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The Forecast in Decline of India's Citrus Peel Exports in 2028: A Trend Analysis

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ABSTRACT

India's citrus peel exports from 2014 to 2024 have substantial declining trends, as shown by CAGR and linear regression analysis. The data reveal negative CAGRs of (-4.52%) for export volume and (-3.17%) for export value. Projections suggest that if these trends persist, export value may hit a low point by 2028. Despite an annual citrus production of approximately 16.8 million tons, exports are constrained by high post-harvest losses (up to 30.7%), elevated shipping costs (2.5 to 3 times higher), strong domestic demand (75%) and COVID-19 pandemic has undergone a gradual but impactful by 20% of the amount received in the lockdown indicated that even with high demand in the world, India was unable to effectively get its fruit to the borders. Climate issues, such as fruit splitting and pests, further diminish peel quality and export potential justify the decline of trends in citrus exports in India. Improving storage infrastructure, pest control, and value-added processing are crucial steps to enhance export performance.

Keywords: Citrus peel exports, Trade decline, post-harvest losses, Climate impact, Value addition.

INTRODUCTION

Citrus fruits are extensively cultivated across India, making the country one of the world's top citrus producers. Major producing states include Maharashtra, Madhya Pradesh, Punjab, Rajasthan, and Haryana, with Nagpur famously called the "Orange City". India ranks second among the world's orange producers, with approximately 14 million tons of citrus produced annually. Despite this, only a small share of the produce is exported, as most is consumed domestically in fresh form. Export revenue primarily comes from nearby markets like Bangladesh and Nepal. Consequently, a significant amount of citrus peel is generated domestically, presenting strong opportunities for value-added processing and utilisation of by-products. This study reviews historical export data to analyse the decline in exports and to project future trends.

Objective of the Study

An analysis of India's citrus peel export data from 2014 to 2024 was conducted using linear regression to project future trends through 2035 and uncover reasons for the anticipated decline.

REVIEW OF LITERATURE

Ali, M., Hussain, M. H., and Zaman, W. Q. (2022) examine the use of Orange Peel Waste (OPW) in functional foods like beverages, yoghurts, and extruded snacks. They detail extraction techniques for obtaining essential

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oils, pectin, and carotenoids, and discuss bioconversion processes such as digestion and fermentation that yield products such as lactic acid, xanthan gum, biomethane, and bioethanol, thereby supporting a circular bioeconomy. The review also introduces a citrus-based bioflavonoid taste-enhancer powder. It provides scientific evidence on citrus peel's potential as a source of functional and flavour-active compounds, offering insights into sustainable extraction and use strategies for clean-label product development.

Sonawane, N., Patil, C., & Chinchore, R. (2024) review orange peel, a nutrient-rich by-product that contains flavonoids (hesperidin, naringin), phenolics, carotenoids, and essential oils such as limonene and linalool. It emphasizes their antioxidant and antimicrobial effects and explains extraction methods like Soxhlet and aqueous techniques. The review also explores their uses in food preservation and health-oriented products. This analysis supports research efforts by providing evidence of how citrus waste can be repurposed to recover bioactive compounds for value-added applications.

Dadwal and Gupta (2023) describe citrus peel as a sustainable bioresource that can be converted into food additives and functional ingredients. They emphasize its rich content of flavonoids, essential oils, and dietary fibre, which offer antioxidant and health benefits. They also discuss how citrus waste can be transformed into natural flavourings and value-added products using sustainable processing techniques. This supports the idea that India should move from exporting raw citrus peel to producing high-value bioactive compounds, thereby enhancing export competitiveness and mitigating the impact of declining raw peel exports.

Anbalagan, T., Tejkumar, J. P., George, A., & Kommu, K. K. (2021) highlight that India’s citrus yield stands at 12.5 tons per hectare, which is lower than yields in Brazil, China, and the USA. This discrepancy is mainly due to research institutions providing less than 1% of disease-free planting materials. Biotic stresses such as HLB, tristeza, canker, and Phytophthora, along with abiotic stresses like drought and salinity, further reduce both yields and fruit quality. While the cultivated area is increasing, these issues hinder export competitiveness. The authors recommend that adopting better management practices could raise exports from the current 15-20% to 30-40%, supporting the current finding that structural constraints limit peel availability and weaken export performance.

