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Economics of Cultivation and Distillation of Damask Rose: A Case Study in Palampur (Himachal Pradesh)

Kehar Singh and Virendra Singh*

INTRODUCTION

Human beings in their social existence have always been fascinated by the aesthetic sense and pleasant fragrances of flowers. Roses are the most appreciated throughout the ages in the world. Rose water, rose oil, rose concretè, absolute, rose attar, gulroghan, gulakand, pankhuri (dried rose petals) and dried rose buds are different rose products derived from the scented rose flowers. Rose oil is one of the oldest and the most valuable perfumery material used in cosmetics and other industries. Needless to mention, no high-grade perfume is complete that does not contain at least some quantities of rose oil which lends glamour and depth to odour blends.

Damask rose (*Rosa damascena* Mill.) has been recognised as the best-known commercial species of the scented roses as it gives comparatively high yield and quality grade oil. Bulgaria, Turkey, Italy, Morocco, Russia and India are the main countries where it is cultivated on large scale for production of rose aroma concentrates. Turkey and Morocco are the largest producers of rose oil in the world producing 10 tonnes of oil per year (Singh *et al.*, 1992) while the total world demand is 20 tonnes per year (Tajuddin *et al.*, 1986).

Commercial cultivation of Damask rose in India dates back to Mughal times. However, its cultivation has remained restricted to some parts of Uttar Pradesh, Rajasthan and Jammu and Kashmir (Singh *et al.*, 1997). In India about 4,000 hectares are presently under its cultivation; and a part of its harvest has been used for producing about 200 kg oil annually (personal communication). Rose water is the major produce made from this plantation. It has been found that mild temperate climate of western Himalayas, including Shivalik hills is the best for its cultivation.

Himachal Pradesh has suitable soil and congenial climatic conditions for the cultivation of perfumery rose as the mid hill region of this state has similar climate

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like that of European countries (Mukherjee, 1997; Saini and Sharma, 1997), where the cultivation of Damask rose can be taken on commercial scale (Tajuddin *et al.*, 1986). Realising the commercial importance of rose and its suitability to mid hill region of Himachal Pradesh, the scientists at IHBT (CSIR), Palampur introduced its cultivation in Himachal Pradesh and developed its cultivation and distillation practices (Anonymous, 1991-96). However, to provide economic justification for its commercial cultivation a thorough economic analysis of Damask rose cultivation and distillation is essential, and has been attempted during the year 1997-98.

METHODOLOGY

The study is based upon the primary data collected from the experimental farm of Institute of Himalayan Bioresource Technology (IHBT), located at Palampur in Himachal Pradesh from 1992-93 to 1997-98. There is at present four-hectare area under ten-year old and two-hectare under five-year old Damask rose plantation while the expected productive life span of Damask rose is twenty-three years, including initial three years as its gestation period. The Institute has established a rose oil steam distillation unit (400 kg/batch) plant suitable for large-scale cultivation in 1990-91. This unit processes the flowers produced from the experimental farm every year. The primary data collected include, *inter alia*, exhaustive information on fixed and working capital requirement, investment on distillation plant along with installed capacity and operational expenses. The whole analysis of Damask rose cultivation and distillation was carried out on average annual basis. The following analytical framework was employed to work out the costs and returns of the cultivation and distillation for two-hectare and four-hectare plantation units.

Costs

Total cost includes expenses on human labour + expenses incurred on material inputs + depreciation and interest on fixed capital + interest on working capital + land revenue + imputed rental value of land + imputed value of risk factors and management input at the rate of 10 per cent each of the working capital.

The cost of cultivation has been divided into two parts, one is cost incurred during non-bearing stage (gestation period) termed as an establishment cost and the other is cost incurred during bearing stage termed as maintenance cost. The establishment cost has been defined as the initial fixed investment plus cost incurred during gestation period. It has been assumed as fixed cost for the remaining life of plantation and it was, therefore, amortised over the period using 12 per cent interest rate as below:

$$AAEC = CEC \div PL + S_i; S_i = TI \div PI$$

where AAEC is average annual establishment cost; CEC is cumulative establishment cost; PL is the project life in years except gestation period; S_i is the average interest

and TI is the total interest under amortised decreasing repayment plan for ten yearly instalments.

