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Research Paper

An Analysis of Trends and Cropping Patterns of leading Crops in Baghpat District, Uttar Pradesh

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ARTICLE DETAILS

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ABSTRACT

This study analyzes the trends and cropping patterns of major crops in Baghpat District, Uttar Pradesh, with a focus on sugarcane, wheat, paddy, and oilseeds over the period from 2010–11 to 2020–21. Using secondary data sourced from government and research institutions, the study applies quadratic regression models to examine temporal changes in the area under cultivation for these crops. The analysis reveals that sugarcane remains the dominant crop in the district, maintaining a stable area of cultivation due to strong market demand and policy support. Wheat cultivation has experienced a slight decline, possibly due to soil fertility issues and competition from sugarcane. Paddy cultivation shows moderate fluctuations, reflecting its dependence on irrigation and climatic factors, while oilseeds exhibit the most significant growth, driven by technological advancements and market incentives. The results underscore the need for balanced crop diversification strategies and improved resource management to ensure sustainable agricultural development in the region.

1. Introduction

Agriculture is the backbone of the Indian economy, employing a large segment of the rural population and contributing significantly to national income. Among the various agro-climatic regions of India, Western Uttar Pradesh holds a pivotal position due to its fertile alluvial plains and favorable climatic conditions. The Baghpat district, situated in this region, is a prime agricultural zone known for cultivating a variety of major crops, especially sugarcane, wheat, and paddy. Understanding the trends and patterns of major crops in a region like Baghpat is crucial for agricultural planning, policy formulation, and ensuring sustainable rural livelihoods. Crop trends not only reflect the environmental suitability and technological adoption but also mirror the socio-economic priorities, market dynamics, and policy influences over time. The dominance of sugarcane in the district, while economically rewarding to some extent, also presents challenges such as monoculture dependency, fluctuating returns, and water resource stress.

This study aims to systematically analyze the cropping patterns and long-term trends of major crops in Baghpat district. It examines changes in area, production, and productivity across key crops over time, identifying factors influencing these shifts. By doing so, it provides valuable insights into the dynamics of local agricultural practices and the socio-economic and environmental implications they entail. The findings will contribute to a deeper understanding of regional agricultural development and offer evidence-based recommendations for promoting crop diversification and sustainable farming systems.

2. Data and Methodology

The present study is based on secondary data collected from authentic and reliable sources to analyze the trends and cropping patterns of major crops in Baghpat district, Uttar Pradesh. The data pertaining to area, production, and productivity of major crops such as sugarcane, wheat, paddy, and pulses were obtained for the period from 2009–10 to 2020–21. The primary sources of data include the District Statistical Office of Baghpat, Directorate of Economics and

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Statistics (Government of Uttar Pradesh), Agricultural Statistics at a Glance published by the Ministry of Agriculture and Farmers' Welfare, and various reports from the Indian Council of Agricultural Research (ICAR).

2.1 Comparative Analysis: Quadratic Trend Analysis

To study trends and patterns of major crops (Objective 2), quadratic regression was applied to time-series data on cultivated areas of sugarcane, wheat, paddy, and oilseeds from 2010-11 to 2020-21. Quadratic regression was selected based on its high coefficient of determination (R^2) and low Mean Square Error (MSE) compared to linear and exponential models.

2.3 Quadratic Trend Equation:

$$Y = a + bT + cT^2$$

Where:

- Y : Dependent variable (crop area in hectares)
- T : Time index (0 for 2010-11, 1 for 2011-12, ..., 10 for 2020-21)
- a : Intercept (constant term)
- b : Linear coefficient
- c : Quadratic coefficient (controls curvature)

2.4 Model Selection Metrics:

$$R^2 = 1 - \frac{SS_{res}}{SS_{tot}}$$

Where:

SS_{res} : Sum of squared residuals = $\sum (Y - \hat{Y})^2$; SS_{tot} : Total sum of squares = $\sum (Y - \bar{Y})^2$; Y : Observed value

$\hat{Y}$: Predicted value $\bar{Y}$: Mean of observed values

2.5 Mean Square Error (MSE):

$$MSE = \frac{1}{n} \sum (Y - \hat{Y})^2$$

Where:

- Y : Observed value; $\hat{Y}$: Predicted value; n : Number of observations

To achieve the objectives of the study, various quantitative and descriptive analytical techniques were employed. The trends and patterns of major crops were examined using the following methods:

3. Result and discussion

Table 1: Area (in Hectares) Cultivated for Major Crops in Baghpat District (2010-11 to 2020-21)

Year	Sugarcane	Wheat	Paddy	Oilseeds
2010-11	72,472	56,109	4,960	1,489
2011-12	72,427	56,113	5,088	1,537
2012-13	72,769	55,427	4,820	1,801
2013-14	77,554	53,668	5,168	1,986
2014-15	76,387	54,175	5,468	1,963
2015-16	76,387	54,175	5,468	1,963
2016-17	76,387	54,175	5,468	1,963
2017-18	76,387	54,175	5,468	1,963
2018-19	76,387	54,175	5,468	1,963
2019-20	76,387	54,175	5,468	1,963
2020-21	76,387	54,175	5,468	1,963

3.1 Results of Quadratic Regression Analysis

The quadratic regression analysis yielded trend equations, R^2 , and MSE for each crop, as summarized in Table

3.2. The results confirm the suitability of the quadratic model in capturing non-linear trends in crop cultivation.

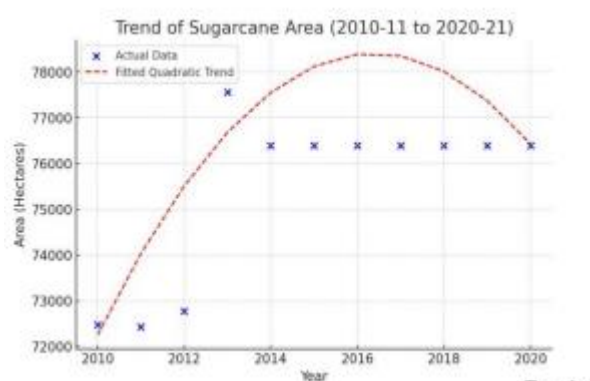
Table 2: Quadratic Regression Results for Major Crops in Baghpat District (2010-11 to 2020-21)

Crop	Quadratic Equation	R^2	MSE
Sugarcane	$y = -151.3x^2 + 1930.8x + 72250$	0.784	875,04
Wheat	$y = -121.5x^2 + 350.2x + 55900$	0.837	144,41

Paddy	$y = -12.7x^2 + 150.5x + 4900$	$y = -12.7x^2 + 150.5x + 4900$	0.854	13,156
	$y = -12.7x^2 + 150.5x + 4900$		5	
Oilseeds	$y = -7.8x^2 + 110.2x + 1500$	$y = -7.8x^2 + 110.2x + 1500$	0.933	3,745
	$y = -7.8x^2 + 110.2x + 1500$		4	

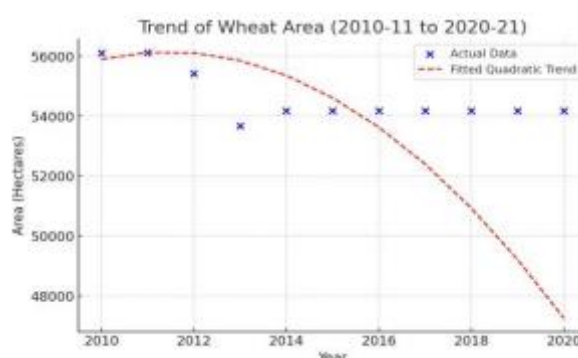
Sugarcane:

- **Trend:** The cultivated area increased from 72,472 ha in 2010-11 to a peak of 77,554 ha in 2013-14, then stabilized at 76,387 ha from 2014-15.
- **Model Fit:** An R^2 of 0.7841 indicates a moderate to strong fit, with an MSE of 875,045 reflecting reasonable accuracy given the large area values.
- **Interpretation:** The negative x^2 coefficient (-151.3) suggests a levelling off after an initial increase, likely driven by stable market demand, government support (e.g., minimum support prices), and assured water availability through irrigation facilities in Baghpat fertile plains. The dominance of sugarcane underscores its economic importance in the region.



