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An Analytical Study of the Factors Influencing Farmers' Preference for Sugarcane Cultivation in the Baghpat District, Uttar Pradesh

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ABSTRACT

This study explores the key factors influencing farmers' preference for sugarcane cultivation in Baghpat district, Uttar Pradesh—an agriculturally intensive region with widespread sugarcane farming. Using primary data collected from 120 sugarcane farmers through a multistage stratified random sampling method, the research investigates socio-economic, infrastructural, and institutional drivers of crop choice. Sixteen variables were evaluated using a five-point Likert scale and analyzed through Principal Component Analysis (PCA) to reduce dimensionality and identify dominant patterns. Four principal components—economic security, market accessibility, risk management, and profitability—were found to collectively explain 54.8% of the total variance. These components were further validated using multiple linear and quadratic regression models. Results reveal that assured pricing, government support, proximity to markets, and profitability are significant determinants of farmers' crop preferences. The findings offer valuable insights for policymakers, suggesting that interventions targeting price stability, infrastructure development, and income diversification could enhance the sustainability and attractiveness of sugarcane cultivation in the region.

1. Introduction

Agriculture forms the backbone of the Indian economy, employing a significant portion of the rural population and contributing substantially to the nation's GDP. Among the diverse agricultural activities practiced in India, sugarcane cultivation holds a prominent position due to its economic value, high yield potential, and the growing demand from the sugar and allied industries. Uttar Pradesh, one of India's largest agrarian states, plays a crucial role in sugarcane production, with the Baghpat district being a notable contributor to the state's sugarcane output. Baghpat, located in western Uttar Pradesh, is characterized by fertile alluvial soil, an extensive canal irrigation network and favorable climatic conditions—factors that collectively support intensive agricultural practices. Over the years, sugarcane has emerged as the dominant crop in the region, often replacing other traditional food and cash crops. This preference for sugarcane cultivation among farmers raises critical questions about the socio-economic, institutional and environmental factors influencing crop choice in the district. The decision to cultivate sugarcane is influenced by a complex interplay of factors such as assured market linkages with sugar mills, higher profitability compared to other crops, availability of irrigation facilities, government incentives and long-standing farming traditions. However, this preference also presents challenges such as water resource depletion, delayed payments by sugar mills and reduced crop diversification, which may affect the long-term sustainability of the agricultural ecosystem.

2. Data and methodology

This study is based on primary data collected from Baghpat district in Uttar Pradesh, where sugarcane is widely grown. Using a multistage sampling method, three blocks with high sugarcane cultivation were selected. From each block, two villages were randomly chosen, and 120 farmers (20 per village) were surveyed using a structured questionnaire. The

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survey gathered information on land size, income, irrigation, market access, and farmers' views on sugarcane. Secondary data from government reports and research studies supported the analysis. The responses covered 16 factors (C1 to C16) rated on a five-point scale. Data were standardized using Z-scores, and Principal Component Analysis (PCA) was used to reduce complexity and identify key factors. The first four components explained 54.8% of the total variation. Varimax rotation helped clarify which variables influenced each component. Tools like scree plots and heatmaps were used for better understanding, and statistical software ensured accurate results. To further analyze the influence of identified factors on the extent of sugarcane cultivation, multiple statistical and econometric techniques were applied. Descriptive statistics were used to profile the respondents and summarize key socio-economic indicators. The extracted principal components were used as explanatory variables in a **multiple linear regression model** to quantify their impact. Furthermore, a **quadratic regression model** was applied to capture the potential non-linear relationship between farmer income and sugarcane acreage. The key formulas employed in the analysis are outlined below:

Principal Component Analysis (PCA):-

Let X be the data matrix with n observations and p variables. The components are extracted by solving:

$$\text{Maximize Var}(Z) = \text{Maximize } a' \Sigma a \text{ subject to } a' a = 1$$

where $Z = a'X$ is the principal component, and Σ is the covariance matrix.

Multiple Linear Regression Model

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k + \varepsilon$$

where Y is the dependent variable (e.g., sugarcane area), X_i are independent variables (factors), β_i are coefficients, and ε is the error term.

Quadratic Regression Model

$$Y = \alpha + \beta X + \gamma X^2 + \varepsilon$$

Where Y is the area under sugarcane cultivation, X is income or another influencing factor, and γ captures the curvature of the relationship.

The combination of these tools allows for a comprehensive assessment of the socio-economic, infrastructural, and policy-related factors affecting the farmers' preference for sugarcane cultivation in Baghpat district.

3. Result and discussion

3.1 Results of Principal Component Analysis Explained Variance:

The PCA identified 16 principal components, with the first four explaining a cumulative 54.8% of the total variance. Table 1 summarizes the variance explained by each component.

