

## Geographical Analysis of Trends and Patterns in Sugarcane Production: A Case Study of Meerut District, Uttar Pradesh, India

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Sugarcane, a commercial crop, is the second-largest agro-based industry in India, producing nearly 25% of global production. India is the second-largest country producing sugarcane after Brazil, and its production is crucial to the country's economy. Sugarcane cultivation in India is divided into tropical and sub-tropical regions, with the sub-tropical region contributing 47% of the country's production. Uttar Pradesh is the largest producer, providing employment opportunities. However, input prices increase, and farmers face challenges such as inadequate quantity and delayed payment from sugar mills. Thus, this study aims to study the economics of sugarcane production in the study area. The study uses secondary sources of data from various sources, including the District Statistical Handbook, Census of India, and various journals. It uses percentage methods and pictorial diagrams to show trends in sugarcane cultivation. The Compound Annual Growth Rate (CAGR) method is used to measure sugarcane production growth from 2002-03 to 2021-22. The study reveals fluctuations in sugarcane production, area, and productivity in the Meerut district over the last 20 years. However, the area under sugarcane shows an increasing trend, with little change in the state and Meerut. Sugarcane is a crucial cash crop and politically sensitive, so small steps in favour of farmers lead to larger changes in cropping patterns. The cost of cultivation and harvesting has increased alarmingly due to labour shortages and unpredictable monsoons. The government can play a vital role by providing weather forecasting and strong policies for crop procurement to stabilize production and price.

**Keywords:** Sugarcane Production, weather forecasting, delayed payments, government intervention, procurement policies.

### INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is a commercial crop belongs to the Graminae family of Glumiflorae order. This cash crop is mainly utilized as a material for the sugar business, which is the second-biggest agro-based industry in India. It is cultivated commercially in most tropical and sub-tropical regions of the globe. India is the second-largest country producing sugarcane after Brazil, producing nearly 25% of total global production (Kamta *et al.*, 2022) The sugarcane industry has an important role in the world, with the world's largest crop by product, and the three most important countries in sugarcane production are Brazil, India, and China. Sugarcane plays an essential role in the economy of the country (Pushpa and Srivastava, 2014). Sugarcane

cultivation, while economically significant, can have several potential environmental impacts, including: deforestation and habitat loss, soil degradation, water consumption and pollution, greenhouse gas emissions, loss of carbon sinks, impact on indigenous communities and pesticide exposure. To mitigate these environmental impacts, sustainable farming practices such as agroforestry, integrated pest management, conservation tillage, and water-efficient irrigation techniques can be adopted. Additionally, certification schemes and regulatory measures can help enforce environmental standards and promote responsible sugarcane production. The production of sugarcane can have significant socio-economic implications for local communities, both positive and negative: employment opportunities, income generation, market access and trade, infrastructure development, social

cohesion and community development, environmental degradation and health risks, land disputes and displacement. Overall, the socio-economic implications of sugarcane production on local communities depend on various factors such as land tenure systems, agricultural policies, market dynamics, and environmental sustainability practices. Balancing the economic benefits of sugarcane production with social equity and environmental stewardship is essential for promoting inclusive and sustainable development in sugarcane-producing regions.

In India, the agro-climatic regions of sugarcane cultivation can be divided into two: tropical and sub-tropical. The sub-tropical region constitutes the northern states of Uttar Pradesh, Bihar, Uttarakhand, Punjab, Haryana comprises of 55% of total area under sugarcane and contributes 47% of country's sugarcane production (Saravanan, 2016). The region under sugarcane cultivation and production in 2019–2020 year was 4867 ha and 3,77,766 tonnes and the productivity was 77.6 ton/ha (Anonymous, 2021-22). During 2018, 79.9% of total sugarcane production of India was used in the manufacture of white sugar, 11.29% was used for jaggery production, and 8.80% was used as seed and feed materials. 840.16 MT sugarcane was exported in the year 2019. Uttar Pradesh is the largest producer of sugarcane in India. Sugarcane plays a vital role in the economy of the state and providing employment opportunities to large number of people (Zaidi and Munir, 2014). In Uttar Pradesh, Meerut district occupies an important place in terms of area and production of sugarcane cultivation (Rahman and Bee, 2019). It was grown on area of 132.320 thousand hectares, with its production of 84.02 lakhs metric tonnes and productivity 69.54 t/ha (2007-08). Sugarcane is an intensive input utilization and varies from region to region and farmer to farmer (Yadav, 2007). Input price is continuously increased. Besides that farmers are facing the problem of input availability at proper time, inadequate quantity and with time taking marketing process of the cane untimely and late payment of the produce by the sugar mills (Kant et al., 2015). Keeping in view the above discussion and importance of the sugarcane cultivation, the present study was an attempt to study the economics of sugarcane production in the study area.

