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Trend analysis of area under major crops in Baghpat District of Western Uttar Pradesh: An empirical study

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Abstract

The Present study focuses on the cropping patterns of major crops—Sugarcane, Wheat, Rice, Oilseeds, and Pulses—in Baghpat district and analyzes area trends. Sugarcane, as the primary crop, is examined alongside major crops to provide a comprehensive view of the agricultural landscape. The study examines fluctuations in farming areas of these crops in India, with Uttar Pradesh as a significant contributor. Factors that influence agricultural practices in different regions include land ownership, landholding size, soil type, and land tenure. In Baghpat district, sugarcane is the major crop and plays an important role in the region's agricultural economy. The Present study adopts a descriptive approach, utilizing purposive sampling to select relevant data from these blocks. Data from 180 farmers across six villages were analyzed, focusing on those dedicating over 80% of their land to sugarcane and considering the cultivation of other major crops. The study period spans from 2001-02 to 2022-23, aiming to capture trends in the production of major crops. The findings emphasize the need for sustainable practices to maintain productivity and address environmental concerns in the region, while also highlighting the relationship between sugarcane cultivation and other major crops in Baghpat district.

Keywords: Sugarcane, cropping pattern, crop diversification, growth rate, trend analysis

1. Introduction

Sugarcane is one of the most important commercial crops in India and plays a significant role in the agricultural economy by providing livelihood support to millions of farmers and serving as a major raw material for the sugar industry. It is a versatile crop with multiple uses, including the production of sugar, jaggery, khandsari, fodder, and various by-products such as molasses, bagasse, and press mud. In recent years, sugarcane has also emerged as an important source of renewable energy through the production of bioethanol and other bio-based products, thereby contributing to the country's energy security and sustainable development.

India is the second-largest producer of sugarcane in the world and occupies a prominent position in the global sugar economy. During 2023–24, sugarcane was cultivated on 5.74 million hectares with a total production of 453.16 million tonnes. Among the major sugarcane-producing states, Uttar Pradesh ranked first with 2.65 million hectares under cultivation and a production of 215.81 million tonnes. Maharashtra occupied the second position with 1.44 million hectares and a production of 112.09 million tonnes, followed by Karnataka with 0.54 million hectares and 41.81 million tonnes of production (DA&FW, 2024). The crop continues to be a major source of income for farmers and an important contributor to rural employment generation.

Within Uttar Pradesh, sugarcane cultivation is concentrated in the western and central regions of the state. Major sugarcane-producing districts include Kheri, Bijnor, Muzaffarnagar, Sitapur, Saharanpur, Meerut, Bareilly, Gonda, Amroha, Baghpat, Pilibhit, Kushinagar, Shamli, Bulandshahr, Moradabad, Balrampur, Basti, Hapur, Shahjahanpur, and Hardoi (Department of Agriculture, U.P., 2022) ^[2]. Among these districts, Kheri recorded the largest area under sugarcane cultivation (239,090 ha), followed by Bijnor (201,591 ha) and Muzaffarnagar (72,164 ha). Similarly, Kheri registered the highest sugarcane production (20.48 million tonnes), followed by Bijnor (17.85 million tonnes) and Muzaffarnagar (16.06 million tonnes). The highest productivity was recorded in Shamli district (1,014.16 quintals per hectare), followed by

Muzaffarnagar (933.08 quintals per hectare).

The environment and its perception shape the growth and development of various crops in different regions. In areas with less physical diversity, farming practices tend to be more uniform. For example, farmers in drought-prone Rajasthan grow bajra (bulrush millet), while rice is the main crop in Assam's Brahmaputra basin. Cotton is grown in the regur (black earth) soils of Maharashtra and Gujarat, while wheat, rice, and sugarcane thrive in the loamy soils of western Uttar Pradesh, Haryana, and Punjab. Land ownership, tenure, holding size, and field size all influence agricultural practices in a region.

Sugarcane occupies a unique position in the cropping systems of Western Uttar Pradesh. It is cultivated under diverse cropping patterns, either as a sole crop or in association with companion crops such as wheat and mustard. These systems play a vital role in improving land-use efficiency, cropping intensity, employment generation, and farm income. The integration of sugarcane with other crops enables farmers to diversify their production, reduce risks associated with monocropping, and ensure a more stable flow of income throughout the year. Consequently, sugarcane-based cropping systems have become an important component of the region's agricultural production system.

