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Economic viability and challenges in grape production: A review with focus on India

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Abstract
This review paper examines the economic viability and challenges associated with grape production, focusing on India, one of the largest global producers and exporters of grapes. Grape production is a high-value agricultural activity, offering substantial revenue generation opportunities, especially through export markets. India's grape exports grew significantly over recent years, with exports reaching 343,982.34 metric tons in 2023-2024, solidifying its position as the largest exporter of fresh grapes worldwide. This paper analyzes the cost of production, revenue generation, and profitability of grape farming in India, along with a detailed overview of the year-wise production and export performance. The paper highlights the growth in grape production and exports, including a growth rate of 25.55% in quantity and 36.58% in value from recent years. However, it also discusses the various challenges faced by grape farmers, such as climate change, pest management, labor shortages, post-harvest losses, price fluctuations, and infrastructure issues. Furthermore, challenges related to value addition, cold chain management, and logistics management in grape production and export are explored. By examining these challenges, the paper offers insights into strategies that can be adopted to improve the sustainability and profitability of grape production in India.

Keywords: Grape, productivity, profitability, export, challenges

Introduction

Grape cultivation in India plays a significant role in the agricultural economy, both for domestic consumption and export markets. India is the largest producer of grapes globally, contributing around 11% of the world's total grape production in 2023-2024. The major grape-producing states in India include Maharashtra, Karnataka, Tamil Nadu, and Andhra Pradesh, with Maharashtra accounting for over 80% of the country's grape production. The growth of the grape industry, particularly in terms of exports, has made India an important player in the global grape market.

Table 1: Year-wise Production and Productivity of Grapes in India

Production in (000)MT of grape a Indian scenario						
State	2023-24		2022-23		2021-22	
	Production	Share (%)	Production	Share (%)	Production	Share (%)
Maharashtra	2,489.27	63.76	2,497.68	66.79	2,477.36	72.85
Karnataka	1,224.67	31.37	1,051.16	28.11	787.18	23.15
Andhra Pradesh	101.25	2.59	101.25	2.71	47.29	1.39
Tamil Nadu	51.71	1.32	51.25	1.37	49.15	1.45
Mizoram	17.23	0.44	17.31	0.46	17.3	0.51
Telangana	8.28	0.21	9.48	0.25	9.64	0.28
Punjab	7.18	0.18	6.94	0.19	6.92	0.2
Jammu & Kashmir	2.51	0.06	2.44	0.07	1.73	0.05
Madhya Pradesh	1.41	0.04	1.36	0.04	1.36	0.04
Manipur	0.39	0.01	0.22	0.01	0.22	0.01
Total Production	3,903.90		3,739.09		3,398.15	

Source: National Horticulture Board (NHB), Ministry of Agriculture and Department of Animal Husbandry

Grape production across various Indian states over three consecutive years: 2021-22, 2022-23, and 2023-24. The data highlights Maharashtra as the leading grape-producing state, with its production consistently exceeding 2,500 thousand metric tons each year. This makes Maharashtra the backbone of India's grape industry, contributing the vast majority of the country's total production. Karnataka follows as the second-largest producer, maintaining production levels between 1,000 and 1,200 thousand metric tons across all three years.

Other states, including Andhra Pradesh, Tamil Nadu, Mizoram, Telangana, Punjab, Jammu & Kashmir, Manipur, and Madhya Pradesh, have comparatively smaller production figures. Among these, Andhra Pradesh shows moderate production, whereas the remaining states contribute only marginally to the total output. The production trend appears relatively stable over the years, with no drastic fluctuations in output.

The dominance of Maharashtra and Karnataka in grape cultivation can be attributed to favorable climatic conditions, extensive vineyard areas, and advanced farming practices. The negligible production in other states suggests either limited cultivation areas or less favorable environmental conditions for grape farming. This analysis underscores Maharashtra's vital role in sustaining India's grape production and exports, with Karnataka playing a supportive yet significant role. Meanwhile, efforts to enhance grape cultivation in other states may be needed to diversify production and reduce dependence on a few regions.