## MATERIALS AND METHODS

The present study is mainly based on secondary sources of data. The data were obtained from; District Statistical Handbook, Census of India, Sankhyakiya Patrika, Department of Agriculture Uttar Pradesh, Sugarcane Breeding Institute Coimbatore, Directorate of Economics and Statistics, Ministry of Agriculture, Department of Agriculture & Farmer welfare Different Journals, Magazines, Articles, Books etc. The relevant data available on different websites were also incorporated in the study. For showing the trends

and pattern of area under sugarcane cultivation simple percentage method and different pictorial diagrams were used.

Compound Annual Growth Rate (CAGR) is a widely used metric to measure the mean annual growth rate of an investment or, in this case, the production of sugarcane over a specific period. Its simplicity makes it a preferred method for evaluating trends in various fields, including agriculture. The formula for calculating CAGR,

$$\text{CAGR} = (\text{Ending Value}/\text{Beginning Value})^{(1/n)} - 1,$$

where 'n' represents the number of periods, typically years in this context, provides a clear and straightforward means to determine the annual growth rate in area, production and productivity. For the area, production and productivity of sugarcane from 2002-03 to 2021-22, CAGR can be utilized to analyze the growth trend effectively. This method offers insights into the average annual growth rate of sugarcane production over the entire period, providing a single figure that encapsulates the overall trend. The CAGR approach is valuable for its simplicity, as it condenses complex data into a single metric, facilitating easy comparison and interpretation. However, it's essential to note that while CAGR offers a useful snapshot of growth, it may not capture fluctuations or nuances within the period under consideration.

## RESULTS

**Scenario of Sugarcane Production in Uttar Pradesh:** Uttar Pradesh, the largest producer of sugarcane alone produces around 45 per cent of total sugarcane production in India. (2020-21). The table 1 represents the clear picture that the sugarcane production is concentrated in the Western Uttar Pradesh. The Kheri district is the leading district in terms on area (0.2 mha) and production (20.47 m tonnes) of the sugarcane crop whereas Shamli ranks first in productivity (1014.6 t/ha). Among top 20 districts of sugarcane producing districts 13 districts belong to the Western Uttar Pradesh. Meerut district ranks 6<sup>th</sup> in term of Area and Production and 3<sup>rd</sup> in term of productivity.

**Compound annual growth rate of sugarcane production:** Table 2 represents the Compounded Annual Growth Rate of sugarcane in India, Uttar Pradesh and Meerut for the year 2002-03 and 2021-22. The table shows that during the last twenty years the sugarcane production of the crop has increased but the growth was very slow. The CAGR of India for the above period is +2.05 per cent which was lower than the state (+2.38 per cent) and marginally higher than Meerut (+1.99 per cent). The slow growth rate in the production may be due to attributes such as area under sugarcane production, low yield, price risk and competition with other crops such as potato, wheat etc.



