



ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating: 4.97
IJAFA 2025; 7(6): 01-05
www.agriculturaljournals.com
Received: 20-03-2025
Accepted: 22-04-2025

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Marketing and Cultivation Challenges of Bt Cotton and SAU Cotton Varieties in Tamil Nadu

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DOI: <https://www.doi.org/10.33545/2664844X.2025.v7.i6a.430>

Abstract

The cultivation of cotton in Tamil Nadu has evolved significantly with the adoption of Bt cotton and the continued promotion of State Agricultural University (SAU) cotton varieties. This article explores and compares the key marketing and cultivation challenges faced by farmers cultivating these two types of cotton. Using primary data collected from selected districts and analyzed with statistical tools such as the Friedman test, the study highlights issues such as pest resistance, input cost burden, seed accessibility, and market volatility. The results indicate that while Bt cotton offers yield advantages, it also introduces challenges related to sustainability and input dependency. SAU varieties, though eco-friendlier and more cost-effective, lack competitive market incentives. The study concludes with recommendations for policy interventions aimed at strengthening farmer support systems, enhancing market access, and promoting balanced varietal adoption in cotton farming.

Keywords: Bt cotton, SAU cotton varieties, cultivation constraints, marketing challenges, Friedman test, pest resistance, seed availability, cotton farming, agricultural sustainability

Introduction

Importance of Cotton in Indian Agriculture

Cotton is a vital fiber crop in India and holds immense economic importance. It supports the livelihoods of over 6 million farmers and countless workers in the textile and garment industries. India ranks as the world's largest cotton producer and the second-largest exporter, underscoring its influence in global textile supply chains. Tamil Nadu, although not a major producer, plays a significant role in processing due to its dense cluster of textile mills, making it a hub for cotton-based industries.

Emergence of Bt Cotton and SAU Varieties

The introduction of Bt cotton in India in 2002 brought a major shift in cotton cultivation. Bt cotton contains a gene from the bacterium *Bacillus thuringiensis*, which produces a protein toxic to bollworms, a major pest. It gained popularity due to higher yields and reduced pesticide use. Parallel to this, State Agricultural Universities (SAUs), including Tamil Nadu Agricultural University (TNAU), continued developing high-yielding, region-specific non-GM (non-genetically modified) varieties tailored to local agro-climatic conditions. These varieties emphasize ecological sustainability and seed cost reduction.

Cultivation Practices and Input Challenges

Farmers adopting Bt cotton often rely on high-cost hybrid seeds, fertilizers, and pesticide regimens to maximize returns, leading to increased dependency on external inputs. Conversely, SAU varieties are more input-efficient but sometimes yield less. Bt cotton farmers may also experience pest resistance and secondary pest outbreaks over time, whereas SAU varieties may be more pest-prone in the short term but support long-term soil health and ecosystem balance. Access to irrigation, quality seeds, and technical guidance further affect cultivation success across both varieties.

Yield and Profitability Differences

Studies and field evidence indicate that Bt cotton tends to offer better yields—sometimes up to 20-30% more than SAU varieties—primarily due to its pest resistance. However, SAU varieties can be cost-effective in the long run due to lower input costs. Profitability, therefore, hinges on a combination of yield, input cost, and sustainability. In rainfed areas, where resources are limited, some farmers prefer SAU varieties for their resilience and affordability.

Sustainability and Environmental Concerns

SAU cotton varieties are often viewed as more sustainable due to their compatibility with organic and low-input farming systems. They promote biodiversity, reduce chemical load on the soil, and pose no risk of genetic contamination. On the other hand, long-term cultivation of Bt cotton has raised concerns about soil fertility depletion, monoculture practices, and rising resistance in bollworm populations. These factors influence farmers' long-term preference for either variety.

Marketing Constraints and Price Fluctuations

One of the most pressing issues for both Bt and SAU cotton growers is market instability. Cotton prices fluctuate widely due to changing global demand, international trade policies, and the absence of an effective Minimum Support Price (MSP) procurement mechanism in many areas. SAU varieties are often under-marketed and poorly branded, making it hard for farmers to secure competitive prices. Bt cotton, though more popular, still faces price uncertainties and market dominance by private seed companies and traders.

Role of Middlemen and Lack of Procurement Support

In the absence of robust marketing channels or farmer-producer organizations (FPOs), cotton growers often depend on middlemen, who exploit the situation by offering low prices. Procurement by government agencies like Cotton Corporation of India (CCI) is either irregular or insufficient in Tamil Nadu, leading to distress sales. This disproportionately affects SAU cotton farmers, who lack visibility and face difficulties in accessing wider markets.

