain production since 2012-13, reaching a remarkable 334.60 million tonnes in 2020-21 (NHB, 2020-21). Vegetable cultivation is mostly carried out by the small and marginal farmers, and it has been observed that it is the family labour that carries out most of the operations. Therefore, it gave hope to small landholders to double their income by growing vegetables, whose contribution was more than 80 per cent of total horticulture production, especially vegetables (Kumar *et al.,* 2018). The primary reason for this is that cultivated vegetables are annual crops with short growth durations, making them a consistent source of income for small landholders who own less than 2 hectares of land or cultivate on leased-in lands. In 2001, smallholders made a significant contribution of 55 per cent to the total fruit and vegetable production, a notable increase from 51 per cent in 1991 and 43 per cent in 1970-71 (Singh *et al.,* 2002). Smallholders' share of fruit and vegetable production is likely to rise further. Farmers gradually focus on high-value commodities, such as fruits and vegetables. The shift towards high-value commodities, particularly fruits and vegetables, in agricultural diversification has played a vital role in generating non-farm employment opportunities and helped small landholders augment their incomes and bail them out of the vicious circle of poverty (Ryan and Spencer, 2001; Kashish and Dhawan, 2017). Research studies have also uncovered those fruits and vegetables present vast opportunities for elevating the income levels of smallholders and enhancing the productivity of limited resources (Pingali and Rosegrant, 1995; Chand, 1996; Joshi *et al.,* 2003; Kumar *et al.,* 2018). Against this backdrop, the present study examines the profitability and resource use efficiency in vegetable cultivation in the study area.

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MATERIALS AND METHODS

Sampling method

The purposive sampling was used to select the Hamirpur district of Himachal Pradesh due as the to the introduction of vegetable crops in district Hamirpur was being comparatively new compared to other vegetable growing districts of the state. With the continued efforts made by the Department of Irrigation and public health (DIPH)/ District Rural Development Agencies (DRDA)/ Japan International Cooperation

Agency (JICA)/ Department of Agriculture (DoA), the area under vegetables in the district has increased from a few hectares to 4273 hectares in 2021-22 (Govt. of H.P., 2021-22) Two blocks (Nadaun and Bijhari) from the district and five villages from each block were selected randomly. Further, five villages were selected from each selected block viz., such as Manjara, Putriyal, Marchun, Bhadroon and Bharmoti villages from Nadaun, and Chakmoh, Chalali, Suder, Marhun and Morsu Patti villages from Bijhari block. Thus, Aa complete list of all the vegetable growers in of selected villages was prepared and based on the area under the selected crop. After that, a sample of 6 farmers from each selected village was chosen randomly, making a total sample of 60 vegetable growers. Primary data for analysis were collected from selected vegetable farmers through personal interview methods from May to June 2018.

Analytical methods

Both linear and Cobb-Douglas production functions have been tried, but the Cobb-Douglas production function was found to be the best fit in accordance with its value of the coefficient of multiple determination (R^2). A non-linear Cobb-Douglas production model was fitted to analyze the resource use efficiency in vegetable crops (Devi and Singh 2015; Priscilla and Singh 2016; Kumar *et al.,* 2017; Kumar *et al*., 2018; Kant *et al*., 2020). The production function and variables used are given below:

$$Y = b_0 X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6} X_7^{b7} e^U$$

For solving this model with the help of Microsoft excel, logarithm on both sides was taken and the non-linear form of this model was converted into a linear form as follows:-

$$\text{Log } Y = \text{Log} b_0 + b_1 \text{Log} X_1 + b_2 \text{ Log } X_2 + b_3 \text{ Log } X_3 + b_4 \text{ Log} X_4 + b_5 \text{ Log} X_5 + b_6 \text{ Log} X_6 + U$$

where,

Y= Output of vegetable crop (q/ha);

X_1 = Area under vegetable (ha);

