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Productivity Analysis and Employment Effects of Marigold Cultivation in Jammu, India

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Abstract: The present study addresses the potential of marigold cultivation in terms of income and employment effects in the subtropical region of Jammu. Within the field research, we have surveyed 100 marigold farmers from Jammu and Kathua districts of Jammu Region. The region is of special interest in terms of economic development due to disproportional unemployment rate and high level of poverty. The study finds that marigold cultivation exhibits strong employment and income linkages. Marigold cultivation generates employment opportunities of 124.84 man-days (MD) in a season in comparison to 85.37 MD of rice and 49.58 MDs of wheat. Hence, marigold farming could create more and better-paid rural employment possibilities for peasants and lead to a substantial reduction of the poverty headcount ratios. Furthermore, the Cobb–Douglas production function-based econometric specification shows that farmyard manure (FYM), fertilizers, plant protection, and machine hours have a statistically significant positive effect on marigold yield. The second source of the growth of marigold cultivation is the replacement of subsistence farming with a focus on wheat and rice by marigold farming. We find that this kind of growth does not endanger food security in Jammu and Kathua districts. On the contrary, the growing level of income of the rural population could enhance market demand and a greater willingness to pay for the local agri-food sector and assure a greater level of food security.

Keywords: censored regression; Cobb–Douglas production function; marigold cultivation; rural employment

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1. Introduction

Floriculture is one of the gainful and rapidly growing branches of horticulture in terms of rural and peri-urban job creation, poverty alleviation, provision of regular income, assured food security and women empowerment in developing countries [1–3]. A total of 145 countries worldwide are involved in the floriculture industry, among which the Netherlands, USA, Columbia and Italy are major producers and traders worldwide. With a share of 43.7% on the world market, the Netherlands is the major flower exporter on the world market [4]. There is 17 billion USD worth of international floral trade and it increases annually by 15–20% and by 2025, it is going to reach 25 billion USD [5].

Although India ranks second in flower production after China, its share in global floriculture export was only 0.4% in 2018 [4]. India has 255,020 hectares (ha) area under flower cultivation with production of 1,754,500 tons (t) loose flowers and 47,942 t cut flowers. The commercially organized floriculture cultivation plays an important role in agrarian economy of Tamil Nadu, Karnataka and West Bengal. These states are the major floriculture cultivators in India [6]. Cultivation of flowering and ornamental plants for gardens and floristry, and especially cultivation of marigold, generate a relatively high level of return on investment, a greater demand for skilled and unskilled labor, and exhibit a greater level of average labor productivities in comparison to traditional agricultural crops [7–12].

The central reason for the strong job creation linkages of the marigold value chain emanates from the employment of the peasants for the entire crop season, and a relatively high labor-intensity of harvesting and packaging [13]. In addition, among different flower types, marigold exhibits the greatest profit–cost ratio in Pune, Raipur and Karnauj [14–16]. In Jammu, marigold cultivation and logistics exhibit impressive job and value creation effects [17,18]. However, in contrast, the output–input ratio for marigold cultivation equals 1.13:1 and is less than those of rose and tuberose cultivation productivity in Maharashtra [19]. The returns per rupee invested in eastern Uttar Pradesh depend on the size of the marigold farms. The output–input share of the small-sized farms is 1.66:1 and that of the large farms is 2.08:1 [20].

In union territory (UT) of Jammu and Kashmir, flowers were grown over an area of 750 ha in 2013–2014, out of which marigold crop ranked first among all flowers with a maximum area of 530 ha under cultivation followed by gladiolus, rose, tulip, chrysanthemum, etc. [21,22]. In Jammu region, a total of 468.53 ha area was under flower cultivation with a total production of 13,680 t loose flowers and 10.01 lakh number of cut flowers in 2014–2015, out of which, marigold flowers were cultivated on 467.33 ha, which yields total production of 13,680 t [23]. As Jammu is a city of temples, there is a constant requirement of flowers for worship/pooja purposes by certain communities [18].

The present study contributes to the literature on economic development in Indian subtropics. The focus on Jammu region of Jammu and Kashmir is justified by the fact that this region is one of less developed regions of India. The UT of Jammu and Kashmir has a recorded unemployment rate of 13.2% [24], much greater levels of disguised unemployment rate, and poverty headcount ratio of 12.58% at the national poverty line [25]. So far, there is no study which addresses the job creation, income and agricultural sector development potentials of marigold cultivation in Jammu subtropics. The flower cultivation is considered as an excellent venture, which can help the farmers in income augmentation and employs them for the entire crop season.

2. Materials and Methods

2.1. Sampling Strategy

The study was conducted based on the fieldwork data collected in the year 2017–2018 in the subtropical region of Jammu. The Jammu and Kathua districts were selected as these districts had the greatest area under the cultivation of marigold in 2014–2015 and the greatest growth potential in terms of marigold yield and cultivation area.

A multistage sampling technique has been opted as the data collection strategy. At the first stage, the districts were selected purposively and for the selection of villages, a village-wise list of marigold farmers has been provided by the Departments of Floriculture of the respective districts. Five villages having the largest number of farmers in both the districts were selected in the second stage. In the third stage of sampling, ten farmers from each village were selected randomly from the selected villages to constitute a sample of 100 farmers.

