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Economic analysis of apple farming in high-hills of Himachal Pradesh

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Abstract

Himachal Pradesh, known for its diverse agro-climatic conditions, is a significant hub for fruit and vegetable production. The present study was undertaken to assess the economics of apple cultivation in Himachal Pradesh. For this purpose, primary data were collected from three blocks Rohru, Kotkhai, and Jubbal of Shimla district. A total of 180 farmers were selected from these areas for the present study. The findings revealed that the average initial cost of planting per 100 apple plants was ₹ 42583.63. The establishment cost, which covers the expenses from 1 to 5 years of age of the plants, ranged between ₹ 28768.21 and ₹ 40737.50. The results depicted an increase in total cost of cultivation in early years of plantation and was calculated to be ₹ 62564.20, ₹ 69677.65 and ₹ 70541.07 per hundred plants in the age groups of 6-11, 12-17 and 18-22 years, respectively and then gradually decreased to ₹ 64933.62 in the age group of >22 years. It was observed that the average production was recorded highest in age group of 12 to 17 years (68.43 qntl. per 100 plants) with higher net returns of ₹ 354880 per 100 plants. Financial feasibility of apple cultivation was also analysed in which Net present value, IRR and B-C ratio were calculated. These economic indicators found to be highly feasible and profitable to farmers.

Keywords: Apple, cost of cultivation, Net returns, output-input ratio

Introduction

The horticulture sector is a key driver of the Indian economy, contributing significantly to agricultural profitability by generating employment opportunities and enhancing farmers' incomes. Indian horticulture sector contributes about 33 per cent to the agriculture Gross Value Added (GVA) making very significant contribution to the Indian economy. India is currently producing about 320.48 million tones of horticulture produce which has surpassed the food grain production. Productivity of horticultural crops is much higher compared to productivity of food grains (12.49 tonnes/ha against 2.23 tones/ha.). India has emerged as world leader in the production of a variety of fruits and is the second largest producer of fruits and vegetables (Department of Agriculture and farmers welfare, 2022) [1]. It ranks first in the production of mango, banana, and papaya, and is also a major producer of apple, especially in the northern hill states. The country produces 110.21 million MT of fruits (India Stat, 2023-24).

Farmers in the Himalayan region cultivate a wide variety of fruit crops, including pomes. Among these, apple holds a position of dominance over all other horticultural crops (Kala, 2007). Himachal Pradesh, known for its diverse agro-climatic conditions, is a significant hub for fruit production. The state has 235.79 thousand hectares under fruit crops, producing 814.61 thousand MT of fruits (Directorate of Agriculture, Himachal Pradesh, 2022-23). Among the apple-producing regions of Himachal Pradesh, Shimla district holds a prominent place, established orchard systems, and significant contribution to the state's economy. Area under apple cultivation in Himachal Pradesh is 49.38 thousand hectare with production of 360.12 thousand metric tonnes. In this context, the present study undertakes an economic analysis of apple cultivation in Himachal Pradesh, focusing specially on the temperate wet high hills, which are known for their off-season advantage and premium market prices. The study aimed to evaluate the cost and returns of apple to understand the profitability and sustainability of this enterprise.

Materials and Methods

For the assessment of the cost and returns of apple cultivation, wet temperate High hills (zone III) was selected. Shimla district was chosen purposively, as it represents the major apple-producing area in state. This zone is well-known for its seasonal fruits and vegetable harvests, and this season is considered an off-season in the plains. Farmers in these areas obtain greater prices than average. Multistage stratified random sampling method was used to select the farmers.

First stage: Temperate wet high hills (Zone- III) was

selected as this zone is well-known as major apple producing zone. Shimla district was selected on the basis of centre of production.

Second stage: 6 dominant blocks were selected from Shimla district.

Third stage: From each selected block three panchayats were selected.

Fourth stage: From each panchayat ten respondents were selected to create total sample size of 180 respondents.

To meet the objective of the present study, both primary as well as secondary data were collected. Primary data on demographic features such as family size, age, education, livestock composition, cost pertaining to apple cultivation and returns were collected using pretested well-designed schedule by personal interaction with selected respondents. Secondary data pertaining to list of apple farmers were collected from Directorate of Horticulture, Government of Himachal Pradesh.
General statistical and mathematical calculation has been done for the analysis of cost of cultivation for the orchards in order to take all the relevant data for calculating the economics of apple cultivation in the study area. Various items of costs of cultivation and returns and their measurements are given below:

1. Labor

- Labor was categorized into hired and family labor. Hired labor was measured in man-days, with one man-day equivalent to 8 hours of work.
- Family labor included the contributions made by household members and its value was estimated based on prevailing market wages for hired workers.