X_2 = Expenditure on seed (Rs/ha);

X_3 = Expenditure on FYM & fertilizers (Rs/ha);

X_4 = Human labour (Rs/ha);

X_5 = Expenditure on plant protection measures (Rs/ha);

X_6 = Irrigation (number);

b_0 = Constant term;

bi's= Regression coefficients;

U = Random term

To examine the significance of each parameter, t-test was employed as:

$$t_{(\alpha,n-2)} = \frac{b_i}{SE\ (b_i)}$$

where,

$SE\ (b_i)$ = Standard error of regression coefficient;

n = Number of sample observations;

α = Selected level of probability (1 % and 5 %)

The significance of the coefficient of multiple determination (R^2) was tested with the help of F- test as:

$$F = \frac{R^2}{(1 - R^2)} \times \frac{N - k}{k - 1} \sim F\ (k - 1), (N - k) \text{ df}$$

where,

N = Number of sample observations;

k = Total Number of $b_{i's}$ (including constant b_0)

The returns to scale (RTS) were estimated directly by getting the sum of 'bi' coefficients (statistically significant). The RTS would be increasing, constant or diminishing based on whether the value of summation of 'bi' is greater, equal or less than unity, respectively (Singh and Thakur 2022). The principle of unity is equal to numerical 1.

Returns to scale (RTS) = Σbi.

To estimate the resource use efficiency of different resources. The marginal value productivity was computed as:

$$MVP_{xi} = b_i \frac{\overline{y}}{\overline{x_i}} Py$$

Where,

$\overline{y}$ = Geometric mean of output;

$\overline{x_i}$ = Geometric mean of i^{th} input;

bi = Regression coefficients;

Py = Price of output per unit

RESULTS AND DISCUSSION

Distribution of expenditure in summer and winter vegetables

In summer vegetables, the total cost was ₹ 1,04,243, ₹ 1,11,751, ₹ 1,19,191 per hectare in okra, cucumber, and bitter gourd, while in winter vegetables, the total cost was ₹ 1,34,579, ₹ 1,16,375 and ₹ 1,36,094 per hectare in cauliflower, onion, and garlic, respectively. The variable cost was highest in garlic (86.07%), followed by cauliflower (85.92%), bitter gourd (84.10%), onion (83.71%), cucumber (83.04%), and okra (81.82%). The total fixed cost was highest in okra (18.19%) and lowest in garlic (13.93%). The seed expenditure was highest in winter vegetables compared to summer vegetables. While conducting the survey, it was observed that the farmers preferred the seed of high-yielding varieties mostly hybrids in cauliflower, okra, cucumber, and bitter gourd whereas, popular/ local varieties were used in onion and garlic. Among the different vegetable production operations, inter-cultural operations accounted for the highest share of total human labour utilized in major vegetables grown by respondents.

In contrast, hired human labour was available from the nearby locality. In summer vegetables, the share of the hired human labour was about 23.28, 22.44, and 18.92 per cent of the total human labour used in okra, cucumber and bitter gourd, respectively. In winter vegetables, about 15.75, 21.33, and 10.02 per cent of the total human labour was hired in cauliflower, onion, and garlic, respectively. During the survey, it was noticed that smaller farmers used more family labour to cultivate the vegetable crops, while hired labour was more used on large farms because of better resource availability to the large farmer.

Return and profitability in summer and winter vegetable crops

It can be observed from Table 2 that the gross returns from summer vegetables varied between ₹ 1,78,375 per hectare in okra to ₹ 2,17,036 per hectare in bitter gourd. The per hectare gross returns from cucumber were estimated at ₹ 1,89,193. Among the winter vegetables, the per hectare gross returns of garlic were highest at about ₹ 3,25,121. The per hectare gross returns from cauliflower and onion were estimated at ₹ 2,58,557 and ₹ 2,16,990, respectively. The production of major vegetables grown by the respondents was profitable as the net returns over variable costs were positive in all the summer and winter vegetables. The net returns over the total cost of cultivation in the winter vegetables were worked out at ₹ 1,23,978/ha, ₹ 1,00,615/ha and ₹ 1,89,027/ha for cauliflower, onion and garlic, respectively.