The depreciation (component of fixed cost) has been computed by using straight-line method and interest on fixed capital has been calculated under amortised decreasing repayment plan for ten yearly instalments. It has been assumed that the entrepreneur installed the Damask rose distillation plant in the fourth year of plantation.

Returns

Net returns per annum = Gross returns per annum - Average annual total cost.

Gross returns = Quantity of oil x Price per unit + Dried flowers x Price per unit.

In order to examine the economics of scale, on the basis of the data for plantation units of two hectares and four hectares, the data relating to daily fresh flowers production and average annual maintenance cost were obtained for one-hectare plantation unit as follows:

$$D_1 = D_2 \div [1 + (D_4 - D_2) \div D_2]$$

where D stands for data of daily fresh flowers production and average annual maintenance cost and subscripts 1, 2 and 4 for plantation unit size. From the data of one-hectare plantation unit, the data for 3 and 5 to 10-hectare plantation units were obtained as under:

$$D_i = i \times D_1 \times (D_4 - D_2) \div D_2, \quad i = 3, 5, 6, \dots, 10$$

The fixed cost of distillation per annum and the variable cost of distillation per batch are independent of the plantation unit size.

RESULTS AND DISCUSSION

A. Cultivation Costs

1. Establishment cost of Damask rose plantation

The establishment costs of Damask rose plantation for two-hectare and four-hectare land units are presented in Table 1 and discussed as follows:

(a) *Initial fixed capital requirements*: It is evident from Table 1 that planting material accounted for about 73 per cent and 83 per cent of initial fixed capital requirements in the case of two-hectare and four-hectare Damask rose plantation units respectively. To plant two hectares and four hectares of Damask rose, about 10,000 and 20,000 rooted cuttings were needed respectively.

It can be clearly observed from the table that the proportion of per unit investment on planting material increased remarkably with an increase in scale of

plantation while the cost of other materials, viz., power sprayer, farm tools and implements, etc., increased marginally revealing thereby the economies of scale.

(b) *Variable cost during gestation period:* It is clear from Table 1 that the variable cost for four-hectare land unit was almost double of the variable cost for two-hectare plantation unit. Among the various components of working capital, human labour was the most important one. In the first year, about 649 man-days for two-hectare plantation unit and 1,280 man-days for four-hectare plantation unit were required to carry out various operations like land preparation, field layout, digging of pits, interculture, irrigation, application of manure, fertilisers, etc.

In the second and third year of plantation, about 299 man-days for two-hectare plantation unit and 590 man-days for four-hectare plantation unit were needed. Among material inputs, fertilisers per hectare were 120 kg N, 60 kg P₂O₅ and 40 kg K₂O needed every year while 200 quintals of farmyard manure (FYM) per hectare was used during the plantation of rooted cuttings.

(c) *Fixed cost during gestation period:* As may be noted from Table 1, in the first year of plantation, the imputed value of land rent and interest on fixed capital were the main components accounting for more than 84 per cent of total fixed cost. In the second year and third year, the share of these components decreased due to the additional interest on past establishment cost. The total cost incurred in the first year is the past establishment cost for second year and that of second year is for third year and so on.

(d) *Cumulative establishment cost:* The cumulative establishment cost which is the cumulative of total cost over three years was found to be Ps. 3,55,184 and Rs. 6,70,255 for two-hectare and four-hectare plantation units respectively (Table 1). Finally, this establishment cost was considered as fixed cost for the remaining life period of the project.