Hu, W., Wang, K., X., Jiang, P., Lu, Z., Zhang, Z. (2024) Highlight that insect pests reduce citrus yield and fruit quality, lowering the available volume for sale and increasing the risk of export rejection under strict international standards. This agrees with the current study, as pest infestations impair both production and the quality of peels suitable for export. When pests damage the fruits, fewer peels meet global market standards. As a result, ineffective pest control directly hampers the success of citrus peel exports.

Kaur, K., Gupta, M., Anand, S., & Raina, D. (2025) find that higher temperature, rainfall, and humidity increase fruit splitting in Daisy mandarins, reducing marketable yield and overall production. The splitting rate was 4.37% in 2022, up from 3.48% in 2021, mainly due to higher rainfall and humidity. Fruits with thinner peels and higher water content are more susceptible to damage. Since split fruits cannot be sold fresh, this negatively affects export value. These results align with the current study by showing that climate variability compromises fruit quality and peel availability, thereby contributing to the decline in India’s citrus peel exports.

Source Of Data

Secondary data sources are consisted of both international and domestic repositories. The WITS (World Integrated Trade Solution) offers export data spanning from 2014 to 2024.

METHODOLOGY

The datasets were analysed using CAGR calculations, which determine the average annual growth rate, and linear regression to predict future trends based on historical data. These techniques aided in market forecasting and evaluating the project's feasibility.

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Table 1.5.1: Export Quantity and Value of India's Citrus Peel 2014 – 2024

Year	Export Quantity (Metric Tonnes)	Percentage %	Export Value (Usd Million)	Percentage %
2014	265.27	8.45	473.32	10.67
2015	565.88	18.03	890.95	20.09
2016	364.00	11.60	506.78	11.43
2017	249.05	7.94	440.21	9.93
2018	386.34	12.31	391.79	8.84
2019	541.92	17.27	492.00	11.09
2020	253.22	8.07	379.62	8.56
2021	73.73	2.35	161.97	3.65
2022	28.83	0.92	69.97	1.58
2023	242.45	7.73	284.91	6.42
2024	167.12	5.33	342.92	7.73
Total	3137.80	100	4,434.44	100

(World Integrated Trade Solution)

Performance Tools	Export Quantity	Export Value
Mean	285.25	391.79
Sd	170.31	212.21
Cv	1.67	1.90
Cagr	-4.52	-3.17

The export statistics reveal different phases over the last ten years. The first notable peak occurred between 2013 and 2016, with an 8.45% share in quantity 265,27 MT and a 10.67% share in value 473.32 USD million. The highest points were reached in 2014 - 2015, with 18.03% in quantity and 20.09% in value. During 2016 - 2019, exports maintained high volumes but lower values, with 2016 - 2017 showing 7.94% and 2018 - 2019 around 8.84% in quantity, and 17.27% and 9.93% in value, respectively, indicating a shift towards higher volume but lower value. This trend reversed slightly in the following year, with both metrics dropping below previous levels. Between 2021 and 2022, exports declined by 0.92% in quantity and 1.58% in value, a decrease associated with the pandemic's impact, totalling 8.07% in quantity and 8.56% in value during 2019-2022. In 2022 - 2024, the data reflect a drop to 7.73% in quantity 242.45 MT and 6.42% in value 342.92 USD million, indicating a higher value per kilogram despite lower volumes, followed by a slight increase in 2023- 2024 with 7.73% in quantity and 5.33% in value.

The Compound Annual Growth Rate (CAGR) in India's citrus peel exports from 2014 to 2024 results in a negative CAGR of -4.52% in export quantity and -3.17% in export value. The smaller decline in export value compared to quantity suggests that prices remained relatively stable, possibly due to inflation or improved quality standards.

