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Viability and Constraints in Kinnow *(Citrus Reticulata)* Production: An Empirical Study of Fazilka District (Punjab)

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Abstract

The study provides a detailed analysis of kinnow production by assessing its economic viability and constraints faced by growers. Data were collected during the period 2024-25 by multistage sampling, selecting 200 randomly selected farmers from two major kinnow-producing blocks that together account for over 90 per cent of kinnow production in the Fazilka district. Results showed that the establishment cost for kinnow was ₹ 38,672 per acre, with an annual operating cost of ₹ 63,800. The cost-Benefit Ratio, net Present Value, internal Rate of return, and pay-back period were found to be 1:2.25, ₹ 2,42,001, 22.5 per cent, and 7.84 years, respectively, indicating that investing in a kinnow orchard is profitable. However, farmers face constraints affecting production and profitability, including poor-quality irrigation water, price fluctuations, and limited processing facilities. These issues can be addressed through improved water management, government market intervention, and the provision of high-quality extension services to kinnow growers.

Keywords: Economic viability, Kinnow, Production, Marketing.

JEL Classification: Q10, Q12, Q13, Q18

Introduction

In light of the evolving agricultural landscape, the horticultural sector has an essential contribution in ensuring secure livelihoods for farmers, generating employment, and increasing farmers' incomes. Mandarin orange is the most extensively farmed citrus fruit in China, tropical Asia, India, Japan, the Mediterranean, and Florida in the United States (NHRDF, 2018). Kinnow is a hybrid of mandarin, a cross between King mandarin and Willow leaf orange, with skin that is neither too loose nor too tight. Developed and created by H.B. Frost at the Citrus Research Centre, University of California in 1915. It was introduced in Abohar (PAU, Regional Fruit Research Station) by Dr. J.C. Bakhshi in 1954. At first, four plants were conserved, but after assessing their consistent commercial production, kinnow was recommended. Subsequently, kinnow became the most preferred citrus fruit, both in area and in production, thereby initiating "Golden Evolution" in Punjab (Rattanpal *et al.*, 2017).

The "Easy peel" citrus has gained significant commercial relevance and export demand because of its high juice content, exceptional scent, and flavour. The trees are exceptionally productive, yielding substantial net profits from the harvest. Industrial production of orange juice generates a significant amount of solid and liquid byproducts, which are often used as agricultural supplements. Orange residues have significant economic value due to their composition and can function as a basis for numerous industrial operations. The fruit's byproduct is used for cow feed and vermicompost, which is advantageous from an environmental perspective (Government of India, 2021).

Kinnow, also known as Mandarin and often pronounced as Kinoo or Kinu, is predominantly grown in North India, with Punjab the principal region for production in the country. Other contributing states include Rajasthan, Haryana, Madhya Pradesh, Himachal Pradesh, Jammu, and Kashmir (Government of India, 2021). Punjab is one of the country's main producers of kinnow/mandarin. The state's overall kinnow/mandarin production is 1,208.42 thousand tonnes, accounting for 23.69% of the national total. Kinnow/Mandarin is predominantly cultivated in the districts of Fazilka, Muktsar, Bhatinda, and Hoshiarpur within the state (Government of India, 2021). In Punjab, kinnow has emerged as an alternative to wheat and cotton (Kaur and Singla, 2016). The expansion of kinnow cultivation and production has led to an increasing interest in assessing its economic viability and the variables that affect its production (Meena *et al.,* 2018).

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Prior research (Bhat *et al*., 2011; Kaur and Singla, 2016; Kaysar *et al*., 2017; Kumar *et al*., 2021; Priyadarshini *et al*., 2020; Yogi *et al*., 2019) has established kinnow's economic viability across regions but lacks an updated, district-level analysis for Fazilka—Punjab's kinnow hub (80% of the state's area). Despite the crop's significance, the sustainability and viability of kinnow production, as well as its constraints, remain under study. The present paper seeks to fill this gap by analyzing the economic profitability of kinnow and the challenges faced by growers in the Fazilka district. To inform policies for diversification and farmer welfare, the study provides region-specific insights into agricultural sustainability and the difficulties of kinnow production.

