Cotton Cultivation Decisions: An Empirical Study of Acreage Elasticity

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ABSTRACT

The study aimed to analyse the acreage response of cotton cultivation in Rajkot district using the Nerlovian adjustment lag model, with the objective of identifying key factors influencing farmers' decisions on area allocation. A quantitative research design was employed using 15 years of time-series data, and the model incorporated variables such as competing crop area, past prices, past yields, price risk, yield risk, and rainfall. Results showed that the model had high explanatory power with an R^2 of 0.8520, explaining 85.2% of the variation in cotton acreage. The intercept (523,203.16) was statistically significant at the 5% level (p = 0.016). The area under groundnut exerted a negative effect (-0.39152, p = 0.12), suggesting competition with cotton. Past price (-3.76806, p = 0.18), past yield (-12.71739, p = 0.30), price risk (33.9989, p = 0.43), and rainfall (-8.78208, p = 0.71) were all found to be statistically non-significant. In contrast, yield risk emerged as the most influential factor with a large negative coefficient (-62,980.84) and was statistically significant at the 5% level (p = 0.03), indicating that higher yield variability strongly discouraged farmers from allocating more land to cotton cultivation. The study concluded that while most explanatory variables did not significantly impact cotton acreage, yield risk played a critical role in influencing farmers' decisions, highlighting the need for improved agronomic practices, technological support, and effective risk management measures to reduce yield uncertainty and stabilize cotton production in the region.

Keywords: Cotton, Acreage response, Nerlovian adjustment lag model, Rajkot

1. INTRODUCTION

Cotton remains a cornerstone of agricultural economies across the globe, particularly in countries like India where it plays a vital role in rural livelihoods, industrial supply chains, and export earnings. As a cash crop with significant economic importance, the decisions farmers make regarding cotton cultivation especially the allocation of land or acreage are influenced by a complex interplay of market signals, policy interventions, climatic conditions, and resource availability (Godara et al., 2015; Agarwal et al.,2023) . India's cotton production has shown mixed trends in recent years. National output declined slightly from 336.60 lakh bales in 2022-23 to 325.22 lakh bales in 2023-24, indicating a modest contraction in growth. In contrast, Gujarat's cotton production has steadily increased, rising from 87.95 lakh bales in 2022–23 to 90.57 lakh bales in 2023-24, reflecting a positive growth trajectory (Divya, 2024; Oganja et al., 2024a; Bani et al. 2025; Ghadiya & Maheta, 2018). This upward trend in Gujarat is attributed to improved productivity, which surged from 139 kg/hectare in 1960 to 589 kg/hectare in 2024, driven by hybrid seed adoption and farmer-centric policies. Gujarat stands as the undisputed leader in cotton production within India, contributing a substantial share to both the country's total output and its global export footprint (Bharodia et al. 2025).

The state’s dominance is reflected in its expansive cultivation area and its impressive production figures in recent years. In addition to genetic advancements, farmers in Gujarat have embraced a suite of modern agronomic practices. Techniques like drip irrigation have optimized water use efficiency (Rohit et al., 2015; Prajapati et al., 2018; Parmar et al., 2024), while integrated pest management and precision farming have helped maintain ecological balance and reduce input costs (Oganja et al.,2024b; Kumar et al., 2024a). These innovations are supported by a strong network of agricultural extension services, research institutions, and government initiatives that promote sustainable and profitable farming (Sathish et al., 2022; Pithiya et al., 2024b; Kumar et al., 2024b). Policies such as the Minimum Support Price (MSP) scheme and procurement operations by the Cotton Corporation of India (CCI) provide financial stability and market assurance to growers, encouraging continued investment in cotton cultivation (Nariya et al., 2024). Beyond its agricultural significance, Gujarat’s cotton sector is deeply intertwined with the state’s industrial and socio-economic fabric. It supplies raw material to a thriving textile industry, generates employment across rural and urban areas, and sustains the livelihoods of millions of farming families. As such, cotton is not merely a crop in Gujarat it is a strategic asset that underpins the state’s economic resilience and global competitiveness in textiles. Rajkot district in Gujarat is a significant cotton-growing region. Farmers here are increasingly adopting sustainable practices under initiatives like the Better Cotton Initiative (BCI), which promotes eco-friendly cultivation and improved livelihoods (Sathish et al., 2019; Pithiya et al., 2024a). Cotton farming faces several constraints including high water requirements, vulnerability to pests like bollworms, and dependence on chemical inputs. Additionally, fluctuating market prices and climate variability can impact yield and farmer income (Ghangale et al., 2018; Vennila et al., 2018; Nakum et al., 2024b).

