

Effect of Kinnow Production in Agra Region in Socio Economical Condition of Kinnow growing Farmers

Abstract

The cultivation of Kinnow, a hybrid mandarin fruit, in the Agra region has significantly impacted the socio-economic conditions of local farmers. This study examines the effects of Kinnow production on farmer livelihoods in 10 selected villages within the Agra district. Data collected from 100 Kinnow-growing farmers revealed that the crop contributes substantially to income generation, improving the financial stability of farmers. Factors such as landholding size, access to credit, and market linkages influence the profitability of Kinnow orchards. Despite challenges like market fluctuations and environmental conditions, the introduction of Kinnow has provided an alternative source of income for farmers in a semi-arid region. Additionally, this study outlines the costs involved in establishing and maintaining Kinnow orchards, highlighting the initial high investments required, followed by a significant return as orchards mature. The findings suggest that Kinnow production is a viable and profitable agricultural enterprise that can contribute to both economic growth and social development in the region.

Keywords: Kinnow cultivation, Agra district, socio-economic, farmer income, orchard.

Introduction

The most important commercial citrus species in India are the mandarin (*Citrus reticulata*), Sweet orange (*Citrus sinensis*) and acid lime (*Citrus aurantifolia*) sharing 41, 23 and 23 % respectively of all citrus fruits produced in the country. Kinnow, which can be easily identified from a distance by its attractive bright orange colour, is being seen everywhere these days and customers are also buying it in large numbers. (Kumar *et al.*, 2017). Earlier, this fruit was imported from Punjab, but now farmers are cultivating it in many areas of the state and earning good profits. This year (2016-17), it is expected that about 36 thousand metric tonnes of Kinnow will be produced in 1800 hectares in the state. While on one hand it is still time for the local oranges to arrive, on the other hand Kinnow has taken its place in the fruit markets. Many farmers in the state thought about cultivating oranges, but due to the lack of suitable climate for oranges, it was not possible. After this, farmers started cultivating Kinnow.

Kinnow can be cultivated according to the climate of the state. Director, Horticulture and Food Processing Department, UP, said, "At this time, Kinnow is mostly coming to the market. Farmers are growing Kinnow in Hamirpur, Gorakhpur, Kushinagar, Agra, Chitrakoot, Etawah, Jhansi etc. areas of the state. Its fruit is ready in November while no other fruit is available at that time, even oranges are not ready by that time. Anonymous. (2021-22). This is why its demand remains in the markets. Kinnow plant can be planted twice a year. Once in February or March and the second time in July or August. A farmer can earn up to two lakh rupees from one acre in Kinnow cultivation. The best time to pluck the fruit from the orchards is December. After this, it can be plucked till February. Fruit can be produced from a Kinnow tree for 15 years. Along with this, its plant starts bearing fruit in three years. Kinnow plants were planted here one and a half years ago. At present, about eight kinnow plants are planted. These plants will start bearing fruits within one or two years. The production of Kinnow (also known as sweet orange) in Agra region has been an important aspect of the socio-economical condition of the farmers. Kinnow is a major cash crop that is grown extensively in Agra region due to its high demand in the national and international markets. This study aims to analyze the effect of Kinnow production on the socio-

economical condition of Kinnu growing farmers in the Agra region. Phosphorus regulates protein synthesis in plants, because it is a component of the complex nucleic acid structure. Phosphorus is also important in cell division and development of new tissues. (Singh *et al.*, 2022). Presently, development of new varieties for higher yields has reached a plateau and no further increase is achieved unless biotechnological interventions are made. Lodging is the state of permanent displacement of the stems from their upright position. (Archana, *et al.*, 2023). The total reported population is 3.62 million with density of 899/ km² and literacy of 62.60%. The total reported area of the district is 398460 ha, out of which net sown area is 285496 ha and irrigated area is 235063 ha with cropping intensity of 139.51%. Mousumi *et al.*, (2020).

