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Economic viability and sustainability of kinnow orchards in Haryana

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Abstract
Kinnow cultivation has become a significant agricultural activity in Haryana, offering potential economic benefits to farmers due to its high profitability and adaptability to the region's agro-climatic conditions. This study assesses the economic viability of kinnow orchards in the Sirsa and Fatehabad districts of Haryana, focusing on establishment and operational costs, as well as returns over time. The research involved a multistage random sampling technique, with data collected from 30 farmers in selected villages. The analysis reveals that while the total establishment cost per hectare is ₹302,979 and the operational cost over seven years is ₹761,627, kinnow cultivation offers a promising return on investment. Financial indicators such as Net Present Value (NPV) of ₹425,509.29, an Internal Rate of Return (IRR) of 22.29 per cent and a Benefit-Cost Ratio (B:C ratio) of 2.2 suggest that kinnow orchards are economically viable. The Payback Period is 7.7 years, indicating that farmers will recover their initial investment within this timeframe. These findings highlight kinnow cultivation as a sustainable and profitable agricultural practice in Haryana, providing opportunities for farm income growth and regional agricultural diversification.

Keywords: Kinnow, economic viability, Haryana, net present value, payback period

Introduction
Kinnow cultivation has emerged as a significant horticultural activity in Haryana, contributing to the state's agricultural diversification and economic development. Over the years, kinnow has gained significant popularity due to its high profitability and adaptability to the state's agro-climatic conditions. The regions of Sirsa and Fatehabad, in particular, have become major hubs for kinnow production to the favorable weather and soil conditions that support its growth. The increasing demand for kinnow in both domestic and international markets further emphasize its potential as a profitable crop (Bhat *et al*., 2011) [1].

As the cultivation of kinnow continues to expand, there is a growing interest in understanding its economic viability and the factors that influence its production (Meena *et al*., 2018) [6]. The economic success of kinnow orchards in Haryana is driven by several factors, including land preparation, irrigation systems, and the cost of planting materials. Farmers have shown a growing interest in kinnow cultivation due to its relatively low water requirements compared to traditional crops such as paddy and wheat, making it a more sustainable choice in water-scarce regions of the state (Kumar *et al*., 2017) [3].

This research paper aims to assess the economic viability of kinnow orchards in Haryana, focusing on the key aspects of its cultivation. The study highlights the benefits of kinnow production in terms of its economic potential, environmental sustainability and contribution to farm income. By analyzing the trends in kinnow cultivation, this paper seeks to provide insights into the opportunities and challenges faced by farmers in the region, supporting the efforts to promote kinnow as a viable agricultural enterprise in Haryana (Priyadarshini *et al*. 2020) [7].

Materials and Methods
For the study a multistage random sampling technique was used to select the required unit of sample size. Out of total districts of Haryana, two districts Sirsa and Fatehabad were selected purposively on account of highest production under kinnow cultivation in the state. Then, one highest production block of kinnow crop was selected from each of the selected districts. In this way from Sirsa district, Odhan block and from Fatehabad district, Bhuna blocks were

selected. From each selected block, further one village was selected having maximum number of farmers cultivsating kinnow crop. So from Odhan block, Panniwala Mota village and from Bhuna block, Laharian village was selected. Now from each of these villages, out of total kinnow cultivating farmers, 15 farmers were randomly selected and interviewed. Thus, a total of 30 farmers were selected for this study. Primary data for the year 2024-25 were collected from these farmers through personal interview method using a well designed pretested interview schedule.

Economic viability of fruit plants

To analyze the economics of kinnow production, it is essential to study the cost in two parts *viz*., establishment costs and operational costs. The former consists of cost of construction of pond, preparation of land and layout, digging and filling of pits, cost of irrigation system, cost of plants and plant materials, cost of plant protection, cost of manures and fertilizes (incurred before plantation), cost of fencing, etc.

Operational and maintenance costs include the expenditure on manuring (farm yard manure and fertilizer), intercultural operation, irrigation, plant protection, pruning and cutting, rental value of land, depreciation on fixed investment and interest on working capital. For analysis of data, various economic tools were used. To examine the economic feasibility of kinnow cultivation, three indicators were used *viz.,* net present value (NPV), internal rate of return (IRR) and benefit cost ratio (B:C Ratio). The detailed method used to find out these indicators are**:**

Net present value

Future net returns were discounted to their net present value by using the following formula:

$$NPV = \sum_{i=0}^{t} DF * B_t - DF * C_t$$

Where,

DF is discounting factors; $DF = \frac{1}{(1+r)^t}$; r is discount rate, t time span of the project; B_t is the benefits in time t and C_t is the cost incurred in time t.

