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RESEARCH PAPER

Is Kinnow Mandarin Still Economically Viable in 2024? A Case Study of Sirsa District of Haryana

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ABSTRACT

The economic viability of Kinnow Mandarin production remains a significant concern for farmers and policymakers in North-Western India. This study evaluates the sustainability of Kinnow production in 2024, focusing on Sirsa district, Haryana. Previous research has emphasized the profitability of Kinnow cultivation, with high returns on investment and efficient marketing channels ensuring up to 81% of the consumer price for farmers. The establishment cost of Kinnow orchards in Haryana is estimated at ₹ 127,979 per hectare, with an annual net return of ₹ 272,845, yielding an internal rate of return (IRR) of 26.24%. As every year, there is change in cost of production and returns in the value chain of kinnow because of fluctuating prices of input as well as price of the commodity, it is important to find current cost and returns associated in the business. This study aims to provide a comprehensive financial analysis and highlight key challenges and opportunities to sustain Kinnow's economic viability.

HIGHLIGHTS

- Kinnow cultivation remains economically viable, with a Net Present Value (NPV) of ₹ 657,911.78, an Internal Rate of Return (IRR) of 20.37%, and a Benefit-Cost (B:C) ratio of 4.14, indicating strong long-term profitability despite high initial costs.
- Break-even occurs by the 6th year, with positive net returns of ₹ 59,926, and profits rising sharply to ₹ 224,264 in the 7th year, demonstrating sustainable financial gains post-establishment phase.
- Initial establishment cost per hectare is ₹ 179,714.90, with major expenses being pond construction (29.11%), permanent fencing (23.67%), and drip irrigation (13.74%), reflecting the capital-intensive nature of orchard development.
- Operational costs over seven years total ₹ 294,164, with manure & fertilizers, plant protection, and irrigation forming the bulk of recurring annual costs, highlighting the importance of efficient input management.
- Key challenges identified include post-harvest losses, climate-induced risks, high initial investment, and market inefficiencies, suggesting a need for improved value chain interventions, FPO involvement, and policy support.

Keywords: Value chain, kinnow mandarin, economic viability, sirsa etc.

Kinnow Mandarin, a hybrid variety of *citrus*, holds significant importance in the agricultural economy of North-Western India, specifically in the states of Punjab, Haryana, and Rajasthan (Kumar *et al*. 2021). Known for its high juice content, bright color, and

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adaptability to local climatic conditions, Kinnow cultivation has become a lucrative enterprise for farmers in these regions (Kumar *et al.* 2021). Over the years, several studies have highlighted the economic viability of Kinnow production, particularly emphasizing the profitability it offers through high returns on investment and its potential for enhancing farmers' income and supporting agricultural diversification (Kaur & Singla, 2016). However, as we approach 2024, the question of Kinnow's economic sustainability arises, especially in the context of evolving market dynamics, climatic uncertainties, and infrastructural limitations (Nawaz *et al.* 2021).

Previous economic appraisals have underscored the profitability of Kinnow cultivation. In Haryana, the first-year establishment cost per hectare is estimated at ₹ 127,979, with annual returns reaching ₹ 272,845, leading to a net present value of ₹ 783,243.67 and an internal rate of return of 26.24% (Kumar *et al.* 2022). Similarly, studies from other regions such as Himachal Pradesh indicate that larger orchardists benefit more from Kinnow production, demonstrating its scalability (Verma *et al.* 2015). Although emerging marketing channels demonstrate greater theoretical efficiency, traditional marketing channels (TMCs) have been found to yield 14.69% to 19% higher net benefits when accounting for yield and price uncertainties. This suggests that TMCs continue to offer a more reliable marketing option for kinnow producers operating under high-risk conditions (Kumar *et al.* 2020). Despite these promising figures, Kinnow cultivation faces numerous challenges. Market inefficiencies, post-harvest losses, and low adoption rates of modern agricultural practices, such as drip irrigation and plant protection measures, hinder the full realization of Kinnow's economic potential. Additionally, climatic vulnerabilities, such as erratic weather patterns and the increasing frequency of extreme events, pose significant risks to Kinnow farmers. Addressing these challenges requires strategic interventions, including improving value chain efficiency, engagement of new value chain actors, promoting Farmer Producer Organizations (FPOs), and implementing robust crop insurance and price stabilization mechanisms.