Natural variations and outside factors, such as variations in solar radiation, volcanic eruptions, and natural variability within the climate system, have influenced the Earth's climate throughout its history and contribute to the overall natural variability of the climate system. These changes persist over long periods, frequently spanning decades or even longer. But over the past few centuries, human activity particularly since the industrial revolution has significantly altered the makeup of the atmosphere. In spite of a changing climate, climate-resilient agronomy aims to maintain sustainable food production and stable livelihoods for farmers. (Singh *et al.*, 2023). By fixing atmospheric nitrogen, both in conjunction with plant roots and independently, biofertilizers (*Azotobacter* and *Azospirillum*) solubilize insoluble soil phosphates and generate plant growth components in the soil, so contributing significantly to improved soil fertility. (Lokendra *et al.*, 2024).

Nano-technology offers great potential to tailor fertilizer production with the desired chemical composition, higher nutrient use efficiency that may reduce environmental impact and boost the plant productivity. Nano- fertilizers are very effective for precise nutrient management in precision agriculture by matching with the crop growth stage for nutrient and by providing nutrient throughout the crop growth period. Nano-fertilizers are new generation of the synthetic fertilizers which contain readily available nutrients in nano scale range. Nano-fertilizers are preferred largely due to their efficiency and environment friendly nature compared to conventional chemical fertilizers. The nano-fertilizers deal with the elements in nano- meter dimensions. (Singh *et al.*, 2024)

Materials and Methods

The field experiment was carried out during season of 2019-24 at 10 village in Barauli Aheer block in Agra Region (U.P.). The soils of the district are loam sandy loam ravines and wasteland. The fertility status of the soil is poor to very poor. In this study, data was collected from the Kinnu growing farmers in the Agra region through a structured questionnaire. The questionnaire covered various aspects such as demographic information, land holding size, Kinnu production practices, access to credit, market linkages, and socio-economic condition of the farmers. A total of 100 farmers were selected randomly from the regions who are involved in Kinnu production. The production of kinnow (a type of mandarin orange) in the Agra region has a significant impact on the socio-economic conditions of farmers growing this crop. Here are the key effects: Economic Impact (Income Generation, Diversification of Income, Financial Stability), Social Impact (Improved Living Standards, Community Development, Empowerment and Skills Development, Empowerment and Skills Development) and Challenges and Recommendations (Market Fluctuations, Climate and Environmental Issues, Access to Resources) ect. Agra district is situated in South-West semi-arid zone of UP. It is located at altitude of 27.20 North and longitude of 77.90 easts. River Chambal makes the southern boundary of district and flows from West to East separating district Bhind (M.P) In the North

Agra is bounded by districts of Firozabad and Etawah. The average rainfall (annual) of the district is 750 mm. Temperature varies from 4^oC (During December-January) to 48^oC (During May-June) respectively. The district is comprised of six thesils, 15 blocks and 904 villages.

Results and Discussion

The results of the study showed that Kinnu production has a positive impact on the socio-economical condition of Kinnu growing farmers in the Agra region. The majority of the farmers (78%) reported that Kinnu production has helped them in increasing their income and improving their livelihood. Moreover, farmers who had larger land holdings and access to credit were found to have a higher income from Kinnu production as compared to the ones with smaller land holdings and no access to credit. The study also revealed that market linkages play a significant role in increasing profitability for Kinnu farmers.

Selected Village in Agra District Kinnow orchard

Table 1 presents data on Kinnow orchards in selected villages within the Agra district, focusing on various parameters, including the number of farmers, land area, plant density, yield, and gross returns. Number of Farmers: Each selected village has 10 farmers engaged in Kinnow cultivation. Area Under Cultivation (ha): The area allocated to Kinnow orchards per village varies, with a range from 5 hectares (Mahua Kheda) to 10 hectares (Barauli Gujar, Tanora Noorpur, and others). The average area cultivated across villages is 7.9 hectares. Plant Density (ha⁻¹): The number of plants per hectare remains constant across all villages, at 333 plants per hectare. Yield per Plant (kg): Yield per plant varies slightly, with a minimum of 85 kg per plant (Mahua Kheda, Samogar) and a maximum of 95 kg per plant (Visarna). The average yield is 88.4 kg per plant. Yield (q/ha): The yield in quintals per hectare fluctuates between 286 q/ha in Barauli Gujar and 300 q/ha in Higtot Kheriya, with an average yield of 294.0 q/ha across all villages. Gross Returns: This represents the monetary returns from Kinnow orchards. The highest gross returns are in Visarna (₹ 632700), while the lowest are in Mahua Kheda (₹ 566100).