As far as the net returns from the summer vegetables were concerned, these were highest in bitter gourd ₹ 97,845/ha followed by cucumber (₹ 77,442/ha) and okra (₹ 74,140/ha). The total cost of production of summer vegetables varied between ₹ 663/q in the bitter gourd to ₹ 1,004/q in cucumber, whereas in major winter vegetables it ranged between ₹ 676/q in the cauliflower to ₹ 1,166 in garlic. The return per rupee investment ratio was estimated at 1.71, 1.69 and 1.82 in okra, cucumber and bitter gourd. The return per rupee investment ratio was highest in winter vegetables compared to summer vegetables. In comparison, the return per rupee investment was 1.92, 1.86 and 2.38 for cauliflower, onion and garlic in winter vegetables.

Table 1. Distribution of expenditure on different items in summer and winter vegetable crops (% of total cost)

Particulars	Summer vegetables			Winter Vegetables		
	Okra	Cucumber	Bitter gourd	Cauliflower	Onion	Garlic
Total fixed cost (A)	18.19	16.96	15.90	14.08	16.29	13.93
Interest on total fixed investment	6.44	6.00	5.63	4.99	5.76	4.93
Depreciation on total fixed investment	6.95	6.48	6.08	5.38	6.23	5.32
Land rent	4.80	4.47	4.19	3.72	4.30	3.67
Total variable cost (B)	81.82	83.04	84.10	85.92	83.71	86.07
Seed	5.00	6.61	12.43	18.19	9.06	23.54
FYM + Compost	12.16	10.56	10.28	10.54	13.11	10.41
Fertilizers	4.04	3.58	3.28	3.66	4.44	3.66
Staking material used	-	1.42	1.72	-	-	-
Plant protection measures	1.70	1.49	1.47	1.51	1.65	1.20
Labour cost	58.24	58.68	54.21	51.31	54.76	46.54
a. Family labour	34.96	36.25	35.29	35.55	33.43	36.52
b. Hired labour	23.28	22.44	18.92	15.75	21.33	10.02
Interest on working capital	0.68	0.69	0.69	0.71	0.69	0.71
Total cost (₹/ha)	104234	111751	119191	134579	116375	136094
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Table 2. Return and profitability in summer and winter vegetable crops

Particulars	Summer vegetables			Winter Vegetables		
	Okra	Cucumber	Bitter gourd	Cauliflower	Onion	Garlic
Gross return (₹/ha)	178375	189193	217036	258557	216990	325121
Net return over total cost (₹/ha)	74140	77442	97845	123978	100615	189027
Cost of production (₹/q)	901	1004	663	676	804	1166
Return per rupee investment (in ratio)	1.71	1.69	1.82	1.92	1.86	2.39

