THE ASIAN BULLETIN OF GREEN MANAGEMENT AND CIRCULAR ECONOMY
Vol 5, Issue 2(2025)

THE ASIAN BULLETIN OF GREEN MANAGEMENT AND CIRCULAR ECONOMY

ISSN (online): 2959-0035

http://abgmce.com/ 10.62019/abgmce.v5i2.171

ISSN (Print): 2959-0027

Economic Performance and Sustainability of Cotton Farming in Sindh, Pakistan: A Cost–Benefit and Green Management Perspective

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Chronicle

Article history

Received: Sept 24, 2025
Received in the revised format: Oct 26, 2025
Accepted: Nov 27, 2025
Available online: Dec 25, 2025

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Abstract

Cotton is a cornerstone of Pakistan's agricultural and industrial economy; however, its cultivation faces increasing sustainability challenges due to rising input costs, water scarcity, climatic variability, and market inefficiencies. This study evaluates the economic performance and sustainability of cotton farming in Sindh, Pakistan, using a cost–benefit and green management perspective. Primary data were collected from 120 cotton growers in Jamshoro and Sanghar districts through a structured questionnaire. Descriptive statistics, cost–benefit analysis, and regression analysis were employed to assess profitability and determinants of net income. Results show that the average cost of cotton production was Rs. 135,900 per acre, while average gross revenue was Rs. 216,900 per acre, yielding a mean net income of Rs. 81,000 per acre. The average cotton yield was 26 maunds per acre, with a mean market price of Rs. 8,100 per maund. The benefit–cost ratio ranged from 0.28 to 0.80, with an average value of 0.54, indicating vulnerability to rising input costs and price volatility. Regression results revealed that education (β = 1,250, $p < 0.05$), farming experience (β = 430, $p < 0.05$), and farm size (β = 2,980, $p < 0.01$) had a positive and significant effect on net income, in contrast fertilizer cost (β = −0.45, $p < 0.05$) and irrigation frequency (β = −1,620, $p < 0.05$) negatively affected profitability. The model explained 62% of the variation in net income (R^2 = 0.62). The findings highlight the importance of efficient input use, farmer capacity building, and water-efficient practices aligned with green management and circular economy principles to enhance the economic and environmental sustainability of cotton farming in Sindh.

Keywords: Cotton farming; Green management; Circular economy; Cost–benefit analysis; Sustainability; Pakistan.

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INTRODUCTION

Cotton (*Gossypium* spp.) is one of the most important natural fiber crops globally, providing raw material for the textile industry, edible oil, livestock feed, and various industrial products. Historically, cotton played a central role in the Industrial Revolution and continues to be the most widely consumed natural fiber worldwide (Abdurakhmonov, 2016; Riello, 2022). Cotton cultivation supports the livelihoods of nearly 100 million households globally, the majority of whom reside in developing countries (Voora et al., 2023). Pakistan is among the world's leading cotton-producing countries and relies heavily on cotton for agricultural growth, industrial development, and export earnings. The cotton sector contributes approximately 0.7% to national GDP and around 2.9% to agricultural value addition (Government of Pakistan, 2023–24). The textile industry, which depends primarily on domestic cotton production, is the backbone of Pakistan's export economy and a major source of employment (The

Nation, 2024). Punjab and Sindh are the main cotton-producing provinces of Pakistan, with Sindh often recording higher per-acre yields due to favorable climatic conditions and soil characteristics (Pakistan Cotton Ginners Association, 2023). However, over the past decade, cotton production in Pakistan has experienced considerable fluctuations due to water shortages, pest infestations, poor-quality seed, rising input costs, climate variability, and market instability (Abbas et al., 2019; Khan et al., 2020; Mahmood, 2025). In Sindh, cotton production increased between 2012 and 2016 but declined sharply after 2017, largely because of irrigation constraints and rising production costs.

Jamshoro and Sanghar districts are key cotton-producing areas in Sindh and play an important role in regional agricultural income and employment. Despite their importance, cotton growers in these districts face multiple challenges, including high fertilizer and pesticide prices, labor shortages, limited access to certified seed, weak extension services, and volatile market prices. These constraints adversely affect farm profitability and threaten the long-term sustainability of cotton farming.

