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Economic Analysis of Fennel Cultivation in Nagaur District of Rajasthan

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ABSTRACT

More than 60 per cent area of Rajasthan falls under arid zone, where soil is light textured, have poor fertility and low water holding capacity. Since, reducing cost of cultivation itself is a big challenge due to varied economic reasons, promoting diversification towards high value crops like fennel can be a plausible solution to the low farm income problem in the arid regions. Therefore, a sample of 80 fennel growers were investigated in Nagaur district of Rajasthan to understand the cost and returns structure; and thus, profitability associated with fennel cultivation. The data were collected in the agricultural year 2020-21 and analyzed through CACP cost concepts for detailed study. The results showed that the per hectare total cost of cultivation of fennel was ₹ 49027.46. Out of which, operational cost accounted for 69.64 per cent and fixed cost was 30.36 per cent of total costs. Cost of production was highest (₹ 3315.55 per quintal) for small farmers and lowest (₹ 3210.15 per quintal) for large farmers with an overall average of ₹ 3256.65 per quintal. Overall gross returns, net returns, farm business income and family labour income were ₹ 115920, 61989.79, 83971.00 and 71733.53 per hectare, respectively. The average returns per rupee were ₹ 2.14, which shows that production of fennel is highly profitable. Since fennel seemed to fetch good prices, the farmers can be sensitized about its export trading prospects along with the option of contract farming and future trading of fennel. Grading and standardization facilities should also be ensured so that farmers can realize the maximum profits through quality fennel produced.

Keywords: Fennel, CACP, Returns per rupee, Cost of cultivation, Rajasthan

India, world's largest producer and exporter of spices, produced 10.53 million tonnes of spices, from 4.49 Million ha area during 2020-21 (Spice Board, 2021). Despite the COVID 19 Pandemic, Indian spices export sustained its upward trend in 2021-20 and attained an all-time high of 15.65 lakh tonnes valued at ₹ 27,193 crores. The export showed an increase of 30% in volume and 23% in rupee value. The country ranks first in global fennel production with the share of more than 70 per cent with production of 128,497 tonnes in 2020-21, cultivated over 79,842 hectares.

Fennel is one of the major spices, grown in different parts of the world, especially in the sunny and temperate regions. Different states are known for different spices but seed spices are mostly grown in Rajasthan and Gujarat with more than 80 per cent contribution (Jankiram and Lal, 2018). Rajasthan ranked second accounting 26.67% of fennel seed, produced in India in 2020-21 with 34,276 tonnes annual production cultivated over 31,622 hectares. (Spices Board India, Ministry of Commerce and

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Industry, Government of India, 2022). In Rajasthan, fennel crop is mainly grown in Nagaur, Sirohi, Jodhpur, Pali, Sawai Madhopur, Dausa, Jalore and Tonk districts. Nagaur district is the major fennel growing district of the Rajasthan and occupies first rank in area and production under the crop. Nagaur district covered an area of 9,959 hectares and produced 12,473 tonnes fennel during the year 2018-19 (Directorate of Economics and Statistics, Jaipur).

More than 60 per cent area of Rajasthan falls under arid zone where soil is light textured; have poor fertility and low water holding capacity. Reducing cost of cultivation itself is a big challenge given the persistent price rise trend on agricultural input sectors. Therefore, promoting diversification towards high value crops can still be viewed as a plausible solution to the low farm income problem. Furthermore, accurate information on cost of cultivation is crucial for the economic viability of a farm sector. It not only helps farmers to make decision regarding their limited resources allocation, but also helps them in assessment of their farm profitability (Srivastava *et al.* 2017). Despite being such an important seed spice, there is no systematic literature available on economics of fennel crop production. Therefore, to fill this research gap, the present study was undertaken to understand costs and returns and thus profitability from fennel cultivation in Nagaur district of Rajasthan.