Access to Credit and Institutional Support

High input costs in Bt cotton cultivation often require farmers to borrow from informal sources at high interest rates. While formal credit exists, not all farmers qualify due to lack of land titles or collateral. SAU varieties, being lower in input demand, may reduce financial risk, but limited promotional support, extension outreach, and credit-linked incentives hinder their widespread adoption.

Seed Availability and Farmer Awareness

While Bt cotton seeds are readily available in the market, they are expensive and controlled by a few large companies. In contrast, SAU seeds are distributed by government agencies or university research stations, but their availability is seasonal and limited. Lack of awareness among farmers regarding the benefits and performance of SAU varieties adds to the challenge, reducing adoption rates despite their potential advantages.

Objectives

The main objective of the present study is to analyse the Impact of Cotton Varieties Released by SAU's Vs Bt Cotton in Tamil Nadu. The specific objectives are;

To analyze the marketing and cultivation challenges faced by farmers in adopting SAU's cotton variety compared to Bt cotton.

Null Hypothesis (Ho): There is no significant difference in the marketing and cultivation challenges faced by farmers in adopting SAU's cotton variety compared to Bt cotton.

Review of Literature

Economic Benefits and Profitability of Bt Cotton

Gayathri & Karunakaran (2022) ^[7] demonstrated that Bt cotton technology improved productivity and profitability in Tamil Nadu and Maharashtra. The study found that Bt cotton farmers had higher technical efficiency (94-97%) compared to non-Bt farmers (74-76%). Resource use efficiency was suboptimal, indicating the potential for higher yields with better resource management. The study recommends extension services and training to enhance farmer's skills and improve efficiency.

Tokel *et al.*, (2020) ^[24] examined the economic impacts of Bt cotton technology. The study highlighted how Bt cotton increased yields, reduced pesticide use, and improved farmer's profitability. The authors also discussed the sustainability challenges and the potential for resistance development among pests.

Ibrahim *et al.*, (2020) ^[8] conducted a study on the economic and environmental effects of Bt cotton adoption. Their findings highlighted the increased profitability for farmers but raised concerns over soil health degradation and pest resistance.

Environmental and Pest Control Effects

Arends *et al.*, (2021) ^[3] investigated the relationship between landscape composition and resistance selection in Bt cotton systems. The study found that the abundance of maize, cotton, and soybean influenced the effectiveness of resistance management strategies.

Kranthi (2020) ^[10] reviewed the long-term performance of Bt cotton in India, noting the stagnation in yield gains and the emergence of resistance issues. The study emphasized the need for integrated pest management practices to sustain the benefits of Bt cotton.

Arshad *et al.*, (2015) ^[4] compared the population dynamics of insect predators and parasitoids between Bt and non-Bt cotton fields in Pakistan. Field trials revealed no significant difference in the abundance of beneficial insects, concluding that Bt cotton does not negatively impact biological control agents under field conditions.

Little *et al.*, (2017) ^[12] evaluated the effectiveness of microbial and chemical insecticides for bollworm control on Bt and non-Bt cotton in the U.S. The study found that supplemental insecticide applications were effective on non-Bt cotton but unnecessary on Bt cotton due to lower bollworm densities (Bhopala UD *et al.*, 2023) ^[26].

Sustainability Challenges

Riaz *et al.*, (2020) ^[8] investigated the effects of Bt and non-Bt cotton mulches on soil properties, weed dynamics, and productivity of subsequent winter crops. The study found that non-Bt mulches enhanced soil porosity and organic

matter, resulting in better crop performance compared to Bt mulches, which negatively impacted soil properties due to the release of Bt toxins. Explored the morpho-physiological and proteomic response of Bt and non-Bt cotton to drought stress. Their findings demonstrated that Bt cotton exhibited enhanced drought tolerance, attributed to improved photosynthesis, water retention, and antioxidant activity compared to non-Bt varieties. Little *et al.*, (2017) ^[12] highlighted the adoption of Bt cotton has significantly increased cultivation area, with a 42% rise by 2017-18, due to its effectiveness in controlling bollworms, which caused 20-66% yield losses in non-Bt cotton. It reduced insecticide use and improved productivity. However, the misuse of illegal or low-tolerance Bt cultivars by farmers has led to crop damage and increased resistance in secondary pests. This threatens the long-term sustainability of Bt cotton, especially in developing countries. Effective policies and integrated pest management practices are essential to address these challenges.