The study is significant because it provides a comprehensive and up-to-date economic analysis of kinnow cultivation in the Fazilka district, a major production region. It offers valuable insights into both profitability and the practical constraints faced by farmers, helping policymakers design targeted interventions such as improved irrigation, price support, and processing infrastructure. The findings are also useful for farmers in making informed investment decisions and for researchers seeking recent empirical evidence. Despite the economic importance of kinnow cultivation, existing studies are largely outdated or provide general insights without considering recent, region-specific conditions in major producing areas such as Fazilka. There is a lack of comprehensive research that simultaneously evaluates detailed economic viability indicators along with production and marketing constraints using primary data. Furthermore, emerging issues such as water quality problems, price fluctuations, and inadequate processing infrastructure have not been sufficiently addressed in recent literature. Hence, an updated, micro-level empirical analysis was needed to fill this gap.

Data Sources and Methodology

The period of the study was 2024-25 and this study was based on primary data, collected from the Fazilka district of Punjab. The reason for selecting Fazilka district is that it covers 80 per cent of the total area under kinnow in Punjab (Government of Punjab, 2023). Out of the five blocks in the district (Abohar, Khuian Sarwar, Arniwala, Jalalabad and Fazilka), two blocks namely Abohar and Khuian Sarwar were selected for the study because these blocks cover more than 90 per cent of the area under kinnow cultivation in Fazilka (Department of Horticulture, Abohar). The share of kinnow cultivation under different blocks of Fazilka is shown in Table 1. A total of 200 Kinnow farmers were selected for the study, with 100 farmers from each of the two major blocks of Fazilka district. From each block, five villages were chosen at random. The selected villages from Khuian Sarwar block were Sappanwali, Daulatpura, Diwan Khera, Dalmir Khera, Patti Billa, and Alamgarh, while those from the Abohar block included Patti Sadiq, Himmatpura, Sito Gunno, Rampura, and Khuban and Shergarh. Within each selected village, farmers were first approached based on initial contacts, followed by the identification of additional respondents using snowball sampling. To analyse economic viability, Benefit- Cost Ratio (BCR), Net present Value (NPV), Internal Rate of Return (IRR), and Pay-Back Period (PBP) were used. The data were collected on various aspects, such as establishment cost, operational cost, and marketing problems faced by kinnow farmers. Only farmers who sold their orchards to pre-harvest contractors were included in the study, as they constituted almost 95 per cent of the total kinnow growers in Fazilka. Growers typically sell their orchard to the pre-harvest contractor, who then assumes all post-harvest expenses, including harvesting, grading, waxing, loading, unloading, and transportation.

Table 1: Block-wise area of Kinnow in Fazilka district, 2024-25

Blocks	Area (ha)	Area (percentage)
Abohar	17606	49.24
Khuian Sarwar	15407	43.09
Arniwala	2205	6.16
Jalalabad	244	0.68
Fazilka	292	0.81
Total	35754	99.99

Source: Department of Horticulture, Abohar

Four indicators were used to assess the kinnow orchard's economic viability. The details for calculating these variables are provided below.

Net Present Value (NPV)

"It referred to the difference between the present value of cash inflows and the present value of cash outflows."

$$NPV = \sum_{i=1}^{n} \frac{B_n - C_n}{(1+r)^n}$$

Whereas,

B_n = Benefit in n years,

C_n = Cost in n years,

r= interest rate (12 per cent),

i =1, 2, 3, …..n years (Kaur and Singla, 2016).

Internal Rate of Returns (IRR)

It pertained to the discount rate at which the net present value of all cash flows, both positive and negative, equated to zero. It was calculated using several rates until the sum of the discounted series of positive values (returns) and the sum of the discounted series of negative values (cost) was equal to zero (i.e., B–C = 0) (Kaur and Singla, 2016).

$$IRR = \sum_{i=1}^{n} \frac{B_n}{(1+r)^n} - \sum_{i=1}^{n} \frac{C_n}{(1+r)^n}$$

Benefit-Cost ratio (CBR)

It was used to measure the profitability of an investment. It was defined as the proportion of the aggregate of discounted net benefits of returns (R) to the aggregate of discounted costs (K). If BCR is greater than unity, then the investment made was economically viable (Priyadarshini *et al.,* 2020).

$$BCR = \frac{R}{K}$$

Pay-Back Period (PBP)

It determined the timeframe required for the complete recovery of the kinnow orchard's costs from its generated revenues. More precisely, it indicated the time span in years during which the returns (R) equal the expense of the orchard (K). This requires the following mathematical relation to be fulfilled

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

Whereas,

i =1, 2, 3, ……n years,

R = Returns over n years,

K = Cost of orchard (Priyadarshini *et al.,* 2020).