2.2. Economic Analysis

The cost and returns analysis were worked out using the methodology proposed by the Commission for Agricultural Costs and Prices (CACP). CACP is an advisory body that is attached to the Ministry of Agriculture and Farmers Welfare of India (New Delhi, India).

In accordance with this methodology, there are cost concepts such as cost A_1, A_2, B_1, B_2, C_1, C_2 and C_3, whereby cost A_1 encompasses wages of hired human labor, the value of the hired bullock labor, the value of owned bullock labor, the value of owned machinery labor, the hired machinery charges, the value of seed (both farm produced and purchased), the value of insecticides and pesticides, the value of manure (owned and purchased), the value of fertilizer, depreciation on implements and farm buildings, irrigation charges, land revenue, taxes, interest on working capital, and miscellaneous expenses. A_2 covers all components of A_1 plus the rent paid for leased-in land. B_1 covers all the components of A_1 plus interest on the value of owned fixed capital assets (excluding land). B_2 encompasses B_1 plus rental value of owned land and the rent paid for leased in land. C_1 consists of B1 and the imputed value of family labor. C_2 covers B_2 and the imputed value of family labor. C_3 contemplates C_2 plus the value of management input (10% of Cost C_2).

Gross returns were calculated by multiplication of the yield and the average prices received by the farmers. The Net returns were calculated after deduction of cost of cultivation from gross returns. The returns per rupee investment were calculated by dividing gross returns with cost of cultivation. This is also termed the benefit–cost ratio.

2.3. Input-Output Relationship/Regression Analysis

To analyze the contribution of the potential factors of production to marigold output and to determine the essential drivers of the productivity of marigold production, this study applies an econometric strategy, which is predicated on a translog production function approach. To this end, the study employs a Cobb–Douglas production function with unitary elasticity of substitution [26].

The underlying Cobb–Douglas production function has the following functional form

$$Y = AX_1^{b1}\, X_2^{b2}\, X_3^{b3}\, X_4^{b4}\, X_5^{b5}\, X_6^{b6}\, X_7^{b7} X_8^{b8} u \quad (1)$$

where Y stands for the yield of ith crop ($q{\cdot}ha^{-1}$), A for the intercept, X_1 for the seed rate ($kg{\cdot}ha^{-1}$), X_2 for farm yard manure ($q{\cdot}ha^{-1}$), X_3 for fertilizer employment ($kg{\cdot}ha^{-1}$), X_4 for value of plant protection measure (₹$\cdot ha^{-1}$) * Converted to USD; 1 ₹= 0.013 USD (as on 27 December 2021), X_5 for the family labor (man-days ha^{-1}), X_6 for the employment of the hired labor (man-days ha^1), X_7 for the use of tractor hours ($h{\cdot}ha^{-1}$), X_8 for employment of bullock labor (bullock pair days ha^{-1}). b_1 to b_8 are regression coefficients. These coefficients indicate production elasticities with respect to the respective production factors. u is an error term. Taking the natural log of Equation (1) yields the following functional form:

$$\ln(Y) = \ln A + b_1 \ln(X_1) + b_2 \ln(X_2) + b_3 \ln(X_3) + b_4 \ln(X_4) + b_5 \ln(X_5) + b_6 \ln(X_6) + b_7 \ln(X_7) + b_8 \ln(X_8) + u$$

The sum of regression coefficients/elasticities of production indicates returns to scale.

If, $\sum bi = 1$, constant returns to scale

$\sum bi < 1$, decreasing returns to scale

$\sum bi > 1$, increasing returns to scale

The expected increase in the gross returns with the use of an additional input keeping all other inputs constant is shown by marginal value productivity. In Cobb–Douglas production function, MVP can be calculated as:

$$\text{MVP} = b\frac{\bar{Y}}{\bar{x}}Py$$

where, $\bar{Y}$ = Geometric mean of output Y

$\bar{x}$ = Geometric mean of input Xi

bi = Regression coefficients/Elasticities of production

Py = value of dependent variable

Then the calculated MVP is compared with marginal input cost (MIC) and the inferences are drawn as:

If, MVP/MIC = 1; Optimal resource use
MVP/MIC > 1; Underutilization of resource
MVP/MIC < 1; Overutilization of resource

2.4. Censored Regression Analysis

For censored regression analysis, a Tobit model was used to describe the relationship between the non-negative dependent variable and a number of independent variables. This model assumes that the stochastic index ($b_0 + b_tX_t + U_t$) is observed only when it is positive.

