Economic Feasibility of Polyhouse Establishment With and Without Government Subsidy Support: A Case of Gerbera Cultivation in Maharashtra, India

by Prakash P., Pramod Kumar, Prabhat Kishore, D. Jaganathan, and Sheela Immanuel

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Prakash P[1*], Pramod Kumar[2], Prabhat Kishore[3], D. Jaganathan[1] and Sheela Immanuel[1]

[1]ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala - 695017, India
[2]ICAR-Indian Agricultural Research Institute, New Delhi -110012, India
[3]ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi – 110012, India
*Address correspondence to: P. Prakash at Section of Extension and Social Sciences, Central Tuber Crops Research Institute, Thiruvananthapuram, India. E-mail: prakashiari@yahoo.com

Abstract

In India, 86% of the total farmers are categorized as small and marginal (possessing landholding <2 ha) who often faces financial constraints to adopt capital intensive technology. The government provides subsidies to farming communities to adopt efficient farm technologies to improve farm productivity and income. The adoption rate of technologies varies and some technologies are adopted without subsidy support. The protected cultivation provides better yield and increased profitability. Thus, the study was undertaken to determine the economic feasibility of polyhouse establishment with and without subsidy support. The profitability of gerbera cultivation under polyhouse was estimated along with its price spread. The establishment cost of gerbera under polyhouse was very high but offered higher returns. Feasibility analysis has shown that in both cases-with and without subsidy gerbera cultivation under polyhouse are feasible. But, with subsidy support it is highly remunerative to farmers which could increase its adoption for efficient farming. Farmers have preferred marketing channel which consisted of commission agents in APMC market (Agricultural Produce Marketing Committee) as it provided higher income compared to other existing channel. The subsidy scheme needs to be continued in near future as it will have demonstration effect on large section of farmers for its profitability.

Key words: *Gerbera jamesonii;* economic feasibility; conjoint analysis; marketing channel

Introduction

The strategy of agriculture development in the past focussed primarily on increasing agricultural output and improving food security of the country (Chand, 2017). The Government has committed to double farmers real income by 2022 over base year of 2015 to bring income equality among agricultural and non-agricultural sectors. Among various strategies to achieve goal of doubling farmer's income, protected cultivation can play a pivotal role for increasing the income of farmers with enhanced adoption of this technology. Protected cultivation can return higher income to the farmers due to higher productivity with better quality, efficient utilization of resources, control against pests and diseases and off

season production (Van Lenteren 2000; Kallo and Singh 2001; Jethi et al. 2012; Negi et al. 2013; Spehia 2015). The Government of India is creating awareness and providing financial assistance to the farmers for adopting protected cultivation through many schemes and programmes. Maharashtra is one of the leading states in the area under protected cultivation. The major share of horticulture production in the state is from fruits (50.1%) followed by vegetables (48.56%) during 2016-17 (Government of India, 2017). It is also one of the leading cut flower producing states in the country which accounts for 6.93% of total production in the country during 2017-18 (Government of India, 2018). Gerbera (*Gerbera jamesonii* L.) is widely used as a decorative garden plant and it is the 5th most important cut flower in the world. In Maharashtra, gerbera is cultivated under polyhouse condition. The government efforts in promotion of gerbera cultivation under polyhouse would mitigate climate mediated risks and increase farmers income. Therefore, an investigation was attempted to evaluate the economic feasibility of polyhouse cultivation of gerbera and to assess its price spread.

Materials and Methods

This study is based on a farm survey of households who grew crops under protected cultivation in Pune and Nasik districts of Maharashtra state. The districts were selected based on total area under polyhouse during the year 2017-18. Two blocks from each district were selected which had the highest polyhouse area. From each block two clusters of villages were selected. For a sample selection in each selected cluster of village, a random sampling procedure was followed for the primary survey of 15 farmers practicing protected cultivation from each village. Further, for the comparison purpose, 10 farmers following open method of cultivation were also selected randomly from the same cluster of villages. Thus, a total of 200 farmers were intensively interviewed comprising 120 farmers practicing protected cultivation and 80 farmers practicing the open field cultivation. The information on socioeconomic parameters, input use and its price, crop yield, price of farm produce, farm income, marketing cost and other related aspects were collected for the year 2018-19. Also, informal interview were conducted for farm produce aggregators, wholesalers and retailers in both districts for value chain analysis. Of the total respondents, 30 farmers were growing gerbera in polyhouse. Three aggregators, three commission agents from APMC market, three wholesalers and five retailers were involved in gerbera supply chain.

