International Journal of Economic, Finance and Business Statistics (IJEFBS)
Vol. 3 No. 5 2025: 281-292

Economic Analysis of BT. Cotton Cultivation in Hyderabad, Sindh, Pakistan

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A R T I C L E I N F O

Keywords: Bt. Cotton, Production, Land, Total Expenditure, Rupee, Pakistan

Received: 19, August
Revised: 20, September
Accepted: 30, October

A B S T R A C T

The present study was carried out with the objectives of evaluating the costs and revenue obtained from Bt. cotton, cultivated in the District Hyderabad, Sindh province of Pakistan. This study aimed to find out the physical and revenue productivity and to compute net returns and the input-output ratio of this crop. For this study, sixty Bt. cotton growers were selected through a purposive sampling technique, where they were interviewed using a detailed questionnaire. Results show that the average age of selected respondents was 43.25 years, about 75 percent of growers were literate, and 25 percent were illiterate. The growers have about 12.08 years of Bt. cotton growing experience, while 20 percent of farmers had their first experience with Bt. cotton cultivation. The results further show that per acre average revenue was Rs. 231000 and average expenditure (per acre) was Rs. 111571, where they earned a net profit of Rs. 119429 per acre. The Bt. cotton grower had obtained input input-output ratio of 1:2.07, and the cost-benefit ratio was calculated as 1:1.07. This study reveals that the major constraints faced by the growers in the study area were a shortage of water, a lack of modern technologies, and lack of storage facilities, and a higher interest rate of agricultural loans. It is, therefore, suggested that the government must take effective steps to counter those problems by providing technical information, training, and easy credit facilities. Agriculture extension assistance should be mobilized to work with Bt cotton growers with advanced technologies in Sindh Province.

DOI: https://doi.org/10.59890/ijefbs.v3i5.174
ISSN-E: 3025-9959
https://dmimultitechpublisher.my.id/index.php/ijefbs

INTRODUCTION

Cotton is the leading industrial crop in Pakistan, occupying around 15% of the nation's cultivable land. Its cultivation is primarily concentrated in Punjab and Sindh provinces, where approximately 1.6 million farmers, most of whom own plots smaller than five hectares, are engaged in its production. Globally, Pakistan ranks as the fourth largest cotton producer and the third biggest consumer while also being the top exporter of cotton yarn. As the most significant non-food cash crop, cotton plays a vital role in Pakistan's economy. Together with the textile and clothing industries, it contributes about 11% to the country's Gross Domestic Product (GDP) and makes up 60% of the total export earnings. Moreover, it provides jobs to 35% of the industrial workforce. The cotton industry supports Pakistan's largest manufacturing segment, which includes over 400 textile factories, 1,000 ginning operations, and 300 facilities for cottonseed oil extraction and refining. Despite its importance, cotton farming in Pakistan faces serious plant health challenges, particularly the widespread and damaging Cotton Leaf Curl Virus (CLCV), which is spread by whiteflies that have developed resistance to many insecticides. Currently, there are no genetically engineered cotton varieties available that can resist CLCV or other sap-sucking pests. To address this issue, the U.S. government launched the "Cotton Productivity Enhancement Program" in 2011, aiming to help Pakistan maintain its cotton industry. This initiative involves joint efforts by American and Pakistani agricultural scientists to develop disease-resistant cotton strains through a comprehensive research approach (Gop, 2023).

Bennett et al. (2004) found that adopting Bt cotton in South Africa led to reduced insecticide use, with positive impacts on economic performance and environmental toxicity. Pakistan buys a large amount of high-quality cotton from other countries to make fine fabrics for export. It also mixes imported cotton with local cotton to produce textiles and clothing for markets that don't need expensive products. In the 2013/14 marketing year, cotton imports were expected to be around 2.2 million bales, 25% less than the 2.9 million bales in 2012/13 because Pakistan was expecting a better local cotton harvest. However, the textile industry planned to import more Pima cotton in 2013/14, increasing from 5,000 bales to 25,000 bales. This was due to lower prices and higher demand for luxury fabrics. Pakistan's cotton exports were predicted to reach 800,000 bales in 2013/14, a 60% rise from the previous year, thanks to better domestic production. As the need for top-quality fabrics and special products grows, Pakistan's textile sector is expected to rely more on imported U.S. Pima and Extra-Long Staple (ELS) cotton as well as clean upland cotton to meet quality standards. Pakistan is one of the biggest buyers of U.S. Pima and ELS cotton. (Stone, 2010). During the 2013/14 marketing year, the demand for extra-long staple (ELS) cotton is expected to grow as Pakistan shifts its focus toward producing premium goods for Western markets, especially the European Union, assuming Pakistan receives the proposed GSP trade status. To support their export operations, many Pakistani companies import upland cotton mainly because local cotton often suffers from contamination issues. These problems are caused by foreign materials like polypropylene and jute, which

get mixed in during harvesting and handling. Such contamination disrupts the production process by affecting the strength of the yarn and how well it absorbs dye. It's estimated that these quality issues increase production costs by around 10% (PCCC, 2013).