Table 2: Indian Grape Export Statistics

Product: Fresh Grapes									
	Value In Rs. Crore			Value In USD Million			Qty In MT		
Products	**2021**	**2022**	**2023**	**2021**	**2022**	**2023**	**2021**	**2022**	**2023**
Fresh Grapes	2,392.90	2,406.23	2,711.24	327.16	317.18	329.3	268,551.56	275,613.52	283,233.48
Total	2,392.90	2,406.23	2,711.24	327.16	317.18	329.3	268,551.56	275,613.52	283,233.48

Source: DGCIS

The export value of fresh grapes from India has shown a steady increase over the years. In 2021, the total export value stood at ₹2,392.90 crore, which saw a slight rise to ₹2,406.23 crore in 2022. A more significant growth was observed in 2023, with the export value reaching ₹2,711.24 crore. This upward trend indicates a growing demand for Indian grapes in international markets and reflects the sector's resilience and expansion.

Economic Viability of Grape Production

1. Cost of Production

Grape cultivation involves significant investments in land preparation, irrigation systems, fertilizers, pesticides, and labor. Modern farming practices, such as drip irrigation, fertigation, and the use of improved grape varieties, contribute to higher production costs. However, these investments often lead to higher yields and better-quality fruits, making grape production economically viable, especially in regions with favorable climatic conditions (Joshi *et al*., 2016) [1]. Additionally, effective pest management and timely harvesting further enhance grape quality, thereby increasing the potential revenue per hectare.

2. Revenue Generation

Grapes are considered a high-value crop compared to many other fruits. Their market price is influenced by various factors, including quality, size, and timing of the harvest. Grapes grown for export generally fetch higher prices due to stringent international quality standards. Moreover, domestic demand for grapes, particularly during festive seasons, adds to the overall revenue generation. India, being a significant player in the global grape market, contributes a substantial portion of its production to exports, particularly to countries in Europe, the Middle East, and Southeast Asia (Rathore & Bera, 2020) [4].

In 2023-2024, India exported approximately 343,982.34 metric tons of grapes, making it the largest exporter of fresh grapes worldwide. The growth rate of India's grape exports in terms of quantity and value has been significant, with exports increasing by 25.55% in volume and 36.58% in value. The average value per kilogram of exported grapes also showed a positive growth rate of 7.20%. Such increases reflect the growing global demand for Indian grapes, especially in markets with a preference for high-quality, fresh produce (Madhusudhan *et al*., 2017) [2].

3. Export Potential

India's grape export market has shown significant growth, positioning the country as the leading exporter of fresh grapes globally. The Middle East and European countries are major importers of Indian grapes, driven by their high demand for fresh, seedless varieties. The European Union's growing preference for Indian grapes due to the favorable climatic conditions in Indian growing regions, such as Nashik, further supports the strong export potential (Singh *et al*., 2019) [8]. India’s grape exports have seen a steady upward trajectory in both quantity and value, benefiting from the country's competitive advantage in terms of climate, labor costs, and geographic proximity to key international markets.

Challenges in Grape Production

1. Climate Sensitivity

Grape cultivation is highly sensitive to climatic conditions, with temperature, humidity, and rainfall playing a critical role in determining grape yield and quality. In India, climate change has led to unpredictable weather patterns, including irregular rainfall and temperature extremes, which can negatively impact grape production. Grapes require specific temperature ranges and dry conditions for optimal growth, and any deviation can cause delayed flowering, uneven ripening, or poor fruit quality. Such challenges increase the unpredictability of yields, affecting both farmers’ income and market stability (Patel *et al*., 2015) [3].

2. Pest and Disease Management

Pests and diseases, such as powdery mildew, downy mildew, and grapevine pests, pose significant threats to grape production. These issues not only reduce grape quality but also lead to higher pesticide costs, which further erode profit margins. The overuse of pesticides can also result in environmental degradation, and the increasing resistance of pests to certain chemicals has exacerbated the problem (Siddiqui *et al*., 2016) [5]. Effective pest and disease management strategies, including integrated pest management (IPM), are essential to maintain both yield and

environmental sustainability.