Design of the Study

Selection of Study Area

The study was conducted in the districts of Virudhunagar and Perambalur, selected purposively due to their prominent role in cotton cultivation in Tamil Nadu. Virudhunagar records a cultivated area of 19,131 hectares, while Perambalur accounts for 12,629 hectares.

Data Collection Methods

Primary Data: Gathered using a structured interview schedule through face-to-face interactions with selected farmers. **Secondary Data:** Sourced from official publications such as government reports, TNAU bulletins, scholarly journals, and statistical records relevant to cotton cultivation.

Sample Size

A total of 60 farmers were selected for the study, evenly distributed between the two districts. In each district, 15 Bt cotton farmers and 15 SAU cotton farmers were surveyed, ensuring balanced representation. Virudhunagar: 30 farmers (15 Bt + 15 SAU), Perambalur: 30 farmers (15 Bt + 15 SAU)

Sampling Technique

A two-stage sampling method was employed:

- **Stage 1:** *Purposive sampling* was used to select districts based on their large area under cotton cultivation.
- **Stage 2:** *Snowball sampling* was applied to identify and select the required number of cotton farmers within each district.

Tools and Analytical Techniques

Objective 1: Friedman test (non-parametric test)

Results and discussion

Objective 1

Friedman test (non-parametric test) Rank-based test used for comparing multiple related groups. Suitable for non-normally distributed data and ordinal rankings.

Perambalur offers a diverse cotton cultivation landscape, with farmers growing both, Bt cotton (genetically modified for pest resistance), SAU-released cotton varieties (conventionally bred, non-GM). This diversity provides an ideal setting for comparative economic analysis of both cotton types under similar agro-climatic conditions.

Objective

To analyze the marketing and cultivation challenges faced by farmers in adopting SAU's cotton variety compared to Bt cotton.

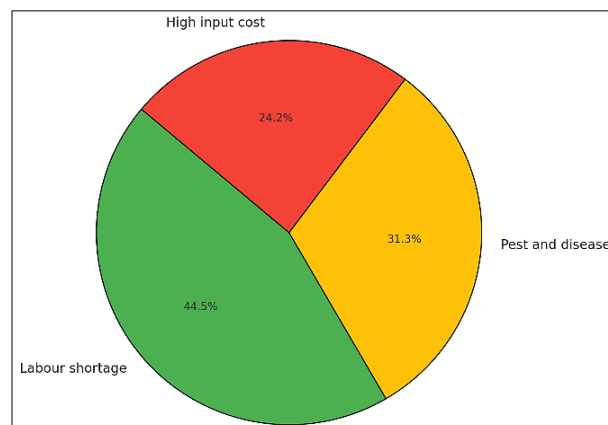


Fig 1: Cultivation Challenges - Bt

Cultivation Challenges

Bt Cotton

Labour Shortage: 2.67 (ranked highest - most significant issue), Pest and Disease: 1.88, High Input Cost: 1.45 (ranked lowest - least significant issue)

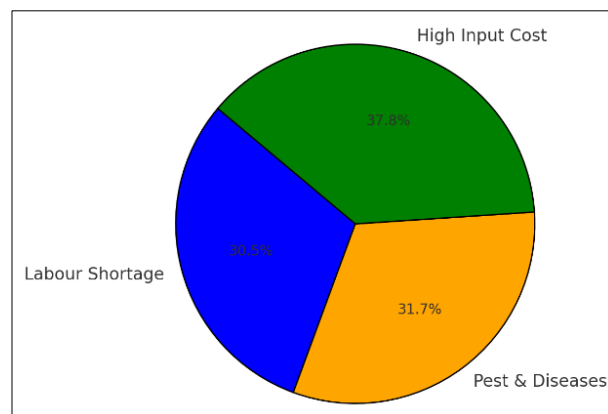


Fig 2: Cultivation Challenges - SAU

SAU's Cotton

High Input Cost: 2.27 (ranked highest - most significant issue), Pest and Disease: 1.90, Labour Shortage: 1.83 (ranked lowest - least significant issue)

Interpretation

Bt Cotton farmers face more labour shortage issues, while SAU's cotton farmers face higher input costs. Both cultivation challenges are statistically significant.