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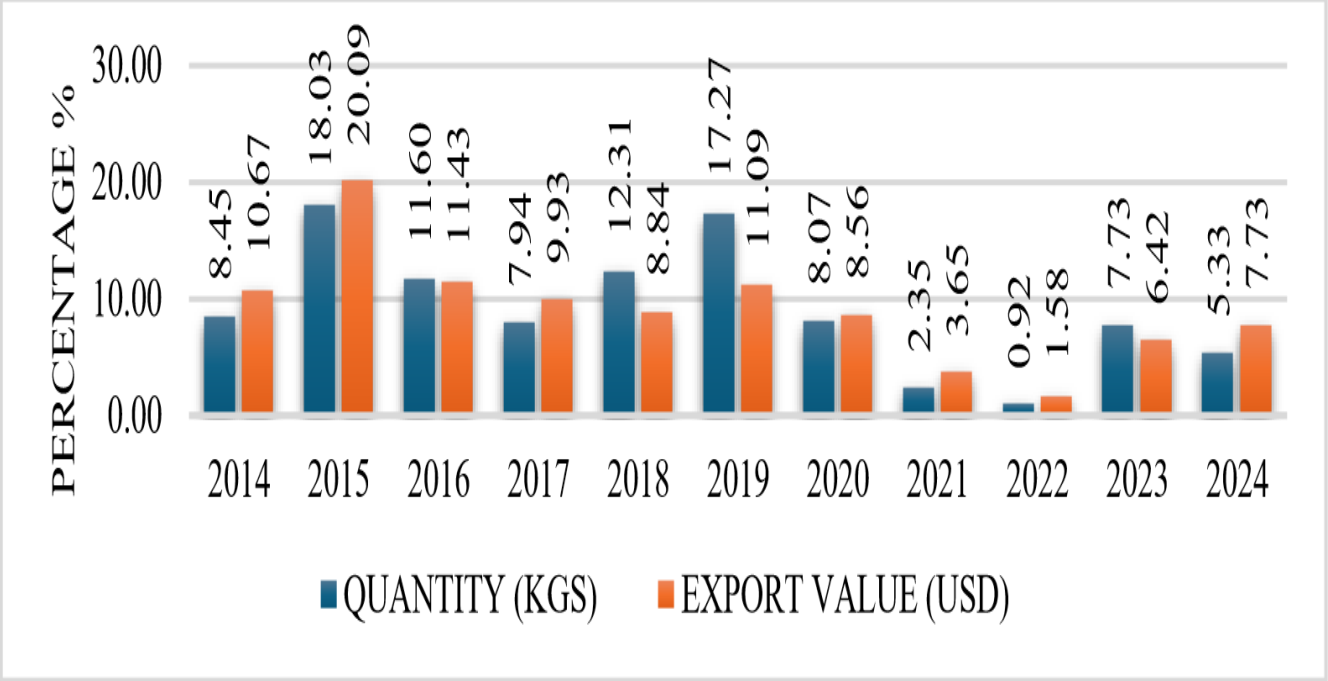
The mean export quantity between 2014 and 2024 is 285.25, and the mean export value is 391.79. These averages represent the annual level of citrus peel exports over the ten-year period. The typical annual export performance of India's citrus peel during this period.

The Standard Deviation (SD) 170.31 MT and 212.21 USD million shows a large change from year to year, meaning export performance is inconsistent.

The Coefficient of Variation (CV) is (1.67) for export quantity and (1.90) for export value, showing high variability compared to the mean. Since both values are greater than (1), it indicates strong fluctuations and instability in citrus peel exports between 2014 and 2024. This supports the conclusion that exports were volatile and experienced a substantial decline during this period.

Figure 1.5.1: EXPORT QUANTITY AND VALUE OF

India's Citrus Peel 2014 – 2024



Trend Analysis

Citrus is a highly volatile commodity due to its perishability and climate sensitivity. Trend analysis forecasts India's future export values for 2025–2035, based on citrus peel export data from the World Integrated Trade Solution (WITS) database, covering 2014-2024.