Understanding the elasticity of acreage response to various economic and non-economic factors is crucial for policymakers, agronomists, and stakeholders in the cotton value chain (Kormla et al., 2015; Katariya et al.,2016; Sulthana et al.,2019; Vasoya et al.,2024; Nakum et al., 2024a). Acreage elasticity, in particular, reflects the sensitivity of farmers’ planting decisions to changes in prices, input costs, and other incentives. This empirical study aims to quantify and analyse the determinants of acreage allocation for cotton cultivation, shedding light on how farmers respond to changing economic environments in Rajkot district. By employing econometric models and time-series data, this research investigates the extent to which cotton acreage decisions are influenced by price expectations, government support mechanisms, and competing crop profitability. The findings are expected to offer insights into the behavioral patterns of farmers and contribute to more informed agricultural policy design, especially in Rajkot district where cotton is a dominant crop.

2. MATERIAL AND METHODS

2.1 Source of data

This study was conducted in the year 2025. The study was based on secondary data collected for the period of 15 years from 2010 to 2024. The annual data for related to hectareage and yield was collected from Directorate of Agriculture, Gujarat state, Gandhinagar (DAG). The data pertaining to farm harvest prices was collected from Directorate of Economics and Statistics, DAC & FW, Ministry of Agriculture and Farmers Welfare, GoI, New Delhi. The data related to rainfall was collected for the month of sowing and total annual rainfall.

2.2 Selection of competing crop

Selection of competing crops was done on the basis of its total area, sowing season and/or the magnitude as well as direction of correlation between the areas of these crops. In Rajkot, district groundnut was selected as competing crop.

2.3 Nerlovian adjustment lagged mode

This model was applied to examine the acreage response of cotton crop during the 2025. Cotton acreage was regressed on lagged cotton acreage, lagged cotton price, lagged cotton yield, price risk, yield risk and pre-sowing rainfall in the selected district area. Using Nerlovian Adjustment Lag model (Nerlove, 1958) as a basic framework, the form of equation for the acreage response function is specified as follows for Nerlovian Adjustment Lag model:

$$\mathbf{A_t = a + b_1A_{t-1} + b_2RP_{t-1} + b_3AG_{t-1} + b_4RY_{t-1} + b_5PR + b_6YR + b_7RF_t + U_t}$$

Where,

a = Intercept

A_t = Area in hectares under the crop (Cotton)

A_{t-1} = Area in hectares under the crop in the year t-1 (Cotton)

AG_{t-1} = Area in hectares under the crop in the year t-1 (Groundnut)

b_1 to b_7 = Regression co-efficient

RP_{t-1} = Price of crop in year t-1(Rs/qtl)

Ry_{t-1} = Yield of crop in year t-1(Kg/ha)

PR = Price risk measured in terms of standard deviation

YR = Yield risk measured in terms of standard deviation

RF_t = Total rainfall (mm) in the year t

U_t = Random error term

3. RESULTS AND DISCUSSION

To analyze the factors influencing farmers' decisions regarding land allocation for cotton cultivation, the Nerlovian adjustment lag model was applied using a time-series dataset consisting of 15 observations. This model is particularly suited for capturing the dynamic nature of agricultural decision-making, where past behavior and economic variables influence current choices. The model yielded a high explanatory power, with an R^2 value of 0.8520, indicating that 85.2% of the variation in the area allocated to cotton could be explained by the independent variables included in the analysis. This strong fit underscores the relevance of the selected factors in shaping farmers' planting decisions.

The intercept of the model, valued at 523,203.16, was statistically significant at the 5% level ($p = 0.016$), suggesting a solid foundational level of cotton cultivation area even in the absence of other influencing variables. Among the explanatory variables, the area under cotton cultivation in the previous period showed a positive coefficient (0.16463), implying that farmers tend to maintain or slightly increase cotton acreage over time, possibly due to habitual cropping patterns or infrastructural investments. However, this relationship was not statistically significant ($p = 0.47$), indicating that inertia alone may not be a strong predictor of future allocation. In contrast, the area under groundnut cultivation exhibited a negative coefficient (-0.39152), approaching statistical significance ($p = 0.12$). This suggests a potential competitive relationship between cotton and groundnut, where an increase in groundnut acreage may lead to a reduction in cotton area, likely due to resource constraints or comparative profitability. Such insights are crucial for policymakers and agricultural planners aiming to balance crop diversification with optimal land use.