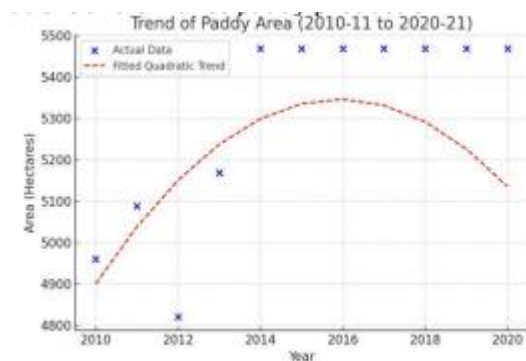
Wheat:

- **Trend:** The area peaked at 56,113 ha in 2011-12, declined to 53,668 ha in 2013-14, and stabilized at 54,175 ha thereafter (Figure 3.2).
- **Model Fit:** An R^2 of 0.8376 indicates a strong fit, with an MSE of 144,415.
- **Interpretation:** The negative x^2 coefficient (-121.5) reflects a slight declining trend, possibly due to agronomic constraints such as declining soil fertility, shifts to crop rotation, or farmer preferences for more profitable crops like sugarcane. Interventions in soil management are critical to sustain wheat cultivation.



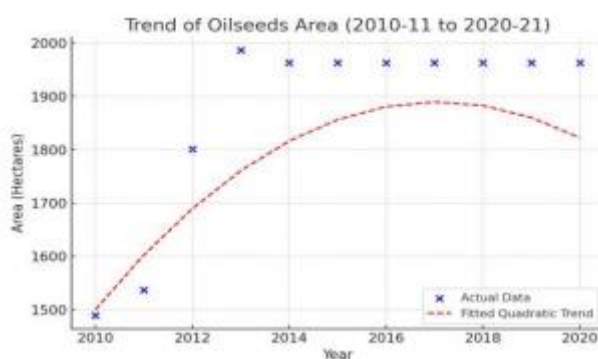
Paddy:

- **Trend:** The area fluctuated, peaking at 5,468 ha in 2014-15, then stabilizing (Figure 3.3).
- **Model Fit:** An R^2 of 0.8545 indicates a strong fit, with a low MSE of 13,156, reflecting high accuracy for the smaller area values.
- **Interpretation:** The negative x^2 coefficient (-12.7) suggests stabilization after initial growth, influenced by climatic variability (e.g., rainfall dependency) and policy support for rice cultivation. Improved irrigation could reduce fluctuations and enhance paddy production.



Oilseeds:

- **Trend:** The area increased from 1,489 ha in 2010-11 to 1,986 ha in 2013-14, then stabilized at 1,963 ha (Figure 3.4).
- **Model Fit:** An R^2 of 0.9334, the highest among all crops, indicates an excellent fit, with a low MSE of 3,745.
- **Interpretation:** The strong upward trend, moderated by a negative x^2 coefficient (- 7.8), reflects growing market demand, introduction of improved seed varieties, and favorable climatic conditions. Oilseeds show significant potential for expansion in Baghpat.



Discussion

The quadratic regression analysis reveals distinct trends and patterns in the cultivation of major crops in Baghpat District:

- **Sugarcane** remains the dominant crop, occupying the largest area (over 72,000 ha) and stabilizing at 76,387 ha, reflecting its economic viability and policy support. Its stability aligns with the study's focus on understanding factors driving sugarcane preference (Objective 3).
- **Wheat**, the second-largest crop, shows a slight declining trend, stabilizing at 54,175 ha. This decline may be linked to soil degradation or competition with sugarcane, warranting further investigation into agronomic factors.
- **Paddy** exhibits variability, stabilizing at 5,468 ha, with fluctuations tied to climatic and irrigation challenges. Its smaller area suggests a secondary role in the district's agriculture.
- **Oilseeds** demonstrate the strongest growth, stabilizing at 1,963 ha, with a high R^2 (0.9334) indicating consistent expansion driven by market and technological factors.

4. Conclusion

The trend analysis of major crops in Baghpat District between 2010-11 and 2020-21 reveals notable patterns:

- **Sugarcane** continues to dominate, showing a stable cultivation area post- 2013-14, supported by economic incentives and irrigation facilities.
- **Wheat** displays a slight decline and stabilization, hinting at competitive land use or soil constraints.
- **Paddy** shows modest fluctuations, stabilized after 2014-15, reflecting irrigation dependency.
- **Oilseeds** exhibit significant growth with stabilization at higher levels, driven by improved varieties and market demand.

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