Daystar and Kurtz (2017) carried out a survey among U.S. cotton farmers to evaluate how cotton farming affects the environment. They compared the results with a similar natural resource survey from 2016. The report looked at cotton production across four U.S. regions Southeast, the Mid-South, the Southwest, and the Far West, with 925 farmers taking part. The study covered key areas of cotton sustainability, such as crop rotation, use of cover crops, soil care tilling methods, water use and irrigation, advanced farming tools, and conservation efforts. It also measured energy consumption and greenhouse gas (GHG) emissions from the field to the point where cotton is processed at the gin

Pakistan is the world's fourth-largest cotton producer, but when it comes to crop yield, it ranks much lower at number ten. There are several reasons for this low output: expensive farming supplies like fertilizers and pesticides, frequent pest and insect attacks, shortage of water for irrigation, limited use of modern farming methods, low farmer education levels, and poor-quality or fake pesticides. So, the low yield isn't caused by just one or two issues. Some problems can be managed by the government, like setting fair prices and making good seeds available. Other choices, like which seed to plant, are up to the farmers themselves (Agro-News, 2009)

LITERATURE REVIEW

A review of the literature is important for every research study to carry on the investigation productively. Some of the imperative studies on the linked topics have been reviewed here under:

Khachatryan et al. (2018) studied cotton farming in a country where half of the farmland was used for cotton. After gaining independence, the government tried to shift focus from cotton to wheat to become self-sufficient. Reforms were introduced, like privatizing markets and removing state control, but the government still heavily influenced cotton production. The study suggests that switching from traditional cotton to cotton grown under plastic could improve economic and social conditions.

Dagistan et al. (2017). This research looked at energy use in cotton farming in Hatay, Turkey. Farms used about 19,558 MJ of energy per hectare, mostly indirect energy like fertilizers and irrigation. Nitrogen fertilizer was the biggest energy input. Cotton farming was found to be economically viable with a benefit-cost ratio of 1.24, although most costs were variable, showing that farms were run intensively

Tariq (2013) Pakistan is a major cotton producer and earns most of its foreign income from cotton products. However, farmers relied on good weather and didn't prepare for heavy rains, which led to pest attacks and reduced yields. Pesticide use increased drastically, raising production costs and forcing Pakistan to import cotton to meet demand.

Lewis (2001) Cotton lint yield depends a lot on both genetics and environmental factors. These elements help decide how much cotton is produced. Many models have been made to explain this, and one example shows that the number of seeds per hectare and the fiber weight per seed are key parts of the total yield. To grow cotton, farmers need important inputs like seeds, fertilizers, pesticides, machinery, advice from experts, and financial support. Fertilizer and pesticide companies are mostly owned by private businesses, while banks and government agriculture departments provide credit and guidance. A few big international companies now control the fertilizer and pesticide market, which has made these inputs very expensive for farmers. Also, the efficiency of fertilizers has dropped farmers now need more fertilizer to get the same amount of cotton. This shows that the input market in Pakistan is not well-managed, leading to low profits for farmers and high earnings for private companies. Cotistics, (2015) Almost all cotton farms are privately owned, with different systems like full ownership, sharecropping, and renting. The main product is seed cotton (Phuti), and plant waste is reused for making furniture or used as fuel. Some of this waste is also exported to other countries.

Khushik and Memon (2003) explained that farmers sell their crops in two main ways: directly to customers (like roadside stalls) or indirectly through middlemen, where they don't meet the buyers. Direct selling needs farmers to change their approach—they must grow crops based on what nearby customers want, not just general farming. The key idea is that marketing and selling are not the same. Farmers can earn more by doing the marketing themselves instead of relying on others. For fruits and vegetables, direct marketing includes steps like picking, cleaning, packing, transporting, and selling. Sometimes brokers and wholesalers are also involved. Usually, the price in shops is two to three times higher than what farmers get. Even though farmers can sell large amounts this way, their profit is often very low. Because wholesale prices keep changing, farmers sometimes have to sell their crops for less than it costs to grow them. Siddiqui (2014) determined that Support prices help farmers by ensuring they get fair payment, especially when harvests are large. These prices also help stabilize market rates over time. The study also looked at custom ginning and hedge trading as part of the cotton market system.