**Table 1. Area, Production and Yield of Major Sugarcane Producing Districts in Uttar Pradesh. (2021-22)**  
Department of Agriculture U.P.

| Sr. | District      | Area (Hac) | Production (Tonnes) | Productivity (q/ha) |
|-----|---------------|------------|---------------------|---------------------|
| 1   | Kheri         | 239090     | 20476624            | 856.44              |
| 2   | Bijnor        | 201591     | 17851286            | 885.52              |
| 3   | Muzaffarnagar | 172164     | 16064279            | 933.08              |
| 4   | Sitapur       | 148508     | 11561645            | 778.52              |
| 5   | Saharanpur    | 136526     | 11395552            | 834.68              |
| 6   | Meerut        | 129265     | 11824128            | 914.72              |
| 7   | Bareilly      | 93401      | 7284531             | 779.92              |
| 8   | Gonda         | 77926      | 6032719             | 774.16              |
| 9   | Amroha        | 76106      | 6379205             | 838.20              |
| 10  | Bagpat        | 72769      | 6361757             | 874.24              |
| 11  | Pilibhit      | 71621      | 5773798             | 806.15              |
| 12  | Kushi Nagar   | 70750      | 5088057             | 719.16              |
| 13  | Shamli        | 63660      | 6456143             | 1014.16             |
| 14  | Bulandshahr   | 50485      | 4465701             | 884.56              |
| 15  | Moradabad     | 47426      | 3690881             | 778.24              |
| 16  | Balrampur     | 44387      | 2905218             | 654.52              |
| 17  | Basti         | 39394      | 2559192             | 649.64              |
| 18  | Hapur         | 38448      | 3192568             | 830.36              |
| 19  | Shahjahanpur  | 38000      | 3006864             | 791.28              |
| 20  | Hardoi        | 37668      | 3012385             | 799.71              |

Source: Department of Agriculture U.P.

**Table 2. Compound Annual Growth Rate (CAGR) of Sugarcane Production in India, Uttar Pradesh and Meerut (2002-03 and 2021-22).**

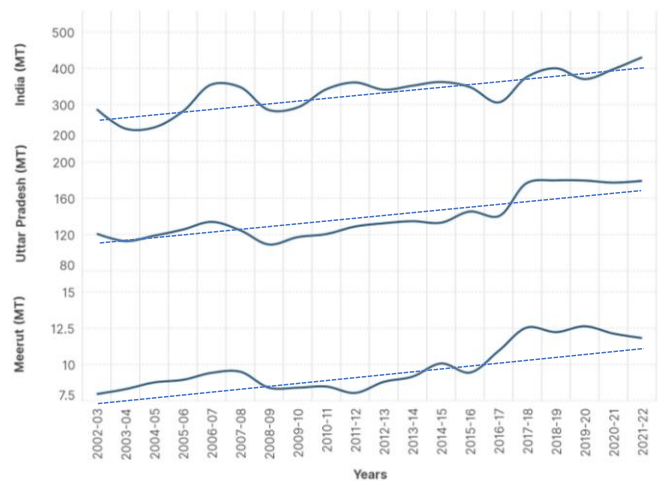
| Years   | India (Million Tonnes) | Uttar Pradesh (Million Tonnes) | Meerut (Million Tonnes) |
|---------|------------------------|--------------------------------|-------------------------|
| 2002-03 | 287.38                 | 110.80                         | 7.96                    |
| 2021-22 | 431.81                 | 177.43                         | 11.82                   |
| CAGR    | +2.05                  | +2.38                          | +1.99                   |

Source: Sankhikya Patrika 2022

**Trend and pattern of sugarcane production:** The Table 3 and Figure 1 show the sugarcane production from 2002-03 to 2021-22 in India, Uttar Pradesh and Meerut. The table and figure show an uneven trend of sugarcane production and CAGR during the study period. This uneven trend could be due to the uncertain and irregular monsoon, Land Use and Crop Rotation, Market dynamics and Government policies. The substantial increase in the production of sugarcane was noticed during the period of 2021-22 (India), 2018-19 (Uttar Pradesh) and 2019-20 (Meerut). It may be due to not only increase in productivity but also due to increase in area, technological advancement, government policies, research and development, infrastructure development, global and national trends and improved extension services.

