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SOCIO-ECONOMIC DETERMINANTS AND SUPPLY CHAIN CONSTRAINTS IN GRAPE CULTIVATION

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ABSTRACT
Grape cultivation is an important horticultural enterprise in Southern Tamil Nadu, where efficient supply chain management is essential for improving farmers' income and reducing marketing inefficiencies. The present study was conducted during 2025 to evaluate the socio-economic factors determining grape cultivation and to identify the major constraints encountered by stakeholders in the grape supply chain. Primary data were collected from 210 respondents, comprising 120 grape growers, 30 commission agents, 30 wholesalers and 30 retailers, using a structured and pre-tested questionnaire. Multiple regression analysis was employed to identify the determinants of grape cultivation, while Garrett's ranking technique was used to prioritize stakeholder constraints. The results revealed that education, landholding size and farming experience significantly and positively influenced grape production and net returns, whereas age and annual income were not statistically significant. Garrett's ranking showed that pest and disease incidence, delayed payment and inadequate storage facilities were the major constraints faced by grape growers, while price fluctuation and payment delays were the dominant constraints among market intermediaries. The study concluded that strengthening farmer education, extension support, market infrastructure and collective marketing mechanisms would enhance supply chain efficiency and improve the profitability and sustainability of grape cultivation in Southern Tamil Nadu.

KEYWORDS: Collective Marketing, Grape cultivation, Garrett Ranking, Market Intermediaries, Multiple Regression.

INTRODUCTION
Grapes (Vitis vinifera L.) are one of the world's most important horticultural crops because of their high economic value, export potential and significant contribution to farmers' income. Owing to their highly perishable nature, the profitability of grape cultivation depends not only on production but also on the efficiency of the supply chain, which includes harvesting, grading, packaging, storage, transportation and marketing. An efficient supply chain minimizes post-harvest losses, maintains fruit quality, improves market access and enhances farmers' price realization, thereby strengthening the competitiveness of the grape industry (FAO, 2025; RBI, 2024).

Global grape production reaches approximately 77.7 million metric tonnes in 2024, with China ranking first, followed by Italy, Spain, the United States, France and Turkey, while India ranks seventh among the world's grape-producing countries (FAO, 2025). In India, grape cultivation continues to expand because of improved irrigation, production technologies and post-harvest management. During 2024–2025, grapes occupy about 179.62 thousand hectares with a production of approximately 3.36 million tonnes. Maharashtra remains the leading producer, followed by Karnataka, Andhra Pradesh and Tamil Nadu. India also exports 271,253.89 metric tonnes of fresh grapes valued at USD 353.54 million during 2024–2025, demonstrating the crop's importance in the national economy (NHB, 2025; APEDA, 2025).

In Tamil Nadu, grape cultivation is concentrated mainly in the Southern Zone, particularly in Theni district, where favourable climatic conditions, irrigation facilities and improved cultivation practices support higher productivity than the state average. Despite these advantages, grape growers continue to face pest and disease incidence, inadequate storage facilities, price fluctuations, delayed payments and marketing inefficiencies, which reduce farm profitability and weaken supply chain performance (Government of Tamil Nadu, 2025; BIM, 2019).

Earlier studies primarily focus on grape production, socio-economic characteristics and production constraints. Gotyal et al., (2010) identify technical, financial and marketing constraints and emphasize cooperative marketing and improved market information systems. Babybowna (2018) reports inadequate market facilities, low prices, high transportation costs and poor cold storage infrastructure as major challenges. Vanetha (2022) demonstrates that grape growers' associations strengthen farmers' cooperation, knowledge sharing and marketing participation but mainly examines organizational functioning. Pradhen et al., (2024) report that education, landholding and income significantly influence grape cultivation but do not evaluate supply chain efficiency or stakeholder-specific marketing constraints.