This case study focuses on Sirsa district in Haryana, a key Kinnow-producing region, to assess whether Kinnow Mandarin remains economically viable in 2024. Through a detailed analysis of costs, returns, NPV, IRR, CB ratio and payback period, this study aims to provide insights into the current state of Kinnow production and offer recommendations for sustaining its economic viability in the years to come.

MATERIALS AND METHODS

The present experiment was conducted during 2024-25 in Sirsa district of Haryana. Multistage stratified sampling technique was adopted to select the ultimate unit of sample. Out of 22 districts of Haryana state, Sirsa district was selected, on the basis of highest production of total citrus. A sample of 440 kinnow producers as respondents were taken purposively from various 22 villages (Malekan (1), Khari Surera (2), kalanwali (3), Panniwala Mota (4), Mithri (5), Tejakhera (6), Chautala (7), Asha khera (8), Kaluana (9), Godika (10), Mangiana (11), Gori wala (12), Mathdadu (13), Jandwala Bishnoyia (14), Shergad (15), Bijuwali (16), Rampura Dhillon (17), Darbakalan (18), Nathusrikalan (19), Dhukda (20), Bhagsar (21) and Badaguda (22)) of all seven blocks of the district (Baragudha, Dabwali, Ellenabad, Nathusary Chopta, Odhan, Rania & Sirsa). These villages considered as clusters by Department of Horticulture, Government of Haryana. Primary data pertaining to the year 2024-25 were collected from selected respondents by conducting personal interviews with help of specifically designed schedule.

Cost estimation: To analyze the cost of production for fruits, it is essential to study the cost in two parts viz., establishment costs and operational costs. The former consists of cost of pond construction, preparation of land and layout, digging and filling of pits, drip irrigation system, plants and planting materials, plant protection, manures and fertilizes (incurred before plantation), permanent 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 (Seavert *et al.* 2019).

Depreciation and interest for fruits: 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 selected fruit crops. Further interest has been taken @ 12 per cent per annum on operational cost (Seavert *et al.* 2019).

Amortization of fixed cost: The annual amortization of cost was computed from the investment made on establishment of kinnow fruits, assuming the rate of interest 12% per annum and the expected life 25 years for kinnow. 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 fruits of respective farmers (Kumar *et al*. 2019).

***Economic viability*:** To examine the economic feasibility of orchard while studying the economics of kinnow cultivation, four indicators were used, viz. net present value (NPV), internal rate of return (IRR), cost benefit ratio and payback period (Kumar *et al*. 2019).

Net Present Value

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

$$N.P.V. = \frac{R_1}{(1+r)_1} + \frac{R_2}{(1+r)_2} + \ldots\ldots \frac{R_{n-1}}{(1+r)_{n-1}} + \frac{R_n}{(1+r)_n}$$

Where, R_1, R_2 ……. R_n are the net returns in the period 1, 2, ……. n, respectively, 'n' is the life span in years of the investment in the orchard, 'r' is the discount rate (prevailing interest rate) and N.P.V. is net present value of returns R_1, R_2, R_3 ……...R_n.

Internal Rate of Return

In estimating the internal rate of return, the investment cost and incremental gross returns for each year in the life of orchard were 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).

$$IRR = \begin{pmatrix}\text{Lower}\\ \text{discount}\\ \text{rate}\end{pmatrix} + \begin{pmatrix}\text{Difference}\\ \text{between two}\\ \text{discount rates}\end{pmatrix} \times \frac{\begin{pmatrix}\text{Present worth of the}\\ \text{cash flow at lower}\\ \text{discount rate}\end{pmatrix}}{\begin{pmatrix}\text{Absolute difference}\\ \text{between the present worth}\\ \text{of the cash flow at}\\ \text{two discount rates}\end{pmatrix}}$$

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 fruits orchard is considered to be economically viable.

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.

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

Where,

i = 1, 2, 3 ……. n year,

R = Indicates the return over a number of year,

K = Indicate the cost of orchard.