3. Results

3.1. Cost Structure for Marigold Cultivation

The operation-wise cost of cultivation of marigold of sampled farms is shown in Table 1 and Figure 1. The cost of cultivation of marigold was 1405.71 USD·ha^{-1} in Jammu district and 1780.57 USD·ha^{-1} in Kathua district with an overall average of 1569.04 USD·ha^{-1} in Jammu subtropics. The various cost concepts were worked out on per hectare basis and are presented in Table 2 and Figure 2. The table revealed that per hectare cost A_1 on the farms of Jammu and Kathua were 799.85 and 1104.42 USD with an overall average of 932.68 USD. Seeds, FYM and hired human labor were the main components of cost A_1 constituting about 71.77%, 76.54% and 74.16% of cost A_1 in Jammu, Kathua and overall farms, respectively. The per hectare cost C_2 was found to be 1405.71 and 1780.57 USD in Jammu and Kathua, respectively, with an overall average of 1569.04 USD. After working out management cost, i.e., 10% of cost C_2, per hectare cost C_3 was found to be 1546.28 and 1958.63 USD in Jammu and Kathua district, respectively, with an overall average of 1725.95 USD on all farms.

Table 1. Operation-wise cost of cultivation of marigold (USD·ha^{-1}).

	Item	Jammu	Kathua	Overall
(i)	Human labour	560.54	680.15	612.42
I	Casual	95.30	109.59	101.50
II	Family	465.24	570.56	510.93
(ii)	Machine labour	71.58	74.99	73.06
(iii)	Seed	229.22	460.28	329.45
(iv)	Fertilizer	30.64	36.87	33.58
(v)	FYM	249.50	275.40	260.74
(vi)	Plant protection chemicals	57.98	61.77	59.62
(vii)	Interest on working capital	56.98	76.55	65.92
	Sub Total A (i to vii)	1256.44	1666.01	1434.78
(i)	Rental value of owned land	133.31	99.98	118.85
(ii)	Depreciation on implement and farm building	8.65	8.97	8.83
(iii)	Interest on fixed capital (Excluding land)	7.31	5.61	6.58
	Sub Total B (i to iii)	149.27	114.57	134.26
	Total cost (A + B)	1405.71	1780.57	1569.04

1 ₹= 0.013 USD (as on 27 December 2021).

3.2. Economics of Marigold Cultivation on Sampled Farms under the Study

Cost concept-wise economics of marigold is presented in Table 3, which revealed that per hectare overall net returns of marigold cultivation over cost A_1, cost A_2, cost B_1, cost B_2, cost C_1, cost C_2 and cost C_3 were 6929.87, 6811.62, 6923.33, 6805.08, 6415.00, 6296.74 and 6140.64 USD, respectively.

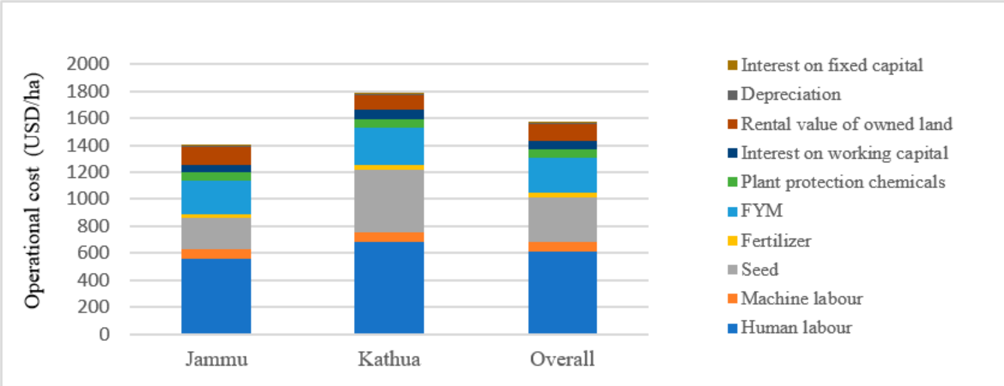

Figure 1. Operation-wise cost of cultivation of marigold (USD·ha^{-1}).

Table 2. Concept-wise cost of cultivation of marigold cultivation (USD·ha^{-1}).

Item	Jammu	Kathua	Overall
Hired human labour	95.30	109.59	101.50
Machine labour	71.58	74.99	73.06
Seed	229.22	460.28	329.45
Manure (FYM)	249.50	275.40	260.74
Fertilizers	30.64	36.87	33.58
Plant protection chemicals	57.98	61.77	59.62
Interest on working capital	56.98	76.55	65.92
Depreciation	8.65	8.97	8.83
Cost A_1	799.85	1104.42	932.68
Rent value of owned land	133.31	99.98	118.85
Cost A_2	933.16	1204.40	1051.54
Interest on fixed capital excluding land	7.31	5.61	6.58
Cost B_1	807.16	1110.03	939.26
Rental value of owned land	133.31	99.98	118.85
Cost B_2	940.47	1210.01	1058.11
Imputed value of family labour	465.24	570.56	510.93
Cost C_1	1272.40	1680.59	1450.19
Imputed value of family labour	465.24	570.56	510.93
Cost C_2	1405.71	1780.57	1569.04
Imputed value of family labour	465.24	570.56	510.93
Cost C_3	1546.28	1958.63	1725.95