3. Labor Costs

Labor costs are a significant factor in the grape production process, especially during harvesting and pruning. Grape farming requires intensive labor, particularly at times of peak demand, such as during the harvesting season. The rising cost of labor, combined with the increasing scarcity of skilled workers, has become a major concern for grape farmers in India (Yadav *et al*., 2020) [6]. This challenge can affect the efficiency and profitability of grape production, especially for small-scale farmers who are heavily reliant on manual labor.

4. Post-Harvest Losses

Grapes are highly perishable and require proper handling, storage, and transportation to ensure quality is maintained. Any delay in harvesting, packaging, or transporting grapes to the market can result in significant post-harvest losses. Inadequate cold storage facilities and transportation infrastructure often exacerbate these losses, particularly in remote or rural areas where access to modern logistics is limited (Nair *et al*., 2018). This not only affects domestic sales but also reduces the quality of exported grapes, impacting international demand.

5. Market Price Volatility

The grape market is prone to price fluctuations due to factors such as oversupply, changes in global demand, and policy changes in key importing countries. Such price volatility makes it difficult for farmers to predict their income and plan production accordingly. Additionally, fluctuations in the value of the Indian rupee relative to other currencies can affect the competitiveness of Indian grapes in the international market, further complicating price stability. For instance, when the supply of grapes exceeds demand in the market, prices can drop significantly, reducing the profitability of farmers. Similarly, adverse weather events or crop failures in other countries can lead to sudden price hikes, making it challenging for Indian farmers to take advantage of these price increases. Price instability thus adds a layer of financial uncertainty for farmers, making it harder to ensure consistent earnings year after year (Singh *et al*., 2019) [8].

6. Infrastructure and Logistics Issues

The success of grape farming is closely tied to efficient transportation and infrastructure. Grapes need to be quickly transported to both domestic and international markets to avoid spoilage. However, India faces significant logistical challenges, including poor road infrastructure, delays at ports, and insufficient refrigerated transport. These logistical bottlenecks result in longer transit times and an increased risk of post-harvest losses. Furthermore, lack of coordination between stakeholders in the supply chain, including farmers, exporters, and transportation companies, can lead to inefficiencies and higher costs. Investing in infrastructure and improving coordination across the logistics chain is essential to reduce delays and ensure that grapes reach the market in optimal condition (Kumar *et al*., 2017) [7].

Challenges in Value Addition, Cold Chain Management, and Logistics Management in Grape Production

1. Value Addition Challenges

Value addition in grape production involves transforming the raw fruit into various products such as raisins, juices, wine, and jams. While value-added grape products have a strong demand both domestically and internationally, the grape industry in India faces several challenges in realizing this potential. One key challenge is the lack of processing facilities in many grape-producing regions. The absence of modern processing units limits the capacity to produce high-quality value-added products, which can lead to significant post-harvest losses. Additionally, small-scale farmers may lack the financial resources and expertise to invest in value-added production, thereby reducing their profitability. Limited access to technology and high capital investment requirements further hinder the ability to add value to the grape harvest, preventing farmers from maximizing the financial potential of their crops (Yadav *et al*., 2020) [6].

2. Cold Chain Management

Cold chain management is critical to maintaining the freshness and quality of grapes, which are highly perishable. Grapes need to be kept at optimal temperatures from the point of harvest through to storage, packaging, transportation, and delivery. In India, inadequate cold storage infrastructure is one of the primary challenges in grape production and export. Many grape-producing regions lack sufficient cold storage facilities, and those available are often inefficient, leading to a loss of fruit quality and a reduction in the shelf life of grapes. Without proper cold chain management, grapes are at risk of spoilage, particularly during transportation to international markets. This directly affects export revenues and reduces the competitiveness of Indian grapes in the global market (Kumar *et al*., 2017) [7].