Baghpat district is one of the leading sugarcane-producing districts of Western Uttar Pradesh, where sugarcane occupies a dominant position in the cropping pattern and contributes significantly to the agricultural economy. The district possesses favourable agro-climatic conditions, fertile alluvial soils, and adequate irrigation facilities that support large-scale cultivation of sugarcane. According to the Directorate of Agricultural Statistics and Economics, during 2022–23, sugarcane was cultivated on 85.491 thousand hectares, producing 7,643 thousand tonnes with a productivity of 894.01 quintals per hectare. In comparison, wheat occupied 54.815 thousand hectares, rice 4.807 thousand hectares, oilseeds 3.502 thousand hectares, and pulses 1.737 thousand hectares. These figures clearly demonstrate the predominance of sugarcane over other crops in the district.

However, the relative significance of different crops in a region is not fixed and tends to change over time due to factors like technological advancements, market conditions, policy support, availability of resources, and farmers' preferences. Analyzing changes in the area under different crops provides useful insights into shifts in cropping patterns and the evolving structure of agriculture.

2. Materials and Methods

2.1 Study Area and Sampling Design

The present study was conducted in Baghpat district of Western Uttar Pradesh, a region well known for its intensive sugarcane cultivation and sugarcane-based cropping systems. Baghpat district was purposively selected owing to its substantial area under sugarcane cultivation and its importance in the agricultural economy of the region. For the collection of primary data under the broader thesis investigation, two blocks, namely Binauli and Baraut, were purposively selected from the six blocks of the district on the basis of their larger area under sugarcane cultivation. Subsequently, three villages from each selected block were chosen randomly. The selected villages included Jiwana-Golijan, Bamnauli, and Begmabad Garhi from Binauli block and Bijrol, Malakpur-Loyan, and Barwala from Baraut block. From each village, 30 farmers cultivating sugarcane on more than 80 per cent of their operational holdings

were selected, resulting in a total sample of 180 respondents. The selected farmers were categorized into four operational landholding groups, namely marginal (below 1.0 ha), small (1.0–2.0 ha), medium (2.0–4.0 ha), and large (above 4.0 ha) farmers.

2.2 Data Collection

The study was based on both primary and secondary data. Primary data were collected during the agricultural year 2024–25 through personal interviews using a pre-tested and structured schedule. Information relating to socio-economic characteristics, landholding pattern, and cropping systems of the sample farmers was collected.

For the trend analysis, secondary data on area under major crops, namely sugarcane, wheat, rice, oilseeds, and pulses, were collected for the period 2001–02 to 2022–23. The data were obtained from the Directorate of Economics and Statistics, Government of Uttar Pradesh, through the UPDES portal, the Unified Portal for Agricultural Statistics (UPAg), district agricultural offices, and other relevant published sources.

2.3. Analytical Techniques

Descriptive statistical tools such as averages, percentages, and frequency distributions were used to analyse the socio-economic characteristics of the sample farmers and the distribution of cropping systems. To examine the trend in area under major crops in Baghpat district, a simple linear trend model was employed using the least squares method.

$$Y = a + bt$$

Where:

Y = Area under crop (hectares)

a = Intercept (constant)

b = Slope coefficient representing annual change in crop area

t = Time variable (year)

The estimated value of the slope coefficient (b) indicates the direction and magnitude of change in crop area over time.

Interpretation of Trend

b > 0: Increasing trend

b < 0: Decreasing trend

Higher absolute value of b: Greater rate of change

Coefficient of Determination (R²)

The goodness of fit of the trend equation was assessed using the coefficient of determination (R²), which measures the proportion of variation in crop area explained by the time trend. The value of R² ranges from 0 to 1, with higher values indicating a better fit of the model.