Table 1.6.1: Projected Export Values Of India's Citrus Peel (2025 – 2035)

Year	Export Value (Usd Million)
2025	132.85
2026	87.80
2027	42.75
2028	-2.30
2029	-47.35
2030	-92.39
2031	-137.44
2032	-182.49

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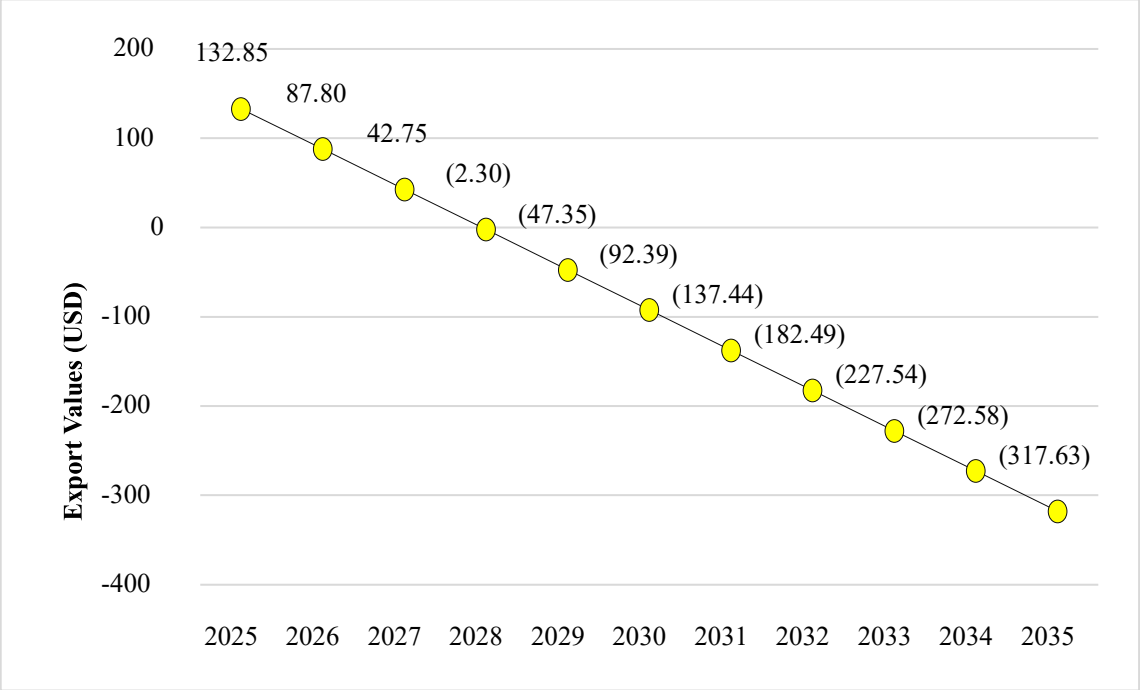
2033	-227.54
2034	-272.58
2035	-317.63

The projection from 2025 to 2035 indicates a decline. The value is high at 132.85 million USD in 2025, then drops sharply to 87.80 million USD in 2026 and further to 42.75 million USD in 2027. In 2028, it turns negative at -2.30 million USD, signifying a shift from profit to loss. Subsequently, the losses grow each year, reaching 317.63 million USD by 2035. The substantial decline shown in Table 1.6.1 occurs because the linear regression model follows the historical trend of the data. In the past years, India's citrus peel export values showed negative growth, and linear regression extends this downward pattern into future projections. Since the slope of the regression line is negative, the model estimates that export values will decrease steadily each year, which explains the fall from 132.85 USD million in 2025 to 42.75 USD million in 2027, and eventually to -317.63 USD million by 2035.

Figure 1.6.1: Projected Export Trend of India's Citrus Peel (2025 – 2035)



FINDINGS AND DISCUSSION

This section highlights the main findings from analyzing India's citrus peel export data between 2014 and 2024. The insights are discussed in terms of trend patterns, structural inefficiencies, and other significant factors, all pointing to a potential decline in the future export value (2025 – 2035) of citrus peel exports.

Export Trend and Decline: The export data from 2014 to 2024 show a substantial decline in India's citrus peel exports. The negative CAGR of (-4.52%) in quantity and (-3.17%) in value confirms a steady decrease over time. The mean values (285.25) for quantity and (391.79) for value show the average annual performance, while the high SD (170.31) for quantity (212.21) for value and CV (1.67) for quantity and (1.90) for value indicate strong fluctuations and instability. Overall, the results show both decline and volatility in export performance during this period.