Table-1 Selected Village in Agra District Kinnow orchard

S.No	Selected Village in Agra District	No. of farmers	Growing in Kinnu crop area in ha ⁻¹	No. of plant ⁻¹ ha ⁻¹	Plant ⁻¹ Yield (kg)	Yield. (q/ha)	Gross returns (Rs./ha)
1	Mahua Kheda	10	5	333	85	283	566100
2	Etmadpurmadara	10	8	333	88	293	586080
3	Higtot Kheriya	10	7	333	91	300	599400
4	Samogar	10	5.5	333	85	283	566100
5	Nadota	10	7.5	333	90	300	599400
6	Tanora Noorpur	10	10	333	88	293	586080
7	Mehranaharganj	10	8	333	90	300	599400
8	Visarna	10	10	333	95	216	632700
9	Sarbatpur	10	8	333	87	290	579420
10	Barauli Gujar	10	10	333	86	286	572760
	Average	100	7.90	333	88.40	294	588744

On average, the gross returns per village stand at ₹ 588744. Variation in Area and Yield: While the plant density is uniform across all villages, differences in the area under cultivation and the yield per plant contribute to the variation in the overall yield and returns. Villages like Visarna and Higtot Kheriya show higher yields per plant, leading to higher gross returns. Impact of Area on Gross Returns: The table suggests that larger areas under cultivation do not necessarily correlate with higher gross returns. For instance, Barauli Gujar, with one of the

largest areas under cultivation (10 hectares), has the lowest gross returns due to lower yield per plant and yield per hectare. Consistency in Plant Density: The uniform plant density across all villages indicates a standard practice in orchard management, which helps in comparing the productivity and profitability of different villages on a level field. Gross Return Trends: Villages with higher yield per hectare like Higtot Kheriya and Sarbatpur generally show higher gross returns, suggesting that productivity improvements can directly enhance financial outcomes for farmers. These results are in conformity with the findings of Gangwar *et al.*, (2005) and Bhat *et al.*, (2011).

Establishment cost of Kinnow orchard

Table 2 outlines the detailed cost components required to establish a Kinnow orchard in Agra, Uttar Pradesh, per hectare. The major activities involved in the establishment include land preparation, pit digging, plant procurement, irrigation setup, and the construction of infrastructure such as ponds and equipment purchases. The total establishment cost is ₹ 55,658 per hectare. Preparation of land and layout: This involves clearing the land, leveling it, and marking the layout for planting the trees, costing ₹ 6,987. Digging and filling of pits: Essential for planting, pit digging costs ₹ 5,343. Cost of irrigation: Ensuring the availability of water through an irrigation system, this involves ₹ 1,051. Cost of plant and replacement plants: The cost of Kinnow plants and replacing dead plants amounts to ₹ 6,358 and ₹ 965, respectively. Manures and fertilizers: Soil fertility is enhanced using manures and fertilizers, with a cost of ₹ 4,737. Transportation of plants: This includes costs related to moving plants to the orchard, which is ₹ 4,659. Plantation cost: The actual planting of the trees costs ₹ 2,963. Intercultural operations: Post-plantation activities like weeding and soil management cost ₹ 1,469. Construction of pond: A significant part of the cost (₹ 12865) is allocated to pond construction, which is necessary to store water for irrigation. Cost of equipment: Equipment needed for orchard management costs ₹ 5,874. Miscellaneous costs: Other minor but essential expenses total ₹ 2,387.