The most significant development in the sugarcane production was during 2005-08 when the political power at the centre changed and encouraged the sugarcane production. The sugarcane production in district took other turn when the production reached to its peak during 2019-20. This phenomenal increase was the cumulative impact of number of measures taken by the state government. The most important reason could be replacement of MSP of sugarcane with FRP (Fare and Remunerative Price) making it more stabilized which boosted the sugarcane cultivation in the district. Then in following years this FRP was increased by the government which motivated the farmers to grow the sugarcane crop. The SAP (State Advisory Price) launched in the state also gave the advantage to the farmers of the district.

The production CAGR during 2002-03 to 2006-07 of sugarcane of 3.43% reflects the positive growth trajectory where as it declined in next five years to -3.27% suggesting a decline in production due to economic factors, regional dynamics and specific challenges such technologies disruptions, supply chain issues and regulatory hurdles. There was a recovery in CAGR (+4.44%) during 2012-13 to 2016-17 indicating the accelerated growth which could be due to agricultural practices, technological advancements and favourable market conditions. In next five years there was negative CAGR indicating slight contraction in production which was due to climatic variations, market demands and policy changes in agriculture sector.



**Figure 1. Trend of sugarcane production in India, Uttar Pradesh and Meerut (2002-03 to 2021-22)**

**Trend and pattern of area under sugarcane production:** The Table 4 and Figure 2 shows that there is uneven trend in India, Uttar Pradesh and Meerut for area under the sugarcane cultivation between 2002-03 and 2021-22. The decline in area under sugarcane production was due to poor government's pricing policy for sugarcane which demotivated the farmers to cultivate the sugarcane and shifted to grow other crops.



**Table 3. Year-wise Sugarcane Production (2002-03 to 2021-22).**

| Years   | India<br>(Million Tonnes) | CAGR  | Uttar Pradesh<br>(Million Tonnes) | CAGR  | Meerut (Million<br>Tonnes) | CAGR  |
|---------|---------------------------|-------|-----------------------------------|-------|----------------------------|-------|
| 2002-03 | 287.38                    |       | 120.94                            |       | 7.96                       |       |
| 2003-04 | 233.86                    |       | 112.75                            |       | 8.30                       |       |
| 2004-05 | 237.08                    |       | 118.71                            | +2.06 | 8.76                       | +3.43 |
| 2005-06 | 281.17                    | +4.34 | 125.47                            |       | 8.94                       |       |
| 2006-07 | 355.52                    |       | 133.94                            |       | 9.42                       |       |
| 2007-08 | 348.18                    |       | 124.66                            |       | 9.50                       |       |
| 2008-09 | 285.02                    |       | 109.04                            |       | 8.40                       |       |
| 2009-10 | 292.30                    | +0.72 | 117.14                            | +0.65 | 8.40                       | -3.27 |
| 2010-11 | 342.38                    |       | 120.54                            |       | 8.48                       |       |
| 2011-12 | 361.03                    |       | 128.81                            |       | 8.04                       |       |
| 2012-13 | 341.19                    |       | 132.42                            |       | 8.80                       |       |
| 2013-14 | 352.14                    |       | 134.68                            |       | 9.16                       |       |
| 2014-15 | 362.33                    | -2.14 | 133.06                            | +1.14 | 10.07                      | +4.44 |
| 2015-16 | 348.44                    |       | 145.38                            |       | 9.44                       |       |
| 2016-17 | 306.07                    |       | 140.16                            |       | 10.93                      |       |
| 2017-18 | 376.90                    |       | 177.05                            |       | 12.55                      |       |
| 2018-19 | 400.15                    |       | 179.71                            |       | 12.23                      |       |
| 2019-20 | 370.50                    | +2.69 | 179.53                            | +0.24 | 12.63                      | -1.19 |
| 2020-21 | 397.65                    |       | 177.26                            |       | 12.13                      |       |
| 2021-22 | 430.50                    |       | 179.20                            |       | 11.82                      |       |