The farm business analysis was done to estimate the costs and returns of gerbera cultivation in polyhouse. Fixed and variable costs were determined. Rental value of land was charged at

the prevailing rate. Interest on fixed capital and working capital was assumed at 7% and 12% per annum, respectively. Amortized cost for crop establishment was calculated based on compound growth rate formula and economic life of gerbera cultivation. A straight line method was used to calculate the assets based on expected lifespan. The cost of planting materials, manures, fertilizers, plant protection chemicals, hired labour, hired machine labour, packaging and transportation were calculated on actual basis. The cost of owned planting materials, machine and family labour were based on prevailing market rate. The irrigation charges were estimated based on cost incurred for the electricity.

Gross and net returns were calculated to determine the profitability of gerbera grown under protected system. The gross returns were calculated by multiplying the total production of gerbera with respective price received. The net returns was estimated by subtracting annual total costs from gross returns and was determined following equation

$$\pi = GR - TC \quad \text{... (1)}$$

Where π is net returns; GR is gross returns and TC is total cost

Break-even analysis was done to determine the level of production at which the farmers neither make profit nor incur loss determined following Jovicich et al. (2005).

$$BEA = \frac{TFC}{P-V} \quad \dots (2)$$

Where, TFC is the total fixed cost, P is the unit sale price and V is the unit variable cost

Project evaluation techniques of modified net present value (MNPV), benefit cost ratio (BCR), modified internal rate of returns (MIRR) and payback period (PBP) were employed to evaluate the feasibility analysis of protected cultivation of gerbera under polyhouse. The project life of the polyhouse was assumed to be 12 years. The life of polythene sheets, shade nets and fertigation was assumed to be 5 years with replacement in the sixth year. The gerbera crop remains for four years in the polyhouse, so three cycles of gerbera cultivation in one polyhouse were considered for analysis.

Standard net present value method is based on the assumption that the intermediate cash flows are re-invested at a rate of return equal to the cost of capital. When this assumption is not valid, the reinvestment rates applicable to the intermediate cash flows need to be defined for calculating the modified net present value which was determined by following Chandra 2009; McClure and Girma, 2004.

$$MNPV = \frac{\sum_{t=1}^{n} B_{t(1+r)^{n-t}}}{(1+k)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+k)^t} \quad \text{... (3)}$$

Where r is the reinvestment rate; k is the cost of capital; C_t is the net cash outflow at time t. The second term in equation (3) is the present value of all net cash outflows discounted at the firm discount rate.

Benefit cost ratio (BCR) is obtained by dividing the present worth of the benefit stream with that of the cost stream determined following Gittinger (1982). The investment made on the polyhouse can be considered as economically viable if BCR is more than one.

$$BCR = \frac{\sum \frac{B_t}{(1+r)^t}}{\sum \frac{C_t}{(1+r)^t}} \quad \text{... (4)}$$

Where, B_t is the benefit in the year t; C_t is the cost in the year t; t is the project life in years; r is the rate of discount.

Modified IRR models were used as an alternative measure of internal rate of return and addressed many of the limitations of the IRR (Mcclure and Girma, 2004; Kierulff, 2008; Satyasai, 2009; Ivanovic et al, 2015). The formula (5) is based on the assumption that negative cash flow appears not only at the beginning of the investment period, but also later during investment.

$$\sum_{t=0}^{n} \frac{C_t}{(1+r)^t} = \frac{\sum_{t=0}^{n} B_t (1+r)^{n-t}}{(1+MIRR)^n} \quad \text{... (5)}$$

Where C_t is the cash outflows; B_t is the cash inflows; r is the cost of capital; MIRR is the modified internal rate of return; n is the years of investment use and t is the individual year of investment use.

The modified IRR was determined following equation

$$MIRR = \sqrt[n]{\frac{\sum_{t=0}^{n} B_t (1+r)^{n-t}}{\sum_{t=0}^{n} \frac{C_t}{(1+r)^t}}} - 1 \quad \text{... (6)}$$

Payback Period (PBP) is the length of time which takes to recover the cost of an investment determined following Panwar et al. (2014).

$$PBP = \frac{I}{E} \quad \text{... (7)}$$

Where, I is the initial investment and E is the projected net cash flows per year from the investment.