Table.2 Establishment cost of Kinnow orchard in Agra (Uttar Pradesh)

S. No.	Particulars	Value (₹)/ ha.
1	Preparation of land and lay out	6987
2	Digging and filling of pits	5343
3	Cost of irrigation	1051
4	Cost of plant	6358
5	Cost of replacement plant	965
6	Manures and fertilizer	4737
7	Transportation of plant	4659
8	Plantation cost	2963
9	Intercultural operation	1469
10	Construction of pond	12865
11	Cost of equipment	5874
12	Miscellaneous	2387
	Total	55658

The total establishment cost for setting up a Kinnow orchard is significant, amounting to ₹ 55658 per hectare. The construction of a pond accounts for more than 50% of the total cost (₹ 12865), reflecting the critical role of water management in orchard establishment. Agra's semi-arid climate necessitates reliable water storage and irrigation systems, which increases the

capital requirement for pond construction. This cost, though high, is crucial for the long-term sustainability of the orchard as it ensures a consistent water supply during dry periods. The cost of plants and their transportation are the next major cost contributors, amounting to ₹ 6,358 and ₹ 4,659 respectively. Kinnow plants are valuable and their survival is vital for orchard productivity, making the expense on quality plants and transportation justified. Expenses for manures and fertilizers (₹ 4,737) highlight the importance of ensuring soil fertility for the successful growth of the Kinnow trees. This cost, along with expenses on intercultural operations (₹ 1,469), reflects the ongoing need for maintaining orchard health through proper soil management and weed control. Although miscellaneous expenses (₹ 2,387) and equipment costs (₹ 5,874) are comparatively smaller, they play a supportive role in the efficient operation of the orchard. These results are in conformity with the findings of Gangwar *et al.*, (2005) and Bhat *et al.*, (2011) Mousumi *et al.*,(2020)

Operational cost of Kinnow orchard in Agra

Table 3 presents the yearly operational costs involved in maintaining a Kinnow orchard in Agra over the period from 2019 to 2024. The table captures key operational activities, including the application of manure and fertilizers, plant protection, pruning, intercultural operations, irrigation, labor charges, and other miscellaneous expenses.

Manure and Fertilizer: Gradually increases from ₹ 3,127 in 2019 to ₹ 3764 in 2024, reflecting rising input prices and the growing nutrient needs of maturing trees. **Plant Protection:** A significant expense that rises steadily from ₹ 3256 in 2019 to ₹ 3681 in 2024, emphasizing the need for ongoing pest and disease control as the orchard matures. **Pruning and Cutting:** Starts at ₹ 3,411 in 2019, reaching ₹ 3,964 in 2024, necessary for managing tree growth and ensuring healthy production. **Intercultural and Hoeing:** Increases from ₹ 4,847 to ₹ 4,253, indicating the rising labor and maintenance costs associated with orchard management. **Irrigation:** Costs escalate from ₹ 4,498 in 2019 to ₹ 4,791 in 2024, highlighting the importance of water management in sustaining orchard productivity in Agra's climate. **Labour Charges:** One of the most significant cost components, starting at ₹ 5,023 in 2019 and surging to ₹ 10,321 in 2024, reflecting both the intensity of manual work required and the rising cost of labor. **Replacement and Casualty:** Represents the cost of replacing dead or damaged plants, rising from ₹ 1,437 in 2019 to ₹ 2,396 in 2024. **Staking:** Begins only in 2022 with a cost of ₹ 3,500, rising to ₹ 4,192 in 2024, associated with supporting the growth of young trees. **Miscellaneous:** Includes additional small expenses, rising from ₹ 1,724 in 2019 to ₹ 2,785 in 2024. The total operational cost of maintaining the orchard shows a substantial increase over the years, starting from ₹ 27153 in 2019 and reaching ₹ 39147 by 2024.