Economic indicators such as the lagged price of cotton (-3.76806; p = 0.18) and previous year's yield (-12.71739; p = 0.30) both had negative but statistically insignificant effects, implying that past market performance did not strongly influence current planting decisions. This suggests that farmers in the study region may not rely heavily on past price trends or yield outcomes when planning their crop area, possibly due to limited access to market intelligence or a lack of trust in price stability. Price risk, measured by the standard deviation of cotton prices, had a positive coefficient (33.9989), suggesting that volatility might encourage planting, yet its impact was not statistically validated (p = 0.43) but hinting that some farmers might perceive volatility as an opportunity for higher returns. However, its lack of statistical significance indicates that this perception is not widespread or influential enough to drive planting decisions. In contrast, Yield risk was identified as the most influential factor affecting farmers' decisions on cotton area allocation, as evidenced by its significantly negative coefficient of -62,980.84 and a p-value of 0.03. This statistical significance underscores the strong deterrent effect that uncertainty in crop yield has on farmers' willingness to commit land to cotton cultivation. The magnitude of the coefficient suggests that even moderate increases in yield variability can lead to substantial reductions in the area planted with cotton. This finding reflects the deep vulnerability of farmers to production shocks, such as pest outbreaks, erratic weather, or soil degradation, which can severely impact harvest outcomes. Given their limited capacity to absorb such risks, farmers tend to adopt a cautious approach, preferring crops with more predictable returns. The aversion to yield risk highlights the need for targeted interventions—such as improved access to crop insurance, adoption of resilient seed varieties, and enhanced extension services—to mitigate uncertainty and build confidence among growers. Addressing yield volatility is therefore essential not only for stabilizing cotton production but also for supporting the economic security of farming communities. Rainfall had a minor negative effect (-8.78208; p = 0.71), but it was statistically insignificant effect, possibly due to irrigation coverage or variability in rainfall patterns.

Overall, the analysis revealed that while several variables influenced cotton area allocation, yield risk was the most decisive and statistically significant factor shaping farmers' choices during the study period. Given these insights, policy interventions should prioritize reducing yield uncertainty to encourage cotton cultivation. This could include promoting climate-resilient seed varieties, expanding access to crop insurance, and improving extension services that offer timely agronomic advice. Additionally, enhancing farmers' access to reliable market information and forecasting tools could help them make more informed decisions, potentially increasing their responsiveness to price signals. By addressing both production and information risks, stakeholders can foster a more stable and confident environment for cotton growers.

Table 1. Acreage response of Cotton crop in Rajkot district

Variables	**Coefficient**	**P Value**
Intercept	523203.16	**0.016****
Area in hectares under the Cotton crop (ha)	0.16463	0.47^{NS}
Area in hectares under the Ground nut crop (ha)	-0.39152	0.12^{NS}
Price of crop in year t-1(Rs/qtl)	-3.76806	0.18^{NS}
Price of crop in year t-1 (qtl/ha)	-12.71739	0.30^{NS}
Price risk (Standard deviation)	33.9989	0.43^{NS}
Yield risk (Standard deviation)	-62980.84	**0.03****
Rainfall (mm)	-8.78208	0.71^{NS}
R^2 = 0.8520 n = 15		

d.f. = 14

*NS = Non-significant, ** Significant at 5 per cent level*

4. CONCLUSION

The Nerlovian adjustment lag model revealed that 85.2% of the variation in cotton cultivation area in Rajkot district could be attributed to the selected explanatory variables, demonstrating strong predictive capability. Although the area under cotton showed a positive association with future allocation, the effect was statistically insignificant, indicating limited influence. In contrast, the area under groundnut exerted a negative impact, suggesting a competitive relationship between the two crops for land resources. Other factors such as past cotton prices, previous yields, and rainfall did not significantly affect farmers' decisions on area allocation. Notably, yield risk emerged as the most influential determinant, with a substantial and statistically significant negative effect. This finding highlights that greater uncertainty in crop yield strongly discourages farmers from dedicating land to cotton, making yield risk the dominant factor shaping acreage decisions in the region.

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