2. Inputs and Land

- Cost of farm implements used in apple cultivation was calculated using the straight-line depreciation method.
- The value of land was calculated using imputed rental value, reflecting its opportunity cost. Fertilizers and plant protection materials were valued at the actual market prices paid by farmers. Farmyard manure was price was observed on current local market rates.

3. Financial Costs and Metrics

- Interest on both fixed and working capital was taken into account as per the prevailing financial conditions in the study area (7%).
- **Pro-rated establishment cost:** Establishment costs incurred during the non-bearing years of the orchard were annualized over the productive life of the apple trees using the following formula:

$$P = EC \frac{1}{(1-(1-i)^{-n})}$$

Where,
P = Annual amortized cost
EC = Total establishment cost
I = Interest rate
n = Number of productive years

- Fixed costs included land rent, depreciation, amortized establishment cost, and interest on fixed capital.
- Variable costs covered human labor, seeds, manure, fertilizers, chemicals, irrigation, interest on working capital, and miscellaneous expenses.
- Total cost was obtained by summing fixed and variable costs. Net income was calculated by subtracting total cost from gross returns. The output-input ratio was derived by dividing net income by total cost.

Financial analysis: To appraise the financial feasibility of investment in polyhouse, discounted (net present value, benefit cost ratio and internal rate of return) and undiscounted methods (payback period) were used. The cash inflows and outflows were worked out for 35 years old apple plants.

a. Net present value: The net present value represents the discounted value of the net cash inflows to the project. This is simply the present worth of the net cash flow stream.

$$NPV = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+r)^t}$$

Where,
NPV = Net present value in period 't'
B_t = Benefit from polyhouse cultivation in each year
C_t = Cost of polyhouse cultivation in each year
r = Discount rate
t = 1,2,3…. n, the entire life of polyhouse across the study regions.
n = Number of years (5 years data was observed under the study)

b. Benefit cost ratio: The benefit cost ratio of an investment is ratio of the discounted value of all cash inflows to the discounted value of all cash outflows during the life of the project and computed as

$$\text{B: C ratio} = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+r)^t}}$$

c. Internal rate of return: The rate at which the net present value is equal to zero is internal rate of return (IRR) to the project and it represent the average earning power of money used in the project life.

$$IRR = \frac{LDR + \text{Difference between 2 discount rates} \times \text{NPV of cash flow at LDR}}{\text{Absolute difference between NPV of cash flow at two dicount rates}}$$

Where,
IRR = Internal Rate of Return
LDR = Lower Discount rate

Results and Discussion

Initial costs of apple plantation per hundred plants in the study area

The cost structure, production and returns of apple cultivation in the study area were analyzed based on the

costs associated with cost of plantation, maintenance during the non-bearing period, and expenses incurred during the bearing stage. The summation of costs incurred during plantation (initial investment) and costs during non-bearing stage is termed as cost of establishment, which was distributed over the productive lifespan of the plantation.

Cost and return analyses were conducted on a per hundred-plant basis. To estimate the cost and returns of apple cultivation, the following assumptions were made:

- First bearing starts from 6th year onward
- The major operation and input requirement remain same in the plant age group of 6-11, 12-18, 18-22 and >22 year old plants
- Total economic life of plantation is expected to 35 years.

The groups mentioned above are primarily focused on the physiological growth and productivity patterns of the plant. This section of the analysis has been divided into four parts:

1. Initial investment
2. cost during non-bearing stage of apple plantation
3. Cost during bearing stage of apple plantation
4. Production and returns from apple cultivation

Initial costs of apple plantation per hundred plants in the study area

Initial costs of apple plantation per hundred plants are presented in Table 1. It was observed that apple orchardists in the study area incurred an average total initial stage cost of Rs. 42583.63 per hundred plants. Material inputs accounted for 53.77 per cent of the total cost, while the cost incurred on human labour was observed to be 20.56 per cent. Managerial costs and risk margins each contributed 7.43 per cent to the total cost, while rental value of land constituted 5.50 per cent. Similar results were also recorded by Kireeti *et al*. (2014) [3] and Sharma *et al*. (2018) [6] in high hills of Himachal Pradesh.