The choice based conjoint analysis was employed to value farmers preference of gerbera. The attributes color, variety, yield and price were considered. Software (SPSS, ver. 22.0, Armonk, NY) was employed to produce a set of 12 product profiles. The hypothetical good generated were shown to the respondents for arranging in order of their preference. After ordering, utility or part-worth scores of each attribute were calculated.

Results and Discussion

Socioeconomic attributes of the respondents under polyhouse cultivation in Maharashtra are presented in Table 1.The majority of the respondents age was between 30 to 45 years. About 40% of the farmers practicing polyhouse had completed their high school followed by intermediate school (35%) and graduate and above (25%). Farming experience indicated farmers who cultivated crops under polyhouse are newer to farming. This might be due to attractive and promising business for making profit. Most farmers practicing polyhouse cultivation possess marginal landholding (70%) and the remaining 30% were small farmers.

Table 1: Classification of farmers based on socioeconomic attributes

Particulars	Classification	% of sample farmers
Age (years)	< 30	-
	30-45	90
	> 45	10
Education (years)	Illiterate (0)	-
	Primary school (1-5)	-
	High school (6-10)	40
	Intermediate school (11-12)	35
	Graduate and Above (>12)	25
Farming experience (years)	< 2	-
	2 to 5	20
	5 to 10	80
	> 10	-
Landholding size (ha)	Marginal (<1)	70
	Small (1-2)	30
	Medium (2-4)	-

The establishment cost of gerbera under polyhouse is given in Table 2. Polyhouse size fall into the categories: 0.1, 0.2 and 0.4 ha. Fixed cost of polyhouse construction varied based on polyhouse size. The government support in the form of subsidy for adopter farmers are 42 to 44% of the total establishment cost. The highest proportion of total establishment cost was for making polyhouse structure (71 to 72%). The crop establishment, irrigation system and equipments for lesser amount of total establishment cost. The amount spent on galvanized iron (GI) pipe was highest in polyhouse cultivation.

Table 2: Establishment cost of gerbera under polyhouse

Particulars	0.1 ha		0.2 ha		0.4 ha	
	Amount (₹)	% to total	Amount (₹)	% to total	Amount (₹)	% to total
Polyhouse structure						
Structural frame (GI pipe)	542530	39.33	1074166	42.36	2107347	43.16
Polythene sheet	107785	7.81	193894	7.65	380892	7.80
Shade net	39008	2.83	74663	2.94	143290	2.93
Packaging unit	150000	10.87	150000	5.91	250000	5.12
Miscellaneous	157185	11.39	310569	12.25	615691	12.61
Sub total (A)	996507	72.24	1803291	71.11	3497220	71.62

Irrigation system and equipments						
Drip fertigation	117000	8.48	208000	8.20	352000	7.21
Sprayer	5500	0.40	5500	0.22	7000	0.14
Sub total (B)	122500	8.88	213500	8.42	359000	7.35
Crop establishment						
Planting material	216000	15.66	432000	17.04	864000	17.69
Bed preparation	29750	2.16	59500	2.35	119000	2.44
Organic manures	5126	0.37	9975	0.39	18960	0.39
Fertilizers	1799	0.13	3846	0.15	4022	0.08
Plant protection chemicals	2775	0.20	5625	0.22	11750	0.24
Labour	5020	0.36	8200	0.32	9200	0.19
Sub total (C)	260470	18.88	519146	20.47	1026933	21.03
Total establishment cost (A+B+C)	1379477	100	2535937	100	4883152	100
Subsidy	575500		1106000		2120000	
Establishment cost minus subsidy	803977		1429937		2763152	

The cost of cultivation of gerbera under polyhouse condition categorized into fixed costs and variable costs. The average annual cost of cultivation of gerbera under polyhouse condition varied based on polyhouse size (Table 3). The fixed cost accounted for 49 to 56% of the total annual cost of cultivation. Among the fixed cost, interest on fixed capital accounted for the highest share (about 42% of the total fixed cost), followed by depreciation on structure and equipments (about 30% of the total fixed cost). The variable cost accounted for 43 to 50 % of the total cost of cultivation. Among the variable costs, the expenses on human labour are the highest (about 56% of the total variable cost) followed by packaging and transportation (about 26% of the total variable cost).