MATERIALS AND METHODS

Sampling Framework

Multistage sampling was done to identify the respondents. At first stage Nagaur district in Rajasthan was chosen purposively as it occupies first rank in area under fennel. Of the 13 blocks of Nagaur district tehsils. Out of which, two tehsils namely Merta City and Jayal were selected purposively as these tehsils had comparatively higher area under fennel cultivation. Four fennel growing villages namely Basni and Lambajatan from Merta City tehsil and Kalvi and Mundi from Jayal tehsil were chosen next for the study. A list of all the fennel growers of each of the selected villages along with their size of operational holdings was prepared with the help of *patwaries* of the concerned villages, separately. Finally, 80 fennel growers were selected through probability proportion to size method from four standard size category, the details of which have been presented in Table 1.

Table 1: Classification of sample farmers in different farm size group

Farm size group	Average operational land holding size (in ha)	Total number of fennel growers in Nagaur District	Total number of sample fennel growers
Small	1.44	235	43
Semi – medium	3.07	105	19
Medium	7.28	72	13
Large	12.96	28	05
Total/ overall	**3.86**	**440**	**80**

Analytical Framework

CACP cost concepts were used to workout the cost of cultivation of fennel with following cost items:

1. Value of hired human labour
2. Value of owned animal labour
3. Value of hired animal labour
4. Value of owned machine labour
5. Valve of hired machine labour
6. Value of owned seed
7. Value of purchased seed
8. Value of owned farm yard manure (FYM)
9. Value of purchased farm yard manure (FYM)
10. Value of fertilizers and insecticides
11. Irrigation charges
12. Depreciation on farm building and implements
13. Land revenue
14. Interest on working capital
15. Miscellaneous expenses
16. Interest on fixed capital
17. Rental value of owned land
18. Rent paid for leased in land
19. Value of family labour

Cost A_1: 1 to 15 items

Cost A_2: Cost A_1 + rent paid for leased in-land.

Cost B_1: Cost A_1 + interest on fixed capital assets (excluding land)

Cost B_2: Cost B_1 + rental value of owned land + rent paid 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.

Interest on working capital

Interest on working capital was worked out on the basis of 7% interest rate charged by financial institutions for short term credit in the study area.

Interest on fixed capital

In the study area, interest on present value of fixed assets (excluding land) such as implements, machinery and buildings was calculated as per the 10% rate charged by the financial institutions for term loans.

Depreciation

Depreciation on an asset was calculated using the straight line method as follows:

$$\textit{Depreciation} = \frac{\text{Purchase price of an asset} - \text{Junk value}}{\text{Expected life of the asset in year (expected life)}}$$

After calculating total annual depreciation of the farm, the depreciation for fennel crop was worked out as below:

$$\textit{Depreciation under fennel} = \frac{\text{Total annual depreciation}}{\text{Total cropped area}} * \text{Area under fennel crop}$$

Rental value of owned land

It was calculated on the basis of prevailing rates of leased out of owned land on the sample farms in the study area.

Cost of production

The cost of production was worked out by using following formula:

$$\textit{Cost of production per quintal} = \frac{\text{Total cost of cultivation}}{\text{Quantity of main product}}$$

Income measures: Following income concepts were used to calculate income earned from fennel cultivation.

Gross income: It is the total value of main product as well as by-product.

$$G_I = Q_m * P_m + Q_b * P_b$$

Where,

G_I = Gross Income in rupees

Q_m = Quantity of main product

P_m = Price of main product

Q_b = Quantity of by product

P_b = Price of by product

Farm business income: Gross income - Cost A_1 (Cost A_2 in case of tenant operated land)

Family labour income: Gross income – Cost B_2

Net income: Gross income – Cost C_2

Return to management: Gross income – Cost C_2

Return per rupee of investment: Gross Income (G.I.)/ Total Cost (cost C_2)

RESULTS AND DISCUSSION

The input use patterns, cost items and different types of costs borne by the sample farmers in cultivation of fennel, along with gross returns, net returns, family income, farm business income and return per rupee was estimated and presented under the following subheads:

(A) Utilization of inputs in fennel cultivation

(B) Component wise costs in fennel cultivation

(C) Cost groups in fennel cultivation

(D) Returns from the cultivation of fennel

(A) Utilization of inputs in fennel cultivation

Different types of farm inputs utilized (in physical terms) by different farm size groups of farmers in the fennel cultivation have been presented in the Table 2.

