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Production and marketing challenges faced by sugarcane cultivators in Namakkal district

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Abstract
Sugarcane cultivation remains an integral pillar of agricultural livelihood in Tamil Nadu, particularly in Namakkal District. However, sugarcane farmers here face mounting production and marketing constraints that hinder productivity and profitability. This study adopts a mixed-method approach combining econometric modelling and qualitative inquiry to assess the agronomic, economic, and institutional barriers facing 250 farmers across five taluks. Findings reveal that red loamy soils, erratic water availability, high labour costs, and inefficient cooperative mills critically affect yields and returns. Marketing limitations such as delayed payments, price volatility, and limited access to formal markets further disincentivize investment in sugarcane. Regression analysis confirms irrigation, fertilizer, and seed as significant inputs, while Garrett ranking and thematic coding outline infrastructure and policy gaps. The study concludes by recommending integrated value-chain interventions, mechanization, market reform, and cooperative restructuring.

Keywords: Sugarcane cultivation, marketing challenges, production efficiency, regression analysis, Tamil Nadu, cooperative mills

1. Introduction
Agriculture plays a vital role in India's economy, contributing significantly to employment, food security, and rural development. Among the various agricultural commodities, sugarcane occupies a prominent place due to its multifaceted economic importance. As a key cash crop, sugarcane supports not just millions of farming households but also a wide range of agro-industrial activities such as sugar production, ethanol manufacturing, bio-composting, and jaggery processing. India is the second-largest producer of sugarcane in the world after Brazil, and Tamil Nadu is one of the top-performing states in terms of productivity and sugar recovery, despite its semi-arid climate and seasonal water constraints.

In Tamil Nadu, Namakkal District is recognized as an important sugarcane-growing region within the Kongu Nadu zone. Known for its agricultural dynamism and industrial base (particularly poultry and transport-related industries), Namakkal has a total cropped area of approximately 336,700 hectares, of which around 60,900 hectares are under irrigation and the rest rely on rainfed systems. Sugarcane is cultivated predominantly in regions like Kabilarmalai, Pallipalayam, Mohanur, Tiruchengode, and Paramathi Velur. These regions form the agrarian backbone of the district, where sugarcane is not only a means of livelihood but also a cultural and seasonal indicator of prosperity.

Despite its significance, sugarcane cultivation in Namakkal has come under increasing pressure in recent years. The average yield of about 37 tons per acre (~91.5 t/ha) in the district is significantly below the state average, reflecting the multifaceted challenges faced by cultivators. These challenges include high input costs, unreliable irrigation, labour shortages, pest infestations, and most notably, inefficiencies in cooperative sugar mills. For instance, the Mohanur Cooperative Mill, a major processing facility in the region, has not functioned at full capacity since 2011-12 due to ongoing financial and technological constraints. These issues disrupt not just the value chain but also farmer morale, confidence, and long-term investment capacity.

In terms of agronomic constraints, the district faces substantial variability in rainfall, poor soil moisture retention due to red loamy soils, and low adoption of precision irrigation methods like drip or sprinkler systems. Although state and central governments have

promoted the Sustainable Sugarcane Initiative (SSI) and other integrated water-saving practices, uptake remains low due to high initial costs, inadequate training, and limited follow-up support. Labour costs are another pressing concern. Tamil Nadu's wage rates for agricultural labour are estimated to be 2-3 times higher than in sugarcane-dominant states like Uttar Pradesh, making the crop economically unsustainable for small and marginal farmers unless yields are significantly improved or prices are guaranteed.

On the marketing front, challenges are equally severe. Most farmers are tied to cooperative mills, which often delay payments by several months due to poor cash flow and underutilized capacity. The Fair and Remunerative Price (FRP) mechanism set by the central government is often not fully realized in practice due to deductions, inefficiencies, and price volatility in the downstream sugar market. With limited access to regulated Agricultural Produce Market Committees (APMCs) or private procurement channels, farmers are forced to sell through intermediaries, losing substantial margins in the process. Many also lack cold storage or on-farm jaggery units that would allow them to hold or process cane for better value realization.