Depreciation and Interest Rate A 4 per cent expected depreciation has been calculated on the establishment cost (fixed investment) by presuming the life cycle of the orchard to be 25 years. Complementary, the interest rate on operational/ maintenance cost has been taken as 12 per cent.

Amortisation of Fixed/Establishment Cost

The amortisation cost was calculated on the fixed one-time expenditure on the orchard setup using an interest rate of 12 per cent per annum, and the life expectancy of 25 years.

$$I = \frac{Br}{1 - (1+r)^{-n}}$$

Whereas,

I = Yearly cost (in Rs.),

B = Present fixed cost/ establishment cost (in Rs.),

r = Interest rate 12 per cent per annum,

n = Economic life of kinnow orchard (in years) (Kumar *et al.*, 2019).

Identification of the Constraints

The percentage method was used to determine and rank the key difficulties encountered by citrus growers in Fazilka. Because respondents could select multiple issues, assigning individual rankings to constraints was impractical. Therefore, the frequency of each problem was calculated and expressed as a percentage of the total respondents. The issues were then ranked in descending order by these percentages, with the highest proportion indicating the most common constraint.

Establishment cost: It included all the expenses incurred by the farmer during the time of planting which were land preparation, nursery cost, fencing materials (such as wire and poles), insecticide and FYM, labour costs, and other miscellaneous expenses

Operational cost: It was considered the cost borne by the farmer every year after the establishment of the Kinnow orchard. It included fertiliser and manure expenses, plant protection expenses, growth regulators, micronutrients, pruning and thinning, Intercropping, hoeing, irrigation, rent of machinery, labour costs, and miscellaneous costs.

Results and Discussion

It was incurred from Table 2, at the time of planting saplings and included all the expenditures related to the initial setup of the kinnow orchard. It comprised the rent for a laser land leveller used for land preparation before plantation, the cost of nursery, fencing materials (such as wire and poles), insecticide and FYM, labour costs, and other miscellaneous expenses. These costs were the non-recurring expenses during the expected life span of the kinnow orchard. The Punjab Government provided a subsidy of ₹ 8000 per acre for kinnow plantations under the National Horticulture Mission (NHM) Scheme to expand kinnow cultivation. Therefore, the net establishment cost is calculated by subtracting the nursery subsidy from the total gross establishment cost.

Table 2: Establishment Cost (Rs. per acre) of Orchard

Sr. No.	Items	Expenditure
I.	Land preparation	3000 (6.43)
II.	Nursery cost	14300 (30.64)
III.	Fencing material cost	19500 (41.78)
IV.	Insecticide (chlorpyrifos), SSP and, Farm Yard Manure (FYM)	3772 (8.08)
V.	Labour cost*	4900 (10.50)
VI.	Miscellaneous cost**	1200 (2.57)
	Total establishment cost	46672 (100.00)
	Subsidy by the Government on the nursery	8000
	Net establishment cost	38672

*Figures in brackets represent the proportion of the entire establishment cost. *It includes the expenses incurred for pesticide spraying, application of farmyard manure, fencing, digging/filling of pits and the plantation nursery. **It includes transportation cost, fuel charges, and plant replacement costs.*

The findings revealed that the total establishment expenditure of a kinnow orchard in Fazilka amounted to ₹ 38,672 per acre. The major share of this cost was attributed to fencing and planting material, which constituted 41.78 per cent and 30.64 per cent of the total establishment cost, respectively. Labour expenses (10.50 per cent), pesticides and FYM (8.08 per cent), and land preparation (6.43 per cent) were other significant components contributing to the overall establishment cost. Labor cost included planting cost (digging, lining, and filling the pits), fencing, irrigation cost, and spraying of pesticides, and FYM. For a kinnow plantation, per acre ₹8000 subsidy was given by the Punjab Government to surge area under kinnow farming. So, the net establishment cost became ₹ 38,672 after subtracting the subsidy.