Marketing Challenges

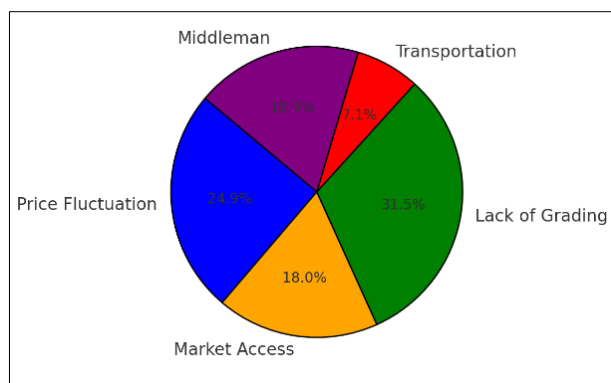


Fig 3: Marketing Challenges - Bt

Bt Cotton

Lack of Grading: 4.73 (ranked highest - most significant issue), Price Fluctuation: 3.73, Middleman Influence: 2.77, Market Access: 2.70, Transportation: 1.07 (ranked lowest - least significant issue)

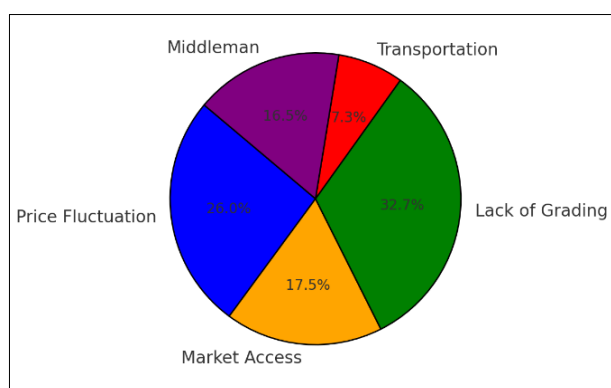


Fig 4: Marketing Challenges - SAU

SAU's Cotton

Lack of Grading: 4.90 (ranked highest - most significant issue), Price Fluctuation: 3.90, Middleman Influence: 2.63, Market Access: 2.47, Transportation: 1.10 (ranked lowest - least significant issue).

Interpretation

Both Bt and SAU's cotton farmers face grading issues as the most significant marketing challenge. Transportation issues are ranked the lowest.

Conclusion

Marketing and Cultivation Challenges

The study also examined the marketing and cultivation challenges faced by farmers in adopting Bt and SAU's cotton varieties using the Friedman Non-Parametric Test. The results revealed statistically significant differences in the severity of challenges encountered by the two groups. In terms of cultivation challenges, Bt cotton farmers reported labor shortage as the most significant issue, with a mean rank of 2.67. This was followed by pest and disease problems (mean rank of 1.88), while high input costs were ranked the lowest (mean rank of 1.45). The statistically significant p-value of 0.040 indicated that the differences were significant. The prevalence of labor shortages among Bt cotton farmers may be due to the larger-scale cultivation of Bt cotton, which requires more labor during harvesting and field management.

Conversely, SAU's cotton farmers ranked high input costs as their most significant challenge, with a mean rank of 2.27. This was followed by pest and disease problems (mean rank of 1.90), while labor shortage was ranked the lowest (mean rank of 1.83). The p-value of 0.040 confirmed the statistical significance of the differences. The higher input costs for SAU's cotton farmers reflect their greater expenditure on pesticides and fertilizers, which reduces their profitability.

In terms of marketing challenges, both Bt and SAU's cotton farmers identified lack of grading facilities as the most significant issue. Bt cotton farmers ranked lack of grading highest, with a mean rank of 4.73, followed by price fluctuation (mean rank of 3.73), middleman influence (mean rank of 2.77), and market access (mean rank of 2.70). Transportation was ranked the lowest, with a mean score of 1.07. The statistically significant p-value of 0.000 indicates that these challenges significantly affect Bt cotton farmers. Similarly, SAU's cotton farmers ranked lack of grading as their most significant marketing challenge, with a mean rank of 4.90, followed by price fluctuation (3.90), middleman influence (2.63), and market access (2.47). Transportation was again ranked the lowest, with a mean score of 1.10. The p-value of 0.000 confirmed the statistical significance of the challenges faced by SAU's cotton farmers.

The results indicate that while both Bt and SAU's cotton farmers face significant marketing and cultivation challenges, they differ in severity. Bt cotton farmers encounter more labor shortage issues, while SAU's cotton farmers face higher input costs. The shared marketing challenge of lack of grading facilities highlights structural inefficiencies in the cotton value chain, which reduce farmers' bargaining power and income potential.

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