RESULTS AND DISCUSSION

Cost and Return Analysis

The establishment cost included expenditure on construction of ponds constitutes the highest expense, accounting for 29.11% of the total cost. This significant investment highlights the importance of water management infrastructure in agriculture, particularly in regions facing water scarcity. Proper construction and maintenance of ponds ensure an adequate water supply for irrigation, crucial for the sustainability of farming operations. Permanent fencing, making up 23.67% of the total

cost, is another major expense. This emphasizes the need to protect agricultural land from animals and trespassers, which is essential for securing crops and preventing damage. Drip irrigation expenses represent 13.74% of the total cost. This modern irrigation technique is vital for efficient water usage, reducing wastage, and ensuring that crops receive the right amount of water directly at the root level. The adoption of drip irrigation systems demonstrates a commitment to sustainable agricultural practices. The cost of plants is a notable expense, accounting for 10.10% of the total cost. This reflects the initial investment required for acquiring high-quality planting material, which is essential for achieving good yields and maintaining crop quality. Preparation of land and layout (3.97%), manures and fertilizers (3.42%), and digging and filling of pits (3.37%) are moderate expenses. These activities are foundational for establishing a productive agricultural system, ensuring the land is adequately prepared and fertile. Transportation of plants (2.92%), cost of equipment (2.26%), and plantation costs (2.02%) are necessary operational expenses. These costs cover the logistics of moving planting material, acquiring tools and machinery, and the actual planting process. Cost of irrigation (2.00%), excluding drip irrigation, highlights traditional irrigation methods' ongoing necessity, though they are less efficient than modern techniques. Miscellaneous expenses (1.35%) and intercultural operations (1.07%) cover various minor yet essential activities, including weeding and maintaining the plantation. Finally, the cost of replacement plants (1.00%) ensures that any dead or unhealthy plants can be replaced, maintaining the overall health of the plantation. As shown in table 1.

Table 1: Establishment cost of kinnow orchards

Sl. No.	Particular expenses	Value (₹/ hectare)	Per cent
1	Preparation of land and layout	7142	3.97
2	Digging and filling of pits	6060	3.37
3	Cost of irrigation	3600	2.00
4	Cost of plant	18150	10.10
5	Cost of replacement plant	1800	1.00
6	Manures and fertilizer	6150.9	3.42
7	Transportation of plant	5250	2.92
8	Plantation cost	3636	2.02
9	Intercultural operation	1930	1.07
10	Construction of pond	52305	29.11
11	Drip irrigation	24683	13.74
12	Permanent fencing	42524	23.67
13	Cost of equipment	4058	2.26
14	Miscellaneous	2426	1.35
	Total Cost	Rs. 179714.9	100

The total operational cost across all activities and years amounts to ₹ 294,164. The average annual cost per hectare is ₹ 48,488.05. Manure and Fertilizers: Over the seven-year period, manure and fertilizers account for a significant portion of the total cost, amounting to ₹ 50,073 with an average annual cost of ₹ 7,153.29. This indicates the essential role of soil nutrition in sustaining crop yields and maintaining soil fertility. Plant Protection: Plant protection costs steadily increase over the years, reaching a total of ₹ 44,244 with an average annual cost of ₹ 6,320.57. This reflects the ongoing need for pest and disease management to ensure healthy crop growth. Pruning and Cutting: Starting from the second year, the cost of pruning and cutting totals ₹ 20,774, with an average annual cost of ₹ 3,462.33. These activities are critical for maintaining plant health and optimizing yields. Intercultural and Hoeing: The total cost for intercultural operations and hoeing over the period is ₹ 20,875, with an average annual cost of ₹ 2,982.14. These practices help manage weeds and improve soil conditions, contributing to better crop growth. Irrigation Cost: Irrigation is a significant expense, totaling ₹ 34,154 over the years with an average annual cost of ₹ 4,879.14. Efficient water management is crucial, especially in semi-arid regions like Sirsa, to ensure consistent crop production. Replacement and Causality: The cost associated with replacement and causality amounts to ₹ 23,410, with an average annual cost of ₹ 3,344.29. This expense covers the replacement of dead or unhealthy plants, ensuring the overall health of the plantation. Watch and Ward: The costs for security measures (watch and ward) total ₹ 21,900, with an average annual cost of ₹ 3,128.57. Protecting crops from theft and damage is essential for securing the investment in agriculture. Picking Cost: From the fourth year onwards, the cost of picking increases significantly, totaling ₹ 55,720 with an average annual cost of ₹ 13,930.00. Harvesting costs rise as the plantation matures and yields increase. Miscellaneous: Miscellaneous

expenses over the period amount to ₹ 23,014, with an average annual cost of ₹ 3,287.71. These costs cover various minor yet essential activities not categorized elsewhere. As shown in table 2.