In response to these systemic problems, some farmers in Namakkal are exploring decentralized and alternative models, such as converting cane into jaggery on-farm or within the village, thereby avoiding mill dependency and payment delays. The state government has supported this trend by offering subsidies (up to ₹1 lakh) for establishing mould jaggery units in high-production blocks. However, without organized marketing systems, jaggery producers also face issues related to quality grading, storage, and price negotiation.

Over time, this situation has created a structural shift in sugarcane farming in Namakkal-what was once a well-integrated farm-to-mill system is now a fractured ecosystem with rising farmer discontent, variable cultivation practices, and inconsistent processing channels. Traditional sugarcane farming is thus at a developmental crossroads, facing competing forces of modernization, sustainability, and economic necessity. Policymakers, researchers, and institutions are therefore challenged to reimagine the sugarcane value chain through the lenses of productivity, profitability, and participatory planning.

Against this backdrop, the present study seeks to comprehensively analyze the production and marketing challenges faced by sugarcane cultivators in Namakkal District. Using a mixed-method research approach involving structured surveys, focus group discussions, econometric modeling (Cobb-Douglas regression), and constraint ranking (Garrett method), the study aims to quantify the constraints, trace their causes, and suggest actionable interventions for improvement. Unlike prior studies that focused on limited technical aspects or sample sizes, this research integrates agronomic, economic, institutional, and market-related perspectives to offer a holistic view of the problems and prospects of sugarcane cultivation in this important but under-examined region of Tamil Nadu.

2. Literature Review

Balamurugan *et al.* (2021) [1] investigated the barriers to adopting drip irrigation systems in Dharmapuri District of Tamil Nadu. Their study identified that despite awareness about water-saving techniques, several technical issues-such as clogging of drip emitters, rodent damage to pipelines, and lack of access to maintenance services-deterred long-term usage among farmers. The authors concluded that sustained adoption could be improved through hands-on farmer training and after-installation support mechanisms.

Manikandan and Santhoshkumar (2019) [2] evaluated the performance of the Sustainable Sugarcane Initiative (SSI) integrated with drip fertigation techniques in western Tamil Nadu. Their findings demonstrated substantial improvements in both yield and water-use efficiency, particularly when subsurface drip systems were used. However, the study also reported that small and marginal farmers were discouraged by the high initial investment cost, indicating a need for financial incentives and better credit access for scaling adoption.

Jayanthi *et al.* (2023) [3] conducted a case study on production and marketing barriers in southern Tamil Nadu's sugarcane belt. Their research highlighted multiple stress factors such as irregular monsoons, pest outbreaks (notably whitefly and red rot), and delayed payments from sugar mills. Additionally, the absence of regulated markets and inadequate price support mechanisms compounded market instability. The study advocated for robust policy interventions focusing on price assurance and mill restructuring to regain farmer confidence.

Meena *et al.* (2024) [4] explored sugarcane production challenges in Kerala, with a focus on ecological and labor-related constraints. Their study found that wildlife interference, harvest delays, and high dependence on manual labor reduced the efficiency of farm operations. On the marketing side, price fluctuations and the dominance of unregulated procurement systems were identified as major concerns. The authors suggested integrating insurance, mechanization, and regulated procurement infrastructure to enhance resilience.

Roshini and Devraj (2022) [5] examined the economics of jaggery production in Anakapalle, Andhra Pradesh, and its implications for smallholder farmers. They found that jaggery offers a viable alternative to mill-based processing due to its shorter financial cycle and ease of sale in local markets. Nonetheless, the absence of standardized grading, packaging, and long-term storage facilities limited its scalability. The study recommended branding initiatives and farmer cooperatives to improve market outreach and value addition.

Nanthakumaran and Palanisami (2019) [6] analyzed the economic and technical efficiency of irrigation systems among sugarcane farmers across Tamil Nadu. Based on a sample size of 500 farmers using both tank and well irrigation, the study reported high technical efficiency (around 92%) but relatively lower allocative efficiency (70%). This gap was attributed primarily to rising input costs, particularly for water and fertilizers. The authors emphasized the need for advisory services that help optimize input allocation for cost efficiency.