Cotton Australia (2016) shared that farmers growing important crops like cotton aim for both high quality and large harvests. Cotton growers are paid based on each bale of fiber they produce, with one bale weighing 227 kg. Just like grain farmers, cotton growers earn more when they produce more lint. However, if the fiber quality is poor, they get paid less. In Australia, better cotton varieties and improved farming methods have played a big role in increasing production. Thanks to these changes, cotton yields grew from 110,000 bales in 1975 to a record 3.4 million bales in 2001.

Ashiq and Khan (2018) studied how competitive cotton farming is in Pakistan and whether current government policies match the country's natural advantage in growing cotton. They focused on Punjab and Sindh, the two biggest cotton-producing provinces. To estimate production costs, they used

data from the Agricultural Prices Commission (APCOM) covering five years from 2011–12 to 2017–18. They calculated the average cost per acre for each province and then combined the data at the national level based on each province's share in total production. To assess competitiveness and the impact of policies, they used a method called the Policy Analysis Matrix (PAM). They measured cotton's advantage using two tools: the Domestic Resource Cost (DRC) ratio and the Social Benefit-Cost (SBC) ratio.

Thus, the specific objectives of the study are to carry out research with the following objectives: (i) To assess the status of Bt. cotton production in Sindh; (ii) To identify the different characteristics of Bt. cotton in the research area (iii) To check physical productivities and net returns on Bt. cotton in Sindh, and to suggest some policy measures to improve the situation.

METHODOLOGY

This study was based on primary data, and that is the principal objective of the study, which was collected through a field survey of Bt. Cotton Growers. Shikarpur district was selected for this study because it is considered to be the main Bt. cotton-growing region in Sindh, Pakistan. A purposive sample selection of Bt. cotton farmers were carried out to ensure the generalization of my research findings. I preferred purposive sampling because this type of sampling covers every respondent in the study area due limited growers of strawberries. The 60 Bt. cotton respondents were selected from the district purposively. Primary data was collected from the selected respondents, which was interviewed through a well-designed questionnaire developed for the purpose. Question was asked of respondents, while having face-to-face interactions during field visits, which allowed very detailed insights information about their expenditures, problems they face, and management practices they applied for Bt. cotton production.

Analytical Measures

The data was further analyzed using Microsoft Excel to estimate the cost and revenue analysis, Average, Mean, estimation of land, labor cost, estimation of returns, total cost of production, net returns, input-output ratio, cost-benefit ratio, and other statistical calculations of Bt cotton crop productivity.

Arithmetic Mean

The arithmetic mean or average is the sum of a collection of numbers divided by the count of numbers in the collection. The arithmetic mean or average can also be used for tabulated presentation of data. It is a true representation of the whole data.

$$\text{Average} = \Sigma Xn/n$$

Where Σ= Total sum, xn = Variable used in analysis, n = no of observations.

Net Return

After deducting all expenditure from the total Income generated, we have a net return/profit.

$$TP = TR - TC$$

Where TP= Total profit, TR= Total revenue, TC= Total cost

RESULT AND DISCUSSION

This chapter presents the findings of the study, highlighting the present condition of Bt. cotton farming methods and the challenges faced by Bt. cotton growers. Analyzing and interpreting the collected data is a crucial part of any scientific research. These steps are essential for making broader conclusions and forecasts, which are key goals of research. The conclusions are based on the traits and opinions shared by the farmers who participated in the study.

Table 1. Area Production and Average Yield of Cotton in Pakistan (2007-08 to 2019-20)

Year	Area (000, ha)	Production (000 Bales)	Yield(K.gs/ha)
2007-08	3035	11650	653
2008-09	2850	12060	719
2009-10	3120	12698	692
2010-11	3200	14010	744
2011-12	2834	13595	816
2012-13	2878	13030	770
2013-14	2805	12768	774
2014-15	2961	13959	802
2015-16	2901	9917	581
2016-17	2489	10671	729
2017-18	2700	11945	752
2018-19	2373	9860	707
2019-20	2516	9151	619

Source: Agricultural Statistics of Pakistan, Government of Pakistan, (2020).