The data underscores the importance of several key activities in the agricultural lifecycle. Manure and fertilizers, plant protection, and irrigation represent substantial ongoing costs, reflecting their critical role in maintaining crop health and productivity. Pruning, intercultural operations, and replacement of plants are necessary maintenance activities that ensure the long-term viability of the plantation. Security measures and harvesting costs are significant as the plantation matures, indicating the need for sustained investment in these areas. Efficient cost management across these activities is essential for optimizing agricultural production and achieving economic sustainability.

Table 3 depicts the total costs include rental value of land, amortized fixed cost, operational cost, depreciation on fixed cost, and interest on operational cost. These costs collectively show a consistent increase over the years, reaching ₹ 169,936.31 in Year 7. The initial years see a moderate rise in costs, primarily driven by rental and operational expenses. The rental value of land is a significant cost component, starting at ₹ 42,000 in Year 1 and increasing to ₹ 56,000 by Year 7. This steady increase reflects the rising land lease rates, which impact the overall profitability of agricultural activities. The amortized fixed cost remains constant at ₹ 21,548.79 per year.

Table 2: Operational cost of kinnow orchard

Sl. No.	Particulars	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7 & Onwards	Total Cost	Average Cost Per Anum Per hectare
1	Manure and Fertilizers	6150	6457	6780	7120	7475	7849	8242	**50073**	**7153.29**
2	Plant Protection	3650	4015	4416	5300	6625	8612	11626	**44244**	**6320.57**
3	Pruning and Cutting	—	2200	2420	2662	3327	4325	5840	**20774**	**3462.33**
4	Intercultural and Hoeing	2200	2420	2662	2928	3220	3545	3900	**20875**	**2982.14**
5	Irrigation Cost	3600	3960	4356	4792	5270	5798	6378	**34154**	4879.14
6	Replacement and Causality	1800	2160	2600	3200	3800	4450	5400	**23410**	**3344.29**
7	Watch and Ward	2500	2700	2900	3100	3300	3600	3800	**21900**	**3128.57**
8	Picking Cost	—	—	—	5760	12440	15020	22500	**55720**	**13930.00**
9	Miscellaneous	2426	2668	2935	3230	3551	3907	4297	**23014**	**3287.71**
	Total Operational Cost	22326	26580	29069	38092	49008	57106	71983	294164	48488.05

Table 3: Cost and Return of Kinnow Fruit business

Sl. No.	Particulars	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
1	Rental Value of Land	42000	45000	47000	49500	51500	54000	56000
2	Amortized Fixed Cost	21548.79	21548.79	21548.79	21548.79	21548.79	21548.79	21548.79
3	Operational Cost	22326	26580	29069	38092	49008	57106	71983
4	Expected depreciation on fixed cost investment @4%	11766.56	11766.56	11766.56	11766.56	11766.56	11766.56	11766.56
5	Interest on operational cost @12%	2679.12	3189.6	3488.28	4571.04	5880.96	6852.72	8637.96
6	Total Cost (1 to 5)	100320.47	108084.95	112872.63	125478.39	139704.31	151274.07	169936.31
7	Production (qtls)	—	—	—	50	95	160	270
8	Price (₹/qtls)	—	—	—	1150	1250	1320	1460
9	Gross returns	—	—	—	57500	118750	211200	394200
10	Net returns	-100320	-108083	-112872.6	-67978	-20954	59926	224264
11	Return from inter cropping	36500	32340	28062	23270	15340	—	—
	Total Return	-63820	-75743	-84810.6	-44708	-5614	59926	224264