Table 3 displayed the operational cost of a kinnow orchard in Fazilka district. The table covers only seven years of operational costs, but the average productive lifespan of a Kinnow orchard is about 25 years. This is because the average operational cost of Kinnow cultivation stays mostly consistent throughout the orchard's lifespan. Operational costs increased over the period due to higher expenses on various inputs. This trend indicated the direct relationship between the requirement of physical inputs and the age of the Kinnow orchard, except in the fourth year, because the cost of intercropping dropped to zero after the third year. The annual operational cost ranged from ₹ 34,144 in the first year to ₹ 63,800 per acre in the seventh year. The operational cost continued to rise until the seventh year and thereafter remained relatively stable. During the initial three years, the major cost component was intercultural operations. However, from the fourth year onwards, expenditure on intercropping ceased, and the primary contributors to operational expenses became pesticides, fungicides, fertilizers and FYM.

The cost and returns depend on the age of the orchard, as shown in Table 4, that displayed data from the first to the seventh year. Kinnow production begins in the fourth year, ranging from nearly 35 q/acre to 120 q/acre by the seventh year. However, after the seventh year, production generally stay constant. Therefore, gross returns per acre increased through the seventh year. The gross returns per acre at full bearing were estimated at ₹ 2,64,000, and these returns were expected to remain roughly the same up to 25 years. Net returns were estimated after deducting land's rent, amortized fixed costs, operational expenses, management charges, risks, interest on operational costs, and expected depreciation on fixed or establishment costs. Despite income from intercropping, total net returns remained negative until the fifth year. During the sixth and seventh years, returns were approximately ₹ 56,636.19 and ₹ 109,059.47 per acre, respectively, and they stabilised up to 25 years. Overall, the data in Table 4 indicated that returns were negative until five

Table 3: Year-wise operational cost of Kinnow orchard in Fazilka district (Rs. per acre)

Sr. no.	Particulars	Years							Total cost	Annual Average cost	Percentage
		1	2	3	4	5	6	7 and onward			
I	Fertilizers and Farmyard Manure (FYM)	2200	3568	4895	7367	8300	9000	10400	45730	6532.86	13.58
II	Plant protection	4475	6600	7043	8300	9560	11420	12890	60288	8612.57	17.90
III	Pruning and thinning	1000	3600	4800	5000	7000	9000	12000	42400	6057.14	12.59
IV	Intercropping expenses	18000	20400	20510	0	0	0	0	58910	8415.71	17.49
V	Irrigation charges	4000	4500	4500	6000	6500	7000	7000	39500	5642.86	11.73
VI	Rent of machinery	1500	1500	1500	5850	9000	9000	9000	37350	5335.71	11.09
VII	Labour cost*	2100	2905	4257	6020	6924	7820	8820	38846	5549.43	11.54
VIII	Miscellaneous cost**	869	1000	1500	1820	2160	2680	3690	13719	1959.86	4.07
	Total Operational Cost	34144	44073	49005	40357	49444	55920	63800	336743	48106.14	100.00

*Figures are per centages to the total operational cost. *It includes the expenses incurred for pesticide and plant protection spraying as well as application of farmyard manure.*

***It includes expenses on the replacement of dead plants, fuel charges, fly trap charges, and other incidental overheads.*

Table 4: Cost and returns from the Kinnow orchard, Fazilka (Rs. per acre)