The operational costs of a Kinnow orchard in Agra show a sharp upward trend over the years, particularly driven by rising labor charges, plant protection, and irrigation expenses. By 2024, the operational costs escalate almost fivefold compared to 2019, which is indicative of the growing intensity of labor, resource management, and maintenance as the orchard matures. Labor charges stand out as the most significant cost, especially in the later years.

Table-3 Operational cost of Kinnow orchard in Agra Value (₹ /hectare)

Sr. No	Particulars	Years					
		2019	2020	2021	2022	2023	2024
1	Manure and fertilizer	3127	3258	3423	3568	3694	3764

2	Plant protection	3256	3250	3242	3234	3241	3681
3	Pruning and cutting	3241	3481	3173	3245	3741	3964
4	Intercultural and hoeing	4252	4468	4631	4863	4521	4847
5	Irrigation cost	4498	4120	4961	4546	4276	4791
6	Replacement and casualty	1437	1654	2145	2754	2124	2396
7	Labour charge	5023	10413	10421	10323	10531	10321
8	Staking	0	0	0	3500	3800	4192
9	Miscellaneous	1724	1923	2149	2465	2563	2785
	Total operational cost	27153	31467	33445	37398	37791	39147

The leap from ₹ 5,023 in 2019 to ₹ 10,321 in 2024 reflects the high labor requirement for various activities such as pruning, hoeing, irrigation, and other manual tasks critical to maintaining the orchard. This spike could be attributed to increased labor rates and the need for more hands-on management as trees reach peak production. Plant protection costs also increase significantly, demonstrating the growing need to protect the orchard from pests and diseases as it matures. The jump from ₹ 3,256 in 2019 to ₹ 3,681 in 2024 shows that as the trees grow, their exposure to potential risks rises, demanding more resources for protection. Irrigation and intercultural operations represent a substantial part of the overall cost, especially in the context of Agra's semi-arid climate. The increase from ₹ 4,498 to ₹ 4,791 for irrigation and from ₹ 4253 to ₹ 4,847 for intercultural operations reflects the consistent need for efficient water management and ground maintenance to sustain tree health and productivity. Manure and fertilizer costs also exhibit a steady rise, underlining the increasing nutrient demands of the orchard as the trees mature and require more inputs for sustained growth and fruiting. Pruning and cutting, starting at ₹ 3,241 and reaching ₹ 3,964, further underscore the importance of canopy management as the trees grow. Regular pruning helps ensure that the trees produce high-quality fruit and maintain proper growth. The total operational cost rises dramatically, reaching ₹ 39147 in 2024 from ₹ 27153 in 2019. This significant cost escalation indicates that while initial investments might be lower during the early years of orchard establishment, maintaining a mature orchard requires substantial resources. As the trees reach full production, the higher costs also suggest that the potential revenue from fruit production must offset these operational expenses for the orchard to be economically viable (Table 3). These results are in conformity with the findings of Gangwar *et al.*, (2005) and Bhat *et al.*, (2011) Mousumi *et al.*, (2020)

Costs and returns from Kinnow orchard

Table 4 provides a breakdown of the costs and returns associated with Kinnow orchard cultivation in Agra over the years 2019 to 2024. The data captures crop yield, average fruit weight, yield per tree and hectare, prices, and the corresponding returns from both Kinnow production and intercropping activities. Crop Load (Fruits/Tree): The crop load begins in 2022 with 253 fruits per tree, increasing to 450 fruits per tree by 2024. Average Fruit Weight: In 2022, the average fruit weight is 159 grams, increasing to 176 grams by 2024. Yield (kg/Tree): Yield starts at 58 kg per tree in 2022, increasing to 85 kg per tree by 2024. Yield (q/ha): This refers to the total yield per hectare, beginning at 193 quintals in 2022 and rising to 283 quintals by 2024. Price per Quintal: The price of Kinnow per quintal rises significantly from ₹ 1,600 in 2019 to

₹ 2,000 in 2024, reflecting market demand and price fluctuations. Return from Kinnow: The income from Kinnow cultivation begins at ₹ 386000 in 2022 and increases to ₹ 566000 by 2024. Return from Intercropping: This additional source of revenue varies, peaking at ₹ 70422 in 2019 to 76876 in 2024.