The table 2 shows that overall utilization of human labour in fennel cultivation was 35.14 man days/ha Among the farm size groups, total human labour utilized in fennel cultivation per hectare was 30.39, 33.30, 37.00 and 39.86 man days on small, semi-medium, medium and large farms, respectively. It was observed that utilization of total human labour had positive relationship with the size of farm holdings. Family labour utilization was observed 23.19, 21.94, 12.35 and 7.05 man days/ha for small, semi-medium, medium and large farms, respectively, with the overall of 16.13 man days/ha Whereas, hired human labour utilized in fennel cultivation per hectare was 7.20 man days on small, 11.36 man days on semi-medium, 24.65 man days on medium and 32.81 man days/ha on large farms. The overall utilization of hired human labour in cultivation of fennel was 19.08 man days/ha Thus, with the increase in farm size holding, family labour involvement decreased, while hired labour participation increased.

Overall machine labour utilization in fennel cultivation was estimated at 13.65 hrs./ha and it was 11.86, 12.78, 14.76 and 15.20 hrs./ha on small, semi-medium, medium and large farms, respectively. Use of machine labour was lowest (11.86 hrs./ha) on small farms and highest (15.20 hrs./ha) on large farms.

The common seed sowing practice followed by the sample farmers in the study region was dibbling method. Among the different categories, used quantity of fennel seeds was highest for large farms (4.39 kg/ha) and lowest for small farms (2.74 kg/ha). On an average, seed rate of fennel was calculated as 3.75 kg/ha.

The overall utilization of farm yard manure in cultivation of fennel was found 107.48 quintal per hectare. The quantity of farm yard manure per hectare was estimated to be 135.36, 114.78, 95.60 and 84.65 quintal on small, semi-medium, medium and large farms, respectively.

In case of the fertilizer utilization, on an average, total consumption of fertilizers in cultivation of fennel was 117.28 kg/ha. The utilization of fertilizers was observed as highest (132.97 kg/ha) on large farm and lowest (102.56 kg/ha) on small farm. Among the fertilizers, the overall utilization of nitrogen (*i.e.*, urea) was 70.88 Kg/ha. Among different farm size groups, quantity of nitrogen utilization varied from 63.22, 67.03, 73.62 and 79.67 Kg/ha for small, semi-medium, medium and large farms, respectively. The quantity of phosphorus (*i.e.*, DAP) was estimated at 39.34 kg/ha on small, 44.34 kg/ha on semi-medium, 48.63 kg/ha on medium and 53.30 Kg/ha on large

Table 2: Utilization of inputs in fennel cultivation on different farm size groups

Sl. No.	Farm Inputs \ Farm size	Small	Semi-medium	Medium	Large	Overall
1	**Human labour (man days/ha)**					
(A)	Family labour	23.19	21.94	12.35	7.05	16.13
(B)	Hired labour	7.20	11.36	24.65	32.81	19.08
	Total human labour (A+B)	30.39	33.30	37.00	39.86	35.14
2	Hired machine labour (hrs./ha)	11.86	12.78	14.76	15.20	13.65
3	Seed (Kg/ha)	2.74	3.34	3.84	4.39	3.75
4	Manures (FYM) (quintal/ha)	135.36	114.78	95.60	84.65	107.48
5	**Fertilizers (in Kg/ha)**					
(A)	Nitrogen (Urea)	63.22	67.03	73.62	79.67	70.88
(B)	Phosphorus (DAP)	39.34	44.34	48.63	53.30	46.40
	Total Fertilizers (A+B)	102.56	111.37	122.25	132.97	117.28
6	Plant protection chemicals (Lit/ha)	0.53	0.61	0.66	0.73	0.63
7	Number of Irrigations (Per hectare)	6	7	8	9	7.5

farms with the overall phosphorus utilization of 46.40 Kg/ha.

In cultivation of fennel, quantity of plant protection chemicals (like Dimethoate, Karathane etc.) was utilized as 0.53, 0.61, 0.66 and 0.73 lit/ha on small, semi-medium, medium and large farms, respectively, with an overall plant protection chemicals application of 0.63 lit/ha. Utilization of plant protection chemicals increased with increase in the farm size holdings.