Sr. No.	Particulars	Years						
		1	2	3	4	5	6	7 to 25
1.	Total operational cost	34144	44073	49005	40357	49444	55920	63800
2.	Interest on operational cost @ 12%	4097.28	5288.76	5880.6	4842.84	5933.28	6710.4	7656
3.	Total variable cost (Sub-total of 1 to 2)	38241.28	49361.76	54885.6	45199.84	55377.28	62630.4	71456
4.	Management charges @ 10 %	3824.128	4936.176	5488.56	4519.984	5537.728	6263.04	7145.6
5.	Risk factor @ 10 %	3824.128	4936.176	5488.56	4519.984	5537.728	6263.04	7145.6
6.	Expected depreciation on fixed investment @ 4%	1546.88	1546.88	1546.88	1546.88	1546.88	1546.88	1546.88
7.	Amortised fixed @12 %	4930.45	4930.45	4930.45	4930.45	4930.45	4930.45	4930.45
8.	Rental value of owned land	46800	49140	51597	54177	56885	59730	62716
9.	Total cost (sub-total of 3 to 8)	99166.87	114851.44	123937.05	114894.14	129815.07	141363.81	154940.53
10.	Production (q)	0	0	0	35	50	90	120
11.	Price (per q)	-	-	-	2200	2200	2200	2200
12.	Gross returns*	0	0	0	77000	110000	198000	264000
13.	Net returns (12–9)	-99166.87	-114851.44	-123937.05	-37894.14	-19815.07	56636.19	109059.47
14.	Returns from intercropping	41000	44280	53480	0	0	0	0
15.	Total net returns	-58166.87	-70571.44	-70457.05	-37894.14	-19815.07	56636.19	109059.47

**Gross returns have been calculated using the average price obtained by growers throughout the peak marketing period.*

Table 5: Net Present Value of Kinnow Orchard in Fazilka District

Year	Negative returns	Positive returns	Discount coefficient $1/(1+r)^n$ r = 12 %	Present Value	
				Negative returns	Positive returns
1	-58166.87	-	0.8929	-51934.70	-
2	-70571.44	-	0.7972	-56259.12	-
3	-70457.05	-	0.7118	-50149.94	-
4	-37894.14	-	0.6355	-24082.41	-
5	-19815.07	-	0.5674	-11243.60	-
6	-	56636.19	0.5066	-	28693.66
7 to 25	-	109059.47	3.7317	-	406977.22
Total	-256904.56	165695.66		-193669.77	435670.88

NPV = 435670.88- 193669.77 = 242001.11, BCR = 435670.88/193669.77 = 2.25

year and positive returns began from the sixth year onward and continuing through 25 years (Priyadarshini *et al*., 2020; Yogi *et al.,* 2019).

Net Present Value (NPV) of Kinnow Orchard

Cost and returns failed to function as a reliable indicator for favouring Kinnow orchards over alternative yearly crops. The primary reason was that the expenses associated with Kinnow production and the returns generated over time were not comparable to those of the other yearly. Returns from annual crops were typically realised in the same year, whereas the Kinnow orchard necessitated a minimum period of 3 to 4 years to yield income. In those three to four years, the operational cost must be bear by the farmer. Consequently, it was essential to compute the net present value of future returns, which was calculated by discounting both costs and returns at the current interest rate (Kumar *et al.,* 2021). In the context of research, the prevailing interest rate of 12% per annum has been used as the discounted rate to find out NPV of the orchard. As shown in Table 5, the per-acre NPV of the Kinnow orchard was ₹ 2,42,001.11 over its 25-year life, indicating the profitability of Kinnow in the region.

Benefit-Cost Ratio (CBR)

The calculated BCR was 2.25 at the 12 % discount rate, which revealed that the investment of Rs 1 in a kinnow orchard would earn Rs 2.25. Since it exceeds 1, it demonstrates the investment's viablity in kinnow farming and these results are in accordance with the findings of Kaur and Singla, 2016, Kumar *et al.,*2025; Yogi *et al.,*2019).

Internal Rate of Return (IRR)

To ascertain the present value, the discount rate was calculated through various random discount rates till the difference in the aggregate of the discounted positive and negative cash flows was as close to zero as possible, or it was just barely below that corresponding IRR values were presented in Table 6. The results indicated a remarkably high IRR of 22.54 per cent annually, suggesting that investments in kinnow orchards yield substantial profitability, as this rate significantly exceeds the prevailing market interest rate of 12 per cent per annum (Kumar *et al.,* 2019; Kumar *et al.,*