Sharma *et al.* (2020) [7] conducted a cross-regional study examining supply chain constraints in the sugarcane value chain across South India. Their research highlighted systemic delays in mill payments, high cane transportation costs, and the absence of farm-gate procurement systems. They proposed the integration of digital tools such as blockchain to improve transparency, track produce, and eliminate inefficiencies introduced by middlemen and layered logistics.

Kshetri and Voas (2023) [8] focused on blockchain applications in Indian agriculture with a specific emphasis on sugarcane marketing. The study illustrated how blockchain-based platforms could reduce price manipulation and middlemen influence by offering direct farmer-to-buyer

transactions. Pilot implementations in parts of Maharashtra showed increased price transparency and quicker payment cycles, suggesting that similar models could benefit sugarcane farmers in Tamil Nadu and other states.

Thangavel and Arun (2021) [9] analyzed the policy framework of Minimum Support Price (MSP) and Fair and Remunerative Price (FRP) in the sugarcane sector. Their study noted a persistent gap between the FRP announced by the central government and the actual amount disbursed to farmers by mills. The delay in disbursement, combined with weak enforcement of pricing laws, resulted in growing distrust among farmers and reduced long-term investment in sugarcane cultivation.

ICAR-SBI Annual Report (2022) [10] documented the results of field trials in Tamil Nadu on sugarcane varieties tolerant to water stress. The report highlighted that Co 11015 and Co 13014 outperformed traditional varieties like Co 86032 in both yield and resilience under limited irrigation. However, it also observed that the distribution of these improved varieties was delayed due to institutional and supply chain constraints, which restricted timely adoption by farmers.

3. Research Objectives

The research aims to:

1. Quantify agronomic and marketing constraints affecting sugarcane productivity in Namakkal.
2. Analyze input-output efficiency using regression analysis.
3. Evaluate technology adoption and institutional support systems.
4. Recommend policy and structural interventions to enhance yield and market efficiency.

4. Research Gaps

While previous studies highlight irrigation, pest, and market-related constraints in various districts of Tamil Nadu, they are limited in sample size (n < 120) and scope. No comprehensive study has simultaneously modeled both production and marketing challenges in Namakkal using a sample size ≥250 with both econometric and thematic analysis.

5. Significance and Limitations of the Study (150 Words)

This study is significant in offering a comprehensive, district-level assessment of both agronomic and marketing challenges faced by sugarcane cultivators in Namakkal District, Tamil Nadu. By combining quantitative tools such as Cobb-Douglas regression and Garrett ranking with qualitative thematic analysis, the research provides a holistic understanding of the constraints impacting productivity and profitability. The findings can inform policymakers, cooperative mills, and extension agencies in designing targeted interventions such as irrigation support, price stabilization, and mill modernization.

However, the study has certain limitations. It is cross-sectional in nature, capturing data at a single point in time, which may not fully reflect seasonal variations or long-term trends. The research is also geographically limited to five taluks within Namakkal District, which may affect the generalizability of findings to other sugarcane-growing regions. Furthermore, institutional perspectives were captured from a small sample size, which could limit the depth of stakeholder i0nsights.

6. Methodology

6.1 Study Area

Namakkal District lies between 11°00'-11°36' N and 77°40'-78°30' E and covers about 3,420 km². The region has red loamy soils, receives 716-875 mm rainfall annually, and falls under semi-arid agroclimatic conditions. Irrigation is supported by open wells, bore wells, and canals like the Mettur East Bank.

6.2 Sampling

A stratified random sample of 250 farmers from five taluks (Namakkal, Pallipalayam, Mohanur, Tiruchengode, and Kabilarmalai) was chosen to represent irrigated and rainfed farms of various sizes.

6.3 Data Collection

Primary data were collected via structured questionnaires, Likert-based constraint rankings, and focus group discussions with 30 farmers and eight stakeholders. Secondary data were sourced from Krishi Vigyan Kendra, district agriculture offices, and cooperative records.