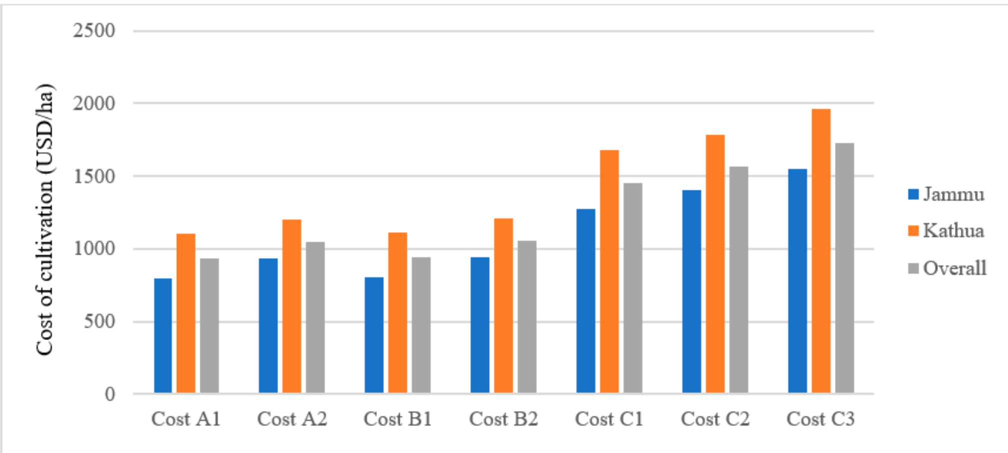

Figure 2. Cost structure of Marigold cultivation (USD·ha^{-1}).

Table 3. Productivity, income and cost concept-wise economics of marigold cultivation.

Item	Jammu	Kathua	Overall
Yield per ha (q)	168.27	167.90	168.09
Gross Income (USD·ha^{-1})	7081.16	8871.68	7857.83
Net income over Cost (USD·ha^{-1})			
Cost A_1	6285.37	7772.87	6929.87
Cost A_2	6152.73	7673.39	6811.62
Cost B_1	6278.09	7767.28	6923.33
Cost B_2	6145.46	7667.81	6805.08
Cost C_1	5815.21	7199.61	6415.00
Cost C_2	5682.57	7100.14	6296.74
Cost C_3	5542.69	6922.98	6140.64
Benefit-cost Ratio			
Cost A_1	8.85:1	8.03:1	8.43:1
Cost A_2	7.58:1	7.37:1	7.47:1
Cost B_1	8.77:1	7.99:1	8.37:1
Cost B_2	7.53:1	7.33:1	7.43:1
Cost C_1	5.57:1	5.28:1	5.42:1
Cost C_2	5.04:1	4.98:1	5.01:1
Cost C_3	4.58:1	4.53:1	4.55:1

The return per rupee investment on all farms over cost A_1, cost A_2, cost B_1, cost B_2, cost C_1, cost C_2 and cost C_3 were 8.43, 7.47, 8.37, 7.43, 5.42, 5.01 and 4.55 USD, respectively. On the basis of cost C_2, returns per rupee were higher for farms of Jammu district (5.04 USD) than the Kathua district (4.98 USD).

3.3. Employment Potential in Marigold Cultivation

Marigold cultivation provides good employment opportunities to farmers. In the present study, marigold cultivation for a single season required labor for 115.13 man-days (MD) in Jammu and 137.54 MD in Kathua in a season (Table 4). The employment generated by the major crops of the area revealed that labor use per hectare was highest in Marigold (124.84 MD) followed by rice (85.37 MD) and wheat (49.58 MD) in a season (Table 5). Further, it was also observed that in marigold, maximum labor employed was family labor (83.43%), while in case of rice and wheat crops, the share of family labor dropped and had a share of 60.59% and 63.70%, respectively. The most labor-intensive operations in marigold cultivation were plucking of flowers (harvesting), intercultural operations, irrigation, etc., while in rice, the most labor-intensive operations were harvesting and threshing, irrigation and transplanting, which needed 25, 20.25 and 19.11 MD, respectively, and in wheat, the maximum number of labor required were for harvesting and threshing followed by irrigation and land preparation, which needed 24, 10.29 and 8.00 MD, respectively.

3.4. Input-Output Relationship/Regression Analysis

Production function estimates and resource use efficiency of marigold cultivation is shown in Tables 6 and 7, respectively. The regression coefficients of FYM, fertilizer, plant protection and machine hours were found significant at the 5% level of significance and the sum of regression coefficients of inputs was less than 1, which shows decreasing returns to scale existed in marigold cultivation in Jammu subtropics. The value of R^2 was computed to be 0.73. The MVP to MIC ratio was greater than one in the case of FYM, fertilizer, plant protection and machine hours, which reveals the scope of increasing yield by raising the use of these inputs, while seed, family labor and hired labor showed negative MVP and thereby it is optimal to decrease the use of these inputs.

Table 4. Operation-wise employment (mandays) generated in marigold cultivation.