Table.4 Costs and returns from Kinnow orchard in Agra Value (₹/ hectare)

Sr. No.	Particulars	Years					
		2019	2020	2021	2022	2023	2024
1	Crop load (fruits/tree)	0	0	0	253	276	450
2	Av. fruit weight (g)	0	0	0	159	168	176
3	Yield (kg/tree)	0	0	0	58	72	85
4	No. of plant ha ⁻¹	333	333	333	333	333	333
5	Yield (q/ha)	0	0	0	193	240	283
6	Price (₹) per Quintal	1600	1700	1800	2000	2000	2000
7	Return from Kinnow	0	0	0	386000	480000	566000
8	Return from inter cropping	70422	72673	75124	70977	73545	76876
9	Gross returns	70422	72673	75124	456977	553545	642876
10	Total Cost of cultivation	27153	31467	33445	37398	37791	39147
	Net Return	43269	41206	41679	419579	515754	603729

Gross Returns: This figure combines the returns from both Kinnow and intercropping activities, increasing from ₹ 70422 in 2019 to ₹ 642876 in 2024. **Total Cost of Cultivation:** Costs associated with cultivating the orchard increase from ₹ 27153 in 2019 to ₹ 39147 in 2024. **Net Return:** The net return, after subtracting total costs from gross returns, shows a significant turnaround, going from negative returns in the early years to a positive return ₹ 43269 in 2019 to ₹ 603729 in 2024.

The data from 2019 to 2024 highlights a critical aspect of Kinnow orchard economics: initial investments and early operational costs are high, with no returns from Kinnow in the early years. However, as the orchard matures, both crop yield and fruit prices increase significantly, leading to substantial profits by 2024. **Early Years (2019-2021):** During the first three years, the orchard generates no income from Kinnow because the trees are not yet mature enough to bear fruit. The only returns during these years come from intercropping, which provides supplementary income ranging from ₹ 43,269 in 2019, ₹ 41,206 in 2020 and ₹ 41,679. **Mature Years (2022-2024):** Beginning in 2022, the trees start to bear fruit, with 253 fruits per tree and a yield of 193 quintals per hectare. Returns from Kinnow production begin at ₹ 386,000 in 2022 and rise sharply to ₹ 5,56000 by 2024 as both the yield and fruit prices increase. This substantial income from Kinnow, combined with the falling contribution of intercropping (₹ 76876 by 2024), leads to gross returns of ₹ 603729 in 2024. **Price Fluctuations:** The price per quintal of Kinnow also plays a pivotal role in the overall profitability of the orchard. Prices increase from ₹ 1,600 in 2019 to ₹ 2,000 in 2024, likely due to market demand, increased quality of fruit from mature trees, and inflation. These price increases boost returns significantly, even though yield per hectare also rises over time. **Cost of Cultivation:** The total cost of cultivation increases year after year, starting at ₹ 27153 in 2019 and reaching ₹ 39147 by 2024. This rise reflects higher operational expenses, including labor, plant protection, and irrigation. Despite these increasing costs, the corresponding rise in Kinnow returns more than offsets these expenses. **Net Returns:** The most striking aspect of this table is the transformation of net returns from negative values during the non-productive years to impressive positive returns by 2024. However, by 2024, the net return is ₹ 603729, illustrating the high profitability potential of Kinnow orchards once they

reach full production. These results are in conformity with the findings of Gangwar *et al.*, (2005) and Bhat *et al.*, (2011) Mousumi *et al.*, (2020)

Profitability Analysis:

Initial Losses and Investment: During the establishment phase (2019-2021), the orchard faces net losses because of the non-productive phase of Kinnow trees. While there are returns from intercropping during these years, they are insufficient to cover the high operational costs, such as labor, irrigation, and plant protection. This period represents the initial investment needed to establish the orchard, and losses are expected as the trees do not yet bear fruit.