2. Maintenance cost of Damask rose plantation

(a) *Variable cost of maintenance:* The data on working capital requirements were available in physical terms for different years of Damask rose plantations upto five-year plantation age for two-hectare plantation unit and upto ten-year plantation age for four-hectare plantation unit. Since the cultivation was on recommended lines, therefore, the available data have been used as proxies for other years of plantation. Then the physical data have been multiplied by current prices (1997-98 prices) to obtain working capital requirements in monetary term. In this way, average annual variable cost of maintenance of Damask rose for two-hectare and four-hectare plantation units was worked out to be Rs. 56,319 and Rs. 1,07,442 respectively (Table 2). The variable cost of maintenance was different for the 4th/6-9th/11-14th/16-19th/21-23rd years of plantation and for the 5th/10th/15th/20th years of

TABLE 1. ESTABLISHMENT COST OF DAMASK ROSE PLANTATIONS

(Rs.)

Item/age (years)	Two-hectare plantation unit			Four-hectare plantation unit		
	1	2	3	1	2	3
	(1)	(2)	(3)	(4)	(5)	(6)
I. Initial fixed capital requirements (a + b)	68,590	-	-	1,20,670	-	-
(a) Planting material @ Rs. 5 per rooted cutting	50,000 (72.90)	-	-	1,00,000 (82.87)	-	-
(b) Other materials	18,590 (27.10)	-	-	20,670 (17.13)	-	-
II. Total variable cost (a+b+c+d)	82,545	38,623	42,432	1,60,676	78,193	85,793
(a) Working capital (i + ii + iii)	64,995	30,412	33,412	1,26,516	61,569	67,569
(i) Material inputs	16,836	8,086	11,086	33,672	16,172	22,172
(ii) Human labour	40,647	18,726	18,726	80,166	36,952	36,952
(iii) Miscellaneous charges	7,512	3,600	3,600	12,678	8,445	8,445
(b) Interest on working capital @ 14 per cent per annum for 6 months	4,550	2,129	2,338	8,856	4,310	4,710
(c) Management cost	6,500	3,041	3,341	12,652	6,157	6,757
(d) Risk margin	6,500	3,041	3,341	12,652	6,157	6,757
III. Total fixed cost (a+b+c+d+e)	23,974	44,987	54,033	42,664	81,545	1,00,714
(a) Land revenue	25	25	25	50	50	50
(b) Imputed value of land rent @ Rs. 6,000 per ha	12,000	12,000	12,000	24,000	24,000	24,000
(c) Depreciation on fixed capital except planting material	3,718	3,718	3,718	4,134	4,134	4,134
(d) Interest on fixed capital @ 12 per cent per annum	8,231	8,231	8,231	14,480	14,480	14,480
(e) Interest on past establishment cost @ 12 per cent per annum	-	21,013	30,059	-	38,881	58,050
IV. Total establishment cost (I + II + III)	1,75,109	83,610	96,465	3,24,010	1,59,738	1,86,507
V. Cumulative cost of establishment	1,75,109	2,58,719	3,55,184	3,24,010	4,83,748	6,70,255

Note: Figures in parentheses indicate percentages to the total.

plantation. In the 5th, 10th, 15th and 20th years of plantation, ground level pruning was required instead of top pruning performed in the rest of the years for which about 11.5 additional man-days were needed. Also during ground level pruning, FYM at the rate of 200 quintals per hectare was needed.

TABLE 2. VARIABLE COST OF MAINTENANCE AFTER GESTATION PERIOD

Item/age (years)	(Rs.)			
	Two-hectare plantation unit		Four-hectare plantation unit	
	4/6-9/11-14/ 16-19/21-23	5/10/15/20	4/6-9/11-14/ 16-19/21-23	5/10/15/20
(1)	(2)	(3)	(4)	(5)
I. Total variable cost (a to d)	53,413	67,943	1,01,630	1,30,691
(a) Working capital (i to v)	42,057	53,498	80,024	1,02,906
(i) Human labour @ Rs. 62.63 per man-day	18,726	20,167	35,073	37,955
(ii) FYM @ Rs. 25 per qtl.	-	10,000	-	20,000
(iii) Fertilisers*	5,081	5,081	10,162	10,162
(iv) Plucking charges @ Rs. 2.20 per kg	12,250	12,250	23,360	23,360
(v) Miscellaneous expenses	6,000	6,000	11,429	11,429
(b) Interest on working capital @ 14 per cent per annum for 6 months	2,944	3,745	5,602	7,203
(c) Management cost	4,206	5,350	8,002	10,291
(d) Risk margin	4,206	5,350	8,002	10,291
II. Average annual variable cost	(16 x 53,413 + 4 x 67,943) ÷ 20 = 56,319		(16 x 1,01,630 + 4 x 1,30,691) ÷ 20 = 1,07,442	

* 260 kg urea @ Rs. 3.78 per kg, 375 kg SSP @ Rs. 2.60 per kg and 65 kg MOP @ Rs. 9.00 per kg per hectare.