S. No.	Operations	Jammu		Kathua		Overall	
		Family Labour	Hired Labour	Family Labour	Hired Labour	Family Labour	Hired Labour
1	Land preparation	6.00	4.00	6.00	4.00	6.00	4.00
2	Nursery raising	2.90	0.00	3.29	0.00	3.06	0.00
3	Transplanting	11.71	4.66	6.99	9.29	9.66	6.67
4	Fertilizer application	2.00	0.00	2.00	0.00	2.00	0.00
5	Irrigation	27.15	0.00	28.04	0.00	27.54	0.00
6	Intercultural operations	7.25	13.21	30.42	11.26	17.30	12.36
7	Pesticide application	6.25	0.00	6.25	0.00	6.25	0.00
8	Plucking flowers	30.00	0.00	30.00	0.00	30.00	0.00
	Total	93.26	21.87	112.99	24.55	101.81	23.03

Table 5. Comparison of employment generation and benefits between marigold and cereal crops.

S. No.	Operations	Marigold		Rice		Wheat	
		Family Labour	Hired Labour	Family Labour	Hired Labour	Family Labour	Hired Labour
1	Land preparation	6.00	4.00	10.00	5.00	4.00	4.00
2	Nursery raising/Sowing	3.06	0.00	1.51	0.00	1.00	0.00
3	Transplanting	9.66	6.67	6.38	12.73	0.00	0.00
4	Fertilizer application	2.00	0.00	1.21	0.00	3.00	0.00
5	Irrigation	27.54	0.00	20.25	0.00	10.29	0.00
6	Intercultural operations	17.30	12.36	0.00	0.00	0.00	0.00
7	Pesticide application	6.25	0.00	3.29	0.00	3.29	0.00
8	Harvesting and threshing	30.00	0.00	10.00	15.00	10.00	14.00
9	Total	101.81	23.03	52.64	32.73	31.58	18.00
10	Production (main) (q)	168.09		23.94		19.78	
	(byproduct) (q)	0.00		36.86		12.84	
11	Gross income (main) (USD)	7906.95		1364.22		422.31	
	(byproduct) (USD)	0.00		54.12		137.11	
12	Gross returns (USD)	7906.95		1418.34		559.43	
13	Cost of cultivation (USD)	1570.84		538.65		303.37	
14	Net returns (USD)	6336.10		879.69		256.19	
15	BC ratio	5.01:1		2.63:1		1.84:1	

Table 6. Production function estimates of marigold cultivation in Jammu subtropics.

S. No.	Particulars	Estimated Parameters							
		Constant	Seed Rate	FYM	Fertilizers	Plant Protection	Family Labour	Hired Labour	Machine Hours
1	Regression coefficient	2.958 *	−0.021	0.005 *	0.062 *	0.181 *	−0.087	−0.001	0.339 *
2	Standard error	0.369	0.091	0.001	0.021	0.039	0.045	0.001	0.121
3	t-value	7.997	−0.236	3.977	2.963	4.618	−1.897	−0.792	2.808

* at 5% level of significance. $R^2 = 0.73$, F value = 34.79. $Y = 2.958\ X_1^{-0.021}\ X_2^{0.005*}\ X_3^{0.062*}\ X_4^{0.181*}\ X_5^{-0.087}\ X_6^{-0.0008}\ X_7^{0.339*}$.

The resource use efficiency of Jammu district and Kathua district was been calculated separately. The production function estimates of marigold cultivation and resource use efficiency of marigold in Jammu district is given in Tables 8 and 9. The regression coefficients of fertilizer and plant protection were found significant at the 5% level of significance. The value of R^2 was 0.83. As the sum of regression coefficients of inputs was less than 1, decreasing returns to scale existed in marigold cultivation in the Jammu district. The MVP to MIC ratio was greater than one in case of FYM, fertilizer, plant protection chemical and machine hours, which revealed the scope of increasing yield by raising the use of these inputs, while seed, family labor and hired labor showed negative MVP and thereby it is optimal to decrease the use of these inputs.

Table 7. Resource use efficiency of marigold cultivation in Jammu Subtropics.

Variable	Geometric Mean of X	Geometric Mean of Y	MVP	MIC	MVP/MIC	Level of Resource Use
Seed	0.161	166.943	−929.99	3002.94	−0.3097	Overutilization
FYM	0.619	166.943	57.59	6.67	8.6303	Underutilization
Fertilizer	159.7	166.943	2.77	0.20	14.137	Underutilization
Plant protection	4296.1	166.943	0.30	0.013	22.507	Underutilization
Family labour	103.1	166.943	−6.01	5.34	−1.1265	Overutilization
Hired labour	23.2	166.943	−6.01	5.34	−0.0461	Overutilization
Machine hours	7.738	166.943	312.36	9.34	33.434	Underutilization

Table 8. Production function estimates of marigold cultivation in Jammu district.

S. No.	Particulars	Estimated Parameters							
		Constant	Seed Rate	FYM	Fertilizers	Plant Protection	Family Labour	Hired Labour	Machine Hours
1	Regression coefficient	2.148 *	0.000	0.003	0.135 *	0.206 *	0.052	0.001	0.172
2	Standard error	0.455	0.000	0.002	0.031	0.055	0.084	0.002	0.216
3	t-value	4.716	65535	1.418	4.347	3.756	0.623	0.452	0.797

* at 5% level of significance. R^2 = 0.83, F value = 34.28. $Y = 2.148\ X_1^{0.000}\ X_2^{0.003}\ X_3^{0.135*}\ X_4^{0.206*}\ X_5^{0.052}\ X_6^{0.001}\ X_7^{0.172}$.