6.4 Analytical Tools

- Descriptive Statistics
- Cobb-Douglas Regression
- Garrett Ranking Method
- Correlational Market Analysis

7. Discussions

Table 1: Demographic Profile of Sample Sugarcane Farmers (n = 250)

Parameter	Category	Frequency	Percentage (%)
Age	Below 30	18	7.2
	31-45	85	34.0
	46-60	97	38.8
	Above 60	50	20.0
Education	No Formal Education	63	25.2
	Primary	94	37.6
	Secondary & Higher Secondary	72	28.8
	Graduate and above	21	8.4
Farm Size	Marginal (<1 ha)	71	28.4
	Small (1-2 ha)	109	43.6
	Medium (2-4 ha)	52	20.8
	Large (>4 ha)	18	7.2
Type of Irrigation	Rainfed	113	45.2
	Irrigated	137	54.8

Most sugarcane farmers are middle-aged (46-60 years) with small to marginal landholdings. More than 45% still rely on rainfed systems, underlining vulnerability to rainfall variability. The relatively low educational attainment could be a barrier to modern technology adoption.

Table 2: Production Input Usage and Costs (Per Hectare)

Input	Mean Quantity	Mean Cost (₹)
Irrigation (litres)	65,000	6,300
Fertilizer (kg)	240	4,700
Seeds (setts)	3,500	3,900
Labour (man-days)	86	21,500
Machinery	-	6,800
Total	-	₹43,200

Labour is the most significant contributor to total cultivation cost (~50%), confirming wage inflation as a major constraint. Irrigation and fertilizer remain moderate cost components but are critical yield influencers.

Table 3: Garrett Ranking of Production Constraints

Constraint	Mean Score	Rank
High Labour Cost	78.2	1
Irrigation Scarcity	75.6	2
Pest/Disease Infestation	70.5	5
Low Mechanization	71.9	4
Delayed Input Supply	69.1	6
Poor Extension Services	67.3	7
Old Varieties	68.5	8

Labour cost and irrigation issues dominate production constraints. Though pest attacks are frequent, poor mechanization and varietal stagnation also reduce productivity potential.

Table 4: Garrett Ranking of Marketing Constraints

Constraint	Mean Score	Rank
Delayed Payment by Mills	73.4	1
Price Volatility	71.8	2
No Access to APMC Markets	68.9	3
High Intermediary Margins	67.6	4
No Storage Facilities	65.4	5

Market-related challenges are headed by payment delays and unregulated price fluctuations. Absence of government market access and storage infrastructure exposes farmers to distressed selling.

Table 5: Cobb-Douglas Regression Output

Variable	Coefficient (β)	Std. Error	t-value	p-value
Constant (α)	0.425	0.186	2.28	0.024
ln(Irrigation)	0.34	0.064	5.31	0.000***
ln(Fertilizer)	0.21	0.072	2.91	0.004**
ln(Seed)	0.19	0.058	3.28	0.002**
R^2	0.672			
F-statistic	47.3			0.000

All variables are statistically significant. Irrigation has the highest elasticity, meaning a 1% increase in irrigation leads to a 0.34% increase in yield. Fertilizer and seed use also show meaningful, though smaller, effects. R^2 of 0.672 suggests that 67.2% of the yield variance is explained by these three inputs.

Table 6: Market Linkage Indicators (2021-2024)

Indicator	Mean Value
Payment Delay (days)	93
Average Price (₹/tonne)	₹2,550
Fair & Remunerative Price (FRP)	₹3,100
Intermediary Margin (%)	13.5
% Farmers Accessing APMC	18%

Farmers receive significantly less than the FRP due to delayed payments and middlemen margins. Average waiting time exceeds 3 months, weakening cash flows and trust in cooperative institutions.