Internal rate of return

The Internal Rate of Return (IRR) is the discount rate at which the net present value (NPV) of a series of cash flows equals zero. It represents the rate of return at which an investment breaks even. In estimating the internal rate of return, the investment cost and incremental gross returns for each year in the life of kinnow orchard was calculated. The internal rate of return was calculated at the different rate of discount until it satisfies the relationship B - C = 0 where 'B' is the sum of discounted stream of positive value (returns) and 'C' is taken as the sum of discounted stream of negative values (costs) (Kaur and Singla, 2016) [2].

$$\mathbf{NPV} = \sum_{i=1}^{n} (C_t / (1 + IRR)^t) = 0$$

Where:
- NPV = Net Present Value (which equals 0 at the IRR)
- C_t = Cash flows at time t (could be costs or revenues)
- IRR = Internal Rate of Return
- t = Time period (usually years)
- n = Total number of periods (years)

Benefit cost ratio

The benefit cost ratio is the ratio between the sum of discounted net benefits of returns (R) and the sum of discounted cost (K), i.e. B = R/K. If this ratio is greater than 1.00 then the investment in kinnow orchard is considered to be economically viable (Meena *et al*., 2018) [6].

Payback period

It is the period within which the cost of the orchard is fully recovered from its own returns. In other words, it indicates the number of years by which the net returns (R) equal, to the cost of orchard (K). For this condition the following relationship must be satisfied.

$$\sum_{i=1}^{n} Ri = K$$

Where,
i = 1, 2, 3 ……. n year,
R = Indicates the return over a number of year,
K = Indicate the cost of orchard.

Depreciation and interest

For estimating annual cost, the depreciation has been worked out @ 4 per cent per annum of the fixed investment (i.e. establishment cost) by applying straight line method or direct method, assuming the productive life of orchard about 25 years. Further interest has been taken @ 12 per cent per annum on operational cost.

Amortization of fixed cost

The annual amortization of cost was computed from the investment made on establishment of kinnow orchard, assuming that the rate of interest 12 per cent per annum and the expected life of kinnow orchard to be 25 years. Thus, annual amortization was worked out by using the compounding cost formula and by adding it to maintenance cost for estimating the annual cost of cultivation of kinnow orchard of respective farmers.

$$I = B \frac{r}{1-(1+r)^{-t}}$$

Where,
I = Annual cost (in ₹),
B = Present fixed cost (in ₹),
r = Interest rate (12% per annum)
t = Economic life of the orchard (in years).

Results and Discussion
Establishment cost of kinnow orchard

Kinnow cultivation is a long term capital-intensive farming venture. The life of kinnow orchard is near about 25 years. The initial cost of establishment of a kinnow orchard

consists of the preparation of land and layout, digging and filling of pits, cost of filling material (manure, fertilizers) cost of plant material and planting, cost of irrigation, cost of permanent fencing and tools, cost of plant protection chemical, transport and other miscellaneous items like watch and wards etc.

The results presented in Table 1 indicated that the average total cost of establishing kinnow orchard in study area was ₹ 302979 per hectare. The highest cost item of expenditure was incurred on cost of pond and fencing the orchard which accounts 41.84 and 22.64 percent of total cost respectively. Cost of digging and filling (3.11%), cost of preparation of land and layout (4.08%) and cost of drip installation (10.46%) were the other major component of the overall average establishment cost.

Table 1: Establishment cost of kinnow orchard in Sirsa and Fatehabad districts of Haryana

Sr. No.	Particulars	No./Quantity per ha	Value(₹/ha)	Per cent
1	Preparation of land and layout	5	12348	4.08
2	Digging and filling of pits		9434	3.11
3	Cost of irrigation		1318	0.44
4	Cost of plant		28102	9.28
5	Cost of replacement plant		2810	0.93
6	Cost of construction of pond		126755	41.84
7	Manures and fertilizers		5626	1.86
8	Transportation of plant		1235	0.41
9	Plantation cost		4556	1.50
10	Intercultural operations		4175	1.38
11	Installation of drip irrigation		31698	10.46
12	Permanent fencing		68602	22.64
13	Cost of equipments		3850	1.27
14	Miscellaneous		2470	0.82
	Total cost		302979	100.00

Operational cost of kinnow orchard

The operations in an orchard do not come to an end at its establishment only, but they have to be carried on throughout its life duration. The operating cost on various operations like manure and fertilizer, intercultural and hoeing, irrigation, plant protection, pruning and cutting, replacement cost, watch and ward and picking cost, etc. to be incurred every year. It is apparent from the data in the Table 2 that the operating costs per hectare increased over years because of higher expenses incurred on various inputs and rise in other cost. This increase may be attributed to the direct relationship between the physical input requirement and age of the plants.