Growth Rate Estimation

The annual growth rate in area under major crops was estimated using the following expression:

$$\text{Growth Rate (\%)} = \frac{b}{\bar{Y}} \times 100$$

Where:

- b = slope of trend line
- $\bar{Y}$ = mean value of crop area

3. Results and Discussion

3.1 Trend Analysis of Area under Major Crops in Baghpat District

The trend analysis based on the linear regression model revealed

significant variations in the area under major crops in Baghpat district during the period 2001–02 to 2022–23. Table 1 shows the area (ha) of major crops; Sugarcane, Wheat, Rice, Oilseeds and Pulses in the Baghpat district from 2001-02 to 2022-23.

Table 1: Trend in area of major crops in the Baghpat district (area in hectares)

Sl. No.	Year	Wheat	Rice	Sugarcane	Total Oilseeds	Total Pulses
1.	2001-02	57709	5949	63610	1019	46
2.	2002-03	56166	2806	69410	1207	1207
3.	2003-04	57683	3147	70774	1037	1542
4.	2004-05	57480	3230	70317	1373	1811
5.	2005-06	57683	3010	70973	1043	1657
6.	2006-07	56458	2637	67999	945	1314
7.	2007-08	56669	1866	75521	1299	925
8.	2008-09	56176	3279	67501	1306	1730
9.	2009-10	56057	3646	72690	1475	1982
10.	2010-11	55863	4575	72926	1548	1174
11.	2011-12	54923	5108	73363	1575	1730
12.	2012-13	53718	5088	73561	1691	1763
13.	2013-14	55347	7931	71950	2035	1188
14.	2014-15	51752	5792	77107	1749	960
15.	2015-16	52596	6362	71901	3941	2465
16.	2016-17	53849	5375	74144	2130	1782
17.	2017-18	56716	4223	75037	1859	1174
18.	2018-19	54904	5866	74227	1796	1745
19.	2019-20	55446	5468	74735	1944	1570
20.	2020-21	55427	5443	76387	2716	1028
21.	2021-22	57237	5052	80387	3722	1793
22.	2022–23	54815	4807	85491	3502	1737

Source: DE&S, DoA&FW, 2023 and DE&S, Baghpat (U.P.) 2023-24

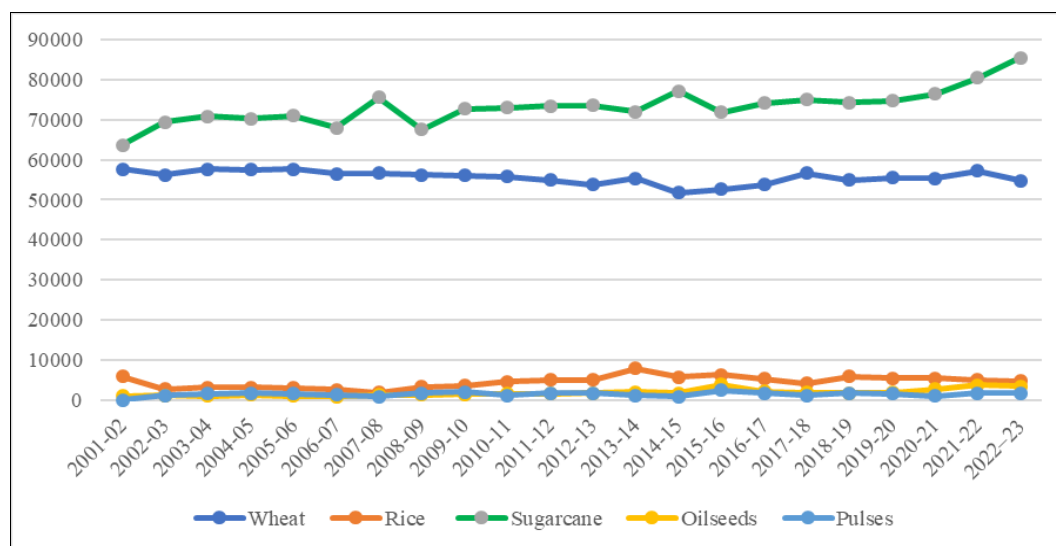


Fig 1: Graphical representation of trend of major crops area

The trend in area under major crops in Baghpat district was analyzed using a simple linear regression model (linear trend

model) based on the least squares method.