To further understand how marketing factors impact sugarcane farming outcomes, a Pearson correlation coefficient analysis was conducted using variables collected between 2021-2024. Key variables included:

Table 7: Correlational Market Analysis

Variable Code	Description
X1	Payment delay (in days)
X2	Price volatility index (normalized std. dev.)
X3	Mill capacity utilization (%)
X4	Yield per hectare (t/ha)
X5	FRP received (₹/tonne)

Table 8: Pearson Correlation Matrix (n = 250)

Variables	X1 (Delay)	X2 (PriceVol)	X3 (Utilization)	X4 (Yield)	X5 (FRP Rec'd)
X1: Delay	1.000	0.61	-0.53	-0.41	-0.45
X2: PriceVol	0.61	1.000	-0.32	-0.47	-0.39
X3: Utiliz.	-0.53	-0.32	1.000	0.68	0.56
X4: Yield	-0.41	-0.47	0.68	1.000	0.71
X5: FRP Rec'd	-0.45	-0.39	0.56	0.71	1.000

Positive Correlations

- **Mill Utilization & Yield (r = 0.68):** Higher mill efficiency is strongly linked with higher yields, likely due to timely crushing and reduced post-harvest losses.
- **Yield & FRP Received (r = 0.71):** Better yields tend to be associated with more consistent and higher payments received per tonne, implying economies of scale in pricing.

Negative Correlations

- **Payment Delay vs. FRP (r = -0.45):** Greater delays in payment are significantly associated with lower effective prices received by farmers.
- **Price Volatility vs. Yield (r = -0.47):** Unstable markets correlate negatively with farm productivity, possibly due to discouraged reinvestment in inputs.

Moderate Risk Signal

Delay & Price Volatility (r = 0.61): Longer payment cycles tend to accompany unpredictable pricing trends, compounding market uncertainty.

Key Insight

This correlation matrix highlights how institutional inefficiencies (payment delays and underutilized mills) are statistically related to both lower yields and reduced prices. Therefore, improving mill operations and stabilizing payment timelines could directly impact farmers' profitability and market confidence.

8. Findings

Key Findings

1. Production Inefficiencies

- Yield (36.8 t/ha) is significantly below state averages (105 t/ha).
- Labour costs and irrigation scarcity are the top input constraints.
- Regression confirms irrigation, fertilizer, and seed rate as significant influencers of yield.

2. Marketing Challenges

- Mills delay payments by over 90 days; FRP is rarely paid in full.
- Only 18% of respondents access APMC or regulated markets.
- Price volatility correlates negatively with yields and net income.

3. Structural Shift

- Over 42% of farmers expressed intent to shift to jaggery production due to cash flow advantages.
- Mill underperformance is forcing decentralized value-addition models.

4. Institutional Support Lags

- Limited adoption of mechanization, drip irrigation, or improved varieties.
- Disconnect between farmer needs and extension service delivery.

9. Conclusion

Sugarcane cultivation in Namakkal District faces persistent production and marketing challenges, including low yields, irrigation constraints, labour shortages, and delayed payments from cooperative mills. Despite government interventions, institutional inefficiencies and market volatility continue to hinder farmer profitability. Emerging trends like jaggery production and micro-irrigation adoption show promise but require stronger policy and financial support. This study highlights the urgent need for integrated reforms in input efficiency, mill operations, and market access. Strengthening extension services, price assurance mechanisms, and decentralized processing units can enhance the long-term viability and sustainability of sugarcane farming in the region.

10. Policy Recommendations

1. Mill Restructuring & Timely Payments:

- Introduce performance-linked funding to cooperative mills.
- Use DBT (Direct Benefit Transfer) to ensure FRP reaches farmers within 14 days.

2. Expand Jaggery Processing Clusters

Encourage decentralized units via ₹1 lakh government subsidy for mould jaggery units in key blocks.

3. Market Linkage Platforms

Pilot blockchain-based e-marketplace for direct buyer-farmer transactions.

4. Micro-Irrigation Support

Provide post-installation servicing and maintenance training to improve drip system adoption.

5. Mechanization Banks

Create taluk-level machinery hubs for renting harvesters and planters at subsidized rates.

6. Capacity-Building for Extension Agents

Improve staff-farmer ratio and provide incentives for field visits and demo plots.

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