Table 1: Explained Variance by Principal Components

Principal Component	Variance Explained (%)
PC1	18.6
PC2	14.9
PC3	12.1
PC4	9.2

The scree plot below illustrates the variance explained by the first four principal components identified through Principal Component Analysis (PCA). The 'elbow' in the plot after the fourth component suggests that these four components capture the most significant variance in the data, justifying their selection for further interpretation. The scree plot (Figure 1) shows how much each of the 16 principal components explains the variation in factors influencing sugarcane cultivation in Baghpat district. The x-axis shows the components (PC1 to PC16), and the y-axis shows the percentage of variance each one explains. A noticeable "elbow" appears after the fourth component, indicating that the first four components—PC1 (18.6%), PC2 (14.9%), PC3 (12.1%), and PC4 (9.2%)—together explain 54.8% of the total variation. This sharp drop after PC4 suggests that these four components are the most important and should be kept for further analysis, as they capture the key factors behind farmers' crop preferences.

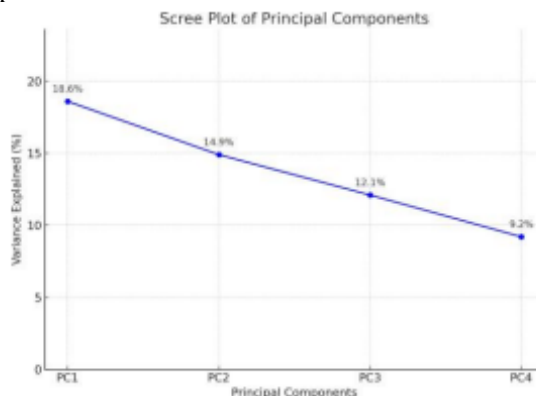


Fig 1: Scree Plot of Principal Components

3.2 Component Loadings and Interpretation:

The rotated component matrix (Table 2) presents the factor loadings for each variable on the first four principal components, highlighting the dominant factors influencing sugarcane cultivation preferences.

Table 2: Rotated Component Matrix

Variable	PC1	PC2	PC3	PC4
C1	0.821	-0.121	0.231	0.341
C2	0.781	0.231	-0.341	0.121
C3	0.231	0.671	-0.451	-0.561
C4	-0.341	0.781	0.121	0.231
C5	0.451	-0.561	0.341	-0.671
C6	-0.121	0.341	-0.781	0.451
C7	0.671	-0.231	0.561	-0.121
C8	0.561	0.451	-0.231	0.671
C9	-0.231	-0.781	0.671	-0.341
C10	0.341	0.121	-0.561	0.781
C11	0.781	-0.341	0.451	-0.231
C12	0.121	0.561	-0.671	0.341
C13	0.671	-0.451	0.231	-0.561
C14	0.451	0.671	-0.341	0.121
C15	0.231	-0.231	0.781	-0.451
C16	-0.561	0.341	-0.121	0.671

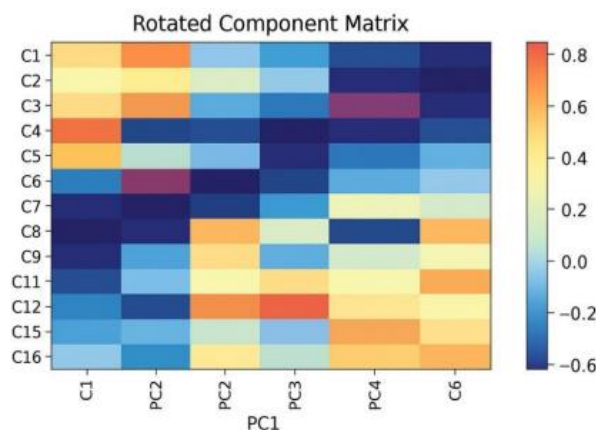


Fig 2: Heatmap of Rotated Component Loadings

The heatmap (Figure 2) visualizes the rotated component loadings from the Principal Component Analysis (PCA) of 16 variables (C1–C16) across four principal components (PC1–PC4) influencing sugarcane cultivation preferences in Baghpat district. Each cell's color represents the loading's direction and magnitude: warm colors (e.g., red) indicate positive loadings, cool colors (e.g., blue) denote negative loadings, and neutral colors (e.g., white) show near-zero loadings. Intense colors reflect stronger associations (e.g., C1: 0.821 on PC1), while lighter colors indicate weaker ones (e.g., C1: -0.121 on PC2). The heatmap clearly highlights dominant variables for each component, such as C1, C2, and C11 for PC1 (Economic Security), and C4, C3, and C14 for PC2 (Market Accessibility), simplifying interpretation and aiding policy recommendations.

3.3 Principal Component 1: Economic Security and Price Assurance

The first principal component (PC1), accounting for 18.6% of the variance, is characterized by high positive loadings on:

- C1 (0.821): Assured Pricing
- C2 (0.781): Government Procurement Support
- C11 (0.781): Minimum Price Risk
- C7 (0.671): Price Stability
- C13 (0.671): Contractual Marketing

This component highlights farmers' preference for economic security through stable income mechanisms, such as Minimum Support Prices (MSP), government procurement, and reliable marketing channels. Farmers prioritizing this factor aim to minimize price volatility and secure predictable revenue.