Table 3: Cost of cultivation per year for gerbera under polyhouse

Cost components	0.1 ha		0.2 ha		0.4 ha	
	Amount (₹)	% to total	Amount (₹)	% to total	Amount (₹)	% to total
A. Fixed cost						
Land rent and revenue	90015	1.96	18030	2.35	35060	2.53
Interest on fixed capital @ 12 % p.a	96477	21.00	171592	22.37	331578	24.01
Amortised cost of crop establishment	50193	10.92	99796	13.01	195852	14.18
Depreciation	70549	15.35	118452	15.45	220998	16.00
Total fixed cost	226234	49.23	407870	53.18	783488	56.72
B. Variable cost						
Plant protection	8540	1.86	14000	1.83	20067	1.45
Fertilizer	15470	3.37	23625	3.08	35117	2.54
Labour	144000	31.34	198000	25.82	303333	21.96
Irrigation electricity charges	2765	0.60	5425	0.71	11167	0.81
Packaging and transportation	47250	10.28	94500	12.32	189000	13.68
Interest on working capital @ 7 % p.a	15262	3.32	23489	3.06	39108	2.83
Total variable cost	233287	50.77	359039	46.82	597791	43.28
Total annual cost (A+B)	459521	100	766909	100	1381280	100

Note: p.a. -per annum

Yield and returns of gerbera crop varied under different size of polyhouses (Table 4). The total yield of gerbera in a year under polyhouse condition was 2.22 lakhs stems, 4.45 lakhs

stems and 8.90 lakhs stems for the polyhouse size of 0.1, 0.2 and 0.4 ha, respectively. Price of gerbera remains to be similar as they followed similar marketing channel. Gross and net returns per unit of area was highest for the polyhouse with size of 0.4 ha in comparison to other categories which may be due to economy of scale effect. The break-even point in terms of yield was higher for larger size of polyhouse as it produced more and cost incurred was higher compared to smaller size polyhouses.

Table 4: Yield and returns from gerbera under polyhouse

Particulars	0.1 ha	0.2 ha	0.4 ha
Number of plants in polyhouse	6000	12000	24000
Yield per plant per year (No.)	37.1	37.1	37.1
Total yield (No.)	222658	445315	890630
Sale price per flower (₹)	2.8	2.8	2.8
Gross return (₹)	623441	1260242	2449233
Total costs (₹)	459521	766909	1381280
Net returns (₹)	163920	493333	1067953
Break-even point (in terms of yield)	129110	201542	376895

The economic feasibility of polyhouse cultivation of gerbera is presented in Table 5. With subsidy support, the payback period for polyhouse cultivation was reduced by about 1 year. The modified IRR for protected cultivation with subsidy support was more than that of their counterparts. The benefit cost ratio for the polyhouse with subsidy was higher than for the polyhouse without subsidy. Pramod Kumar et al, 2021 reported that the benefit cost ratio ranged from 1.71 to 2.32 and internal rate of return ranged from 57 to 99% for cultivation of gerbera under different sizes of polyhouse with subsidy support. Thus it revealed that cultivation of gerbera under polyhouse was observed to be highly profitable and it needs to be further promoted for improving the livelihood of farmers.

Table 5: Feasibility analysis of protected cultivation of gerbera under polyhouse

Size of	Benefit-cost ratio			Modified NPV* (Lakh ₹)			Modified IRR (%)			PBP
polyhouse (ha)	7%	10%	12%	7%	10%	12%	7%	10%	12%	(years)
With subsidy on polyhouse										
0.1	1.64	1.58	1.54	27.02	23.59	21.69	22.19	24.42	25.94	2.20
0.2	1.97	1.90	1.86	65.18	56.96	52.41	26.71	29.02	30.60	1.65
0.4	2.13	2.05	2.00	134.19	117.16	107.73	27.93	30.26	31.85	1.61
With subsidy on polyhouse and planting material										
0.1	1.69	1.64	1.60	28.03	24.58	22.66	24.28	26.54	28.09	2.03
0.2	2.05	1.99	1.94	67.19	58.93	54.34	29.71	32.07	33.68	1.49
0.4	2.23	2.15	2.11	138.23	121.09	111.59	31.28	33.67	35.30	1.45
Without subsidy										
0.1	1.43	1.37	1.32	22.65	19.34	17.52	16.37	18.49	19.94	3.24
0.2	1.70	1.61	1.56	56.86	48.87	44.46	19.56	21.74	23.23	2.56
0.4	1.82	1.73	1.67	118.41	101.82	92.66	20.54	22.74	24.23	2.47