Source: Sankhikya Patrika 2022

**Table 4. Year-wise Area under Sugarcane Cultivation in Meerut District (2002-03 to 2021-22).**

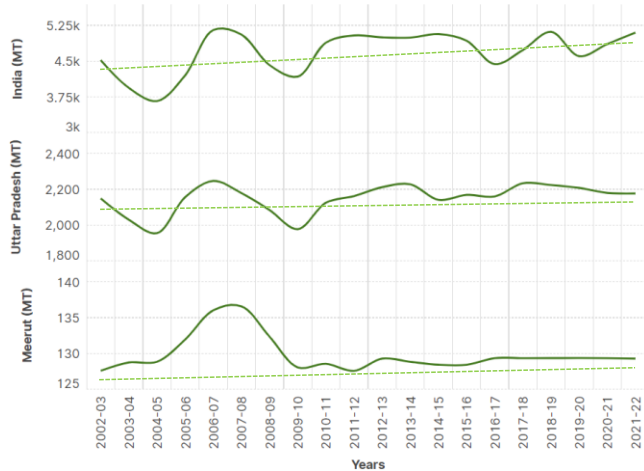
| Year    | India ('000 hac) | CAGR  | UP ('000 hac) | CAGR  | Meerut ('000 hac) | CAGR  |
|---------|------------------|-------|---------------|-------|-------------------|-------|
| 2002-03 | 4520             |       | 2149          | +0.89 | 127.56            | +0.01 |
| 2003-04 | 3938             |       | 2030          |       | 128.72            |       |
| 2004-05 | 3662             | +2.64 | 1955          |       | 128.82            |       |
| 2005-06 | 4201             |       | 2156          |       | 131.92            |       |
| 2006-07 | 5151             |       | 2247          |       | 136.01            |       |
| 2007-08 | 5055             |       | 2179          | -0.15 | 136.57            | -0.01 |
| 2008-09 | 4415             |       | 2084          |       | 132.32            |       |
| 2009-10 | 4175             | -0.06 | 1977          |       | 128.03            |       |
| 2010-11 | 4886             |       | 2125          |       | 128.54            |       |
| 2011-12 | 5038             |       | 2162          |       | 127.54            |       |
| 2012-13 | 4998             |       | 2212          | -0.47 | 129.26            | 0.0   |
| 2013-14 | 4993             |       | 2228          |       | 128.81            |       |
| 2014-15 | 5067             | -2.35 | 2141          |       | 128.40            |       |
| 2015-16 | 4927             |       | 2169          |       | 128.40            |       |
| 2016-17 | 4436             |       | 2160          |       | 129.32            |       |
| 2017-18 | 4732             |       | 2234          | -0.51 | 129.32            | 0.0   |
| 2018-19 | 5114             |       | 2224          |       | 129.33            |       |
| 2019-20 | 4603             | +1.50 | 2208          |       | 129.34            |       |
| 2020-21 | 4857             |       | 2180          |       | 129.32            |       |
| 2021-22 | 5098             |       | 2177          |       | 129.26            |       |

Source: Sankhikya Patrika 2022

Higher market price of other crops in the previous years also effected the choice of farmers. Farmers generally try to grow crops with higher prices. The area roughly remained same

between 2009-10 to 2021-22 although the production was increasing in the district due to increase in the productivity of the sugarcane.