Turning Point in Year 2022: The turning point arrives in 2022 when the Kinnow trees begin bearing fruit, leading to a significant increase in returns. By this year, the orchard produces a yield of 193 quintals per hectare, and the crop load per tree reaches 253 fruits, contributing to a gross return of ₹ 456977. Despite the still-high cost of cultivation (₹ 37398), the orchard achieves a net return of ₹ 419579. This marks the start of the orchard's profitability, as revenues from fruit sales finally surpass the costs.

Rapid Growth in Profit (2023-2024): By 2023, the orchard reaches a productive phase with increased yields and higher fruit prices. The yield per hectare grows to 240 quintals, and the price per quintal of Kinnow increases to ₹ 2,000. This results in a gross return of ₹ 553545, with a net return of ₹ 515754 after deducting cultivation costs (₹ 37791). This trend continues into 2024, where the orchard reaches its full potential. With a yield of 283 quintals per hectare and a price of ₹ 2,000 per quintal, the gross returns reach an impressive ₹ 642876. Despite the increasing cost of cultivation (₹ 39147), the net return peaks at ₹ 603729.

Economic Viability:

The data reveals that Kinnow orchards become highly profitable once they enter their productive phase. By 2024, the high net return of over ₹ 642876 per hectare indicates that the initial losses and operational costs are more than compensated by the orchard's yield and market prices. The consistent increase in fruit prices further enhances the orchard's profitability, making it a lucrative venture in the long term.

Factors Contributing to Profitability:

Increased Yield: As the trees mature, their ability to produce larger crop loads and heavier fruits significantly boosts the yield per hectare. The jump from 193 quintals in 2022 to 283 quintals in 2024 underscores the importance of orchard maturity for maximizing production.

Rising Market Prices: The sharp increase in the price per quintal, from ₹ 1,600 in 2019 to ₹ 2,000 in 2024, plays a crucial role in enhancing profitability. Favorable market conditions, combined with quality fruit production, ensure that the orchard can command higher prices in the market.

Initial Losses and Investment: During the establishment phase (2019-2021), the orchard faces profit because of the non-productive phase of Kinnow trees. While there are returns from intercropping during these years, they are sufficient to cover the high operational costs, such as labor, irrigation, and plant protection. This period represents the initial investment needed to establish the orchard, and profit is expected as the trees do not yet bear fruit. **Sustained Costs:** Although the cost of cultivation rises each year, particularly due to labor, plant protection, and irrigation, the corresponding rise in yields and prices offsets these increases. Efficient management practices can further optimize costs and improve profitability. **Intercropping as Supplementary Income:** During the non-productive years, intercropping provides a valuable source of supplementary income, helping to mitigate some losses. While intercropping income decreases in later years (as Kinnow production becomes the primary focus), it still contributes to

overall returns, especially in the initial years. These results are in conformity with the findings of Gangwar *et al.*, (2005) and Bhat *et al.*, (2011) Mousumi *et al.*, (2020)

Conclusion:

The study highlights the transformative role of Kinnow cultivation in improving the socio-economic conditions of farmers in the Agra region. Kinnow has emerged as a highly profitable cash crop, especially in areas where traditional crops face climatic limitations. Despite the initial high costs of establishing orchards, including land preparation, irrigation setup, and plant procurement, the long-term benefits far outweigh the investments. Farmers who adopt proper management practices, leverage market linkages, and secure access to credit enjoy higher returns, as evidenced by increased yields and substantial gross income over time. The success of Kinnow production not only boosts individual income but also enhances community development by providing employment opportunities and fostering skills in horticulture. However, challenges like fluctuating market prices, climate vulnerabilities, and resource accessibility remain critical concerns that need addressing to sustain growth. By overcoming these challenges and promoting best practices, Kinnow cultivation can continue to drive economic development and improve the quality of life for farmers in Agra, making it a promising avenue for agricultural diversification in semi-arid regions.

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