Table 9. Resource use efficiency of marigold cultivation in Jammu district.

Variable	Geometric Mean of X	Geometric mean of Y	MVP	MIC	MVP/MIC	Level of Resource Use
Seed	0.16	166.962	0	3002.94	0	Overutilization
FYM	0.715	166.962	29.91	6.67	4.4815	Underutilization
Fertilizer	143.55	166.962	6.71	0.20	34.249	Underutilization
Plant protection	4126.1	166.962	0.36	0.013	26.673	Underutilization
Family labour	95.84	166.962	3.87	5.34	0.7246	Overutilization
Hired labour	0.0004	166.962	0.34	5.34	0.0628	Overutilization
Machine hours	7.574	166.962	161.91	9.34	17.33	Underutilization

The production function estimates and resource use efficiency of marigold in Kathua district shows that regression coefficients for FYM, plant protection and machine hours were significant at the 5% level of significance (Tables 10 and 11).

Table 10. Production function estimates of marigold cultivation in Kathua district.

S. No.	Particulars	Estimated Parameters							
		Constant	Seed Rate	FYM	Fertilizers	Plant Protection	Family Labour	Hired Labour	Machine Hours
1	Regression coefficient	2.810 *	−0.024	0.005 *	0.035	0.154 *	−0.053	0.002	0.510 *
2	Standard error	0.586	0.105	0.002	0.031	0.058	0.066	0.002	0.156
3	t-value	4.796	−0.225	2.737	1.116	2.646	−0.793	0.999	3.275

* at 5% level of significance. R^2 = 0.72, F value = 15.23. $Y = 2.810\ X_1^{-0.024}\ X_2^{0.005*}\ X_3^{0.035}\ X_4^{0.154*}\ X_5^{-0.052}\ X_6^{0.002}\ X_7^{0.510*}$.

Table 11. Resource use efficiency of marigold cultivation in Kathua district.

Variable	Geometric Mean of X	Geometric Mean of Y	MVP	MIC	MVP/ MIC	Level of Resource Use
Seed	0.162	166.924	−1052.91	3002.94	−0.3506	Overutilization
FYM	0.536	166.924	66.45	6.67	9.958	Underutilization
Fertilizer	177.83	166.924	1.40	0.20	7.166	Underutilization
Plant protection	4476.32	166.924	0.25	0.013	18.376	Underutilization
Family labour	110.98	166.924	−3.34	5.34	−0.6256	Overutilization
Hired labour	0.0036	166.924	0.59	5.34	0.1112	Overutilization
Machine hours	7.905	166.924	459.92	9.34	49.229	Underutilization

The value of R^2 was 0.72. As the sum of regression coefficients of inputs was less than 1, decreasing returns to scale existed in marigold cultivation in the Kathua district. The MVP to MIC ratio was greater than one in case of FYM, fertilizer, plant protection chemical and machine hours, which revealed the scope of increasing yield by raising the use of these inputs, while seed, family labor and hired labor showed negative MVPs or MVPs less than one and thereby it is optimal to decrease the use of these inputs.

3.5. Censored Regression Analysis

The specific variables included in the model are described in Table 12 and the sample characteristics of the variables are given in Table 13, which revealed the minimum value, maximum value, 1st quartile deviation, 2nd quartile deviation or mean, 3rd quartile deviation and median value of variables used in the tobit model.

Table 12. Description of the explanatory variables used in the regression model.

Variables	Description	Measurement
Income	Income of the farmer from marigold crop per hectare	Rupees (₹) *
Seed rate	Seed rate per hectare	Kilograms (kg)
Farm yard manure (FYM)	FYM applied per hectare	Quintals (q)
Fertilizer	Fertilizer applied per hectare	Kilograms (kg)
Plant protection chemicals	Value of Plant protection chemicals applied in a hectare	Rupees (₹) *
Family labour	Family labour used in a hectare	Mandays (MD)
Hired labour	Hired labour used in a hectare	Mandays (MD)
Machine labour	Machine labour used in a hectare	Number of hours
Age	Age of the sampled farmer	Number of years
Education (Ed.)	Educational status of the farmer	Graduate- Graduate and post graduate High school- higher secondary, middle school- upto matric and matric, illiterate- haven't attended school
Year of cultivation	Years of cultivating marigold on the farm	Number of years
Distance from market	Distance of field from the market place	Kilometer (km)

* Converted to USD; 1 ₹= 0.013 USD (as on 27 December 2021).

R software version 3.21 was used to estimate the parameters of the determinants of the extent of income of farmers from marigold cultivation and the tobit regression estimates of determinants are given in Table 14. The coefficient of determination indicated that 69% of the variation in the income of the farmer by marigold crop is explained by independent variables. The farmer's income from marigold crop was significantly determined by FYM, family labor, hired labor, education and years of cultivating marigold at the 5% level of significance.