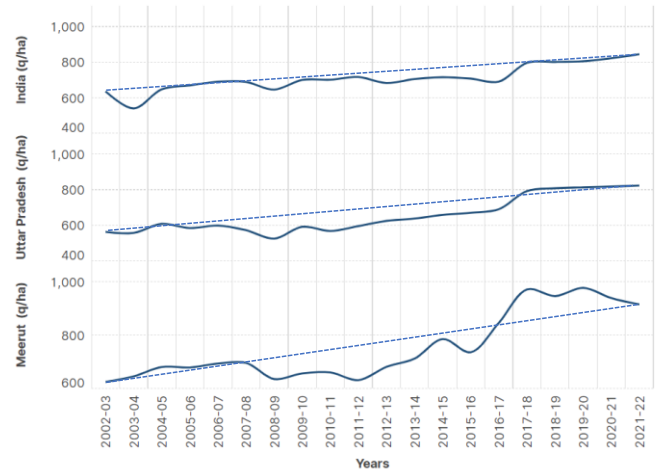




**Figure 2. Trend of area under sugarcane crop for India, Uttar Pradesh and Meerut (2002-03 to 2021-22).**

**Pattern and trend of sugarcane yield:** Table 5 and Figure 3 reveals the trend of sugarcane yield in the country, state and the district (Meerut). Unlike production and area under the sugarcane crop, the data reveals the increase in productivity of the crop. It is evident from the figure that the trend is positive for India, U.P. and Meerut revealing impact of improved varieties, advanced farming practices, improved weed control methods, improved research and development and Training and Extension services. Moreover, from the table it is visible that productivity of crop has not recorded

any remarkable change. While analyzing the yield of the state of Uttar Pradesh as a whole, it is noticed that yield was lower in earlier years but soared in the recent years. The highest yield was recorded in 2021-22 (823 q/ha) and lowest recorded in 2008-09 (524.6 q/ha). In addition to this, Meerut district has its own trend in overall the trend is positive with highest yield during 2019-20 (976 q/ha) and lowest was registered during 2002-03 (624.2 q/ha).



**Figure 3. Trend of yield of sugarcane crop for India, Uttar Pradesh and Meerut (2002-03 to 2021-22).**

**Prediction for the Sugarcane Production:** The table 6 forecasts sugarcane production in India, focusing on Uttar

**Table 5. Sugarcane Yield in India, Uttar Pradesh and Meerut (2002-03 to 2021-22).**

| Year    | India (q/ha) | CAGR  | Uttar Pradesh (q/ha) | CAGR  | Meerut (q/ha) | CAGR  |
|---------|--------------|-------|----------------------|-------|---------------|-------|
| 2002-03 | 635.8        |       | 562.8                |       | 624.2         |       |
| 2003-04 | 539.8        |       | 557.1                |       | 645.0         |       |
| 2004-05 | 647.5        | +1.65 | 608.0                | +1.23 | 680.2         | +2.11 |
| 2005-06 | 669.2        |       | 584.1                |       | 678.3         |       |
| 2006-07 | 690.2        |       | 598.5                |       | 693.0         |       |
| 2007-08 | 688.7        |       | 572.2                |       | 695.6         |       |
| 2008-09 | 645.5        |       | 524.6                |       | 635.0         |       |
| 2009-10 | 700.2        | +0.79 | 591.5                | +0.80 | 656.1         | -1.93 |
| 2010-11 | 700.9        |       | 567.7                |       | 659.9         |       |
| 2011-12 | 716.6        |       | 595.5                |       | 630.7         |       |
| 2012-13 | 682.5        |       | 624.6                |       | 680.7         |       |
| 2013-14 | 705.2        |       | 637.7                |       | 711.5         |       |
| 2014-15 | 715.1        | +0.21 | 658.2                | +2.01 | 784.9         | +4.43 |
| 2015-16 | 707.2        |       | 670.2                |       | 735.4         |       |
| 2016-17 | 690.0        |       | 690.0                |       | 845.7         |       |
| 2017-18 | 796.6        |       | 792.4                |       | 970.9         |       |
| 2018-19 | 801.1        |       | 808.0                |       | 945.8         |       |
| 2019-20 | 804.9        | +1.17 | 813.1                | +0.76 | 976.8         | -1.18 |
| 2020-21 | 822.0        |       | 818.0                |       | 938.6         |       |
| 2021-22 | 844.4        |       | 823.0                |       | 914.7         |       |

Source: Sankhikya Patrika 2022





Pradesh state and Meerut district, from the agricultural year 2021-22 to 2033-34. There is a continual increase in sugarcane production in all three regions during this time. India's sugarcane production is projected to rise from 431.81 million metric tons (MT) in 2021-22 to 550.87 million MT in 2033-34. Uttar Pradesh's production is forecasted to climb from 177.43 million MT to 235.29 million MT, and Meerut's production is likely to rise from 11.82 million MT to 14.97 million MT in the same period.