This fixed annual expense includes long-term investments in infrastructure and equipment that are spread over multiple years, ensuring sustained agricultural operations. Operational costs cover various activities such as manure and fertilizers, plant protection, pruning, irrigation, and more. These costs show a notable rise, from ₹ 22,326 in Year 1 to ₹ 71,983 in Year 7. The significant increase in later years is primarily due to the growing scale of operations and the intensification of farming practices. Depreciation on fixed cost investment, calculated at 4%, remains constant at ₹ 11,766.56 annually. The interest on operational costs, at 12%, rises as the operational costs increase, reaching ₹ 8,637.96 in Year 7. These expenses highlight the financial burden of maintaining and expanding agricultural operations. Gross returns begin in Year 4 with the start of production. Returns increase significantly as production scales up, from ₹ 57,500 in Year 4 to ₹ 394,200 in Year 7. This rise in gross returns showcases the growing profitability as the plantation matures. Net returns, calculated as gross returns minus total costs, reveal an initial negative trend due to high initial investments and operational costs. However, from Year 5 onwards, net returns improve, turning positive in Year 6 (₹ 59,926) and seeing substantial growth in Year 7 (₹ 224,264). This positive turnaround indicates the breaking even and eventual profitability of the agricultural venture. Returns from intercropping provide an additional income stream, particularly in the initial years when primary crop returns are not yet realized. Intercropping returns decrease over time, from ₹ 36,500 in Year 1 to ₹ 15,340 in Year 5, eventually ceasing in the later years. This decrease may be due to the focus shifting to the main crop as it becomes more productive. Total returns, which include net returns and intercropping returns, show an initial negative trend but gradually improve. The total return becomes positive in Year 6 (₹ 59,926) and substantially increases in Year 7 (₹ 224,264). This progression reflects the long-term viability and profitability of the agricultural investment.

The data reflects the high initial costs and financial challenges in the early years of agricultural investment. However, with sustained investment, efficient management, and the eventual increase in production, the venture becomes profitable. Effective cost management, adoption of modern agricultural practices, and leveraging intercropping for early returns are crucial strategies for achieving long-term success in agriculture. The significant increase in returns in the later years underscores the potential for substantial profitability once the initial challenges are overcome.

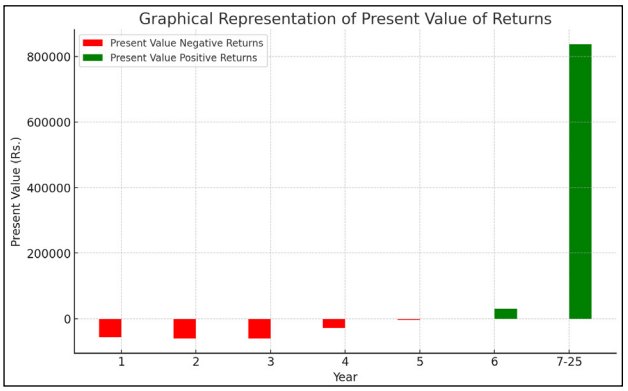

Fig. 1: Graphical representation of Present Value of Returns (negative and positive) in Kinnow fruit business

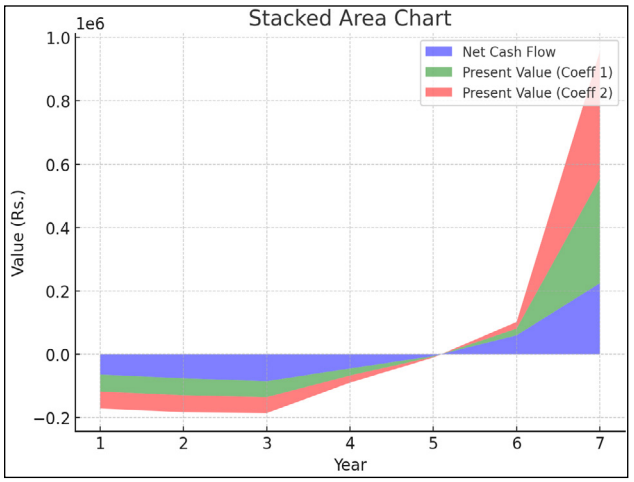

Fig. 2: Graphical representation of Net Cash Flow and Present Value (Coeff 1 & Coeff 2) in Kinnow fruit business

Economic Viability of Kinnow Fruit Production Business from Financial Data from Table 4 and 5

This financial analysis outlines the net returns from agricultural activities over a seven-year period, with projections extending to 25 years, using discount coefficients to calculate the present value of returns. Here are the key takeaways:

Initial Negative Returns: The first five years show negative returns, reflecting the initial high costs of establishing and maintaining the agricultural

Table 4: Net Present Value and Cost Benefit Ratio from Cost and Return of Kinnow fruit business