Post-harvest and loss impact significantly contribute to declining exports. Data shows that citrus losses in developing countries are between 25% and 30%, while in developed nations, they range from 5% to 10%. In India, orange losses are estimated at 8.3% to 30.7%. Transportation losses from Nagpur to Delhi vary between 15.6% and 20.7% by truck and 19.2% and 21.9% by train (NRC Citrus; ICAR-CIPHET, 2015).

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The principle of losses is mainly from improper storage, moisture condensation, inadequate ventilation, and heat accumulation. Moreover, mishandling during harvesting and transportation further reduces fruit quality. Since export markets demand high-quality produce, such inefficiencies significantly limit the volume of peel that can be exported. The National Horticulture Board emphasises the importance of precise harvesting, the use of suitable packing materials, and improved marketing systems to maintain fruit quality.

Temperature Management and Climatic Stress: Citrus fruits are non-climacteric and sensitive to temperature changes. Storing them below 10°C can cause chilling injuries. During storage, juice content may increase by up to 16%, and acid levels can rise by 24%, thereby affecting fruit quality and peel characteristics. Climate variability further destabilises production systems. The Indian Meteorological Department noted moisture shortages in Vidarbha and colour break issues related to heat in Punjab's kinnow area. Similar climate instability has affected competitors such as Pakistan, where citrus exports have dropped significantly due to trade and climate disruptions. These issues indicate that climate stress reduces both yield and peel quality, thereby hampering export performance.

India produces about 16.8 million tonnes of citrus each year, representing nearly 10% of global output. Approximately 75% of this is consumed domestically. Industry reports and NCCD estimates suggest that between 15% and 25% of the produce is lost after harvest due to inadequate pre-cooling, inconsistent grading, and fragmented orchard management. This high level of domestic use and post-harvest losses greatly limits the surplus available for export. Despite its strong production capacity, structural inefficiencies hinder India's ability to participate effectively in long-distance export markets.

Disruptions in logistics and sea trade driven by Middle East geopolitical tensions have sharply raised global shipping costs. Container freight rates are now 2.5 to 3 times what they were in early December 2023, with spot rates through the Suez Canal nearly quintupled. Rerouting vessels around the Cape of Good Hope has added up to two weeks of delays. For perishables such as citrus peel, longer transit times increase the risk of spoilage. While shipping companies may benefit from higher freight charges, exporters face increased costs and diminished competitiveness, which directly cuts into export margins.

Regulatory and Pest Impact: Insect pests and diseases greatly affect citrus yield and quality. The Agricultural Pest Act 2026, along with updated Integrated Pest Management (IPM) guidelines, enforces stricter monitoring, promotes the use of biological controls, and limits the use of hazardous pesticides. Although these measures aim for sustainability, they increase compliance burdens for farmers and exporters. Non-compliance with international residue standards can lead to export rejections. Small and marginal farmers may find it financially difficult to adapt to these new regulations. Consequently, this regulatory shift puts short-term pressure on export performance, despite supporting the long-term sustainability of agriculture.

Post Pandemic Assertion: During the year 2021 and 2022 the COVID-19 pandemic has undergone a gradual but impactful rise in domestic citrus fruit demand, largely due to the valuable Vitamin C content it contains. The lockdown coincided precisely the critical harvest period of the Rabi season, so there were severe labour shortages and disrupted inland supply chains due to the mobility restrictions. The reduction in the number bringing to the wholesale markets by 20% of the amount received in the lockdown indicated that even with high demand in the world, India was unable to effectively get its fruit to the borders. Harvest losses remained large, ranging between 15 - 25%, because it did not have fungicide-management lines needed in the high-quality export markets.

Limitations of the Study

This study relies on secondary trade data and linear regression forecasting, which assumes a consistent trend. External factors like policy reforms, technological progress, or a global trade recovery could influence future results.

CONCLUSION

The study indicates a substantial decline in India's citrus peel exports, with the trend likely to continue if current conditions remain unchanged. Although citrus production is sturdy, export performance faces challenges

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including post-harvest losses, inadequate infrastructure, climate stress, pests, high shipping costs, and strong domestic demand. Enhancing storage, management, and value-added processing is crucial to stabilising the industry.

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