Various variables may contribute to the anticipated rise in sugarcane production. These innovations encompass improvements in agricultural technology, such as the use of high-yielding sugarcane varieties, enhanced farming techniques, superior irrigation technologies, and the application of fertilizers and pesticides. Government initiatives, such as subsidies and price guarantees, can also help stimulate sugarcane production by assisting farmers. Moreover, optimal weather conditions, such as adequate rainfall and appropriate temperatures, may enhance sugarcane production in these areas. The table indicates a positive forecast for sugarcane production in India, Uttar Pradesh, and Meerut, highlighting possible growth prospects for the sugarcane industry in the coming years.

**Table 6. Sugarcane production prediction for India, Uttar Pradesh and Meerut**

| Years   | India<br>(Million<br>Tonnes) | Uttar Pradesh<br>(Million Tonnes) | Meerut<br>(Million<br>Tonnes) |
|---------|------------------------------|-----------------------------------|-------------------------------|
| 2021-22 | 431.81                       | 177.43                            | 11.82                         |
| 2022-23 | 440.66                       | 181.65                            | 12.06                         |
| 2023-24 | 449.70                       | 185.98                            | 12.30                         |
| 2024-25 | 458.91                       | 190.40                            | 12.54                         |
| 2025-26 | 468.32                       | 194.93                            | 12.79                         |
| 2026-27 | 477.92                       | 199.57                            | 13.04                         |
| 2027-28 | 487.72                       | 204.32                            | 13.30                         |
| 2028-29 | 497.72                       | 209.19                            | 13.57                         |
| 2029-30 | 507.92                       | 214.16                            | 13.84                         |
| 2030-31 | 518.33                       | 219.26                            | 14.11                         |
| 2031-32 | 528.96                       | 224.48                            | 14.39                         |
| 2032-33 | 539.80                       | 229.82                            | 14.68                         |
| 2033-34 | 550.87                       | 235.29                            | 14.97                         |

## DISCUSSION

Sugarcane (*Saccharum officinarum* L.) is a vital cash crop, predominantly grown in tropical and sub-tropical regions, notably in India, the world's second-largest producer after Brazil. In India, Uttar Pradesh leads in production. The industry significantly contributes to the economy and job market. However, challenges like input availability, rising input costs, and delayed payments from sugar mills persist, impacting farmers. Despite hurdles, sugarcane remains a cornerstone of agriculture, with its economic significance

prompting ongoing studies on production economics in key regions like Meerut district. The study highlights Uttar Pradesh as India's foremost sugarcane producer, accounting for 45% of the nation's total production. Within Uttar Pradesh, Kheri district emerges as a leader in both area under cultivation and production, while Shamli district excels in productivity. Notably, 13 out of the top 20 districts are situated in Western Uttar Pradesh. These findings are consistent with prior research by Kant *et al.* (2015); Tripathi and Meena (2015); Gohain and Singh (2018); Kishore *et al.* (2017); Chandra *et al.* (2021). Examining the Compound Annual Growth Rate (CAGR) of sugarcane production from 2002-03 to 2021-22, the study reveals India's CAGR to be +2.05%, with Uttar Pradesh slightly outperforming at +2.38%, and Meerut recording a marginally lower rate at +1.99%. Despite this, growth rates have been sluggish, attributed to factors such as low yield, price volatility, and competition from alternative crops. These findings echo those reported by Kshirsagar (2008); Rama (2011); Rout *et al.* (2013); Kumar and Singh (2017); Kant *et al.* (2015); Tripathi and Meena (2015); Krishnamoorthy (2017); Gohain and Singh (2018); Singh *et al.* (2020).