Year	Negative returns (₹)	Positive returns (₹)	Discount coefficient $1/(1+r)n$	Present value Negative returns (₹)	Positive returns (₹)
1	-63820		0.8929	-56984.88	
2	-75743		0.7972	-60382.32	
3	-84810.6		0.7118	-60368.19	
4	-44708		0.6355	-28411.93	
5	-5614		0.5674	-3185.384	
6		59926	0.5066		30358.512
7 (and onward up to **25** years)		224264	3.7317		836885.97
Total	-302627	310724		-209332.7	867244.48
Net present value (NPV) = 867244.48 – 209332.70 = 657911.78					
B:C ratio = 4.14					

Table 5: Internal Rate of Return and Payback Period of Kinnow Fruit Business

Year	Net cash flow	Present value coefficient	Corresponding present value	Present value coefficient	Corresponding present value
1	-63820	0.8403	-53630.25	0.8403	-53630.25
2	-75743	0.7062	-53487.04	0.7062	-53487.04
3	-84810	0.5934	-50327.95	0.5934	-50327.95
4	-44708	0.4987	-22294.48	0.4987	-22294.48
5	-5614	0.4190	-2352.54	0.4190	-2352.54
6	59926	0.3521	21102.48	0.3521	21102.48
7 (onward up to 25 years)	224264	1.4767	331170.64	1.7854	400400.94
Total	—	—	170180.85		239411.16
IRR = 20.37					
Pay back period = 7 year					

operations. In Year 1, the negative return is ₹ 63,820, which, when discounted at a coefficient of 0.8929, results in a present value of -₹ 56,984.88. This trend continues in the subsequent years, with negative returns of -₹ 75,743 in Year 2 (present value: -₹ 60,382.32), -₹ 84,810.6 in Year 3 (present value: -₹ 60,368.19), -₹ 44,708 in Year 4 (present value: -₹ 28,411.93), and -₹ 5,614 in Year 5 (present value: -₹ 3,185.384). Shift to Positive Returns: From Year 6 onwards, positive returns begin to appear, signaling the break-even point and the start of profitability. In Year 6, the positive return is ₹ 59,926, with a present value of ₹ 30,358.512. This upward trend significantly accelerates in Year 7 and beyond, with a projected positive return of ₹ 224,264, discounted to a present value of ₹ 836,885.97 using a coefficient of 3.7317. Cumulative Analysis: Summing up the present values of negative returns (-₹ 209,332.7) and positive returns (₹ 867,244.48) over the analysis period provides a comprehensive picture of the net present value (NPV). The NPV is calculated as ₹ 867,244.48 (positive returns) minus ₹ 209,332.7 (negative returns), resulting in an NPV of ₹ 657,911.78. This positive NPV indicates that the agricultural investment is financially viable and profitable over the long term. Benefit-Cost Ratio (B:C): The benefit-cost ratio is 4.14, which is calculated by dividing the total present value of positive returns by the total present value of negative returns. A B:C ratio greater than 1 indicates that the benefits of the investment outweigh the costs, making the agricultural project a worthwhile investment. The IRR (Internal Rate of Return) is 20.37%, which is a robust return, indicating that the investment is expected to yield a high rate of return over time. The payback period is

7 years, meaning it takes 7 years for the investment to break even and start generating positive returns.

Significance

- **Initial Investment and Risk**: The initial years of the agricultural investment exhibit significant negative cash flows due to high upfront costs and financial risks. This period necessitates substantial capital investment and effective management to navigate the early challenges successfully. Despite these early financial hurdles, these initial investments lay the groundwork for future profitability.
- **Break-Even and Profitability**: From Year 6 onwards, the agricultural venture begins to generate positive cash flows, marking the transition to profitability. This shift demonstrates the potential for high returns once the initial establishment phase is successfully managed. Reaching this break-even point is crucial as it signifies the venture's ability to cover its costs and start yielding profits.
- **Long-Term Financial Health**: The positive Net Present Value (NPV) and high Internal Rate of Return (IRR) are strong indicators that the investment is financially viable and expected to generate substantial returns over the long term. The calculated payback period of 7 years reflects the time required to recover the initial investment, after which the venture continues to be profitable.
- **Investment Attractiveness**: With a high IRR of 20.37% and a positive NPV, this agricultural investment is highly attractive to investors. These metrics suggest that the project is likely to provide competitive returns compared to other investment opportunities. The favorable financial outlook makes it an appealing option for those seeking long-term profitability.