3.4 Principal Component 2: Market Accessibility and Infrastructure:

The second principal component (PC2), explaining 14.9% of the variance, shows strong loadings on:

- C4 (0.781): Proximity to Markets
- C3 (0.671): Local Market Facilities
- C14 (0.671): Transportation Infrastructure
- C8 (0.451): Access to Processing Units
- C12 (0.561): Storage Facilities

This factor emphasizes the importance of market access and infrastructure. Farmers influenced by PC2 value proximity to markets, efficient transportation, and adequate storage and processing facilities, which reduce transaction costs and facilitate timely sales.

3.5 Principal Component 3: Risk Management and Diversification

The third principal component (PC3), contributing 12.1% to the variance, is defined by high loadings on:

- C15 (0.781): Multiple Income Streams
- C9 (0.671): Crop Risk Reduction
- C7 (0.561): Pest/Disease Risk Mitigation
- C11 (0.451): Weather Dependency

This component reflects farmers' focus on risk minimization and income diversification. Sugarcane's stability, potential for by-product revenue, and resilience to environmental risks make it a preferred crop for farmers prioritizing this factor.

3.6 Principal Component 4: Profitability and Productivity

The fourth principal component (PC4), accounting for 9.2% of the variance, exhibits significant loadings on:

- C10 (0.781): Higher Profitability
- C8 (0.671): Yield Potential
- C16 (0.671): Land Productivity

This factor underscores profit maximization and productivity. Farmers influenced by PC4 choose sugarcane for its high returns per hectare and efficient resource utilization.

4. Conclusion

The study reveals that farmers in Baghpat district prefer sugarcane cultivation primarily due to four key factors: economic security, market accessibility, risk management, and profitability. Principal Component Analysis (PCA) effectively identified these dimensions, with the first four components explaining a significant portion of the total variance in farmer preferences. Economic security, including assured pricing and government procurement, emerged as the strongest driver. Market infrastructure and access to local facilities also played a critical role, followed by considerations of crop-related risk reduction and the potential for higher profitability and productivity. These insights suggest that policy interventions focused on price stability, improved market linkages, risk mitigation strategies, and yield enhancement can further strengthen the viability of sugarcane farming in the region.

5. References

- Chand, R., & Raju, S. S. (2009). *Instability in Indian agriculture during different phases of technology and policy*. Indian Journal of Agricultural Economics, 64(2), 283–288.
- Government of Uttar Pradesh. (2023). *Statistical Diary of Uttar Pradesh 2022-23*. Lucknow: Directorate of Economics and Statistics.
- Jain, R. K., & Singh, A. K. (2020). Factors affecting crop choice decisions among farmers in India. *Journal of Rural and Agricultural Research*, 20(2), 25–30.
- Kumar, S., & Singh, J. (2017). *Economic analysis of sugarcane cultivation in Uttar Pradesh: A case study of Meerut district*. International Journal of Research in Economics and Social Sciences, 7(10), 156–165.
- Ministry of Agriculture and Farmers Welfare. (2021). *Agricultural Statistics at a Glance 2020-21*. New Delhi: Government of India.
- Mishra, A. K., & Mohanty, S. (2018). *Crop diversification and risk: Empirical evidence from Indian agriculture*. Journal of Development Policy and Practice, 3(1), 65–84.
- Narayanamoorthy, A. (2016). *Profitability in crops: A comparative analysis of sugarcane and competing crops in India*. Indian Journal of Agricultural Economics, 71(3), 308–321.
- National Bank for Agriculture and Rural Development (NABARD). (2022). *District Credit Plan: Baghpat District 2022–23*. NABARD Uttar Pradesh Regional Office.
- Pathak, H., & Verma, D. (2019). *Sustainability challenges in sugarcane cultivation in India: A review*. Agricultural Reviews, 40(3), 180–186.
- Reddy, G. P., & Suresh, A. (2021). *Determinants of crop choices in Indian agriculture: Role of infrastructure, market access, and policies*. Agricultural Economics Research Review, 34(1), 25–35.
- Saxena, R., & Tiwari, P. (2015). *Impact of market access on farmers' income in sugarcane-producing regions of western Uttar Pradesh*. Indian Journal of Economics and Development, 11(3), 121–127.
- Sharma, P., & Singh, S. (2018). *Assessment of profitability and resource-use efficiency in sugarcane cultivation in north India*. Agricultural Situation in India, 74(5), 45–52.

- Singh, K. M., & Meena, M. S. (2016). *Cropping pattern in India: Trends and determinants*. Agricultural Economics Research Review, 29(1), 87–94.
- Sinha, R. K., & Kumar, A. (2020). *Factors affecting the selection of cash crops by Indian farmers: A micro-level study*. International Journal of Social Science and Economic Research, 5(2), 336–347.
- Yadav, S. K., & Tomar, A. (2022). *A study of socio-economic characteristics and cropping pattern of sugarcane farmers in western Uttar Pradesh*. Journal of Rural and Agricultural Studies, 9(1), 33–40.