Cobb–Douglas production function

Various production models were used to analysis of resource use efficiency, but the Cobb-Douglas production model was the best fit because of its high R^2 value than other models (Goni *et al.*, 2013; Kumar *et al.*, 2018). Table 3 depicts the results of the Cobb-Douglas production function for different summer vegetables and winter vegetables grown in the study area. The value of R^2 was significant for all the summer and winter vegetable crops grown. In summer vegetables, the value of R^2 was observed to be 0.79, 0.83 and 0.85 for okra, cucumber and bitter gourd, indicating that the explanatory variables included in the regression analysis explicate around 79, 83 and 85 per cent of the total variation in the gross returns obtained from vegetables by the farmers through respective vegetables. The regression analysis results revealed that the area under the crop in okra and cucumber vegetable crops significantly affects the production obtained from vegetables. The one per cent increase in the area under crop would increase output by 0.080 and 0.335 per cent in okra and cucumber. Seed was found to have a significant positive influence on bitter gourd at 5 per cent, which implies that farmers' production could be increased by 0.294 per cent with the increase of one per cent of seed. Farmyard manure and fertilizers were only significant for cucumber and bitter gourd. The regression results explained that plant protection measures were a significant variable affecting the production of all the summer vegetables. Further, the returns to scale to the tune of 1.219, 1.459 and 1.132 were obtained in okra, cucumber, and bitter gourd, which revealed that there would be more than one per cent increase in the production of these crops if all the factors of production would simultaneously be increased by one per cent. This showed a condition of increasing returns to scale. The results indicated that these vegetable growers were still operating in the first stage of the classical production function. This is in line with the findings of Adeoye and Balogun (2016), Ali *et al.* (2017) and Kant and Singh (2020) for cucumber and Mila *et al.* (2015) for bitter gourd.

In winter vegetables, the value of R^2 was found to

Table 3. Estimated production function for summer and winter vegetable crops

Particulars	Summer vegetables			Winter Vegetables		
	Okra	Cucumber	Bitter gourd	Cauliflower	Onion	Garlic
Constant (b_0)	0.232 (0.582)	-3.189 (0.336)	-2.696 (0.766)	0.292 (0.479)	-2.574 (0.452)	1.372 (0.376)
Area (b_1)	0.080** (0.030)	0.335* (0.096)	0.108 (0.165)	0.046** (0.022)	0.034 (0.037)	0.324** (0.128)
Seed (b_2)	0.053 (0.034)	0.076 (0.044)	0.294** (0.149)	-0.026 (0.043)	0.043** (0.021)	-0.018 (0.050)
FYM & fertilizers (b_3)	-0.152 (0.191)	0.814* (0.083)	0.582* (0.147)	0.291** (0.132)	0.467** (0.191)	-0.037 (0.075)
Labour (b_4)	0.323** (0.129)	0.014 (0.040)	0.070 (0.131)	0.035 (0.065)	0.152* (0.034)	0.178* (0.054)
Irrigation (b_5)	0.469* (0.119)	0.056** (0.027)	-0.135 (0.201)	0.666* (0.149)	0.025* (0.117)	0.226** (0.112)
Plant protection (b_6)	0.446** (0.206)	0.164* (0.051)	0.213** (0.098)	0.009 (0.078)	0.492** (0.130)	0.343** (0.171)
R^2	0.79**	0.83**	0.85**	0.74**	0.85**	0.75**
$\sum bi$	1.219	1.459	1.132	1.021	1.213	0.856

Note: *1% level of significance; **5% level of significance be highest in onion (0.85), followed by garlic (0.75) and cauliflower (0.74). The area under all the crops were positively significant at 5 per cent level of significance except for onion. The one per cent increase in the seeds of onion would increase the farmers' production by 0.043 at 5 per cent level of significance. The Table further showed that the one per cent increase in FYM & fertilizers would result in a 0.291 and 0.467 per cent increase in production from cauliflower and onion, respectively. Irrigation was a significant variable affecting the production of all the winter crops. Labour was significant for onion and garlic at 1 per cent level of significance. It revealed that 1 per cent increase in human labour would increase the production by 0.152 and 0.178 per cent of onion and garlic, respectively. The plant protection measures given were found to be significant at 5 per cent for onion and garlic. The returns to scale for cauliflower (1.021) and onion (1.213) were greater than one revealing increasing returns to scale. In garlic, the returns to scale were 0.856, indicating diminishing returns to scale if all the factors of production will be increased by one per cent, meaning that there could be less than one per cent increase in the output from garlic. It is in line with the study of Kantariya *et al.* (2018) for onion and Sharma *et al.* (2018) for garlic crop.