Table 1: Initial costs of apple plantation per hundred plants in the study area (Rs./100 plants)

Particular	Overall
i. Planting Material	16928.55
	(39.75)
ii. FYM cost	4560.12
	(10.71)
iii. Fertilizers and other	1406.94
	(3.30)
Subtotal	22895.61
	(53.77)
a. Family labour	5864.12
	(13.77)
b. Hired labour	2891.39
	(6.79)
v. Interest on working capital	1107.79
	(2.60)
vi. Risk Margin	3165.11
	(7.43)
vii. Managerial cost	3165.11
	(7.43)
Total variable cost	39089.13
	(91.79)
i. Land revenue	7.00
	(0.02)
ii. Depreciation	930.47
	(2.19)
iii. Interest on Fixed capital	213.28
	(0.50)
iv. Rental value of land	2343.75
	(5.50)
Total fixed cost	3494.50
	(8.21)
10. Total cost	42583.63
	(100)

*Figures in parentheses are percentages

Maintenance Cost during non-bearing stage of apple plantation

Table 2: Maintenance cost during non-bearing stage of apple plantation per hundred plants in case of overall farms (Rs./100 plants)

Particular	Establishment cost during non-bearing stage / 100 plants				
	1st year	2nd year	3rd year	4th year	5th year
1. Variable cost					
i. Material Cost					
a. Gap filling	2139.09	1473.59	0.00	0.00	0.00
	(7.44)	(4.67)	(0.00)	(0.00)	(0.00)
b. Bordeaux mixture	679.60	742.44	803.86	850.35	867.49
	(2.36)	(2.35)	(2.40)	(2.30)	(2.13)
c. Lime	252.63	214.77	246.75	245.94	219.25
	(0.88)	(0.68)	(0.74)	(0.67)	(0.54)
d. FYM cost	4149.13	4574.75	4908.95	5135.98	5609.11
	(14.42)	(14.5)	(14.63)	(13.9)	(13.77)
e. Fertilizer cost	1468.01	1800.15	2199.41	2579.82	2833.56
	(5.1)	(5.71)	(6.56)	(6.98)	(6.96)
f. Fungicide	785.3	817.62	881.98	942.67	1004.86
	(2.73)	(2.59)	(2.63)	(2.55)	(2.47)
g. Insecticide	654.22	830.58	859.28	933.38	975.56
	(2.27)	(2.63)	(2.56)	(2.53)	(2.39)
Subtotal	10127.98	10453.90	9900.22	10688.13	11509.84
	(35.21)	(33.13)	(29.51)	(28.92)	(28.25)
ii. Labour cost					
a. Family labour	4037.69	4039.65	4329.5	3773.4	3938.49
	(14.04)	(12.8)	(12.9)	(10.21)	(9.67)
b. Hired labour	4099.29	4482.56	4647.35	5357.79	5469.04

	(14.25)	(14.21)	(13.85)	(14.5)	(13.43)
Subtotal	8136.98	8522.21	8976.85	9131.19	9407.52
	(28.28)	(27.01)	(26.75)	(24.7)	(23.09)
iv. Interest on working capital	593.61	616.72	613.5	644.13	679.81
	(2.06)	(1.95)	(1.83)	(1.74)	(1.67)
v. Risk Margin	1826.50	1897.61	1887.71	1981.93	2091.74
	(6.35)	(6.01)	(5.63)	(5.36)	(5.13)
vi. Managerial cost	1826.50	1897.61	1887.71	1981.93	2091.74
	(6.35)	(6.01)	(5.63)	(5.36)	(5.13)
Total variable cost	22511.56	23388.06	23265.99	24427.31	25780.64
	(78.25)	(74.13)	(69.34)	(66.09)	(63.28)
2. Fixed cost					
i. Land revenue	7	7	7	7	7
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ii. Depreciation	925.04	958.01	1027.99	1089.87	1109.19
	(3.22)	(3.04)	(3.06)	(2.95)	(2.72)
iii. Interest on Fixed capital	212.92	215.06	219.61	223.64	224.89
	(0.74)	(0.68)	(0.65)	(0.61)	(0.55)
iv. Rental value of land	2343.75	2343.75	2343.75	2343.75	2343.75
	(8.15)	(7.43)	(6.99)	(6.34)	(5.75)
v. Interest on Pre- establishment cost	2767.94	4637.87	6688.6	8869.55	11272.02
	(9.62)	(14.70)	(19.93)	(24.00)	(27.67)
Total fixed cost	6256.65	8161.7	10286.96	12533.81	14956.86
	(21.75)	(25.87)	(30.66)	(33.91)	(36.72)
3. Total cost	28768.21	31549.76	33552.95	36961.12	40737.50
	(100)	(100)	(100)	(100)	(100)