Finally, the overall number of applied irrigation in fennel cultivation was calculated at 7.5 per/ha during its entire life. Among different categories of sample farms, the total number of applied irrigations was estimated at 6, 7, 8 and 9 per hectare for small, semi-medium, medium and large farms, respectively.

(B) Component wise costs in fennel cultivation

The several cost items incurred in the cultivation of fennel on different farm size groups are shown in Table 3.

The table 3 depicts that, on an average, per hectare total cost of cultivation of fennel was ₹ 49027.46. Out of which, operational cost accounted for 69.64 per cent *i.e.* ₹ 34140.45/ha and fixed cost was 30.36 per cent of total costs *i.e.* ₹ 14887.01/ha. A lot of studies reported similar kind of cost shares in which variable costs ranged from 40 per cent to 78 per cent for spices like cumin, coriander etc. (Salve *et al.* 2017; Patel *et al.* 2018 and Meena *et al.* 2020). Table further reveals that the total cost of fennel cultivation ranged to ₹ 44307.89, ₹ 46894.69, ₹ 50982.45 and ₹ 54280.83 per hectare for small, semi-medium, medium and

Table 3: Component wise costs in fennel cultivation on different farm size groups (₹/ha)

Sl. No.	Farms size / Inputs	Small	Semi-medium	Medium	Large	Overall
(A)	**Operational costs**					
1	Hired machine labour	5930.23 (13.38)	6394.81 (13.64)	7367.16 (14.45)	7601.62 (14.00)	6823.45 (13.92)
2	Human labour					
	(i) Hired labour	2162.79 (4.88)	3410.59 (7.27)	7395.97 (14.51)	9843.24 (18.13)	5703.14 (11.63)
	(ii) Family labour	6957.71 (15.70)	6582.78 (14.04)	3707.27 (7.27)	2116.21 (3.90)	4840.99 (9.87)
	Total human labour (i+ii)	9120.50 (20.58)	9993.37 (21.31)	11103.84 (21.78)	11959.45 (22.03)	10544.29 (21.51)
3	Seed	2664.73 (6.01)	3241.89 (6.91)	3729.12 (7.31)	4261.44 (7.85)	3474.29 (7.09)
4	**Fertilizers**					
	(i) Nitrogen (Urea)	331.29 (0.75)	351.27 (0.75)	385.77 (0.76)	417.49 (0.77)	371.45 (0.76)
	(ii) phosphorus (DAP)	983.53 (2.22)	1108.59 (2.36)	1215.75 (2.38)	1332.73 (2.45)	1160.15 (2.36)
	Total fertilizers (i+ii)	1314.82 (2.97)	1449.86 (3.09)	1601.52 (3.14)	1750.22 (3.22)	1529.10 (3.12)
5	Manures	8798.36 (19.86)	7460.62 (15.91)	6214.64 (12.19)	5502.60 (10.14)	6994.05 (14.27)
6	Plant protection chemicals	302.06 (0.68)	342.52 (0.73)	373.93 (0.73)	413.71 (0.76)	358.05 (0.73)
7	Irrigation	2583.50 (5.38)	3129.60 (6.67)	3758.58 (7.37)	4530.25 (8.36)	3500.48 (7.14)
8	Interest on working capital	415.73 (0.94)	445.19 (0.95)	532.70 (1.05)	593.30 (1.09)	496.74 (1.01)
9	Miscellaneous charges	320 (0.73)	390 (0.82)	460 (0.91)	510 (0.94)	420 (0.86)
	Total operational costs (A)	31449.93 (70.98)	32847.79 (70.05)	35141.49 (69.63)	37122.59 (68.39)	34140.45 (69.64)
(B)	**Fixed costs**					
1	Rental value of owned land	10500 (23.70)	10980 (23.41)	11520 (22.60)	12780 (23.54)	11445 (23.34)
2	Depreciation	1867.58 (4.21)	2437.38 (5.20)	3050.71 (5.98)	3242.49 (5.98)	2649.54 (5.40)
3	Interest on fixed capital	490.38 (1.11)	629.52 (1.34)	914.25 (1.79)	1135.75 (2.09)	792.47 (1.62)
	Total fixed costs (B)	12857.96 (29.02)	14046.90 (29.95)	15484.96 (30.37)	17158.24 (31.61)	14887.01 (30.36)
A+B	Total (operational cost + fixed cost)	44307.89 (100)	46894.69 (100)	50982.45 (100)	54280.83 (100)	49027.46 (100)