Table 2: Trend in area of major crops in the Baghpat district (area in hectares)

Major crops	Intercept(a)	Slope(b)	R ²	Trend
Wheat	57078.00	-122.6956522	0.240574066	Decreasing trend
Rice	3148.12987	124.1151892	0.298490612	Increasing trend
Sugarcane	66771.68831	557.4460757	0.639979826	Strong increasing trend
Total Oilseeds	653.4675325	104.8842462	0.61328981	Strong increasing trend
Total Pulses	1198.324675	23.5567476	0.096033966	Slight increasing trend

Wheat

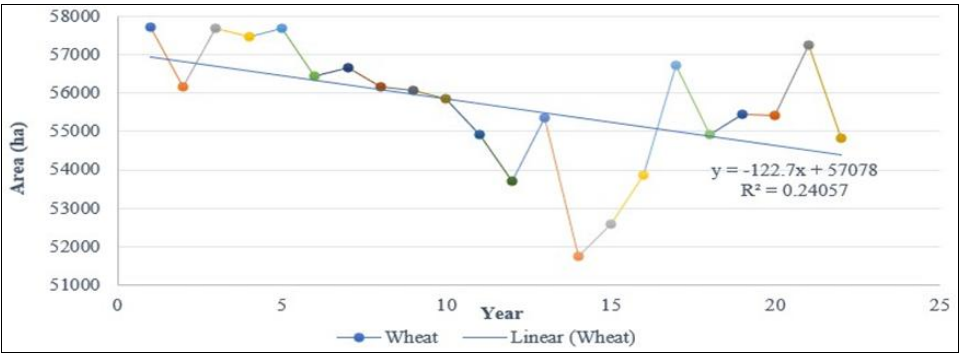


Fig 2: Trend in area of wheat crop based on linear regression

The results reveal a **declining trend** in the area under wheat cultivation over the study period. The estimated slope coefficient ($b = -122.70$) indicates that the area under wheat decreased by 122.70 hectares per year. The R^2 value (0.24) indicates that 24 percent of the variation in wheat area is explained by time, implying the presence of other influencing factors. The negative

trend in wheat area may be attributed to the gradual shift of farmers towards more profitable crops. In particular, the expansion of sugarcane cultivation appears to have reduced the relative importance of wheat in the cropping pattern.

Rice

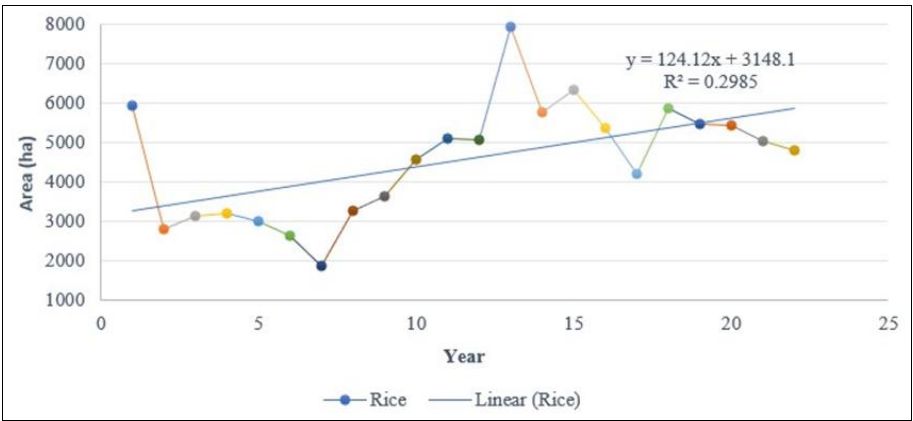


Fig 3: Trend in area of Rice crop based on linear regression

The area under rice cultivation exhibited an increasing trend, as indicated by a positive slope ($b = 124.12$), indicating an annual increase of about 124 hectares. The R^2 value (0.29) indicates a moderate explanatory power of the model. The expansion of rice area may be associated with improved irrigation infrastructure,

availability of high-yielding varieties, and better crop management practices in the study area.

