



Constraints Faced by Bt Cotton Seed Companies in Gujarat: A Comprehensive Analysis

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

India's cotton industry is crucial to the economy, providing raw material for 75% of the textile industry and employing millions. Despite having the largest area under cotton cultivation globally, India faces challenges such as low productivity due to rain-fed farming. To address these challenges by enhancing productivity and pest resistance the Bt cotton producer companies were facing different constraints. Data from various stakeholders in Gujarat's Bt cotton seed market was collected and analysed using the Garrett Ranking Method to identify key factors influencing sales. The findings highlight the major constraints faced by Bt cotton producer companies includes the fixed price policy, lack of skilled manpower and seed adulteration. By improving access to quality

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seeds, enhancing farmer awareness and reforming seed policies, which significantly helps market dynamics in shaping the cotton seed sector.

Keywords: *Bt cotton; seed industry; cotton productivity; Garrett Ranking Method; India; cotton seed market; seed policy.*

1. INTRODUCTION

Cotton, often referred to as "white gold," is a vital crop in India, contributing significantly to the economy by providing employment and serving as a key raw material for the textile industry. Despite having the largest cotton cultivation area globally, India's cotton productivity is limited, mainly due to reliance on rain-fed farming. To address this, innovations like Bt cotton have been introduced, offering better pest resistance and higher yields. The Indian seed industry, driven by public and private sector initiatives, plays a crucial role in enhancing agricultural productivity. Bt cotton has emerged as a major player in India's cotton seed market, helping farmers improve their output despite ongoing challenges such as climate change and fluctuating market conditions [1,2]. Cotton is the backbone of Indian textile industry, which consumes 59 % of the country's total fiber production. It accounts for 34% of the country's export and fetches about Rs.50,000 cores annually to the exchequer. Along with the industry, which it sustains, it touches the country's economy at several points including employment and export earnings. India having the largest area under cotton cultivation in the world ranging between 10.9 million hectares to 12.8 million hectares and constituting about 38% to 41% of the world area under cotton cultivation (cotcorp.gov.in) Around 6 to 6.5 million farmers grow the crop in about 10 States (Punjab, Haryana, Rajasthan, Gujarat, Madhya Pradesh, Maharashtra, Andhra Pradesh, Telangana, Karnataka and Tamil Nadu) [3]. Cotton is one of the most important fibre crops in India as well as the entire world. It plays a major role in the industrial and agricultural economy of the country. It supplies the basic raw material to the textile industry [4]. In addition to this, biodiversity is an important indicator of sustainability of cotton cultivation. About 500 known varieties of cotton are found around the world. Varieties have been developed to suit geographical conditions and include many fascinating characteristics and traits such as coloured cotton, extremely long and fine stapled cotton, and native indigenous or wild cotton [5]. Cotton is a long duration crop in India in which flowering starts during the end of

monsoon and continues for about 80-90 days after the end of this season. The crop suffers severe water stress under rain-fed conditions in India and nutrient deficiency mainly at flowering and boll formation stage, resulting in low yields as well as lack of adoption of standard package of practice and inputs by farmers is also responsible for low yield [6-12]. If the roots stand in water for too long, the cotton crop can be adversely affected. Creating ridges for planting and applying water along the furrows drastically reduces water use and improves the growth of plants [13,1,2]. In a study [14], it was found that labour cost occupies about 10 to 35% of total operational cost across states.

