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Economics of plant protection use and returns from tomato cultivation in plains of Nainital district of Uttarakhand

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Abstract
Plant protection has an indispensable role in modern agriculture. Absence of plant protection nullifies any positive effects of other inputs leading to heavy losses to the farmers. However, excessive use of these chemicals has its own perils; pollution of soil, air and water, alteration of the ecosystem, killing beneficial organisms to name a few. Tomato is an input intensive crop and input use greatly depends on the land holding of the farmer. The study was conducted in the plains of Nainital district of Uttarakhand. A total of 120 farmers (30 belonging to each farm size group) were selected for the study from the two selected blocks, *viz*. Haldwani and Kotabag. CACP cost concepts were used to estimate the cost of tomato cultivation. The cost of cultivation was found to increase with an increase in farm size. Medium and large farmers earned considerably higher returns as compared to small and marginal farmers. Per hectare cost of pant protection decreased with an increase in farm size.

Keywords: Pesticides, tomato, cost and returns, farm size groups

1. Introduction
Tomato (Solanum lycopersicum) is a crop native to Western South America. It is from the Solanaceae family. Its fruit which is classified as a berry is its edible part. Globally, tomato was grown in an area of more than 5 million hectares, with total production of more than 189 m tonnes in 2021. China is the largest producer of tomatoes, producing more than 67 million tonnes of it from an area of more than 1 million hectare. India stood second with a production of more than 21 million hectares from an area of about 0.84 million hectares (FAOSTAT, 2021) [7]. Vegetable cultivation is better suited for the farmers with scattered and marginal land holdings. It is capable of yielding about 2-4 times higher returns as compared to cereal cultivation (Gupta *et al*., 2006) [3]. Uttarakhand is characterized by fragmented land holdings with most of the farmers falling under marginal and small farm category. Vegetable cultivation helps farmers on small land holdings generate quick returns (Birthal *et al.*, 2008) [1]. Nainital district has a diverse topography and climatic conditions which are quite suitable for vegetable cultivation. Tomato, cabbage, onion, pea and tomato are a few major vegetables grown in the area (Fartyal and Rathore, 2013) [2]. Productivity and quality of tomato crop is greatly compromised due to disease infestation as more than 200 diseases have been reported to affect tomato throughout the world (Shelat *et al*., 2014) [6]. In this backdrop, it is imperative to analyse the economics of plant protection use in the region. The present study aims to analyse the cost of plant protection use and returns from tomato cultivation in the plains of Nainital district of Uttarakhand.

2. Materials and Methods
From the 8 blocks of Nainital district, three blocks (Haldwani, Ramnagar and Kotabag) lie in the Bhabar region and the rest lie in the hilly region. For the purpose of the study, two blocks lying in the plain region; *viz*. Haldwani and Kotabag, with highest area and production of tomato in the district were selected purposively. Thereafter, three villages were selected randomly from each block. Lastly, 5 farmers from each farm category (marginal, small, medium and large) were selected randomly from each village of each block. Hence, a total of 120 farmers were selected for collecting primary data for the study for the rabi season tomato for the year 2018-19. From the collected data, the cost of and returns from tomato cultivation were worked out. Then the cost of plant protection use was calculated separately.

To estimate the cost of tomato cultivation cost concepts given by Commission for Agricultural Cost and Prices (CACP) as Cost A_1, Cost A_2, Cost B_1, Cost B_2, Cost C_1, Cost C_2, Cost C_2* and Cost C_3 were used. Gross Returns from tomato cultivation have been worked out as the product of the average price received by the farmers for tomato fruit and the quantity sold in the market as well as consumed by the farm family. In functional form it can be represented as:

$GR = P*Q$

Where,
GR is the Gross returns from tomato cultivation
P is Average Price received by the producer (Rs/kg)
Q is quantity sold in the market, including family consumption (kg/ha)
The net returns over various costs were calculated by deducting the different costs from gross returns as follows:

$NR_i = GR-C_i$

Where,
NR_i is net returns over i th cost (Rs/ha)
C_i is i th cost (i=A_1, A_2,……C_3)

Cost of plant protection was worked out separately for all four farm size groups. The cost of plant protection chemical along with the labour cost incurred in their application and the depreciation of the machine used for application were included. It was categorized as:

Per hectare cost of plant protection use (Rs/ha)
Unit cost of plant protection use (Rs/Qt)
Percent share in total cost

3. Results and Discussion

The cost of tomato cultivation for different farm size groups has been presented in table 1. It is evident that cost A_1 increases with farm size, ranging from Rs 115908 per hectare for marginal farmers to Rs 149774 per hectare for large farmers. Moreover, no difference was observed between costs C_2 and C_2^* in any farm size category, given the actual wage rate was higher than the statutory minimum wage rate in the study area. The total cost of cultivation (cost C_3) ranged from ₹ 186344 to ₹ 195631 per hectare for the four farm size groups. The cost of production for small, marginal, medium and large farm size groups was found to be ₹ 5.36, ₹ 5.38, ₹ 5.14, ₹ 5.15 and ₹ 5.21 per kg, respectively. The gross returns accrued to the farmers are presented in table 2. They were also found to increase with farm size. For marginal, small, medium, large and overall sample size they were ₹ 322623, ₹ 330620, ₹ 355749, ₹ 360189 and ₹ 351767 per hectare, respectively. The net returns earned by medium (₹ 160774 per hectare) and large farmers (₹ 164559 per hectare) were quite higher as compared to marginal (₹ 136278 per hectare) and small farmers (₹ 142428 per hectare). Jethi *et al.,* (2012) [4] in their study of economics of production of tomato found the gross returns from tomato cultivation under open field conditions to be about ₹ 1,81,500. Table 3 depicts the cost of plant protection across farm size groups. The highest per hectare (₹ 21297) and per ton (₹ 600) cost on plant protection use was incurred by marginal farmers. For all farm size groups, the percent share of plant protection in total cost was more than 10 percent. This indicates that plant protection use forms a major component of the total cost incurred in the region.