The plucking charges also contributed significantly to working capital requirements. The plucking of flowers is a highly specialised operation. It generally takes place daily in the early morning before sunrise. Further, the duration of plucking period lasts for three hours and is confined to a limited period of 30 days in a year. On an average, one adult plucks 11.48 kg fresh flowers daily in the morning.

(b) *Fixed cost of maintenance:* The average annual fixed cost of maintenance has been found to be Rs. 47,487 and Rs. 87,797 for two-hectare and four-hectare plantation units respectively (Table 3). As it is evident from the table, the most important component of fixed cost of maintenance was average annual establishment cost, followed by imputed rental value of land. These components were more than 85 per cent of the fixed cost.

TABLE 3. FIXED COST OF MAINTENANCE OF DAMASK ROSE PLANTATION AFTER GESTATION PERIOD

Particulars	(Rs./annum)	
	Plantation unit	
	Two-hectare (2)	Four-hectare (3)
(1)		
Average annual fixed cost (a to e)	47,487	87,797
(a) Land revenue	25	50
(b) Imputed rental value of land @ Rs. 6,000 per ha	12,000	24,000
(c) Depreciation on fixed capital	3,718	4,134
(d) Average interest on fixed capital @ 12 per cent per annum	2,263	3,982
(e) Average amortised establishment cost	29,481	55,631

B. Distillation Costs

Damask rose is known for high value oil. Its oil has a major use in perfumery industries. Therefore, the distillation forms an integral part for this industry. An attempt has been made to assess the initial investment requirements for distillation plant, fixed expenses per annum and variable cost of distillation per batch run and per annum.

(a) *Initial investment*: The capital requirements to install steam fed single distillation unit plant were estimated at Rs. 8,81,000, details of which are given in Table 4. It is clear from the table that the distillation unit, boiler and shed were the major items accounting for more than 80 per cent of initial investment.

TABLE 4. INITIAL INVESTMENT ON DAMASK ROSE OF DISTILLATION PLANT

Particulars (1)	Amount (Rs.) (2)
Total initial investment (1 to 8)	8,81,000
1. Rose oil distillation unit (400 kg/batch)	3,50,000
2. Boiler (1 tonne capacity)	2,75,000
3. Water pump - 5 HP	20,000
4. Shed cost (a + b)	1,20,000
(a) Material cost	90,000
(b) Construction expenses	30,000
5. Other accessories (canes, baskets, pipes, tools, etc.)	25,000
6. Sale tax @ 10 per cent of (1 + 2 + 3 + 4 a + 5)	76,000
7. Transportation and installation charges	10,000
8. Other unforeseen expenses	5,000

(b) *Fixed cost of distillation*: The average annual fixed cost of distillation was found to be Rs. 72,466 (Table 5). The average annual interest and depreciation on fixed investment accounted for about 83 per cent of the fixed cost.

TABLE 5. FIXED EXPENSES ON DISTILLATION PLANT PER ANNUM

Particulars (1)	Amount (Rs.) (2)
Total fixed expenses per annum	72,466
1. Imputed value of land rent @ Rs. 6,000 per ha	240
2. Average interest on total investment @ Rs. 12 per cent per annum	29,073
3. Depreciation	30,935
4. Repairs and maintenance	6,609
5. Insurance @ 1 per cent per annum	5,609

(c) *Variable cost of distillation*: The average variable cost of distillation per batch was found to be Rs. 2,775, as shown in Table 6. The interest on working capital was not included in the variable cost because the distillation takes place in the last month of production year and lasts for a small period (since flowering season is of 30 days only). The average quantity of fresh flowers distilled per batch was about 229 kg and 281 kg for two-hectare and four-hectare damask rose plantations respectively.