Existing literature provides valuable information on grape production and farmer-related issues but offers limited evidence on the integrated functioning of the grape supply chain involving farmers, commission agents, wholesalers and retailers. Comprehensive assessments of marketing channels, socio-economic determinants and stakeholder-specific constraints remain inadequate, particularly in the Southern Zone of Tamil Nadu. The present study is based on the hypothesis that socio-economic characteristics significantly influence grape cultivation performance and that supply chain stakeholders experience distinct marketing constraints affecting overall supply chain efficiency. Therefore, the study adopts multiple regression analysis to identify socio-economic determinants and Garrett's ranking technique to prioritize stakeholder constraints. This approach provides evidence for improving market efficiency, strengthening stakeholder coordination and enhancing the profitability and sustainability of grape cultivation in Southern Tamil Nadu.

METHODOLOGY

The present study was conducted in Theni District of Tamil Nadu, which was purposively selected because it is the major grape-producing district in the state. Among the eight administrative blocks, Cumbum, Uthamapalayam and Chinnamanur were purposively selected based on their larger area under grape cultivation, higher production and active participation in grape marketing. The sampling frame was prepared using the list of grape growers obtained from the Assistant Directorate of Horticulture. The respondents comprised grape growers, commission agents, wholesalers and retailers involved in the grape supply chain. The sample size was determined using Slovin's formula following the procedure adopted by Kuwornu et al., (2023).

$$n = \frac{N}{(1 + N(e^2))}$$

Where, n = sample size, N = total population e = margin of error

Primary data were collected during September and October 2025 using a structured and pre-tested questionnaire. Information on respondents' socio-economic characteristics, factors determining grape cultivation and supply chain constraints was collected. A total of 210 respondents comprising 120 grape growers, 30 commission agents, 30 wholesalers and 30 retailers were selected.

Multiple regression analysis was employed to estimate the socio-economic factors determining grape cultivation. The explanatory variables included age (X_1), education (X_2), landholding size (X_3), farming experience (X_4) and annual income (X_5). The selection of these variables was based on the studies of Okpolu and Onele (2017), Shinde (2024) and Jadhav et al., (2025). The regression model used was:

$$Y=\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon$$

Where, Y=Grape cultivation (or productivity), β_0 = Intercept, β_1–β_5= Regression coefficients, X1=Age, X2 =Education, X3= Landholding size, X4 = Farming experience, X5= Annual income, ε= Error term.

Garrett's ranking technique was employed to identify and prioritize the constraints encountered by grape growers, commission agents, wholesalers and retailers. The assigned ranks were converted into percent positions and Garrett scores using the standard Garrett conversion table. The total and mean Garrett scores were computed to rank the constraints (Vasanthi and Angadi, 2020; Yarazari et al., 2022; Pradhan et al., 2024; Babar and Satpute, 2025; Satpathy et al., 2025).

$$\text{Per cent Position} = \frac{100(R_{ij} - 0{\cdot}5)}{N_j}$$

Where, Rij = rank assigned by the jth respondent for the ith constraint, Nj = total number of constraints ranked by the jth respondent.

RESULTS

Socio-economic determinants of grape production

Multiple regression analysis was carried out to identify the socio-economic factors influencing grape production and returns among the sample growers (Table 1). The results revealed that education level, total landholding and farming experience significantly and positively influenced both grape production and net returns, whereas age and annual income were not statistically significant. Among the explanatory variables, total landholding exerted the strongest positive influence on grape production (β = 1,167.287; $p < 0.001$) as well as net returns (β = Rs. 58,933.524; $p = 0.001$), indicating that farmers with larger operational holdings achieved higher productivity and profitability. Education level also had a significant positive effect on grape production (β = 1,751.962; $p = 0.027$) and net returns (β = Rs. 99,974.686; $p = 0.014$), suggesting that educated farmers were more likely to adopt improved cultivation practices, utilize production technologies efficiently and make better marketing decisions. Similarly, farming experience significantly enhanced both production (β = 248.386; $p = 0.005$) and net returns (β = Rs. 8,924.142; $p = 0.044$), indicating that experienced growers possessed better technical knowledge and management skills that contributed to higher productivity and income.

Table 1. Multiple regression estimates significant socio-economic factors influencing grape production and net returns.