It is clear from the Table 2 that the operating costs per hectare increased over years because of higher expenses incurred on various inputs and rise in picking cost. This increase may be attributed to the direct relationship between the physical input requirement and age of the plants. The annual operating cost ranges from ₹ 38099 in the first year to ₹ 201752 per hectare in the seventh year. The operational cost goes on increasing up to seventh year of the establishment of an orchard and thereafter it becomes more or less stabilized. The operational cost per hectare per annum from first to seventh years were found to be ₹ 45654 on pruning and cutting (5.99%), ₹ 153186 on picking (20.11%), ₹ 98145 on plant protection (12.89%), ₹ 97229 on intercultural and hoeing (12.77%), ₹ 72451 on watch and ward (9.51%), ₹ 94261 on irrigation (12.38%) followed by ₹ 146056 on manure and fertilizers (19.18%), were the major constituents of operational cost of a kinnow orchard per annum per hectare (Kumar *et al*., 2017) [4].

Table 2: Operational cost of kinnow orchard in Sirsa and Fatehabad districts of Haryana (₹/ha)

Sr. No.	Particulars	Years							Total cost	Average cost per annum
		1	2	3	4	5	6	7		
1	**Manures and fertilizers**									
(a)	FYM (qtls.)	5520.00	6255.00	7468.00	8146.00	9056.00	9556.00	9876.00	55877.00	7982.43 (7.34)
(b)	DAP/SSP/NPK(Kg/Hectare)	1645.00	1754.00	2542.00	3262.00	7072.00	11618.00	12238.00	40131.00	5733.00 (5.27)
(c)	Potash	617.00	740.00	1232.00	4170.00	4778.00	7072.00	7167.00	25776.00	3682.29 (3.38)
(d)	Zinc(Kg/Hectare)	382.00	456.00	1025.00	2254.00	3602.00	3973.00	4275.00	15967.00	2281.00 (2.10)
(e)	Other	602.00	682.00	832.00	1025.00	1336.00	1852.00	1976.00	8305.00	1186.43 (1.09)
	Total	8766.00	9887.00	13099.00	18857.00	25844.00	34071.00	35532.00	146056.00	20865.14 (19.18)
2	Intercultural operation and hoeing	5930.00	6226.00	12120.00	14570.00	17065.00	19648.00	21670.00	97229.00	13889.86 (12.77)
3	Irrigation charges	6918.00	7220.00	10210.00	12241.00	16523.00	18524.00	22625.00	94261.00	13465.86 (12.38)
4	Pruning and cutting	0.00	1482.00	4322.00	7256.00	7658.00	11974.00	12962.00	45654.00	6522.00 (5.99)
5	Plant protection	4860.00	7226.00	7868.00	16670.00	18468.00	20526.00	22527.00	98145.00	14020.71 (12.89)
6	Whitewash on the tree trunk	0.00	0.00	0.00	0.00	5200.00	6000.00	6000.00	17200.00	2457.14 (2.26)
6	Replacement and casuality	4215.00	3812.00	2810.00	2110.00	1405.00	1405.00	0.00	15757.00	2251.00 (2.07)
7	Watch and ward	4940.00	5250.00	5875.00	13220.00	13780.00	14400.00	14986.00	72451.00	10350.14 (9.51)
8	Picking cost	0.00	0.00	0.00	19395.00	26916.00	45125.00	61750.00	153186.00	21883.71 (20.11)
9	Miscellaneous	2470.00	2470.00	2964.00	3200.00	3334.00	3550.00	3700.00	21688.00	3098.29 (2.85)
	Total cost	38099.00	43573.00	59268.00	107519.00	136193.00	175223.00	201752.00	761627.00	108803.86 (100)

Note: Figures in parentheses are the percentage to the average cost per annum

Table 3: Cost and returns from kinnow orchard in Sirsa and Fatehabad districts of Haryana (₹/ha)