*Figures in parentheses are percentages

The establishment or maintenance cost during non-bearing stage of apple plantation is presented in Tables 2. The results revealed that total maintenance cost increased with an increase in plant age. The results indicated that increase in cost is directly associated with plant age. The material cost consisted more than 28.25 per cent of the total cost during all five years. Total maintenance cost was recorded to be Rs. 28768.21, Rs. 31549.76, 33552.95, Rs. 36961.12 and Rs. 40737.50 for first to fifth year old plants, respectively.

The material cost of inputs, such as FYM and fertilizers, increased with the age of the plants. Interest on pre-establishment costs exhibited a positive relationship with plant age during the non-bearing years. Interest on pre-establishment cost was observed to have highest percentage share in fixed costs.

Cost during bearing stage of apple plantation in different farm categories

The total productive lifespan of apple plants was categorized into four age groups, each considered relatively homogeneous in terms of productivity and input utilization. The establishment cost was allocated over a bearing period of more than 22 years on a prorated basis, applying an interest rate of 8 per cent.

Detailed analysis was conducted and presented in Tables 3 of the maintenance costs of apple during bearing stage. The results depicted an increase in total cost of cultivation in early years of plantation and was calculated to be ₹ 62564.20, ₹ 69677.65 and ₹ 70541.07 per hundred plants in the age groups of 6-11, 12-17 and 18-22 years, respectively and then gradually decreased to ₹ 64933.62 in the age group of >22 years. Total Cost was observed to decline in the age group of over 22 years, likely due to the initial years representing the maturation stage of the plants. During this phase, labor and material inputs increased with plant growth, reaching their peak in the 12-17-year age group. Labor utilization was significantly higher during the peak productivity phase, primarily for harvesting, and gradually declined in the later stage (>22 years). The share of labour in total cost of cultivation ranged from 26.15 to 28.17 per cent across different age groups, while fixed cost varied from 29.98 to 33.43 per cent. The rental value of land and prorated establishment cost resulted in maximum proportion of fixed costs in all farm categories.

Table 3: Maintenance cost during bearing stage of apple in case of overall farms (Rs./100 plants)

Particular	Establishment cost during bearing stage / 100 plants			
	6 to 11 years	12 to 17 years	18-22 years	>22 years
1. Variable cost				
i. Material Cost				
a. Bordeaux mixture	356.62	369.78	358.96	320.11
	(0.57)	(0.53)	(0.51)	(0.49)
b. Lime	80.35	84.18	91.56	95.35
	(0.13)	(0.12)	(0.13)	(0.15)
c. FYM cost	6944.05	8410.59	8807.47	7280.05
	(11.10)	(12.07)	(12.49)	(11.21)
d. Fertilizer cost	3013.48	3381.83	3327.17	3031.85