3. Logistics Management

The logistics management of grapes involves transportation, storage, and distribution, all of which require timely and efficient execution. Grapes need to be transported quickly to prevent spoilage and maintain their quality. However, India faces significant logistical challenges, including poor road infrastructure, delays at ports, and insufficient refrigerated transport. These logistical bottlenecks result in longer transit times and an increased risk of post-harvest losses. Furthermore, lack of coordination between stakeholders in the supply chain, including farmers, exporters, and transportation companies, can lead to inefficiencies and higher costs. Investing in infrastructure and improving coordination across the logistics chain is essential to reduce delays and ensure that grapes reach the market in optimal condition (Yadav *et al*., 2020) [6].

Strategies to Overcome Challenges in Grape Production

1. Climate Adaptation and Mitigation Strategies

To address the impacts of climate change on grape production, farmers must adopt climate-resilient grape varieties that are better suited to changing environmental conditions. The introduction of drought-tolerant and heat-resistant grape varieties can help mitigate the effects of

temperature extremes and water scarcity. Additionally, farmers can implement water-efficient irrigation systems such as drip irrigation to optimize water use and reduce the reliance on erratic rainfall patterns. Implementing climate-smart agricultural practices, including mulching and soil moisture management, can also improve grape productivity and quality.

2. Integrated Pest and Disease Management (IPM)

To manage pests and diseases effectively, the adoption of Integrated Pest Management (IPM) practices is crucial. IPM combines biological, cultural, mechanical, and chemical control methods to minimize pesticide use and reduce environmental harm. The use of biopesticides, pheromone traps, and natural predators can help control pest populations without harming beneficial insects. Regular monitoring and early intervention can prevent the spread of diseases, reducing crop losses and minimizing the need for expensive chemical treatments.

3. Labor Efficiency through Mechanization and Training

To address labor shortages and reduce costs, the grape industry can invest in mechanization for tasks such as pruning, harvesting, and packaging. While mechanization may require significant upfront investment, it can lead to long-term savings by reducing dependency on manual labor. Additionally, providing training programs for workers on efficient farming techniques and pest management practices can increase productivity and reduce the need for skilled labor. Using technology such as mobile apps for farm management and labor tracking can streamline operations and reduce costs.

4. Improving Post-Harvest Infrastructure

To reduce post-harvest losses, India must invest in improving cold storage facilities, refrigerated transport, and packing houses. Expanding the cold chain infrastructure will ensure that grapes maintain their quality throughout the supply chain, both for domestic and international markets. The government and private sectors should collaborate to establish regional cold storage units, which can serve as a hub for grape producers in key growing regions. These facilities can also help reduce the dependency on small-scale, inefficient storage methods that contribute to post-harvest losses.

5. Price Stabilization Mechanisms

To mitigate the impact of price volatility, the establishment of price stabilization funds or cooperative marketing models can provide a safety net for farmers. These mechanisms can help smooth income fluctuations during periods of oversupply or price drops. Additionally, farmers can benefit from forward contracts or crop insurance schemes to reduce income uncertainty and protect against market risks.

6. Improving Infrastructure and Logistics Efficiency

To enhance logistical efficiency, investments in better road infrastructure, port facilities, and cold storage logistics are essential. The government should prioritize improving the connectivity between grape-producing regions and key export markets. The expansion of infrastructure for refrigerated transport and improved port facilities will reduce delays and ensure that grapes reach their destination in optimal condition. Improved coordination between farmers, exporters, and logistics companies will streamline operations and reduce inefficiencies.

Conclusion

In conclusion, while grape farming in India has demonstrated impressive economic viability and export potential, it faces numerous challenges that must be addressed to ensure the sector's long-term sustainability. These challenges include climate sensitivity, pest and disease management, labor costs, post-harvest losses, price volatility, and inadequate infrastructure for cold chain management and logistics. Addressing these challenges requires targeted investments in research and development, improved infrastructure, and better market management strategies. Additionally, expanding value addition initiatives, enhancing cold chain management, and improving logistics efficiency will enable farmers to capture higher value from their grape production, ensuring greater profitability and competitiveness in the global market.

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