Sr. No.	Particulars	Years						
		1	2	3	4	5	6	7
1	Operational cost	38099.00	43573.00	59268.00	107519.00	136193.00	175223.00	201752.00
2	Interest on operational cost @12% per annum	4571.88	5228.76	7112.16	12902.28	16343.16	21026.76	24210.24
3	Total operation cost (Sub total of 1 and 2)	42670.88	48801.76	66380.16	120421.28	152536.16	196249.76	225962.24
4	Management charges @ 10%	4267.09	4880.18	6638.02	12042.13	15253.62	19624.98	22596.22
5	Risk Factor @ 10%	4267.09	4880.18	6638.02	12042.13	15253.62	19624.98	22596.22
6	Expected depreciation on fixed cost investment @4%	12119.16	12119.00	12119.00	12119.00	12119.00	12119.00	12119.00
7	Amortized fixed cost	38630.00	38630.00	38630.00	38630.00	38630.00	38630.00	38630.00
8	Land rent	45775.00	47626.00	51870.00	54684.00	55640.00	57870.00	59620.00
9	Transportation cost	0.00	0.00	0.00	14240.00	22350.00	35240.00	45400.00
10	Total cost (3 to 9)	147729.22	156937.11	182275.19	264178.54	311782.39	379358.71	426923.69
11	Production (Qtls.)				110.00	182.00	276.00	322.00
12	Price (Rs./qtls)				1625.00	1720.00	1850.00	1920.00
13	Gross return				178750.00	313040.00	510600.00	618240.00
14	Net Return	-147729.22	-156937.11	-182275.19	-85428.54	1257.61	131241.29	191316.31
15	Return from intercropping	38320.00	35480.00	32206.00	0.00	0.00	0.00	0.00
	Total net returns	-109409.22	-121457.11	-150069.19	-85428.54	1257.61	131241.29	191316.31

Cost and returns from kinnow orchard

The cost and returns from kinnow orchards depends upon the age of plants. Data in Table 3 shows the cost and returns per hectare of kinnow orchard at different ages i.e. from the year of establishment to seventh-year age of orchard. No fruiting till three years of kinnow plantation there after the production of fruits starts increasing steadily from nearly 110 quintals in fourth year to about 322 quintals per hectare in seventh year of orchard age. However, after the age of seventh year it remains almost static with advance in age of the plants. Hence, the gross returns per hectare from kinnow orchard increase up to seventh year age of the plants. The gross returns per hectare worked out to be 618240 in the seventh year that was full bearing stage. This rate of return was expected to be more or less same up to age of 25 years. Taking into account the rental value of land, amortized fixed cost, operational cost, expected depreciation on fixed investment and interest on operational cost, the net returns per hectare have been worked out over time. The net returns from inter cropping ranges from 38320 to 32206 per hectare during the first year to third year of the kinnow orchard. Even after taking the returns from intercropping in the orchard the orchardist has to bear a loss of ₹ 109409.22, ₹ 121457.11, ₹ 150069.19 and ₹ 85428.54 per hectare in first, second, third and fourth year, respectively. During the sixth year the net returns become positive and worked out to be 1257.61 per hectare. The net returns increase up to seventh year i.e. ₹ 191316.31 per hectare and after that it becomes more or less stable up to the age of 25 years. It was indicated from the table that during the first four year the return from kinnow orchard available were found to be negative and the positive returns started from the fifth year and onwards (Sidhu and Vatta, 2012) [8].

Net Present value

Net present value is defined as the present value of all future cash flows associated with the investment, including the outlay. The net present value thus computed has been shown in Tables 4. The figures given that net present values (NPVs) for one hectare kinnow orchard came to be ₹ 425509.29. The present value is also positive. The positive NPV of farms shows that kinnow cultivation is a profitable crop enterprise in the study area (Singh *et al*., 2025) [9]

Table 4: Per hectare net present value of kinnow orchard in Sirsa and Fatehabad districts of Haryana (₹/ha)

Year	Negative returns (₹)	Positive returns (₹)	Discount coefficient $1/(1+r)^n$	Present value	
				Negative returns (₹)	Positive returns (₹)
1	-109409.22	0.00	0.89	-97691.49	0.00
2	-121457.11	0.00	0.80	-96825.60	0.00
3	-150069.19	0.00	0.71	-106819.24	0.00
4	-85428.54	0.00	0.64	-54289.83	0.00
5	0.00	1257.61	0.57	0.00	713.57
6	0.00	131241.29	0.51	0.00	66486.84
7 (and onward upto 25 years)	0.00	191316.31	3.73	0.00	713935.07
Total	-466364.06	323815.21	7.84	-355626.1872	781135.48

Net present value (NPV) = 781135.48-355626.19 = 425509.29

Internal rate of return (IRR)

The internal rate of return (IRR) is also a time-discounted measure of investment worth. It is one of the important indicators for evaluating the desirability of the investment with long gestation period. It is defined as the rate of discount or earning power of the investment which equalizes discounted benefits or returns (B) with the discounted cost (C) i.e. the rate of discount which will satisfy the relationship, B-C=0.