Table 6: Internal Rate of Return (IRR) of Kinnow orchard in Fazilka

Year	Net cash flow	Present Value coefficient r = 22%	Corresponding Value	Present Value coefficient r = 23%	Corresponding Value
1	-58166.87	0.8197	-47677.76	0.813	-47290.13
2	-70571.44	0.6719	-47414.30	0.661	-46646.47
3	-70457.05	0.5507	-38801.18	0.5374	-37862.49
4	-37894.14	0.4514	-17105.38	0.4369	-16555.85
5	-19815.07	0.3700	-7331.56	0.3552	-7038.34
6	56636.19	0.3033	17176.51	0.2888	16355.48
7 to 25	109059.47	1.3470	146903.11	1.231	134252.21
Total			5749.44		-4785.59

IRR = 22+5749.44/5749.44+4785.59 = 22.54 per cent

2025). Hence, it can be concluded that kinnow cultivation in Fazilka district is exceedingly lucrative and represents a viable economic enterprise.

Pay-Back Period (PBP)

The time for an investment to recover its initial cost through net returns generated over time was called PBP. In the case of Kinnow farming, the investment during the initial period was high, and it started earning income usually from the sixth year. Table 7 represented how long it will take for the investment to pay for itself through cumulative net returns over time. The results revealed that during the initial 5 years, growers experienced negative returns due to high establishment and operational costs, resulting in a cumulative loss of ₹ 2,56,904.56 per acre. From the sixth year, the net returns became positive, which slowly reduced the accumulated losses. By the eighth year, the net return turned positive, which showed the full recovery of the initial investment. Therefore, the payback period of investment in Kinnow was seven years and 10 months (Bhat *et al.*, 2011; Kumar *et al.,* 2021; Kumar *et al.,* 2025; Priyadarshini *et al., 2020*).

Table 7: Pay-Back Period (PBP) of Kinnow Orchard in Fazilka district

Year	Net Return	Cumulative Net returns
1	-58166.87	-58166.87
2	-70571.44	-128738.31
3	-70457.05	-199195.36
4	-37894.14	-237089.50
5	-19815.07	-256904.56
6	56636.19	-200268.37
7	109059.47	-91208.90
8	109059.47	17850.57

PBP =7+91208.90/109059.47 = 7+ 0.84 = 7.84 years

Major Problems faced by kinnow growers

The majority of farmers reported various production and marketing-related problems (Table 8). A major issue identified by farmers was the spurious quality of canal water. It was reported by 176 farmers and ranked first. In Fazilka, kinnow farmers use canal water to irrigate their orchards because the groundwater is unsuitable for orchard irrigation. Many farmers reported that canal water becomes contaminated by mixing with Buddha Naala's polluted water, which leads to fungal damage to the roots of kinnow plants. The unavailability of water during critical stages of irrigation was ranked second, with 170 farmers reporting it as a constraint. Low prices and fluctuations in the price of kinnow were other major issues, reported by 149 farmers and ranked third.

A major issue identified by kinnow farmers was the spurious quality of canal water. It was reported by 176 farmers and ranked first. In Fazilka, kinnow farmers use canal water to irrigate their orchards because the groundwater is unsuitable for orchard irrigation. Many farmers reported that canal water becomes contaminated by mixing with Buddha Naala's polluted water, which leads to fungal damage to the roots of kinnow plants. 130 farmers reported a lack of subsidies or knowledge about subsidies for agrochemicals, and they ranked it second. Farmers also reported that kinnow orchards suffer significantly from problems like root fungus and leaf yellowing, mentioned by 129 farmers (64.5 per cent) and ranked third. These issues are caused by spurious irrigation water, poor quality kinnow nurseries, and adulterated fertilizers and pesticides.

Additionally, 90 farmers reported that the quality of agricultural chemicals, especially potash, gypsum, and Single Super Phosphate, fertilizers is poor, placing it fourth in their concerns. Farmers also pointed out that the quality of fertilizers and pesticides often did not meet standard specifications. Although farmers were advised to use potash to enhance the fruit colour and quality, the use of adulterated or fake potash has been observed to increase the soil's pH level, adversely affecting productivity. The high seedling mortality in the early years is ranked fifth. Furthermore, the damage caused by wild animals was reported by 57 farmers and ranked sixth among the constraints faced by them. In border villages such as Billa Patti, farmers also suffered from waterlogging and frequent attacks by wild animals like wild boar and nilgai (wild roz). Despite community efforts, including growers' collective funding to control wild boar populations, an effective solution to the wild boar menace remained lacking.