Bishaw and Kugbei [15] argued that local seed enterprises are better suited to meet the needs of remote farmers, calling for community based approaches and policy support [15]. Sadvi *et al.* [16] identified labor shortages and private sector exploitation in hybrid rice seed production in Telangana, recommending mechanization and government intervention [16]. Kifle and Atilaw [17] examined Ethiopia's seed sector, finding issues in marketing and government support, and suggesting policy reforms for better access to land, marketing and finance [17-20]. Kumar *et al.* [21] highlighted that timely availability of quality seeds is more important than production, emphasizing the significance of seed replacement for productivity improvement [21]. There is a weak distribution systems of vegetable seed sector, despite favorable growing conditions, stressing the need for improved supply chains [22] [23]. Roy *et al.* [24] focused on challenges in India's vegetable seed sector, such as high seed costs and counterfeit seeds, calling for research to improve seed quality [24]. Louwaars and Manicad [25] reviewed global seed security, stressing the importance of resilience in seed systems and the need for diversity in plant genetic resources [25]. Farmers related constraints like labour shortages, yield and input costs are significant constraints for commercial seed growers in India, impacting their ability to scale production [26-29].

2. MATERIALS AND METHODS

This study focuses on analysing the factors influencing the Bt cotton seed market in Gujarat. A sample of 23 companies selling Bt cotton seeds was selected, and primary data was collected through well-structured questionnaires targeted at farmers, dealers, company representatives, and other intermediaries in the marketing channels. Additional information regarding the companies and their products was gathered directly from the companies.

The Garrett Ranking Method (Garrett & Woodworth, 1981) was used to convert the qualitative rankings given by respondents into quantitative data. The following formula was employed to calculate percentage positions based on the ranks assigned to various factors:

$$\text{Percentage Position} = \frac{N_j(100 - (R_{ij} - 0.5))}{100}$$

Where:

R_{ij} = Rank assigned to the i th factor by the j th individual

N_j = Number of factors ranked by the j th individual

This method provided an organized and quantifiable way to assess the impact of various factors on Bt cotton seed sales in the region. Then for each factor, the scores of each individual are added and then total value of scores and mean values of score is calculated. The factors having highest mean value is considered to be the most important factor [30,31].

3. RESULTS AND DISCUSSION

3.1 Constraints Faced by Seed Companies

This study analyses the constraints faced by seed producers, highlighting ten critical factors based on data collected from various sources. The Table 1 ranks these constraints by total scores and mean scores. The most significant challenge identified is the lack of skilled manpower with a mean score of 68.65, followed by competition with larger companies with a mean score of 64.95 and high initial investment costs with a mean score of 60.82. Other notable issues include limited access to suitable

germplasm with a mean score of 59.3, low adoption rates by farmers with a mean score of 52.43, and Unfavourable seed policies with a mean score of 49.65. Recruitment of skill manpower and formulate competitive strategies will help to improve productivity and sustainability in the seed production sector, ultimately fostering a more robust agricultural landscape.

This study examines the constraints faced by seed producers, focusing on six key factors derived from collected data. The Table 2 ranks these constraints based on total scores and mean scores. The most significant challenge identified is the problems related to small land holdings, with a mean score of 62.22, followed by the prices of other inputs at a mean score of 60.48 and the black market of seed prices with a mean score of 51.3. Other notable issues include yield with a mean score of 46.48, weather conditions with a mean score of 39.00, and the effectiveness of promotional campaigns with a mean score of 38.52. Companies should bundle different agro advisory technique and teach farmers about effective utilization of agriculture inputs will be helpful for the sustainability seed production sector.

This study analyses the constraints faced by seed producers, focusing on seven critical factors identified through data collection. The Table 3 ranks these constraints based on total scores and mean scores. The most significant challenge is the lengthy variety release process, with a mean score of 72.56, followed by controlled seed markets dominated by large companies, which has a mean score of 61.21, and a lack of research support from the government with a mean score of 57.47. Other notable issues include weak enforcement of seed laws with a mean score of 54.04, Unfavourable seed policies such as taxation with a mean score of 34.34, poor extension support with a mean score of 39.13, and import and export restrictions with a mean score of 28.82. Government should ease their policy and mechanism so that newly entered companies should survive in the market and dominance of major companies should be minimize and government should promote a more equitable agricultural environment.