Table 13. Descriptive statistics on the variables used in the tobit model.

Income	Seed Rate	FYM	Fertilizers	Plant Protection Chemicals	Family Labour
Min.: 4003.92 1st Qu: 6361.79 Median: 8007.84 Mean: 8026.28 3rd Qu: 9342.48 Max.: 15348.36	Min.: 0.1600 1st Qu: 0.1600 Median: 0.1600 Mean: 0.1619 3rd Qu: 0.1600 Max.: 0.3500	Min.: 0.00 1st Qu: 10.00 Median:10.00 Mean: 12.17 3rd Qu: 20.00 Max.: 33.33	Min.: 33.33 1st Qu: 140 Median: 160 Mean: 171.69 3rd Qu: 200 Max.: 460	Min.: 33.37 1st Qu: 41.71 Median: 58.39 Mean: 58.98 3rd Qu: 66.73 Max.: 83.41	Min.: 63.08 1st Qu: 93.25 Median: 106.92 Mean: 105.21 3rd Qu: 123.25 Max.: 148.25
Hired labour	**Machine hours**	**Age**	**Education**	**Years of cultivation**	**Distance from market**
Min.: 0.00 1st Qu: 0.00 Median: 0.00 Mean: 11.79 3rd Qu: 17.50 Max.: 56.00	Min.: 7.00 1st Qu: 7.50 Median: 8.00 Mean: 7.76 3rd Qu: 8.00 Max.: 10.00	Min.: 25 1st Qu: 40 Median: 46 Mean: 48.05 3rd Qu: 62 Max.: 78	grad: 2 High sch: 3 illiterate: 16 Middle sch: 79	Min.: 2.00 1St Qu: 5.00 Median: 6.00 Mean: 6.77 3rd Qu: 8.00 Max.:12.00	Min.: 0.00 1st Qu: 2.375 Median: 4.00 Mean: 6.465 3rd Qu: 6.00 Max.: 30.00

Table 14. Tobit regression estimates of determinants of income of farmer from marigold crop.

Coefficients	Estimate	Std. Error
Intercept	1.150 **	0.0782
Seed rate	3.247	0.0689
FYM	3.609 *	0.0708
Fertilizer application	5.660	0.0211
Plant protection	−6.263	0.1147
Family labour	2.071 **	0.079
Hired labour	1.904 *	0.0890
Machine hours	2.356	0.00043
Age	5.916	0.093
Ed. (High school)	−2.497 *	0.153
Ed. (illiterate)	−1.930 *	0.093
Ed. (middle school)	−1.593 *	0.0756
Years of cultivation	5.190 **	0.532
Distance from market place	−1.096	0.014

* at 5% level of significance, ** at 1% level of significance.

3.6. Production Related Constraints Faced by the Farmers

Table 15 highlights the production constraints faced by the farmers of the study area. The results indicated that the most serious problems faced by the maximum number of farmers were risky nature of the venture (50%) followed by high input cost (41%), insect pest/disease problem (39%) and lack of new improved varieties (30%). As analyzed through chi square, there were problems having significant difference in the severity between the two districts like unavailability of timely labor, high input cost, stray animals and lack of financial resources.

3.7. Post-Harvest Related Constraints

Table 16 highlights the post-harvest-related constraints prevailing in the study area. It revealed that the most serious problems, which were faced by the maximum number of farmers were unavailability of quality packing material (55%) followed by lack of grading facilities (50%), non-availability of cold storage facilities (30%) and spoilage (18%). The unavailability of quality packing material and spoilage constraints faced by the farmers of Jammu and Kathua districts varied in severity as evident through significant chi square value at 5% level of significance, while others were borne in same severity to the farmers of both the districts and had insignificant chi square value.

Table 15. Constraints faced by farmers of Jammu and Kathua district.

S. No.	Production Constraints	Proportion of Farmers Facing Constraint (Multiple Responses)		Chi Square Value
		Jammu	Kathua	
1.	Lack of technical know-how	02	04	0.344
2.	Lack of new varieties	28	32	0.735
3.	High input cost	28	54	6.98 *
4.	Unavailability of timely labour	12	00	6.38 *
5.	Insect pest/disease problem	32	46	2.06
6.	Lack of financial resources	36	00	21.951 *
7.	Stray animals	00	26	14.94 *
8.	More risky venture	58	42	2.56

* at 5% level of significance.

Table 16. Comparison of post-harvest-related constraints faced by farmers of Jammu and Kathua district.

S. No.	Post-Harvest Related Constraint	Proportion of Farmers Facing Constraint (Multiple Responses)		Chi Square Value
		Jammu	Kathua	
1.	Lack of grading facilities	48	52	0.364
2.	Unavailability of quality packing material	70	40	15.263 *
3.	Spoilage	36	00	21.951 *
4.	Lack of cold storage facilities	26	34	0.765

* at 5% level of significance.