Marginal value productivity

Marginal value productivities (MVPs) of different factors of production for summer and winter vegetables have been presented in Table 4. The marginal value productivity of area under crop was found to be ₹ 23.20 and ₹ 82.00 for okra and cucumber, respectively. It indicates that with the additional one rupee spent on the area under crop in okra and cucumber, total returns would increase by ₹ 23.20 and ₹ 82.00, respectively. This suggested that the farmers of the study area could increase their income by a significant amount by increasing the area under different vegetable crops as most of the vegetables have shown high significant positive MVPs. The marginal value productivity of farmyard manure and fertilizers was positive for cucumber and bitter gourd vegetables. It was found to be highest for cucumber at ₹ 395.81, followed by bitter gourd at ₹ 252.08. The marginal value productivities of human labour used were positive for okra (₹116.76), indicating underutilized of labour in okra. Further, the MVP of irrigation for okra and cucumber were positive with respective values of ₹ 26.44 and ₹ 84.79. This indicates that the vegetable growers should increase the use of irrigation for these crops. The marginal value productivity of plant protection measures was also positive for all summer crops and was maximum for cucumber ₹ 285.31) and minimum for okra ₹ 115.23.

In winter vegetables, the marginal value productivity of crop area was positive for cauliflower and garlic vegetables indicating that with an extra rupee spent on crop area, the gross returns of these crops would increase by ₹ 7.55 and ₹ 141.53, respectively. The MVP of seed for onion also indicated that with an additional one rupee spent on seed, there would be an increase of ₹ 20.58 in the gross returns obtained from the onion. The marginal value productivity of FYM and fertilizers was positive for cauliflower and onion vegetables, indicating that with an additional rupee spent on FYM and fertilizers, there would be an increase of ₹ 150.64 and ₹ 206.44 for cauliflower and onion, respectively. The MVP of irrigation was favourable for all winter crops and varied from ₹ 34.23 in garlic to ₹ 61.25 in onion. The marginal value productivity of plant protection measures was positive for onion at ₹ 25.20 and garlic at ₹ 85.49. This showed that an additional unit spent on plant protection measures will add to the returns for different vegetables.

The result has indicated that vegetable cultivation was a profitable venture, and all the vegetables have shown positive net return over variable cost and return per rupee investment. The Cobb-Douglas production function analysis showed that the value of R^2 was significant for summer as well as winter vegetables. It was observed to be 0.79, 0.83 and 0.85 for okra, cucumber, and bitter gourd in summer vegetables while 0.85, 0.75 and 0.74 for onion, garlic and cauliflower in winter vegetables. The production function encountered

Table 4. Marginal value productivities of resources for summer and winter vegetables

Particulars	Summer vegetables			Winter Vegetables		
	Okra	Cucumber	Bitter gourd	Cauliflower	Onion	Garlic
Area	23.2	82	-	7.55	-	141.53
Seed	-	-	27.45	-	20.58	-
FYM & fertilizers	-	395.81	252.08	150.64	206.44	-
Labour	116.76	-	-	-	57.32	125.68
Irrigation	26.44	84.79	-	52.48	61.25	34.23
Plant protection	115.23	285.31	135.49	-	25.2	85.49

the values of regression coefficients to be positive and significant in variables in each vegetable crop, respectively. Increasing returns to scale were observed in all the major vegetable crops except garlic. The marginal value productivities were estimated to be positive for all factors of production except for seed in okra, cucumber, cauliflower, and garlic, an area in bitter gourd and onion, FYM & fertilizers in okra, and garlic, labour in cucumber, bitter gourd and cauliflower, irrigation in bitter gourd and plant protection chemicals in cauliflower. This shows that farmers of the study area could increase their income by a significant amount by increasing the variable inputs in different vegetable crops.

Authors' contribution

Conceptualization and designing of the research work (PS, RKT, VK); Execution of field/lab experiments and data collection (PS, AS); Analysis of data and interpretation (PS, RKT, VK); Preparation of manuscript (AS, RKT).

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