This study explores the constraints faced by seed producers, highlighting six key factors based on data analysis. The Table 4 ranks these constraints according to total scores and mean scores. The most significant challenge is the additional resources required to produce hybrids,

with a mean score of 63.95, followed closely by the limited amount of foundation seed obtained, which has a mean score of 62.17. Other notable issues include low yield in seed multiplication with a mean score of 59.95, inadequate germplasm material with a mean score of 41.17, low shelf life of seed due to insect attacks and

moisture contact with a mean score of 39.3, and the yield increase associated with fertilizer type and nutrient levels, which has a mean score of 35.52. The monopoly of large seed companies should be restricted to enhance seed production efficiency and ensuring a sustainable agricultural future.

Table 1. Initial phase constraints

Sr. No.	Constrains	Total Score	Mean Score	Rank
1	Competition with larger companies	1494	64.95	II
2	Lack of access to production credit facilities	597	25.96	IX
3	Low adoption rate by farmers	1206	52.43	V
4	Seed marketing problems	1109	48.21	VII
5	Unfavorable seed policy environment	1142	49.65	VI
6	Lack of skilled manpower	1579	68.65	I
7	High initial investment outlay	1399	60.82	III
8	Lack of access to suitable germplasm	1364	59.3	IV
9	Lack of access to extension services	499	21.69	X
10	Unfavorable climatic conditions	984	42.78	VIII

Table 2. Farmers related constrains

Sr. No.	Constrains	Total Score	Mean Score	Rank
1	Yield	1069	46.48	IV
2	Black market of seed price	1180	51.3	III
3	Prices of other inputs	1391	60.48	II
4	Weather conditions	897	39.00	V
5	Effectiveness of promotional campaigns	886	38.52	VI
6	Small land holdings problems	14311	62.22	I

Table 3. Policy related constrains

Sr. No.	Constrains	Total Score	Mean Score	Rank
1	Unfavorable seed policies such as taxation	790	34.34	VI
2	Import and export restrictions	663	28.82	VII
3	Lengthy variety release process	1669	72.56	I
4	Controlled seed markets by large companies	1408	61.21	II
5	Lack of research support from government	1322	57.47	III
6	Weak enforcement of seed laws (e.g., on quality, etc.)	1243	54.04	IV
7	Poor extension support	900	39.13	V

Table 4. Research and development related constrains

Sr. No.	Constrains	Total Score	Mean Score	Rank
1	Inadequate germplasm material	947	41.17	IV
2	Yield increase associated with fertilizer type and nutrient levels	817	35.52	VI
3	Limited amount of foundation seed obtained	1430	62.17	II
4	Low yield in seed multiplication	1379	59.95	III
5	Additional resources is required to produce hybrids	1471	63.955	I
6	Low shelf life of seed (insect attacks, moisture contact)	904	39.3	V

This study examines the constraints faced by seed producers, focusing on eight key factors identified through data analysis. The Table 5 ranks these constraints based on total scores and mean scores. The most significant challenge is land scarcity, with a mean score of 77.26, followed by drought and heavy rainfall issues with a mean score of 67.00. Other notable constraints include difficulty in the adoption of new production techniques, which has a mean score of 53.17, and a lack of access to production inputs with a mean score of 52.57. Additionally, inadequate improved varieties (foundation/breeder seeds) have a mean score of 48.43, while a lack of up-to-date equipment and machinery maintenance has a mean score of 36.39. Inadequate skills of technicians for hybrid seed production and lack of access to seed production and processing infrastructure are further challenges, with mean scores of 39.96 and 22.61, respectively. Companies should provide technical advice and support to farmers for mitigating the natural calamity.