Table 5: Internal rate of return from one hectare of guava orchard in Hisar and Fatehabad districts of Haryana

Year	Net cash flow	Present value coefficient r= 22% (1/(1+r)n	Corresponding present value (₹)	Present value coefficient r= 23% (1/(1+r)n	Corresponding present value (₹)
1.00	-109409.22	0.8197	-89679.69	0.8130	-88950.59
2.00	-121457.11	0.6719	-81602.47	0.6610	-80280.99
3.00	-150069.19	0.5507	-82644.14	0.5374	-80644.77
4.00	-85428.54	0.4514	-38562.37	0.4369	-37323.52
5.00	1257.61	0.3700	465.31	0.3552	446.70
6.00	131241.29	0.3033	39802.61	0.2888	37900.05
7 (and onward upto 25 years)	191316.31	1.3470	257703.07	1.2310	235510.38
Total			5485.595599		-13345.00179

IRR = 22+1 (5485.60)/(5485.60+13345) = 22.29 per cent

In estimating the internal rate of return, the investment costs, gross returns from first to eighth year and the life of kinnow orchard have been depicted in Tables 5. The net cash flow was obtained by using these single values which may have negative and positive signs depending on the quantum of costs and benefits or returns in each year. To find out the present value, the discounted rate was estimated by different discount rate at random until the difference between the sum of discounted streams of positive and negative values is reduced either to zero or to a lowest minimum value. Thus, computed values of internal rate of returns are shown in Tables 5. The data presented in the Tables indicates a very high internal rate of return of 22.29 per cent per annum. This indicates that investment on kinnow orchards is highly profitable and internal rate of return is more than the present market interest rate i.e. 12 per cent per annum. The higher rate of returns from kinnow on was mainly due to better production and management of kinnow orchards on farms. Finally, it can be said that kinnow cultivation in the area is highly remunerative and a paying proposition (Kumar *et al.*, 2022) [5].

Benefit-Cost ratio
The benefit cost ratio is the ratio between the sum of discounted benefits or returns (R) and sum of discounted cost (K) which is presented in Table 4 at different discount rate, the benefit cost ratio was 2.2. It indicates that at the prevailing rate of interest 12 per cent per annum an investment of ₹ 1.00 would fetch a return of ₹ 2.2. Since this ratio is greater than unity, it shows that the investment in kinnow orchard is considered to be economically viable.

Payback period
It is divulged in the Tables 4 that the net cost incurred during the first seven years of the kinnow plantation was ₹466364.0 6per hectare. These costs are more than the return of ₹323815.21 per hectare. It indicates that costs are fully recovered in 8th year of establishment of kinnow plantation. Thus, the payback period of investment of kinnow orchard is 7.7 years.

Conclusion
Kinnow cultivation in Haryana particularly in the districts of Sirsa and Fatehabad is a highly profitable and economically viable horticultural enterprise. The detailed analysis of establishment cost (₹ 3,02,979) and operational costs over 7 years (₹ 7,61,627). It was found that despite the initial years of negative returns, kinnow orchards begin generating substantial profits from the sixth year onwards. The positive NPV of ₹ 4,25,509.29, an impressive IRR of 22.29 per cent, and a B:C ratio of 2.2 all underscore the long-term profitability of kinnow cultivation, even when considering depreciation, interest, and land rental values. Moreover, the payback period of approximately 7.7 years reflects a relatively moderate gestation period for a perennial fruit crop, making kinnow a financially sound option for farmers looking to diversify away from traditional water-intensive crops. The orchard's economic performance stabilizes after the seventh year, continuing to deliver consistent annual returns for up to 25 years, thereby contributing to sustainable agricultural incomes in the region. In conclusion, kinnow cultivation not only holds great potential to improve farm profitability but also promotes sustainable land and water use in Haryana's semi-arid agro-climatic conditions. Policy support in the form of subsidies for orchard establishment, access to quality planting material, irrigation infrastructure, and market linkages can further enhance the adoption and success of kinnow orchards, making it a cornerstone of horticultural development in the state.

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