TABLE 6. VARIABLE COST OF DISTILLATION OF FRESH FLOWERS

Variable cost items (1)	(Rs.)	
	Plantation unit	
	Two-hectare (2)	Four-hectare (3)
A. Working expenses per batch (a + b + c + d)	2,313	2,313
(a) Fuel cost (i + ii)	1,500	1,500
(i) Coal @ Rs. 525 per qtl.	1,260	1,260
(ii) Wood @ Rs. 150 per qtl.	240	240
(b) Labour charges @ Rs. 62.63 per man-day	313	313
(c) Electric and water charges	300	300
(d) Miscellaneous expenses	200	200
B. Variable cost per batch (a + b + c)	2,775	2,775
(a) Working expenses	2,313	2,313
(b) Management cost	231	231
(c) Risk margin	231	231
C. Number of batches run per annum	23	37
D. Average quantity of fresh flowers distilled per batch (kg)	229	281
E. Total variable distillation cost per annum (B x C)	63,825	1,02,675

On an average, 23 and 37 batches of fresh flowers distilled were required for two-hectare and four-hectare Damask rose plantation units respectively. The average annual variable expenses were found to be Rs. 63,825 and Rs. 1,02,675 for the two-hectare and four-hectare plantation units respectively.

It takes almost eight hours to run one complete batch and a maximum of two batches in a day could be run, meaning thereby that a maximum of 800 kg of fresh flowers (400 kg per batch, i.e., the capacity of the unit) could be distilled in a day. On the basis of technical and economic considerations, it has also been found that a minimum of 100 kg of fresh flowers were required to run one batch. Also the flowers could not be stored for second day due to high perishability and significant losses in oil quantity as well as in quality. Thus the excessive produce over the distillation capacity and below the minimum quantity required to distil essentially needs drying to be sold as the dried flowers.

3. Returns

The data on daily fresh flower production, batches run, amount of flowers distilled per batch and fresh flowers dried are presented in Table 7 for two-hectare and four-hectare Damask rose plantations. The quantity of flowers harvested was about 28 kg from two-hectare Damask rose plantation unit on the first day of plucking which increased to 65 kg on the second day of plucking and showed persistent increase plateauing at 341 kg on the 13th day of plucking. The pattern just got reversed and the quantity declined drastically in the subsequent pluckings such that the last day plucking yielded only 12 kg. The same pattern was discernible for four-hectare plantation unit.

TABLE 7. DAILY FRESH FLOWER PRODUCTION, BATCHES RUN, FLOWERS DISTILLED AND LABOUR REQUIREMENTS FOR PLUCKING OF FLOWERS

Day of plucking	Two-hectare plantation unit					Four-hectare plantation unit				
	DFFP (kg)	BR (No.)	FDPB (kg)	FFD (kg)	LR (No.)	DFFP (kg)	BR (No.)	FDPB (kg)	FFD (kg)	LR (No.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	28	-	-	28	2	53	-	-	53	5
2	65	-	-	65	6	123	1	123	-	11
3	110	1	110	-	10	219	1	219	-	19
4	118	1	118	-	10	243	1	243	-	21
5	163	1	163	-	14	302	1	302	-	26
6	185	1	185	-	16	359	1	359	-	31
7	189	1	189	-	16	367	1	367	-	32
8	223	1	223	-	19	421	1	400	21	37
9	265	1	265	-	23	503	2	400+103	-	42
10	290	1	290	-	25	567	2	400+167	-	49
11	302	1	302	-	26	598	2	400+198	-	52
12	337	1	337	-	29	665	2	400+265	-	58
13	341	1	341	-	30	668	2	400+268	-	58
14	332	1	332	-	29	641	2	400+241	-	56
15	329	1	329	-	29	639	2	400+239	-	56
16	318	1	318	-	28	623	2	400+223	-	54
17	301	1	301	-	26	597	2	400+197	-	52
18	289	1	289	-	25	591	2	400+191	-	51
19	259	1	259	-	23	513	2	400+113	-	45
20	211	1	211	-	18	411	1	400	11	36
21	182	1	182	-	16	323	1	323	-	28
22	171	1	171	-	15	244	1	244	-	21
23	125	1	125	-	11	195	1	195	-	17
24	116	1	116	-	10	179	1	179	-	16
25	106	1	106	-	9	163	1	163	-	14
26	63	-	-	63	5	151	1	151	-	13
27	56	-	-	56	5	109	1	109	-	9
28	48	-	-	48	4	82	-	-	82	7
29	34	-	-	34	3	51	-	-	51	4
30	12	-	-	12	1	18	-	-	18	2
Total	5,568	23	5,262	306		10,618	37	10,382	236	