* represent the reinvestment rate to be taken as 1% higher than the cost of capital

Among the attributes, price was the most important attribute followed by yield, colour and variety (Table 6). Deep red was the most preferred colour by the farmers with a relative

utility of 1.033, followed by pink (0.267) and white which had a negative utility value of -1.300. The hybrid variety was given a higher utility value of 0.650 over local variety. High priced gerbera yielded the highest relative utility value of 1.417, whereas medium and low prices ones had relative utility value of 0.567 and -1.983, respectively. Gerbera yield of >2.5 lakh flowers per 0.1 ha was given highest utility value of 1.400, whereas 2 to 2.5 lakh flowers and <2 lakh flowers per 0.1 ha, had a relative utility value of 0.117 and -1.517, respectively. The Pearson's R for entire producers group was 0.977 indicating a strong relation between producers ranking and judgments of attributes.

Table 6: Results of conjoint analysis for gerbera farmers

Attributes	Levels	Part-worth	Relative importance (%)
Colour	Deep red	1.033	
	White	-1.300	27.195
	Pink	0.267	
Variety	Hybrid	0.650	12.201
	Local	-0.650	
Price	Low (<₹2 per flower)	-1.983	
	Medium (₹2 to 4 per flower)	0.567	33.185
	High (>₹4 per flower)	1.417	
Yield	<2 lakh flowers per 0.1 ha	-1.517	
	2 to 2.5 lakh flowers per 0.1 ha	0.117	27.419
	>2.5 lakh flowers per 0.1 ha	1.400	
Constant		4.783	
Pearson's R		0.977	
Kendall's Tau		0.833	

Three types of marketing channels were followed by the respondents for marketing of gerbera grown under protected cultivation and the results are presented in Table 7. The channel I which comprises of aggregators, wholesalers and retailers was followed by 50 % of total farmers. Farmers also sell their gerbera produce through APMC market, which is part of channel II in the marketing channel. Comparison of marketing channels followed for gerbera revealed that farmers received the highest price in channel III but at the same time the price for the consumer was highest among all other channels. Share in consumer rupee is highest in channel II which involved the APMC market for the sale of farmers produce. Marketing cost was almost equal in all channels but involved a different number of market agents. Market margin was highest for channel III even-though it involved the least number of market agents in the transaction of gerbera. This was due to high net margin kept by the agent involved for marketing.

Table 7: Marketing channel followed by the farmers for marketing of gerbera grown under protected cultivation

	Marketing channels					% share	PSCR (%)
I	Farmers (PR=260 MC=21) →	Aggregators (MC=12 MM=58) →	Wholesaler (MC=8 MM=62) →	Retailers (MC=20 MM=100) →	Consumers (PP=500)	50	52
II	Farmers (PR=300 MC=27) →	CA/traders at APMC market (MC=8 MM=10) →	Wholesaler (MC=9 MM=93) →	Retailers (MC=20.5 MM=95) →	Consumers (PP=515)	30	58.25
III	Farmers (PR=310 MC=29) →	Wholesaler (MC=15 MM=125) ⟶	Retailers (MC=22 MM=100) ⟶	Consumers (PP=550)		20	56.36

Note: PR=Price received (₹/100 flowers); PP=Price paid (₹/100 flowers); MC=Marketing cost (₹/100 flowers); MM=Marketing margin (₹/100 flowers); PSCR=Producers share in consumers rupee (%).

Conclusions

The establishment cost of protected cultivation of gerbera under polyhouse required high initial investment and high input cost, but offered higher returns. The feasibility analysis showed that without subsidy support, gerbera cultivation under polyhouse is sustainably feasible but payback period is more compared to with subsidy support. However, government subsidy support considered to be a game changer in establishment of polyhouse structure. Price spread in the marketing of gerbera showed that the producers share in consumer rupees was highest where APMC was involved. With subsidy support to farmers, payback period of their investment in protected cultivation was reduced and returns increased. This could be a driving force for higher adoption of protected cultivation among others farmers.

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