Sugarcane

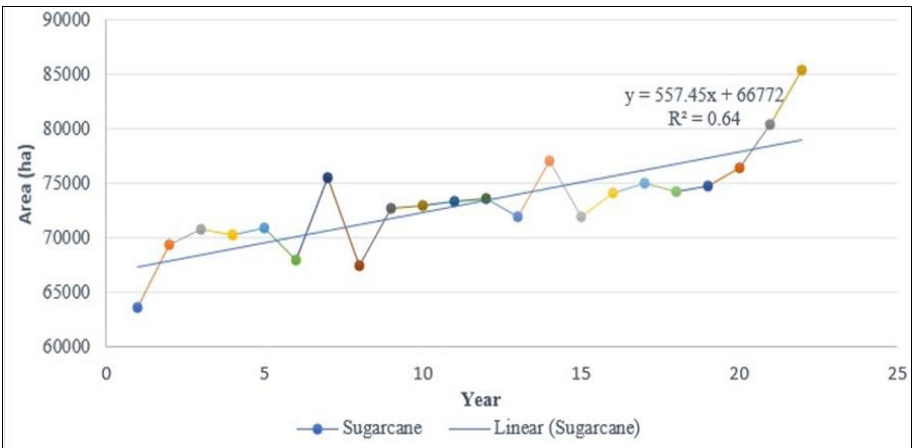


Fig 4: Trend in area of Sugarcane crop based on linear regression

Sugarcane recorded a strong increasing trend, with a high slope value ($b = 557.45$), indicating a substantial annual increase in

cultivated area. The R^2 value (0.64) reflects a relatively strong relationship between time and area, suggesting that the model

explains a significant portion of the variation. The estimated growth rate of sugarcane area (0.76 percent per annum) further confirms its consistent expansion. This increasing trend can be attributed to several factors, including assured market through nearby sugar mills, favorable pricing policies, and higher

economic returns compared to cereal crops. The stability and profitability associated with sugarcane cultivation have made it a preferred choice among farmers in the district.

Total Oilseeds

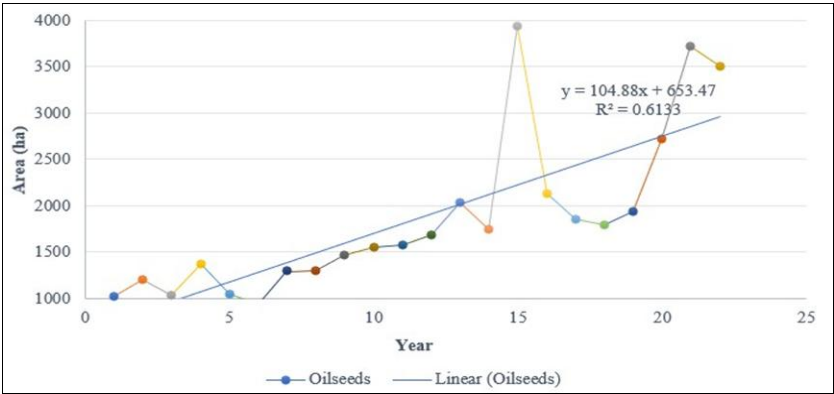


Fig 5: Trend in area of Total Oilseeds crop based on linear regression

The table indicates a strong increasing trend in the area under oilseed crops, with a slope value of 104.88. The relatively high R² value (0.61) indicate that the model fits the data well. The growth in oilseed area may be linked to rising demand for edible oils, increased awareness regarding crop diversification, and government initiatives promoting oilseed cultivation.

Total Pulses

In contrast to other crops, pulses exhibited only a slight increasing trend, with a relatively low slope value (b = 23.56). The R² value (0.096) is quite low, indicating that the model explains only a small fraction of the variation in pulse area.

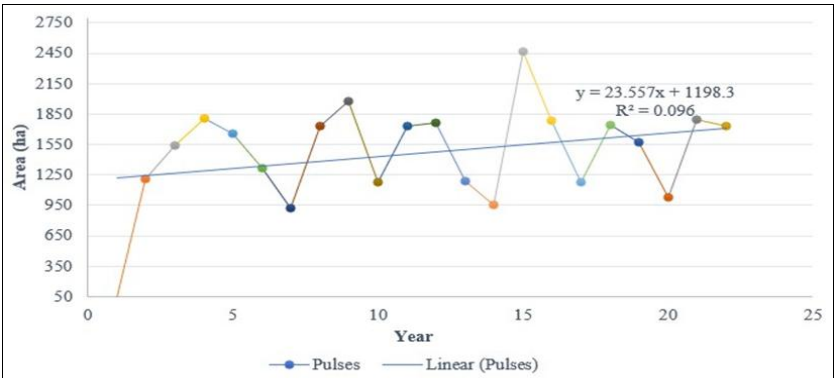


Fig 6: Trend in area of Total Pulses crop based on linear regression

This table indicates that pulse cultivation in the district is relatively unstable and is influenced by external factors such as fluctuations in rainfall, soil fertility conditions, and price volatility. The limited increase in pulse area may also reflect the lower economic returns compared to competing crops, resulting in less emphasis on pulse cultivation.