DFFP = Daily fresh flowers production, BR = Batches run, FDPB = Flowers distilled per batch, FFD = Fresh flower dried, and LR = Labour requirements (number of labour units needed for three hours daily early in the morning).

In juxtaposition to this, the daily labour requirement also varied posing a major problem of Damask rose cultivation (Table 7). As it is evident from the table, two labour units were required on the first day of plucking which increased to 30 units during the peak plucking period and then declined (two-hectare plantation unit). Therefore, irregularity in labour requirement could be the major challenge for commercial cultivation of Damask rose.

The summary of the costs of cultivation and distillation of Damask rose, gross returns, net returns and output-input ratio for different plantation units is presented in Table 8. It is evident from the table that the quantity of average annual fresh flower production was 5,568 kg and 10,618 kg for two-hectare and four-hectare plantation units respectively. Either the fresh flowers were hydro-distilled to get oil or dried to get dry flowers. The quantity of fresh flowers distilled was (as mentioned earlier and an insight of Table 7 also shows) dependent upon daily production, capacity of distillation unit and minimum quantity (one quintal) of flowers required for economical distillation.

From the hydro-distillation of fresh Damask rose flowers, direct rose oil and rose water were obtained. Then rose water was re-distilled with another batch of fresh flowers to recover water oil. The direct oil and the water oil were mixed to obtain commercial rose oil. The percentage of commercial rose oil recovery was, on an average, 0.028 per cent only. The excess fresh flowers left after meeting distillation capacity and below minimum quantity required were dried to 85 per cent moisture content to be sold as dry flowers.

On the basis of net returns and output-input ratios, as shown in Table 8, it may be concluded that two-hectare Damask rose plantation unit with steam-fed-single-distillation plant is not an economic proposition while four-hectare plantation unit is economical.

4. *Effects of Scale of Cultivation*

To see the effects of increase in scale of production of Damask rose on its economic viability, the figures for 1 ha, 3 ha and 5 to 10 ha Damask rose plantation units were obtained by the procedure explained in methodology and the results are presented in Table 8. The table depicts that as the size of plantation unit increased, the average quantity of flowers distilled per batch also increased. But the proportion of total flowers distilled firstly increased to about 98 per cent in four- and five-hectare plantation units. Then it decreased significantly to about 70 per cent in ten-hectare plantation unit due to daily production of fresh flowers above capacity of distillation unit, i.e., 800 kg per day.

Table 8 further reveals that the additional net returns due to added land unit of one-hectare were the highest for the fifth unit (Rs. 39,501) after which the incremental net returns declined due to decreased proportion of fresh flowers distilled. Needless to mention, the minimum break-even land unit of four hectares was required to be planted under Damask rose to make this enterprise just profitable.