4. Discussion of the Results and Outlook

The average cost of cultivation of marigold crop is 1569 USD·ha^{-1} in Jammu subtropics. There is a difference of 374.86 USD·ha^{-1} in the cost of cultivation between the two districts as the farmers of Kathua are using resources more intensively and spending a higher amount on all the inputs. The maximum difference of 231.06 USD between the expenditure incurred by the farmers in the two districts is on seeds because the farmers of Kathua district are specifically using hybrid seeds, while a significant proportion of farmers of Jammu are also using open pollinated farm produced seeds [14,27,28]. Marigold cultivation yields maximum gross returns of 7906.95 USD·ha^{-1} followed by rice (1418.34 USD·ha^{-1}) and wheat (559.43 USD·ha^{-1}) and the net income generated is also maximum for marigold (6336.10 USD·ha^{-1}) followed by rice (878 USD·ha^{-1}) and wheat (256 USD·ha^{-1}) yielding a benefit cost ratio of 5.01:1, 2.63:1 and 1.84:1 in marigold, rice and wheat, respectively, which shows the profitability of marigold cultivation over the two other major crops of the area. Moreover, marigold crop generates employment opportunity for 124.84 MD, while rice and wheat only require labor for 85.37 and 49.58 MD [12,29,30]. The regression analysis shows that FYM, fertilizers, plant protection and machine hours are having significant effects on the output at the 5% level of significance in Jammu subtropics and the value of R^2 is calculated to be 0.73. The production can be increased by increasing the use of FYM, fertilizer, plant protection and machine hours or by decreasing the use of seed, family labor and hired labor [31,32]. The censored regression analysis reveals that FYM, family labor, hired labor, education and years of cultivating marigold have significant effects on the income from marigold cultivation at the 5% level of significance. The value of R^2 is calculated to be 0.69. As marigold is a labor-intensive crop, its production can be increased with application of more labor, whether family labor or hired labor, which in turn can lead to more income. Educational status of the farmer is also significantly associated with the income from marigold crop as it is believed that the more educated farmers has modern knowledge of cultivating marigold and the market information and therefore more educated farmers are more likely to have more income. Along with education, years of cultivating marigold also has a positive effect on farmer's income as the farmers who have been cultivating marigold from older times are believed to have more experience and have more trading contacts than the new farmers. The findings of both the models contradict each other in the case of labor. It shows yield increase does not guarantee more income to farmers but with application of more labor, the farmer can perform additional management functions such as packing, grading, value addition of flowers by making garlands, which raise their value and consequently the farmer's income [17]. The most serious production issues as reported by the farmers are risky nature of the venture followed by high input cost, insect pest/disease problem and lack of new improved varieties. While the most serious constraints related to post-harvest management are unavailability of quality packing material, lack of grading facilities, spoilage and nonavailability of cold storage facilities [33–36].

Growth of the marigold cultivation can substantially contribute to job creation in floriculture and increasing the level of productivity of labor and the surge of the profits of farmers engaged in marigold cultivation. Our empirical Cobb–Douglas production function-based analysis shows that farmers can boost their yield by increasing FYM, fertilizers, plant protection and machine hours, which are underutilized. Income of the farmers is significantly and positively affected by hired labor, family labor, level of education and years of cultivation as more educated and more experienced farmers lead to better production and marketing practices.

Furthermore, we find that marigold cultivation could also grow by replacement of the wheat and rice cultivation by marigold farming. Marigold cultivation is a profit venture and can generate net returns of 6336.10 USD·ha^{-1} offered throughout the flower season in installments and generates employment opportunities of 124.84 MD·ha^{-1}. Meanwhile, the major cereal crops namely rice generate employment of 85.37 man-days and wheat of 49.58 man-days and net income of 879.69 and 256.19 USD· ha^{-1}, respectively, in the end of the crop season. Due to the predominance of subsistence farming in these districts, replacing subsistence farms by modern floriculture does not affect negatively food security of the districts. This kind of development has the potential for generation of the leeway for triggering savings behavior of the former subsistence farmers after selling or leasing their land and supplying their labor to marigold cultivating farmers [37–39].

The relatively small sample size of 100 respondents is the central limitation of the present investigation. With a greater sample size, we could obtain representative results and generalize them for the whole population in the rural areas of Jammu. However, this study can serve as an inspiration for further studies in India and other developing countries, especially African tropics and subtropics, in order to understand the potential of flower cultivation in raising farmers' income and employment opportunities. The farmers' increased income can raise their living standard or help in capital formation by investment in profitable ventures and thereby commercialization of the floriculture sector.

The findings show that by focusing on the cultivation of marigolds, more jobs and profits for the private farmers are possible. This is in line with the Sustainable Development Goal (SDG) 1, no poverty, and SDG 8, decent work and economic growth. On the other hand, shifting from subsistence agriculture to cash crops that can be also exported to Europe and large cities could deteriorate food security in the rural developing areas. This kind of development could be in conflict with SDG 2, zero hunger. Hence, the agricultural and economic policies have to account for this trade-off and try to implement policies, which would facilitate the maximization of this kind of specialization without putting food security at risk. This finding could be useful both in the contexts of theoretical development studies and practical economic policies on the other hand side [38].

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