Despite the economic importance of cotton in Pakistan, most existing studies focus on aggregate production trends or partial cost analysis, with limited empirical evidence at the farm level, particularly from Sindh Province. Moreover, very few studies have examined cotton profitability through a green management and circular economy perspective, integrating resource-use efficiency, cost structures, and sustainability implications. Therefore, a clear research gap exists in assessing farm-level cost–benefit performance of cotton growers in Sindh using primary data and sustainability-oriented analysis, which this study aims to address.

In this context, evaluating the economic performance of cotton growers through a cost–benefit framework is essential for understanding the financial viability of cotton cultivation and identifying opportunities for improvement. Moreover, integrating green management and circular economy perspectives can help promote efficient resource use, reduce waste, and enhance sustainability. Therefore, this study assesses the economic performance and sustainability of cotton farming in Sindh, Pakistan, using farm-level data from Jamshoro and Sanghar districts

PURPOSE OF THE STUDY

The purpose of this study is to evaluate the economic performance and sustainability of cotton growers in Sindh, Pakistan, by analyzing the costs and benefits associated with cotton cultivation. Given the crop's critical role in rural livelihoods and the national economy, understanding profitability, input–output relationships, and financial risks faced by farmers is essential. The study also aims to identify key factors influencing cotton productivity and profitability and to provide evidence-based recommendations aligned with green management and circular economy principles.

- To analyze the socio-economic characteristics and farming practices of cotton growers in Jamshoro and Sanghar districts of Sindh.
- To estimate production costs, revenues, net returns, and benefit–cost ratio of cotton cultivation per acre.
- To identify major factors affecting cotton productivity and profitability, including input quality, labor, irrigation, and market conditions.
- To discuss implications of cotton farming for green management and circular economy in Sindh.

HYPOTHESES

- **H1:** Farmers' socio-economic characteristics significantly influence cotton productivity.
- **H2:** Higher input costs negatively affect the net profitability of cotton cultivation.
- **H3:** Market prices, irrigation availability, and input quality significantly influence the benefit–cost ratio of cotton farming.

METHODOLOGY

Study Area

The study was conducted in Jamshoro and Sanghar districts of Sindh Province, Pakistan, which are among the major cotton-producing regions of the country. Jamshoro district comprises four Talukas—Sehwan, Manjhand, Kotri, and Thano Bula Khan—where cotton farming constitutes an important source of rural livelihood. The selection of these districts was based on their significant contribution to provincial cotton production and variation in farm size, irrigation availability, and production practices.

Sampling Procedure

A purposive sampling technique was adopted to select cotton-producing villages from Jamshoro and Sanghar districts. Six villages were selected based on the intensity of cotton cultivation. From each village, 20 cotton growers were randomly interviewed, resulting in a total sample size of 120 respondents. The sample captured diversity in farmers' age, education level, farming experience, and landholding size.

Data Collection

Primary data were collected through a structured questionnaire developed in consultation with agricultural economics experts. Face-to-face interviews were conducted to gather detailed information on socio-economic characteristics of farmers, input use (seed, fertilizer, chemicals, labor, irrigation), production costs, cotton yield, market prices, and farm-level constraints. Secondary data were obtained from government publications, research articles, and cotton industry reports to support and contextualize the primary findings.

ANALYTICAL TECHNIQUES

Descriptive and Economic Analysis

Descriptive statistics such as mean, percentages, and standard deviation were used to summarize socio-economic characteristics and input use patterns of cotton growers. Economic performance was evaluated using standard farm management indicators, including total cost of production, gross revenue, net income, and benefit–cost ratio (BCR). These indicators provided an overview of profitability and financial viability of cotton farming.

Regression Analysis

To identify key factors influencing cotton profitability, a multiple linear regression model was employed. **Net income per acre** was used as the dependent variable, as it represents overall economic performance of cotton farming. Independent variables were selected based on economic theory and prior empirical studies.