The results show that since 2007-08 and 2019-20, Pakistan's cotton cultivation has experienced both stability and setbacks over the years, with early periods showing strong production supported by consistent yields and cultivated area. However, fluctuations in recent years highlight challenges such as climate variability, pest infestations, and economic constraints affecting input availability. While favorable conditions, improved farming techniques, and better seed varieties contributed to growth at certain points, declining trends emphasize the sector's vulnerability to external pressures. Ensuring long-term sustainability requires strategic investments in irrigation, pest-resistant seed varieties, and farmer support through effective policies to stabilize production and enhance resilience against future disruptions.

Table 2. Shows the Socio-Economic Characteristics

Characteristics		Average
Age (Year)		43.25
Literacy's percent		74
Illiterate percent		26
Bt. cotton Growing Experience (Year)		3.08
Total family size (no)		9.46
Full-time family workers		2.41
Housing characteristics Percent	Kacha	0.1
	Kacha-pacca	0.62

	Pacca	0.28
Sources of income	Crop cultivation	11.2
	Livestock rasing	15.0
	Crops and livestock	66.0
	Other (job, shopkeeping, and artisans)	7.8

Table 2 shows that the majority of Bt. cotton farmers are literate and they are quite mature with an average age of 43.2 years; however, they have decided to produce Bt. cotton on about half of the land. Respondents have full confidence in Bt. cotton production, according to their experience, this study also revealed that 20 percent of farmers had their first season or second season in Bt. cotton growing. The average family size of respondents was 9.46 and 2.41. Average full-time family worker respondents' housing characteristics were divided into three categories, i.e., Kacha, Kacha-Pacca, and Pacca, and the averages were 0.1, 0.6166, and 0.2833, respectively.

The result shows in Table 3 that all respondents' source of income. Agriculture is the main source of income, with 76.7 percent and 15.0 percent of respondents who were also involved in livestock farming with agriculture. Respondents employed in different fields besides agriculture were 5.0 percent, and 3.3 percent of respondents have a source of income from agriculture with shops.

Table 3. Total Variable Costs Per/Acre by the Selected Bt. Cotton Farmer

Particulars	**Average Cost**
Land Preparation	18000
Seedling cost	12000
Labour	4000
Irrigation	13800
Weeding and Hoeing	6121
Fertilizer application	30800
Plant Protection	9600
Marketing Cost	
Harvesting (Picking, Handling, and Packing)	10250
Packing Material	3000
Transportation Charges	4000
Total Production Cost	**111571**

The show that fertilizers, irrigation, and pesticides are the most significant cost components, indicating their critical role in crop productivity. Labor and cultivation also contribute substantially to the overall expenses, reflecting the labor-intensive nature of cotton farming. Other notable costs include picking, implicit expenses, and miscellaneous charges, which together form a considerable portion of the total. Lower expenditures are observed in seed, weedicides, and intercultural operations. Overall, the total variable cost amounts to 192,001, highlighting the financial investment required for effective Bt. cotton cultivation.

Table 4. Yields, Price, Total Revenue, Expenditure, Profit, Input-Output Ratio, and Benefit Cost Ratio of BT Cotton

Yield: mun/acre	30
Price: Rs. /Mun	7700
Total Revenue Rs. /Acre	231000
Expenditure: Rs. /Acre	111571
Net Income: Rs/acre	119429
Input-output ratio Rupees	1:2:07
Benefit cost ratio Rupees	1:1:07

The above results show that BT cotton cultivation has promising economic potential backed by favorable efficiency and profitability indicators. The input-output ratio of 1:2.07 demonstrates that revenue generation significantly outweighs production investment, suggesting that resources are being effectively utilized. Similarly, a benefit-cost ratio of 1:1.07 confirms that the enterprise yields net profit beyond its costs, reinforcing its viability as a commercial crop. This indicates a profitable situation, as the income exceeds the cost, showing that Bt. cotton farming provides a positive return on investment for the farmers in the study area. This is related to the study of Farooqi (2009). These economic ratios reflect not only sound financial returns but also strategic management practices in terms of input optimization and market responsiveness. Altogether, the analysis highlights BT cotton as a reliable agricultural option for farmers seeking sustainable profitability within the current production landscape. According to one view, a reduction in seed prices enabled the farmers to buy seeds at lower prices, and this resulted in the sudden surge in area under BT cotton. (Arora, A. and S. Bansal. 2011)

Problem Faced by the BT. Cotton Growers in the Study Area

It was observed that not availability of canal water ranked first; this problem also raises the cost of production, while the poor road infrastructure problem is ranked 2nd in the list. lack of technical information on fruit production affecting the total output, therefore, effective parameters should be taken to minimize this problem, which are mentioned below.