This study investigates the constraints faced by seed producers, focusing on eight critical factors identified through data analysis. The Table 6 ranks these constraints according to total scores and mean scores. The most significant challenge is seed adulteration and the presence of fake seeds, with a mean score of 59.65, followed closely by a lack of information on available varieties, which has a mean score of 55.57. Other notable constraints include an increase in transaction costs due to bargaining, with a mean score of 55.22, and unpredictable sales ordering by dealers, with a mean score of 50.83. Additionally, bad credit habits and prices that are usually low have mean scores of 50.13 and 49.22, respectively. Coordination and handling problems, along with poor storage facilities, pose further challenges, with mean scores of 46.61 and 30.70. Government should take strict action against seed adulteration and company's marketing staff should take up rigorous promotional campaign to create awareness among the farmers which ensure a more reliable agricultural market.

Table 5. Technical constraints

Sr. No.	Constrains	Total Score	Mean Score	Rank
1	Inadequate skill of technicians for hybrid seed production	919	39.96	VI
2	Lack of access to production inputs	1209	52.57	IV
3	Difficulty in the adoption of new production techniques	1223	53.17	III
4	Land scarcity	1777	77.26	I
5	Lack of access to seed production and processing infrastructure.	520	22.61	VIII
6	Lack of up-to-date equipment, machinery, and their maintenance	837	36.39	VII
7	Inadequate improved varieties (foundation/ breeder seeds)	1114	48.43	V
8	Drought (inadequate rainfall to grow seed)/ heavy rain	1541	67.00	II

Table 6. Distribution related constraints

Sr. No.	Constrains	Total Score	Mean Score	Rank
1	Coordination and handling problems	1072	46.61	VII
2	Increase in transaction costs(bargaining)	1270	55.22	III
3	Prices usually low	1132	49.22	VI
4	Bad credit habit	1153	50.13	V
5	Poor storage facilities	706	30.70	VIII
6	Seed adulteration/ fake seed	1372	59.65	I
7	Unpredictable sales ordering by dealers	1169	50.83	IV
8	Lack of information on the available varieties	1278	55.57	II

Table 7. Constraints for deployment of new varieties

Sr. No.	Constrains	Total Score	Mean Score	Rank
1	Unavailability of seeds in a commercial quantity	1412	61.39	III
2	Lack of awareness of available varieties and hybrids	1203	52.30	IV
3	Acceptance by farmers	1487	64.65	II
4	Fixed price policy	1797	78.13	I
5	Monopolistic distribution of seeds through a single intermediary	786	34.17	VII
6	Slow reimbursement of seed credit sales	978	42.52	V
7	Difficulty in getting access to other seed buyers	576	25.04	VIII
8	Low demand from farmers' lack of awareness	938	40.78	VI

This study analyses the constraints faced by seed producers, focusing on eight key factors identified through data analysis. The Table 7 ranks these constraints based on total scores and mean scores. The most significant challenge is the fixed price policy, with a mean score of 78.13, followed by the acceptance of seeds by farmers, which has a mean score of 64.65. Other notable issues include the unavailability of seeds in commercial quantities, with a mean score of 61.39, and a lack of awareness of available varieties and hybrids, which has a mean score of 52.30. Additionally, slow reimbursement of seed credit sales and monopolistic distribution through a single intermediary present challenge, with mean scores of 42.52 and 34.17, respectively. Lastly, difficulty in accessing other seed buyers and low demand from farmers due to lack of awareness have mean scores of 25.04 and 40.78. Create the awareness of the beneficial characteristic of seed among the farmers and fixing price according to the market dynamics will help to improve seed availability and ultimately fostering a more competitive agricultural landscape.

4. CONCLUSION

The study highlights the multifaceted constraints faced by seed producers in India's cotton industry, particularly in the context of Bt cotton. Key challenges include the fixed price policy, lack of skilled manpower, and seed adulteration, which significantly hinder productivity and market dynamics. Addressing these constraints through targeted interventions, such as improving access to quality seeds, enhancing farmer awareness, and reforming seed policies, is essential for fostering a sustainable and competitive agricultural landscape. By overcoming these barriers, the cotton industry can enhance its productivity and resilience, ultimately benefiting farmers and contributing to the economy.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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