large farms, respectively. Among the total costs, per hectare total operational costs were estimated as ₹ 31449.93 on small, ₹ 32847.79 on semi-medium, ₹ 35141.49 on medium and ₹ 37122.59 on large farms. Whereas, total fixed costs were ₹ 12857.96, ₹ 14046.90, ₹ 15484.96 and ₹ 17158.24 per hectare on small, semi-medium, medium and large farms, respectively. Results suggest that cost was increasing with increase in land holding, which is in consonance with the findings of Viraja *et al.* (2018).

Component-wise, the overall per hectare machine labour charges in fennel cultivation were ₹ 6823.45 which accounted for 13.92 per cent of total costs. Among the different size group of farms, the per hectare machine labour costs were estimated at ₹ 5930.23 in small farm, ₹ 6394.81 in semi-medium farm, ₹ 7367.16 in medium farm and ₹ 7601.62 in large farm groups. Among operational items, human labour was one of major cost items in the fennel cultivation. Out of the total cost, it alone accounted for 21.51 per cent of overall total cost in the cultivation of fennel. Patel *et al.* (2018) reported the similar share of human labour *i.e.* 19.27 per cent while calculating economics of cumin in Banaskantha district of Gujarat. Per hectare human labour cost was estimated to be ₹ 9120.50 (20.58%) on small farms, ₹ 9993.37 (21.31%) on semi-medium farms, ₹ 11103.84 (21.78) on medium farms and ₹ 11959.45 (22.03 %) on large farms. It was interesting to note that the family labour cost was highest on small farms *i.e.* ₹ 6957.71/ha (15.70 %) and lowest on large farms *i.e.* ₹ 2116.21/ha (3.90 %). It gives the notion that more labour was hired for various farming operations in the study region, when farm size increased.

Furthermore, the overall expenses on fennel seed were ₹ 3474.29 per ha which accounted for 7.09 per cent of total cost. Cost of seed varied from ₹ 2664.73 per hectare on small farms to ₹ 4261.44 per hectare on large farms. The cost of fertilizer was found highest (*i.e.*, ₹ 1750.22/ha) on large farms and it was lowest (*i.e.*, ₹ 1314.82/ha) on small farms with an overall cost of fertilizer of ₹ 1529.10 per hectare *i.e.* 3.12 per cent of total cost. Per hectare average cost of farm yard manure (FYM) was estimated at ₹ 6994.05 per hectare (14.27%) of total cost. Kiruthika (2013) reported similar share of FYM *i.e.*, 11.80 per cent to total cost while calculating economics of turmeric in India. Cost of farm yard manure (FYM) varied from small farms (*i.e.*, ₹ 8798.36/ha) to large farms (*i.e.*, ₹ 5502.60/ha). Result suggested that cost of farm yard manure decreased with increase in land holding. The per hectare cost of plant protection chemicals was estimated to be ₹ 302.06 on small, ₹ 342.52 on semi-medium, ₹ 373.93 on medium and ₹ 413.71 on large farms. Overall cost of plant protection chemicals was ₹ 358.05/ha which accounted a minor share of 0.73 per cent to the total cost.

The next important cost item in operational costs was the irrigation charges. On an average, the irrigation charges in fennel cultivation was estimated at ₹ 3500.48/ha (7.14%) of total cost. It was also observed that the irrigation charges were highest (*i.e.*, ₹ 4530.25/ha) on large farms and lowest (*i.e.*, ₹ 2583.50/ha) on small farms. On an average, interest on working capital was calculated as ₹ 496.74/ha It varied from ₹ 415.73/ha on small farms to ₹ 593.30/ha on large farms.