Table 1: Cost of tomato cultivation across farm categories

Particulars	Cost (₹/ha)				% of Cost C_3			
A. Operational costs	**Marginal**	**Small**	**Medium**	**Large**	**Marginal**	**Small**	**Medium**	**Large**
1. Human labour								
a. Hired	4233	6370	21470	29604	2.27	3.38	11.01	15.13
b. Owned	38100	36097	19819	12688	20.44	19.18	10.16	6.48
Total	42334	42468	41289	42292	22.71	22.56	21.17	21.61
2. Machine power								
a. Hired	5363	5418	4668	765	2.87	2.87	2.39	0.39
b. Owned	946	956	3569	7735	0.50	0.50	1.83	3.95
Total	6309	6374	8237	8500	3.38	3.38	4.22	4.34
Sub total (1+2)	48643	48842	49526	50792	26.10	25.95	23.40	25.96
B. Material costs								
1. Seed	6455	6467	8530	7933	3.46	3.43	4.37	4.05
2. FYM	11671	11035	10647	9912	6.26	5.86	5.46	5.06
3. Fertilizers	8117	9087	10226	10057	4.35	4.82	5.24	5.14
4. Plant protection chemicals	20183	20091	19768	19633	10.83	10.67	10.14	10.03
5. irrigation	2593	2382	2717	2649	1.39	1.26	1.39	1.35
6. mulch	20000	20000	20000	20000	10.73	10.63	10.26	10.22
Subtotal (1+2+3+4+5+6)	69019	69062	71888	70184	37.04	36.69	36.87	35.87
Total Working Capital	112837	116165	137875	145203	60.55	61.72	70.71	74.22
C. Other costs								
1. rental value of owned land	15000	15000	15000	15000	8.05	7.97	7.69	7.67
2. land revenue	0	100	100	100	0	0.05	0.05	0.05
3. Depreciation	814	1089	1325	1666	0.43	0.57	0.68	0.85
4. Interest on working capital	2256	2323	2758	2904	1.21	1.23	1.41	1.48
5. Interest on value of fixed assets	395	408	474	485	0.21	0.21	0.24	0.25
Subtotal (1+2+3+4+5)	18466	18920	19657	20155	9.90	10.05	10.08	10.30
Grand total (A+B+C)	136127	136824	141071	141131	73.05	72.70	72.35	72.14
a) Cost A_1	115908	119578	141958	149774	62.20	63.54	72.80	76.55

b) Cost A_2	115908	119578	141958	149774	62.20	63.54	72.80	76.55
c) Cost B_1	116303	119986	142432	150259	62.41	63.75	73.05	76.80
d) Cost B_2	131303	134986	157332	165159	70.46	71.73	80.74	84.42
e) Cost C_1	154404	156083	162250	162946	82.86	82.93	83.21	83.29
f) Cost C_2	169404	171083	177150	177846	90.90	90.90	90.90	90.90
g) Cost C_2*	169404	171083	177150	177846	90.90	90.90	90.90	90.90
h) Cost C_3	186344	188192	194975	195631	100	100	100	100
Average Yield (kg/ha)	34765	34949	37886	37914				
Average price (₹/kg)	9.28	9.46	9.39	9.5				
Cost of production (Rs/kg)	5.36	5.38	5.14	5.15				

Table 2: Returns from tomato cultivation

Returns	Farm categories			
	Marginal	Small	Medium	Large
Gross Return (₹/ha)	322623	330620	355749	360189
Net Return (₹/ha) over				
Cost A_1	206714	211042	213792	210416
Cost A_2	206714	211042	213792	210416
Cost B_1	206319	210634	213318	209931
Cost B_2	191319	195634	198318	195031
Cost C_1	168219	174536	193499	197243
Cost C_2	153219	159536	178499	182343
Cost C_2*	153219	159536	178499	182343
Cost C_3	136278	142428	160774	164559
Returns/rupee of investment at cost C_3	1.73	1.75	1.82	1.84

Table 3: Cost of plant protection

Farm size group	Cost (₹/ha)	Cost (₹/ton)	% share in cost C_3
Marginal	21297	600	11.42...10.65
Small	21266	577	11.30
Medium	20893	550	10.71
Large	20754	528	10.60
Overall	21145	581	10.95

4. Conclusion

The most widely grown tomato varieties in the study area were Laxmi-5005, To-1458, Yuvraj and Skyway-687. Similar findings were reported by Kabdwal *et al*. (2016) [5]. The economic analysis of tomato cultivation reveals across different farm size groups revealed that medium and large farmers obtained considerably higher average yield in comparison to marginal and small farmers. This can be mainly attributed to the use of better, high yielding varieties by them. Hence, these varieties need to be promoted among the marginal and small farmers so that they can earn better returns. Moreover, the farmers in the study area were found totally dependent on chemical measures of pest control. Environment friendly practices of pest control like Integrated Pest Management (IPM) were found to be completely absent. There is a need to encourage farmers towards sustainable practices and dissuade over-dependence on chemicals.

5. Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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