Economic Viability Indicators

- **NPV**: ₹ 657,911.78 (Positive, indicating profitability)
- **B**:C**** Ratio**: 4.14 (Financially viable as B:C >1)
- **IRR**: 20.37% (High return on investment)
- **Payback Period**: 7 years (Time to recover investment)

Key Challenges

Challenges:

- High initial investment costs.
- Post-harvest losses due to inefficient storage.
- Limited access to modern irrigation and plant protection techniques.
- Price fluctuations affecting profitability.

CONCLUSION

The economic viability of Kinnow Mandarin cultivation in Sirsa district remains robust, as evidenced by a high Net Present Value (NPV) of ₹ 657,911.78, an Internal Rate of Return (IRR) of 20.37%, and a Benefit-Cost Ratio (B:C) of 4.14. Despite significant initial costs and negative returns in the first few years, the plantation breaks even by Year 6 and achieves substantial profitability by Year 7. The findings underscore the long-term sustainability of Kinnow production, provided that farmers can navigate early financial constraints and adopt efficient agricultural practices. The study highlights the crucial role of new value chain actors who increased the returns in this business, modern irrigation techniques, post-harvest management, and marketing strategies in maximizing profitability.

While Kinnow cultivation presents promising returns, its long-term success depends on mitigating challenges such as market inefficiencies, post-harvest losses, and climate-induced risks. Addressing these issues through strategic interventions will ensure that Kinnow farming remains a profitable and sustainable enterprise in the coming years. In conclusion, this financial analysis indicates that while the initial years involve significant costs and negative returns, the agricultural investment becomes highly profitable over the long term, making it a financially viable and rewarding endeavor.

Recommendations

Based on the study findings, the following recommendations are proposed to enhance the economic viability of Kinnow Mandarin cultivation in Sirsa district:

1. **Enhanced Water Management:** Given that pond construction constitutes the

highest establishment cost, optimizing water management strategies through efficient drip irrigation and rainwater harvesting will enhance cost-effectiveness and sustainability.

2. **Improved Market Access:** Strengthening Farmer Producer Organizations (FPOs) and digital marketing platforms can help farmers bypass traditional intermediaries, ensuring higher profit margins and market stability.
3. **Post-harvest Infrastructure Development:** Reducing post-harvest losses through the establishment of cold storage facilities, processing units, and value addition strategies will enhance revenue generation.
4. **Adoption of Precision Farming Techniques:** Encouraging the use of modern agricultural technologies, such as automated irrigation, soil health monitoring, and plant protection measures, can optimize input utilization and boost productivity.
5. **Financial Support and Policy Interventions:** Government subsidies and financial incentives for modern irrigation systems, quality planting materials, and storage infrastructure can alleviate the high initial investment burden. Crop insurance schemes should be promoted to safeguard farmers against climate-related uncertainties.
6. **Capacity Building and Farmer Training:** Conducting training programs and workshops on best agricultural practices, integrated pest management, and market intelligence will empower farmers with knowledge to improve yield quality and profitability.
7. **Sustainable Intercropping Practices:** Encouraging intercropping with compatible crops can generate additional income in the early years before Kinnow plantations become fully productive.

REFERENCES

Bhat, A., Singh, M. and Sharma, R. 2011. Marketing efficiency in traditional channels of Kinnow cultivation. *Agricultural Economics Journal*, **45**(3): 145-156.

Goyal, P., Goyal, M. and Singh, A. 2012. Marketing practices of kinnow framers in Punjab. *International Research Journal of Agriculture Economics and Statistics*, **3**(2): 249–52.

Kumar, R. 2011. 'Problems and prospectus of kinnow production under drip irrigation system in Haryana'. *M.Sc. Thesis*, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana.

Parakash, O. 2000. 'Nutritional studies in kinnow mandarin'. Ph.D. Thesis, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana.

Anonymous. 2017. Revised area and production of fruit crops of Haryana for the year 2005-06 to 2017-18. *Directorate of Horticulture*, Panchkula, Haryana.

Arya, V. 2021. Consumer behaviour with regard to consumption of edible oil in Hisar. *Journal of Pharmacognosy and Phytochemistry*, **10**(1S): 350-355.