	(4.82)	(4.85)	(4.72)	(4.67)
e. Fungicide	3599.22	3917.98	3977.94	3782.14
	(5.75)	(5.62)	(5.64)	(5.82)
f. Insecticide/Herbicide	3433.04	3685.94	3773.60	3513.18
	(5.49)	(5.29)	(5.35)	(5.41)
Subtotal	17426.75	19850.29	20336.71	18022.68
	(27.85)	(28.49)	(28.83)	(27.76)
ii. Labour cost				
a. Family labour	8485.54	9539.26	9190.16	8950.60
	(13.56)	(13.69)	(13.03)	(13.78)
b. Hired labour	7877.77	10087.94	10547.33	8700.54
	(12.59)	(14.48)	(14.95)	(13.40)
Subtotal	16363.30	19627.20	19737.49	17651.14
	(26.15)	(28.17)	(27.98)	(27.18)
iv. Interest on working capital	1098.18	1283.02	1302.41	1159.40
	(1.76)	(1.84)	(1.85)	(1.79)
v. Risk Margin	3379.00	3947.75	4007.42	3567.38
	(5.40)	(5.67)	(5.68)	(5.49)
vi. Managerial cost	3379.00	3947.75	4007.42	3567.38
	(5.40)	(5.67)	(5.68)	(5.49)
Total variable cost	41646.23	48656.01	49391.45	43967.99
	(66.57)	(69.83)	(70.02)	(67.71)
2. Fixed cost				
i. Land revenue	7.00	7.00	7.00	7.00
	(0.01)	(0.01)	(0.01)	(0.01)
ii. Depreciation	873.18	970.54	1090.70	917.94
	(1.4)	(1.39)	(1.55)	(1.41)
iii. Interest on Fixed capital	209.56	215.88	223.69	212.46
	(0.33)	(0.31)	(0.32)	(0.33)
iv. Rental value of land	2343.75	2343.75	2343.75	2343.75
	(3.75)	(3.36)	(3.32)	(3.61)
v. Pro-rated establishment cost	17484.48	17484.48	17484.48	17484.48
	(27.95)	(25.09)	(24.79)	(26.93)
Total fixed cost	20917.96	21021.65	21149.62	20965.63
	(33.43)	(30.17)	(29.98)	(32.29)
3. Total cost	62564.20	69677.65	70541.07	64933.62
	(100)	(100)	(100)	(100)

*Figures in parentheses are percentages

Production and returns from different age groups of Apple

Table 4 presents the findings of average production and gross returns from different age groups of Apple. From table, it was observed that the average production was recorded highest in age group of 12 to 17 years (68.43 qntl./100 plants). At overall level, the average production was found 48.93 quintals per hundred plants. The average production across different age groups ranged between 21.25 quintals to 68.43 quintals per hundred plants. The overall average return of apple was worked out and found maximum in 12-17 years old plants. The average return in term of money value was found to be Rs. 637170 for 12 to 17 age year group followed by 18-22 aged plants Rs. 489530, >22 year plants Rs. 389760 and 6 to 11 years plants Rs. 170790.

Table 4: Production and gross returns from different age groups of Apple

Farm category	Average production from different age groups / 100 plants				
	6-11	12-17	18-22	>22	Average production
Production (Qntl.)	21.25	68.43	56.14	49.91	48.93
Gross returns ('000 Rupees)	170.79	637.17	489.53	389.76	421.81
Net Returns ('000 Rupees)	108.22	567.50	418.99	324.83	354.88

Financial feasibility evaluation of apple cultivation

Economic feasibility of apple cultivation is presented in Table 5 in which Net present value, IRR and B-C ratio were calculated. The results showed that apple cultivation was feasible as the economic indicators were found in the acceptable limits. In the study, NPV, calculated by discounting the net cash flow at 12 per cent discount rate for 35 years of apple production. Net present value was found to be Rs. 1819437. Benefit-cost ratio of apple cultivation was 3.79 with 31 per cent of internal rate of return. Therefore, all the economic indicators indicated that cultivation of apple was highly feasible and profitable to farmers. Chapai *et al*. (2024) [10] revealed that financial feasibility tests i.e., NPV, BCR and IRR were positive and proved that investing on apple cultivation was profitable.

Table 5: Measures of investment worth per 100 plants of apple

Economic indicators	Measures of investment worth
Net present value (₹)	1819437
B-C Ratio	3.79
Intarnal rate of return (%)	31

Conclusion

Compared to other agricultural food crops, apple cultivation in Himachal Pradesh has emerged as a highly lucrative economic activity and a commercially attractive enterprise. Apple cultivation is regarded as one of the most effective means of utilizing the natural resources of the hills, offering significantly higher returns to farmers than traditional field crops. Although apple cultivation is labour intensive but in addition it generates greater income, also creates more employment opportunities, leading many farmers to shift from field crops to horticulture crops.

In high hill regions of Himachal Pradesh, apple cultivation yields a net return of ₹ 354.88 for per hundred plants. Average yield was found 48.93 quintals per hundred plants and found highly profitable as the value of NPV, IRR and B-C ratio were found high. Input subsidies, post-harvest infrastructure, and market linkages will also make apple cultivation more sustainable and profitable for small and marginal farmers.

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