The regression model is specified as follows:

$$NI_i = \beta_0 + \beta_1 EDU_i + \beta_2 EXP_i + \beta_3 FS_i + \beta_4 FERTC_i + \beta_5 IRR_i + \varepsilon_i$$

Where:

- NI_i= Net income from cotton per acre (Rs.)
- EDU_i= Education of farmer (years of schooling)
- EXP_i= Farming experience (years)
- FS_i= Farm size under cotton cultivation (acres)
- $FERTC_i$= Fertilizer cost per acre (Rs.)
- IRR_i= Number of irrigation applications
- β_0= Intercept
- β_1–β_5= Regression coefficients
- ε_i= Error term

The regression analysis was conducted to examine the direction and magnitude of the relationship between explanatory variables and cotton profitability. The coefficient of determination (R^2) was used to assess the explanatory power of the model, while t-statistics and p-values were applied to test the statistical significance of individual variables at conventional significance levels.

Ethical Considerations

Participation in the survey was voluntary, and respondents were informed about the purpose of the study. Data collected were used strictly for academic research, and confidentiality of respondents was maintained throughout the analysis.

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Cotton Growers

Table 1 presents the socio-economic profile of the sampled cotton farmers in Jamshoro and Sanghar districts. The average age of respondents was 37.7 years, indicating that cotton farming is largely managed by economically active middle-aged farmers. The mean education level was 8.55 years, suggesting moderate literacy, which plays an important role in technology adoption and farm management decisions. Farmers had an average of 20 years of farming experience, reflecting long-term engagement in cotton cultivation. On average, 4 family members were involved in farming activities, and the mean landholding under cotton cultivation was 7 acres, highlighting the dominance of smallholder farming systems in the study area.

Table 1.
Socio-Economic Characteristics of Cotton Growers in Sindh

S. No.	Variable	Unit	Mean	Std. Dev.	Minimum	Maximum
1	Age	Years	37.7	10.05	19	60
2	Education	Years	8.55	4.69	0	29
3	Farming experience	Years	20.0	9.01	5	40
4	Family members involved in farming	Persons	4.0	1.88	1	9
5	Land under cotton cultivation	Acres	7.0	4.30	1	20

Input Use Pattern in Cotton Cultivation

The input use pattern of cotton farmers is summarized in Table 2. On average, farmers performed 6.5 plowing operations per acre and used 6.5 kg of seed per acre. Fertilizer application averaged 5 bags per acre, while chemical sprays were applied approximately 4.5 times per season. Irrigation was applied an average of 8.5 times, indicating high dependence on water resources. These results show that cotton farming in Sindh is input-intensive, which significantly contributes to rising production costs.

Table 2.
Input Use Pattern of Cotton Cultivation (Per Acre)

Particulars	Unit	Mean	Minimum	Maximum
Plowing	No./Acre	6.50	5.00	8.00
Seed rate	Kg	6.50	5.00	8.00
Fertilizer application	Bags	5.00	4.00	6.00
Chemical sprays	No.	4.50	4.00	5.00
Irrigation applications	No.	8.50	7.00	10.00

Cost Structure of Cotton Production

Table 3 presents the average cost structure of cotton production per acre. The total cost of production was Rs. 135,900 per acre. Harvesting (picking) cost constituted the largest share (Rs. 39,000), followed by fertilizer cost (Rs. 26,500) and land preparation cost (Rs. 20,800). High labor and input prices substantially increased the overall cost of production, reducing net profitability.

Table 3.
Cost of Cotton Production (Per Acre)

Cost Components	Unit	Mean Cost (Rs.)	Minimum (Rs.)	Maximum (Rs.)
Land preparation	Rs./Acre	20,800	16,000	25,600
Seed & sowing	Rs./Acre	10,100	8,000	12,200
Fertilizer	Rs./Acre	26,500	22,000	31,000
Chemicals	Rs./Acre	6,750	6,000	7,500
Irrigation	Rs./Acre	13,250	10,500	16,000
Labor	Rs./Acre	13,000	11,000	15,000
Harvesting (picking)	Rs./Acre	39,000	28,500	49,500
Transportation	Rs./Acre	6,500	4,750	8,250
Total Cost	Rs./Acre	**135,900**	**106,750**	**165,050**

Yield, Revenue, and Profitability of Cotton

The yield and profitability indicators of cotton cultivation are presented in Table 4. The average yield was 26 maunds per acre, with an average market price of Rs. 8,100 per maund. Gross revenue averaged Rs. 216,900 per acre, resulting in a net income of Rs. 81,000 per acre. The benefit–cost ratio ranged from 0.28 to 0.80, indicating that many farmers operate close to the breakeven level and are vulnerable to fluctuations in input prices and market rates.