Variable	Regression Coefficient	Standard Error	t - value	p - value
Education level	1,751.962	768.879	2.279	0.027
Total landholdings	1,167.287	331.801	3.518	<0.001
Farming experience	248.386	83.945	2.959	0.005
Education level	99,974.686	39,597.056	2.525	0.014
Total landholdings	58,933.524	17,087.648	3.449	0.001
Farming experience	8,924.142	4,323.139	2.064	0.044

Garrett's ranking technique was employed to identify the constraints perceived by grape growers in cultivation and marketing (Table 2). Pest and disease incidence ranked first, with the highest mean Garrett score of 67.00, followed by delayed payment from buyers (55.40) and lack of storage facilities (44.40). Price fluctuation (42.40) and low-price fixation (30.00) were ranked fourth and fifth, respectively, while high transportation cost (21.80) and high commission charges (19.30) were perceived as comparatively less severe constraints.

Table 2. Constraints faced by grape growers in cultivation and marketing

Constraints	Total Garett Score	Mean Garett Score	Final Rank
Peat and Diseases	8040	67.00	I
Delayed Payment	6648	55.40	II
Lack of Storage	5328	44.40	III
Price Fluctuation	5088	42.40	IV
Low Price Fixation	3600	30.00	V
High Transportation Cost	2616	21.80	VI
High Commission	2316	19.30	VII

The constraints perceived by commission agents in grape marketing are presented in (Table 3). Price fluctuation in the grape market was ranked as the most severe constraint, with a mean Garrett score of 70.93, followed by delayed payments from buyers (68.20) and high post-harvest losses arising from the perishable nature of grapes (64.73). Inadequate cold storage facilities (60.50), high transportation and handling costs (56.13) and inconsistent quality and supply of grapes (50.77) were ranked as comparatively less pressing constraints

Table 3. Constraints faced by commission agents in the grape supply chain

Constraints	Total Garrett Score	Mean Garrett Score	Final Rank
Price fluctuations in the grape market	2,128	70.93	I
Delayed payments from buyers	2,046	68.20	II
High post- harvest losses due to the perishable nature of grapes	1,942	64.73	III
Inadequate cold storage facilities	1,815	60.50	IV
High transportation and handling costs	1,684	56.13	V
Inconsistent quality and supply of grapes	1,523	50.77	VI

Among wholesalers, delayed payments from retailers was identified as the most severe constraint, with a mean Garrett score of 70.50, followed by high labour costs for handling and packaging (67.27) and inadequate grading and packaging facilities (64.27) (Table 5). Limited access to institutional credit (61.37), intense competition among wholesalers (56.80) and limited access to reliable market information (52.20) were ranked fourth, fifth and sixth, respectively.

Table 4. Constraints faced by wholesalers in the grape supply chain.

Constraint	Total Garrett Score	Mean Garrett Score	Final Rank
Delayed payments from retailers	2,115	70.50	I
High labour costs for handling and packaging	2,018	67.27	II
Inadequate grading and packaging facilities	1,928	64.27	III
Limited access to institutional credit	1,841	61.37	IV
Intense competition among wholesalers	1,704	56.80	V
Limited access to reliable market information	1,566	52.20	VI

Table 5 shows that high spoilage due to the perishable nature of grapes was the most severe constraint faced by retailers, with a mean Garrett score of 71.23, followed by price fluctuation in the retail market (68.03) and fluctuating consumer demand (64.93). Limited storage and refrigeration facilities (61.20), high handling and packaging costs (56.60) and delayed supply from wholesalers (51.90) were ranked as relatively minor constraints.

Table 5. Constraints faced by retailers in the grape supply chain.