TABLE 8. COSTS AND RETURNS FROM DIFFERENT DAMASK ROSE PLANTATION UNITS

Item	Plantation unit (ha)									
	1	2	3	4	5	6	7	8	9	10
1. Total costs per annum (Rs.) [a + b]	1,63,747	2,40,097	2,82,091	3,70,380	4,26,465	4,83,390	5,40,316	5,91,690	6,45,840	7,02,764
(a) Total maintenance cost (Rs.) [i + ii]	55,206	1,03,806	1,45,800	1,95,239	2,42,999	2,91,599	3,40,200	3,88,799	4,37,399	4,85,998
(i) Average annual fixed cost (Rs.)	25,684	47,487	65,407	87,797	1,09,011	1,30,813	1,52,616	1,74,418	1,96,220	2,18,022
(ii) Average annual variable cost (Rs.)	29,522	56,319	80,393	1,07,442	1,33,988	1,60,786	1,87,584	2,14,381	2,41,179	2,67,976
(b) Total distillation cost (Rs.) [a+b]	1,08,541	1,36,291	1,36,291	1,75,141	1,83,466	1,91,791	2,00,116	2,02,891	2,08,441	2,16,766
(i) Average annual variable cost (Rs.) (a + b)	36,075	63,825	63,825	1,02,675	1,11,000	1,19,325	1,27,650	1,30,425	1,35,975	1,44,300
(ii) Average annual fixed cost (Rs.)	72,466	72,466	72,466	72,466	72,466	72,466	72,466	72,466	72,466	72,466
2. Gross returns per annum* (Rs.)	90,304	2,00,004	2,76,528	3,87,919	4,83,505	5,65,945	6,37,015	7,01,830	7,64,878	8,27,834
(a) Total fresh flowers production (kg)	2,921	5,568	7,946	10,618	13,245	15,971	18,545	21,194	23,843	26,491
(b) Fresh flowers distilled (kg)*	1,992 (68.19)	5,262 (94.50)	7,050 (88.72)	10,382 (97.78)	12,926 (97.59)	14,689 (91.97)	15,995 (86.25)	16,898 (79.88)	17,698 (74.23)	18,515 (69.89)
(c) Fresh flowers dried (kg)*	929 (31.80)	306 (5.50)	886 (11.28)	236 (2.22)	319 (2.41)	1,282 (8.03)	2,550 (13.75)	4,296 (20.12)	6,145 (25.77)	7,976 (39.11)
(d) Oil recovered @ 0.028 per cent of fresh flowers distilled (kg)	0.55776	1.47336	1.97400	2.90696	3.61928	4.11292	4.47860	4.73144	4.95544	5.18420
(e) Dry flowers @ 15 per cent of fresh flowers dried (kg)	139	46	133	35	48	192	382	644	923	1,196
(f) Number of batches run (No.)	13	23	23	37	40	43	46	47	49	52
3. Net returns (Rs.) (2-1)	-73,443	-40,093	-5,563	17,539	57,040	82,555	96,699	1,10,140	1,19,038	1,25,070
4. Output-input ratio (2+1)	0.55	0.83	0.98	1.05	1.13	1.17	1.18	1.19	1.18	1.18
5. Incremental net returns (Rs.)	-	33,350	34,530	23,102	39,501	25,515	14,144	13,441	8,898	6,032

Note: Figures in parentheses indicate percentages to total fresh flowers production.

* Quantity of oil (kg) x Rs. 1,32,000 + Quantity of dry flowers (kg) x Rs. 120.

This clearly shows that scale of its cultivation may be regarded as the most important consideration while recommending Damask rose plantation at the farmers' level in the state.

CONCLUSIONS AND POLICY IMPLICATIONS

From the present study it may be concluded that Damask rose plantation is a capital intensive and highly specialised enterprise wherein heavy initial investment on plantation and installation of distillation plant is required. Secondly, the highly variant and seasonal demand for labour especially during short plucking period may also pose management problems to the entrepreneurs for which the possibilities of contractual labour need to be explored before taking this venture. Thirdly, at least four-hectare land unit is needed under Damask rose plantation while adopting large size rose oil steam-fed-single-distillation unit plant. Lastly, the scale of Damask rose cultivation may be regarded as the most important consideration while recommending its cultivation at the farmers' level.

Based upon these peculiarities and specific requirements of Damask rose cultivation, it is emphasised that the farmers may be persuaded to start cultivation on collective or co-operative basis so that they may produce the minimum desired quantity for distillation in each village/region. Therefore, the farmers in a village should put at least three-hectare area under Damask rose to make it just economically viable.

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