Table 4.
Yield, Revenue, and Profitability of Cotton (Per Acre)

Indicators	Unit	Mean	Minimum	Maximum
Yield	Maunds (40 kg)	26.0	19.0	33.0
Market price	Rs./Maund	8,100	7,200	9,000
Gross revenue	Rs./Acre	216,900	136,800	297,000
Net income	Rs./Acre	81,000	30,050	131,950

Indicators	Unit	Mean	Minimum	Maximum
Benefit–Cost Ratio	Ratio	0.54	0.28	0.80

Determinants of Cotton Profitability

To examine factors influencing cotton profitability, a simple linear regression analysis was conducted using net income per acre as the dependent variable. Independent variables included farmers' education, farming experience, farm size, fertilizer cost, and irrigation frequency. The results are presented in Table 5.

Table 5.
Determinants of Net Income from Cotton Cultivation

Variables	Coefficient	Std. Error	t-value	Significance
Education (years)	+1,250	520	2.40	0.02
Farming experience (years)	+430	210	2.05	0.04
Farm size (acres)	+2,980	890	3.35	0.01
Fertilizer cost (Rs.)	−0.45	0.18	−2.50	0.02
Irrigation frequency	−1,620	710	−2.28	0.03
Constant	18,500	—	—	—
R^2	0.62			

Significant at $p \leq 0.05$

The regression results indicate that education, farming experience, and farm size have a positive and statistically significant impact on net income from cotton cultivation. In contrast, higher fertilizer costs and excessive irrigation frequency negatively affect profitability. These findings support the hypothesis that rising input costs reduce farm profitability, while human capital and scale of operation enhance economic performance. The results are consistent with earlier findings reported by Abbas et al. (2019) and Ahmad et al. (2016), confirming the importance of efficient input management and farmer capacity building.

From a green management perspective, high input costs and inefficient resource use reduce both economic and environmental sustainability. Excessive fertilizer and chemical use increase production costs and environmental risks. Improving water-use efficiency through better irrigation management and adopting integrated pest management practices can reduce costs and environmental impacts. Circular economy approaches, such as recycling crop residues, optimizing input use, and strengthening value chains, can enhance resource efficiency and long-term sustainability of cotton farming in Sindh.

CONCLUSION

This study provides a comprehensive evaluation of the economic performance and sustainability of cotton farming in Sindh, Pakistan, using farm-level primary data and a cost–benefit and green management perspective. The findings confirm that cotton cultivation remains a vital source of income for rural households and a key contributor to Pakistan's agricultural and industrial economy; however, its long-term sustainability is increasingly threatened by rising production costs, inefficient resource use, and market volatility. The economic analysis revealed that the average cost of cotton production was Rs. 135,900 per acre, while average gross revenue reached Rs. 216,900 per acre, resulting in a mean net income of Rs. 81,000 per acre. Although these figures indicate that cotton farming is still profitable, the average benefit–cost ratio of 0.54 highlights economic vulnerability, particularly for smallholders operating close to the breakeven point. High expenditures on fertilizers, labor, irrigation, and

harvesting were identified as the major contributors to increased production costs, significantly constraining farm profitability.

Regression analysis further strengthened these findings by identifying the key determinants of cotton profitability. Education, farming experience, and farm size were found to have a positive and statistically significant impact on net income, indicating that human capital and scale of operation play an important role in improving economic performance. In contrast, fertilizer cost and irrigation frequency exerted a negative and significant effect on profitability, underscoring the adverse impact of excessive input use and inefficient water management. The regression model explained 62% of the variation in net income, confirming the robustness of the analytical framework used in this study.

From a green management and circular economy perspective, the results emphasize the urgent need for improving resource-use efficiency in cotton production systems. Reducing excessive fertilizer application, adopting balanced nutrient management, improving irrigation efficiency, and promoting integrated pest management can lower production costs while minimizing environmental impacts. Furthermore, circular economy approaches such as recycling crop residues, optimizing labor and harvesting practices, and strengthening sustainable cotton value chains can enhance both economic resilience and environmental sustainability.