Constraint	Total Garett Score	Mean Garett Score	Final Rank
High spoilage due to perishable nature of grapes	2,137	71.23	I
Price fluctuations in the retail market	2,041	68.03	II
Fluctuating consumer demand	1,948	64.93	III
Limited storage and refrigeration facilities	1,836	61.20	IV
High handling and packaging costs	1,698	56.60	V
Delayed supply from wholesalers	1,557	51.90	VI

DISCUSSION

These findings of factors influencing grape cultivation are consistent with Pradhan and Barker (2024), who report that landholding, education and market orientation are the major socio-economic factors influencing grape productivity and farmers' performance in Nashik district. Similarly, Vanetha (2022) observes that experienced grape growers associated with the Grape Growers Association in Theni district demonstrate better technical decision-making, stronger market participation and improved income through collective action. Babybowna (2018) also reports that limited landholding and inadequate marketing infrastructure reduce the profitability of grape growers in Dindigul district. The present findings indicate that improvements in education, technical knowledge, farming experience and land resources enhance grape productivity and profitability. These findings emphasize the need to strengthen farmer training, scientific cultivation practices and market literacy to improve farmers' competitiveness in the grape supply chain.

The predominance of pest and disease incidence as the major constraint agrees with Gotyal et al., (2010), who identify non-availability of grape experts and plant protection problems as major technical constraints among grape growers. Likewise, Yarazari et al., (2022) report that inadequate processing and storage facilities, limited technical guidance, poor market access and low prices adversely affect grape production and marketing efficiency. Nikam et al., (2014) similarly observe that pest and disease incidence, difficulties in adopting recommended cultivation practices and the absence of a government price policy constrain grape production and marketing. Babybowna (2018) also reports inadequate market facilities, low prices and an unorganized marketing system, supporting the present findings on payment delays and price-related constraints. The comparatively lower importance of transportation cost and commission charges suggests that the Theni grape belt benefits from better market connectivity than many grape-growing regions. These findings emphasize the need for effective pest surveillance, timely extension services and stronger Farmer Producer Organizations to improve collective marketing and price negotiation, consistent with Vanetha (2022).

The ranking of price fluctuation and delayed payment as the major constraints faced by commission agents supports the findings of Gotyal et al., (2010) and Babybowna (2018), who emphasize the absence of an organized pricing mechanism in grape markets. Yarazari et al., (2022) and Nikam et al., (2014) also identify inadequate storage facilities, low prices and poor market infrastructure as major marketing constraints. The prominence of post-harvest losses and inadequate cold storage reflects the perishable nature of grapes and indicates the need for improved cold-chain facilities, market information systems and price stabilization measures.

The prominence of delayed payments and high handling costs among wholesalers is consistent with the marketing constraints reported for growers and commission agents, indicating that payment inefficiencies persist throughout the grape supply chain. Inadequate grading and packaging facilities agree with Babybowna (2018), who reports that poor market facilities reduce grape marketing efficiency in Tamil Nadu. The comparatively lower importance of limited market information suggests that wholesalers possess better market knowledge than growers. These findings highlight the need for organized wholesale infrastructure, standardized grading facilities and efficient payment mechanisms, supporting the regulated marketing system recommended by Gotyal et al., (2010).

The predominance of spoilage as the major retail-level constraint confirms the perishable nature of grapes and is consistent with Babybowna (2018), who reports inadequate cold-storage infrastructure among grape stakeholders in Tamil Nadu. Fluctuating consumer demand and retail price variability limit retailers' ability to manage inventories efficiently. The comparatively lower severity of delayed supply from wholesalers indicates better coordination between wholesalers and retailers. These findings emphasize the need for low-cost storage technologies, consumer demand forecasting and improved retail management practices. Strengthening these interventions, together with collective marketing initiatives recommended by Vanetha (2022), is likely to improve overall grape supply chain efficiency.

CONCLUSION

The study establishes that education, landholding size and farming experience are the principal socio-economic determinants of grape production and profitability. It also demonstrates that production-related constraints, particularly pest and disease incidence, together with marketing problems such as delayed payments, price fluctuations and inadequate storage facilities, reduce the efficiency of the grape supply chain. These findings indicate that improving

farmers' technical knowledge, strengthening extension services, promoting collective marketing and developing post-harvest infrastructure can enhance productivity, profitability and market performance. Greater coordination among growers and market intermediaries, supported by timely market information and improved storage and marketing facilities, is essential for building a more efficient and sustainable grape supply chain in Southern Tamil Nadu.

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