The next important cost component was fixed cost, in which rental value of owned land was found the prime subcomponent in total cost of fennel cultivation. The overall rental value of owned land per hectare was estimated at ₹ 11445 which accounted for 23.34 per cent of total cost. It was calculated as ₹ 10500, ₹ 10980, ₹ 11520 and ₹ 12780 per hectare on small, semi-medium, medium and large farms, respectively. It was also found that rental value of owned land had positive relationship with size of farm holdings. The overall value of depreciation was ₹ 2649.54 per hectare which accounted for 5.40 per cent of total cost. It was highest (₹ 3242.49) on large farms and lowest (₹ 1867.58) on small farms. On an average, fixed capital interest charges were calculated as ₹ 792.47 per hectare. Among the different categories, per hectare interest on fixed capital was estimated to be ₹ 490.38, ₹ 629.52, ₹ 914.25 and ₹ 1135.75, on small, semi-medium, medium and large farms, respectively.

(C) Cost groups in fennel cultivation

In this sub-section, all cost items incurred in cultivation of fennel have been categorized under different cost groups like: cost A_1, cost A_2, cost B_1, cost B_2, cost C_1, cost C_2, and cost C_3. These cost groups in fennel cultivation on different farm size groups are given in Table 4. This table indicates that, on an average, cost A_1 in cultivation of fennel

Table 4: Cost groups in cultivation of fennel on different farm size groups (₹/ha)

Cost groups	Small	Semi-medium	Medium	Large	Overall
Cost A_1	26359.80	28702.39	34484.93	38248.87	31949.00
Cost A_2	26359.80	28702.39	34484.93	38248.87	31949.00
Cost B_1	26850.18	29331.91	35399.18	39384.62	32741.47
Cost B_2	37350.18	40311.91	46919.18	52164.62	44186.47
Cost C_1	33807.89	35914.69	39106.45	41500.83	37582.46
Cost C_2	44307.89	46894.69	50982.45	54280.83	49027.46
Cost C_3	48738.68	51584.15	56080.69	59708.91	53930.21

Table 5: Returns from the cultivation of fennel in different farm size categories

Sl. No.	Particulars	Small	Semi-medium	Medium	Large	Overall
1	Yield (q/ha)	14.70	15.65	17.30	18.60	16.56
2	Gross returns (₹/ha)	102900	109550	121100	130200	115920
3	Total cost (C_3) (₹/ha)	48738.68	51584.15	56080.69	59708.91	53930.21
4	Net returns (₹/ha)	54161.32	57965.85	65019.31	70491.09	61989.79
5	Farm business income (₹/ha)	76540.20	80847.61	86615.07	91951.13	83971.00
6	Family labour income (₹/ha)	65549.82	69238.09	74180.82	78035.38	71733.53
7	Returns per rupee (₹/ha)	2.11	2.12	2.15	2.18	2.14
8	Cost of production (₹/q)	3315.55	3296.11	3241.62	3210.15	3256.65

was ₹ 31949.00/ha in the study area. Among the farm size groups, cost A_1 was estimated to be ₹ 26359.80, ₹ 28702.39, ₹ 34484.93 and ₹ 38248.87 per hectare on small, semi-medium, medium and large farms, respectively. Cost A_2 was equal to cost A_1 because of none of the sample farmer had taken land on rent for fennel cultivation. The per hectare cost B_1 was calculated as ₹ 26850.18 for small farm, ₹ 29331.91 for semi-medium, ₹ 35399.18 for medium and 39384.62 for large farms. The overall cost B_1 was ₹ 32741.47/ha. The cost B_2 was observed as ₹ 37350.18, ₹ 40311.91, ₹ 46919.18 and ₹ 52164.62 for small, semi-medium, medium and large farms, respectively. On an average, cost B_2 was estimated at ₹ 44186.47/ha in cultivation of fennel. Among different size group of farms, cost C_1 on small, semi-medium, medium and large farms was estimated at ₹ 33807.89, ₹ 35914.69, ₹ 39106.45 and ₹ 41500.83 per hectare, respectively, with an overall average of ₹ 37582.46/ha. Further, the Cost C_2 was calculated as ₹ 44307.89 for small, ₹ 46894.69 for semi-medium, ₹ 50982.45 for medium and ₹ 54280.83 for large farms. It was observed that cost C_2 was lowest (*i.e.*, ₹ 44307.89/ha) for small farms and highest (*i.e.*, ₹ 54280.83/ha) for large farms. The overall cost C_2 of fennel cultivation was ₹ 49027.46/ha. Cost C_3 equals cost C_2 and 10 per cent of cost C_2 on account of the management functions performed by the farmers. Thus, the overall C_3 was estimated at ₹ 53930.21/ha. Among the farm size groups, it was found to be ₹ 48738.68 on small farm, ₹ 51584.15 on semi-medium farm, ₹ 56080.69 on medium farm and ₹ 59708.91 on large farms per hectare, respectively.