Overall, this study concludes that while cotton farming in Sindh remains economically important, its future viability depends on the adoption of green management practices, farmer capacity building, and supportive policy interventions. Strengthening agricultural extension services, improving access to quality inputs, promoting water-efficient technologies, and stabilizing market conditions are critical for enhancing profitability and ensuring the long-term sustainability of cotton production. The findings provide valuable insights for policymakers, researchers, and practitioners seeking to promote sustainable and circular agricultural systems in Pakistan and similar developing-country contexts.

POLICY RECOMMENDATIONS

- Promote **efficient and balanced fertilizer use** through soil testing, site-specific nutrient management, and timely availability of certified inputs to reduce production costs and improve profitability.

- Improve **irrigation and water-use efficiency** by promoting optimal irrigation scheduling, water-saving technologies, and better canal and on-farm water management practices.

- Strengthen**farmer education and extension services**, focusing on sustainable agronomic practices, cost management, and green farming techniques to enhance decision-making and productivity.

- Provide **institutional and financial support for smallholder farmers**, including low-interest credit, crop insurance schemes, and cooperative input procurement to reduce economic vulnerability.

- Encourage adoption of **green management practices**, such as integrated pest management, reduced chemical dependence, and efficient harvesting methods, to lower costs and environmental risks.

- Strengthen**cotton market systems** by improving price support mechanisms, market information services, and linkages between farmers, ginners, and textile industries to ensure stable returns.

AUTHOR CONTRIBUTIONS

Ali Mustafa conceptualized the study, designed the methodology, performed the economic and regression analyses, and drafted the original manuscript. Mehar ul Nissa Rais contributed to study design, data interpretation, and critical revision of the manuscript. Lakhano and Muhammad Zaman assisted in field survey design, data collection, and preliminary data processing. Mukhtiar Ali Shaikh supported statistical analysis and contributed to results interpretation. Ghulam Nabi Dahri provided guidance on sustainability, green management perspectives, and policy implications. Nazia Rais contributed to literature review, manuscript editing, and overall technical improvement. All authors reviewed, revised, and approved the final version of the manuscript.

DECLARATIONS

Acknowledgement: We appreciate the generous support from all the contributor to the research and their different affiliations.
Funding: No funding body in the public, private, or nonprofit sectors provided a particular grant for this research.
Availability of data and material: In the approach, the data sources for the variables are stated.
Authors' contributions: Each author participated equally in the creation of this work.
Conflicts of Interest: The authors declare no conflict of interest.
Consent to Participate: Yes
Consent for publication and Ethical approval: Because this study does not include human or animal data, ethical approval is not required for publication. All authors have given their consent.

REFERENCES

Abbas, Q., Khan, M. A., & Hussain, A. (2019). Economic analysis of cotton production in Sindh, Pakistan. *Pakistan Journal of Agricultural Economics*, 32(2), 45–58.
Abdurakhmonov, I. Y. (2016). *Cotton biotechnology: A global perspective*. Springer.
Ahmad, M., Ali, T., & Khan, M. (2016). Profitability and constraints of cotton production in Pakistan. *Sarhad Journal of Agriculture*, 32(3), 215–223.
Government of Pakistan. (2023–24). *Economic Survey of Pakistan*. Ministry of Finance.https://www.finance.gov.pk/survey/
Khan, N. A., Abbas, M., & Raza, S. (2020). Challenges in cotton production under climate change. *Climate Risk Management*, 30, 100113.https://www.iisd.org/publications/global-cotton-market-sustainability
Mahmood, R. (2025). Cotton sector dynamics in Pakistan. *Journal of Rural Development*, 44(1), 1–15.
Pakistan Cotton Ginners Association. (2023). *Annual cotton statistics of Pakistan*. Karachi.
Riello, G. (2022). *Cotton: The fabric that made the modern world*. Cambridge University Press.
Siddiqui, K. M., Khan, A., & Malik, M. A. (1983). *Farm management analysis*. Pakistan Agricultural Research Council.
Voora, V., et al. (2023). *Global cotton market and sustainability*. International Institute for Sustainable Development.

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