Table 3: Growth Rate of Area under Major Crops in Baghpat District (per annum)

Sl. No.	Major Crops	Slope (b)	Mean Area	Growth Rate (%)
1.	Wheat	-122.70	55500	-0.22
2.	Rice	124.12	4500	2.75
3.	Sugarcane	557.45	73300	0.76
4.	Total Oilseeds	104.88	1900	5.52
5.	Total Pulses	23.56	1500	1.57

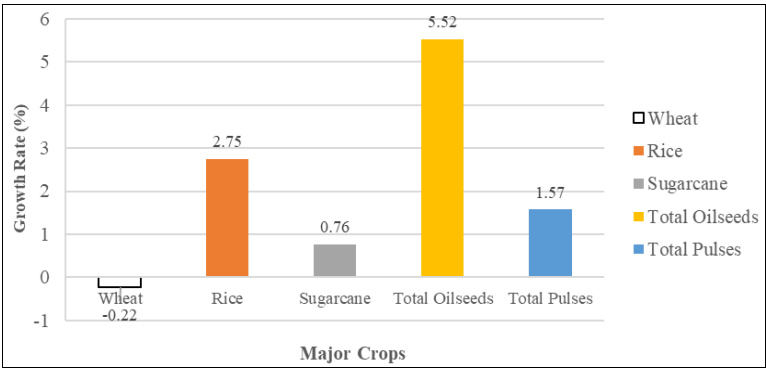


Fig 7: Growth Rate of Area under Major Crops in Baghpat District

The growth rate analysis indicates that wheat recorded a negative growth per annum (-0.22%), showing a decline in its area over time. In contrast, rice (2.75%), sugarcane (0.76%), oilseeds (5.52%), and pulses (1.57%) exhibited positive growth trends. Among these, oilseeds recorded the highest growth, indicating a rapid increase in their cultivation. Overall, the pattern reflects a shift towards more profitable crops, while wheat is gradually losing its area in the cropping system.

The findings indicate a shift in cropping pattern in Baghpat district over the study period. The declining trend in wheat area and the increasing trends in sugarcane and oilseeds reflect a movement towards more profitable and market-oriented crops. Sugarcane has become a dominant crop due to its better economic returns and assured market, while oilseeds have shown the highest growth, reflecting rising demand and diversification. Rice has maintained a moderate growth, indicating its continued importance in the cropping system. In contrast, pulses have shown only a slight and unstable increase, highlighting the need for policy support to promote their cultivation for nutritional security and soil health. The growth rates indicate a decline in wheat area (-0.22%), while rice (2.75%), sugarcane (0.76%), oilseeds (5.52%), and pulses (1.57%) showed increasing trends, with oilseeds recording the highest growth. Overall, the observed trends reflect that farmers' decisions are mainly influenced by profitability, market access, and resource availability, leading to gradual changes in the agricultural system in the study area.

4. Conclusion

The study concludes that the cropping pattern of Baghpat district has undergone noticeable changes during the period 2001–02 to 2022–23. The area under wheat showed a declining trend, whereas sugarcane, rice, oilseeds and pulses exhibited positive trends. Sugarcane remained the dominant crop in the district, mainly due to assured market availability, favourable agro-climatic conditions, irrigation facilities and comparatively better economic returns. Oilseeds recorded the highest annual growth rate, indicating increasing diversification towards commercial and demand-driven crops. However, the slow and unstable growth of pulses reflects the need for policy support to promote pulse cultivation for nutritional security and soil fertility improvement. Overall, the findings suggest that farmers' crop-area allocation decisions in Baghpat district are largely influenced by profitability, market access, irrigation availability and resource conditions.

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