(D) Returns from the cultivation of fennel

The obtained yield, gross returns, total costs, net returns, family labour income, farm business income, returns per rupee and cost of production from the cultivation of fennel are given in Table 5. This table presents that per hectare yield obtained on small, semi-medium, medium and large farms was 14.70, 15.65, 17.30 and 18.60 quintal, respectively. The overall yield realized from fennel cultivation was 16.56 quintal/ha.

Among the different farm size categories, the gross returns were calculated as ₹ 1,02,900, ₹ 1,09,550, ₹ 1,21,100 and ₹ 1,30,200 per hectare on small, semi-medium, medium and large farms, respectively. On average, gross returns form fennel cultivation were estimated at ₹ 1,15,920 /ha. The gross returns were highest on large farms and lowest on small farms.

The average net returns from fennel cultivation were estimated at ₹ 61989.79 per hectare. Net returns were calculated as ₹ 54161.32/ha on small farm, ₹ 57965.85/ha on semi-medium farm, ₹ 65019.31/ha on medium farm and ₹ 70491.09/ha on large farms.

The overall farm business income from fennel cultivation was found to be ₹ 83,971.00/ha in the study area. Family business incomes were calculated as ₹ 76,540.20 on small farms, ₹ 80,847.61 on semi-medium farms, ₹ 86,615.07 on medium farms and ₹ 91,951.13 on large farms.

Among different farm size groups, family labour income were estimated as ₹ 65,549.82, ₹ 69,238.09, ₹ 74,180.82 and ₹ 78,035.38 per hectare on small, semi-medium, medium and large farms, respectively with an average of ₹ 71,733.53 per hectare.

The returns per rupee were calculated as ₹ 2.11, ₹ 2.12, ₹ 2.15 and ₹ 2.18 on small, semi-medium, medium and large sized farms, respectively. On an average, returns per rupee were ₹ 2.14. Since there is no systematic literature available on fennel cultivation but returns per rupee on other seed spice crops and spices were more or less in the similar above range. Return per rupee was found less viz., 1.81 for cumin (Salve *et al*. 2017), while Patidar *et al*., (2018) reported return per rupee of 2.19 for garlic.

The cost of production per quintal was ₹ 3315.55, ₹ 3296.11, ₹ 3241.62 and ₹ 3210.15 on small, semi-medium, medium and large farms, respectively. The overall cost of production of fennel was ₹ 3256.15 per quintal. Thus, cost of production was found to be decreasing with the increase of farm size holdings, this may be due to economies of scale in production achieved on large farms.

CONCLUSION AND POLICY IMPLICATIONS

On an average, per hectare total cost of cultivation of fennel was ₹ 49027.46. Out of which, operational cost accounted for 69.64 per cent *i.e.* ₹ 34140.45/ha and fixed cost was 30.36 per cent of total costs *i.e.* ₹ 14887.01/ha. Component wise cost in fennel cultivation revealed that rental value of owned land was highest accounted for 23.34 per cent *i.e.*, ₹ 11445/ha, followed by cost of human labour was 21.51 per cent of total costs *i.e.* ₹ 10544.29/ha. The results of study indicated that average gross returns from fennel cultivation was ₹ 1,15,920 /ha. The average net returns obtained from fennel cultivation were ₹ 61989.79/ha. Net returns varied from ₹ 54161.32/ha on small farm to ₹ 70491.09/ha on large farms. On an average, returns per rupee were ₹ 2.14, which indicates that production of fennel is profitable hence farmers can be encouraged to bring more area under the crop. Since fennel can fetch good prices, the farmers can be sensitized about its export prospects along with the option of contract farming and future trading of fennel. Grading and standardization facilities should also be created so that farmers can realize the maximum profits through quality fennel produced.

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