Table 5. Problems Faced on BT. Cotton Production

Particular	**Frequency**	**Rank**
Not availability of Canal Water.	60	1st
Poor Road infrastructure	52	2nd
Unavailability of samples locally	52	2nd
Lack of technical information on Bt. cotton production	50	3rd
Commission charges	40	4th
No cold Storage	38	5th
No Local Market.	32	6th
Packing material	30	7th
Lack of handling during packing/ not skilled labor	28	8th
Not aware of the variety of strawberries	27	9rd
Too Much use of Chemical inputs may cause Environmental Degradation.	18	10th
Increase the mortality rate of the seedling due to the	15	11th

long distance.		
Cold Weather.	10	12th

The above problems were faced by respondents while cultivating Bt. cotton in district Hyderabad, sindh shown in (Table. 8). The data indicate that 100 percent of respondents face lack of irrigation water, 86.6 percent complaining for poor road infrastructure this may affects the quality of fruit because Bt. cotton is highly perishable, as well as non-availability of saplings at local market, this is increasing the cost of the local growers. About 83.3 percent of respondents had a lack of technical information about Bt. In cotton production, it was also revealed that about 66.6 percent of respondents faced high commission charges. No cold Storage was at the 5th Rank with 63.33 percent. In fact, there was no local market availability at the 6th rank; it was also a serious problem for growers, with 53.33 percent. Packing material is also an issue for growers because the timely material causes damage and affects the quality of Bt. cotton resulting decrease in gross income was at rank 7th with 50 percent, and lack of handling during packing was at rank 8th with 46.66 percent. It was also observed that 45 percent of respondents were not aware of the variety of Bt. cotton. Too much use of chemical inputs may cause environmental degradation. It is strongly suggested to take effective measures to save land degradation, like proper production technology, training sessions, guidelines, and extension services. It was ranked 10th with 30 percent. The increased mortality rate of seedlings due to long distance was at 11th rank with 25 percent, and cold weather sometimes at 12th rank with 16.66 percent.

CONCLUSIONS AND RECOMMENDATIONS

The study concluded that most respondents had considerable experience in cultivating Bt. cotton. Land ownership in Sindh is generally limited in size, and the majority of farmers work on their own plots. With the continuous rise in population, there is growing pressure to produce more food. To meet this demand, farmers have adopted intensive farming techniques, including increased use of fertilizers and modern technologies, which have contributed to higher agricultural output. To explore the production of Bt. cotton and its effect on crop yield. The research was conducted in the Shikarpur district recognized as a key area for cotton cultivation in Sindh province. Based on the findings, several recommendations were proposed

The study clearly shows that Bt. Cotton growers were achieving higher yields and greater profits. However, a reduction in the overall cotton-growing area negatively impacted total cotton output. Farmers were shifting focus toward expanding Bt. cotton cultivation. Therefore, it is recommended that more farmers receive training and encouragement to boost cotton production. Additionally, farmers lack awareness about the optimal mix of inputs and the correct sowing period. As a result, they either applied inputs inefficiently or planted seeds too early or too late in the season. During the survey, farmers offered several suggestions to improve cotton farming practices

- Availability of irrigation water must be increased and ensured.

- There should be a proper seed policy by the government, and fake seed companies and unregistered seeds must be banned.
- Rates of inputs (seed, fertilizer, pesticides) must be made better in favor of farmers.
- The scientists should make efforts for their own Bt. cotton varieties, because of Bt. Seed was expensive for farmers.
- A large cotton-growing area is under exotic and non-approved Bt cotton varieties.
- Needed system for fast implementation and enforcement of Bio-safety Guidelines.
- Promote integrated pest management (IPM) to reduce pesticide dependency.
- Encourage crop rotation practices to maintain soil fertility and minimize pest buildup.
- Strengthen cotton supply chains by connecting growers with reliable buyers and textile industries.
- Conduct regular workshops on input management, sowing time, and pest control to reduce misuse and optimize production.
- Remote farmer field schools or peer learning programs to spread best practices.

FURTHER STUDY

This research still has limitations, so further research on this topic is still needed.

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