In Fazilka district, the most severe marketing constraint was the absence of Minimum Support Price (MSP), reported by 196 farmers, ranking first. Fluctuations in price, reported by 149 farmers (74.5 per cent), ranked second, reflecting unstable market conditions and seasonal price volatility. The farmers reported that when there is a bumper crop, prices fall, but when production is lower, they get better prices. These price fluctuations create uncertainty among farmers. So, the government should provide MSP or similar price support mechanisms, such as market intervention schemes, for kinnow growers that will ensure farmers' income and protect them from market price swings and exploitation by traders. The third major constraint was the lack of agro-processing industries, reported by 131 farmers (65.5 per cent), indicating limited opportunities for value addition and processing of kinnow.

Inadequate storage infrastructure ranked fourth, with 90 farmers (45 per cent) reporting it and Lack of marketing facilities at the village level, reported by 83 farmers (41.5 per cent), ranked fifth, highlighting poor local market access, and some villages do not have a local market, for example, Patti Billa.

Table 8: Production-related constraints in kinnow cultivation (n= 200) (multiple responses)

Sr. No	Constraints	Number of farmers	Percentage of farmers	Rank
I	High seedling mortality in early years	78	39	5
II	Highly disease-prone plants, like the root fungus, yellow leaves, etc	129	64.5	3
III	Spurious quality of irrigation water	176	88	1
IV	Inferior quality of agrochemicals (Single Super Phosphate, gypsum, and DAP)	90	45	4
V	Lack of subsidies on costly agrochemicals	130	65	2
VI	Damage of crops due to wild animals	57	28.5	6

Table 9: Marketing-related constraints in kinnow cultivation (n= 200) (multiple response)

Sr. No	Constraints	Number of farmers	Percentage of farmers	Rank
I	Absence of Minimum Support Price (MSP)	196	98	1
II	Fluctuations in price	149	74.5	2
III	Lack of agro-processing industries	131	65.5	3
IV	Unfair practices by intermediaries	81	40.5	6
V	Inadequate storage infrastructure	90	45	4
VI	Lack of marketing at the village level	83	41.5	5
VII	Delay in payment of the sold crop	51	25.5	7

Unfair practices by intermediaries, cited by 81 farmers (40.5 per cent), ranked sixth. Some of the kinnow farmers stated that middlemen possess a monopoly in the market. When a farmer takes his produce to mandi for sale by himself, then the trader and commission agent utilise coded hand signals among themselves and decide on the price. Farmers do not know the code language and are therefore excluded from the price-determining process. Such market tactics are reducing the transparency in the market and the bargaining strength of farmers. Consequently, farmers perceive a sense of betrayal even when they market their produce independently, leading them to favour selling directly to traders who procure their goods from the fields. Lastly, delay in payment for the sold crop, reported by 51 farmers (8.7 per cent) and ranked seventh, affects liquidity. These findings are corroborated by the studies of Mavi *et al.,* (2012) and Sohi and Matharu (2018).

Conclusions and Policy Implications

The per-acre establishment cost of a kinnow orchard was ₹38672, and average operational cost for the current year was ₹63800. The CBR, NPV, IRR, and PBP are found to be 1:2.25, ₹2,42,001, 22.5 per cent, and 7.84 years, respectively, indicating the profitability of kinnow in the Fazilka district. Considering profitability and the challenges identified in kinnow production, it is recommended that the government focus more on improving the quality and timely supply of irrigation water, as well as ensuring the availability of high-quality agrochemicals such as pesticides, insecticides, fertilizers, and fungicides. Additionally, it is important to ensure a minimum support price (MSP) or similar price support mechanisms, such as market intervention schemes, for kinnow growers that will lead to ensuring farmers' income and protect them from market price swings and exploitation by traders. Establishing agro-processing industries, especially in kinnow-growing regions, will allow farmers to earn higher profits by producing kinnow juice, candies, and similar products that will create more employment opportunities in the area. Furthermore, developing post-harvest infrastructure such as units for sorting, grading, waxing, packaging, and storage will help farmers increase the productivity and profitability of kinnow farming.

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