Gill, S.M. and M.K. 2010. Package of practices for cultivation of fruits. *Horticulture officers' workshop report*, PunjabAgricultural University Ludhiana.

Kaur, M. and Singla, N. 2016. An economic analysis of Kinnow cultivation and marketing in Fazilka district of Punjab. *Indian Journal of Economics and Development*, **12**(4): 711–718.

Kumar, N., Duhan, A., Bhatia, J. and Malik, V. 2017. Economic appraisal of kinnow production and its marketing in Sirsa District of Haryana, India. *International Journal of Current Microbiology and Applied Sciences*, **6**(11): 4045–53.

Kumar, P., Shehrawat, P.S., Rohila, K.A., Ghanghas, B.S. and Kumar, A. 2016. Constraints faced by farmers of Haryana state in adoption of Masumbi cultivation. *Journal of Applied and Natural Science*, **8**(2): 785–89.

Kumar, R., Kumar, N., Dhillon, A., Bishnoi, D.K., Kavita and Malik, A.K. 2019. Economic analysis of guava (*Psidium guajava* L.) in Sonepat District of Haryana. *Economic Affairs*, **64**(4): 747–52.

Kumar, R., Rathee, A.K., Kumar, N. and Luhach, V.P. 2019. Economic appraisal of mango production in Yamunanagar District of Haryana, India. *Journal of Pharmacognosy and Phytochemistry*, **8**(2): 1298–1302.

Kumar, A. and Devi, P. 2022. Cost analysis and profitability of Kinnow cultivation. *Journal of Agricultural Research*, **58**(4): 321-334.

Kumar, P., Yogi, V., Kar, A., Singh, D.R., Singh, R., Arya, P. and Awasthi, O.P. 2020. Are traditional marketing channels of kinnow really bad?. *Indian Journal of Traditional Knowledge (IJTK)*, **19**(4): 846-860.

Kumar, R. and Singh, V. 2019. Economic feasibility of Kinnow orchards: A case study of Haryana. *Indian Journal of Horticulture*, **76**(1): 89-97.

Kumar, R., Sumit, Bishnoi, D.K. and Kumar, A. 2021. Economic appraisal of Kinnow production in Sirsa district of Haryana. *Indian Journal of Agricultural Sciences*, **91**(3): 464–467.

Nawaz, R., Abbasi, N.A., Hafiz, I.A. and Khalid, A. 2021. Climate variables effect on fruiting pattern of Kinnow mandarin (*Citrus nobilis Lour* × *Citrus deliciosa Tenora*) grown under different agro-ecological conditions. *Scientific Reports*, **11**(1): 1–12.

Seavert, C., Thompson, A. and Long, L. 2019. Orchard Economics: Establishing and Producing Medium-Density Pear Orchards in Hood River County, Oregon. *Oregon State University Extension Service*. https://appliedecon.oregonstate.edu/sites/agscid7/files/oaeb/pdf/aeb0066.pdf

Sharma, R. and Meena, M. 2020. Post-harvest inefficiencies in citrus production: A case study of Kinnow. *Post-Harvest Management Journal*, **12**(2): 89-102.

Singh, P. and Reddy, N. 2021. Barriers to adoption of emerging marketing channels in horticulture. *Horticultural Science Review*, **13**(1): 45-58.

University of Georgia. 2019. An Economic Production Guide for Fruit and Nut Growers, Agents, and Lenders. *Department of Agricultural and Applied Economics*. https://agecon.uga.edu/content/dam/caes-subsite/ag-econ/documents/extension/budgets/2019/fruits/2019%20Fruit%20Production%20Guide%20-%20Oct%202019.pdf

Verma, K., Gupta, A. and Chauhan, R. 2015. Regional disparities in Kinnow profitability. *Journal of Agrarian Studies*, **20**(3): 56-78.

Vijaya, H.M., Godara, R.K., Shashank, S. and Sharma, N. 2017. Effect of exogenous application of micronutrients on growth and yield of kinnow mandarin under semi-arid zone of Haryana. *Journal of Pharmacognosy and Phytochemistry*, **6**(4): 733–35.

Yogi, V., Kumar, P., Prakash, P., Kar, A., Singh, D.R., Singh, R., Arya, P. and Awasthi, O.P. 2019. An economic evaluation of kinnow cultivation in north western India. *Indian Journal of Agricultural Sciences*, **89**(10): 1684–87