The study reveals an uneven sugarcane production trend from 2002-03 to 2021-22 in India, Uttar Pradesh, and Meerut. Increases were observed in 2021-22, 2018-19, and 2019-20, attributed to technological advancements, government policies, research, and infrastructure development. The production CAGR declined in the next five years due to economic factors, regional dynamics, and challenges. The same results were revealed by Kshirsagar, 2008; Rama 2011; Srivastava *et al.*, 2011; Rout *et al.*, 2013; Kant *et al.*, 2015; Tripathi and Meena, 2015; Kumar and Singh, 2017; Krishnamoorthy, 2017; Gohain and Singh, 2018. Between 2002-03 and 2021-22, there was an uneven trend in sugarcane cultivation areas in India, Uttar Pradesh, and Meerut. The decline was attributed to poor government pricing policies, which discouraged farmers from cultivating sugarcane and led them to grow other crops. The area remained relatively unchanged between 2009-10 and 2021-22, despite increased sugarcane productivity in the districts. The same findings were reported by Kshirsagar, 2008; Rama 2012; Rout *et al.*, 2013; Kumar and Singh, 2017; Kant *et al.*, 2015; Tripathi and Meena, 2015; Krishnamoorthy, 2017; Gohain and Singh, 2018; Yasmeen *et al.*, 2018 ; Singh *et al.*, 2020. The data shows a positive trend in sugarcane yield in India, Uttar Pradesh, and Meerut, indicating improved varieties, advanced farming practices, weed control methods, research, and extension services. However, productivity has not significantly changed. Uttar Pradesh yields have soared in recent years, with the highest recorded in 2021-22 and lowest in 2008-09. The same findings were reported by Kshirsagar, 2008; Rama 2012; Rout *et al.*, 2013; Kumar and Singh, 2017; Kant *et al.*, 2015; Tripathi and Meena, 2015; Krishnamoorthy,



2017; Gohain and Singh, 2018; Yasmeen *et al.*, 2018 ; Singh *et al.*, 2020.

The study predicts a continuous increase in sugarcane production in India, Uttar Pradesh, and Meerut from 2021-22 to 2033-34. The growth is attributed to improvements in agricultural technology, improved farming techniques, superior irrigation, and the application of fertilizers and pesticides. The same findings were reported by Kshirsagar, 2008; Rama 2011; Rout *et al.*, 2013; Kumar and Singh, 2017; Kant *et al.*, 2015; Tripathi and Meena, 2015; Krishnamoorthy, 2017; Gohain and Singh, 2018; Singh *et al.*, 2020. Government initiatives, such as subsidies and price guarantees, and optimal weather conditions also contribute to the anticipated growth in the sugarcane industry.

**Conclusion:** It is evident from the study that there are fluctuations in the area, production and productivity of the sugarcane in the Meerut district. Sugarcane production is of paramount importance for Meerut, driving economic growth, industrial development, food security, and cultural heritage preservation. Recognizing and nurturing the significance of sugarcane cultivation in Meerut is essential for sustainable rural development and inclusive economic progress in the region. From the study it is found that the sugarcane production has an increasing trend in the country, State and Meerut District in last 20 years. The area under sugarcane shows increasing trend for India but very little change in area for state and Meerut. The yield also shows an increasing trend in yield in the country, state and Meerut. Since sugarcane is one of the most important cash crop and politically sensitive crop, so a small step in favour of farmers results in bigger changes in cropping pattern in favour of the sugarcane. The impact of FRP has a significant impact on the cultivation of the crop.

As per the experimental observation, it was observed that due to the shortage of labour, the cost of cultivation and harvesting has increased at the alarming rates. The rates provided by the sugarcane factories are not sufficient to cover the cost of production. Under the circumstances, the farmers are finding the way to either migrate to other crop or get the higher price by the intervention of the Government of India. Another reason for lower productivity and production is unpredictable monsoons. Being one of the important cash crop which occupy 10 per cent of the total cropped area in the district, the stabilization of production and price of crop is the need for the district. In this regard, the government can play a vital role. At government level, weather forecasting for the specific crops should be done. The GOI should frame strong policies for crop procurement. These initiatives would enable the scope and increase the production of the sugarcane in district, state and country.

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N. Gohain and P.K. Nimbrayan segregated, cleaned and aggregated the data, A. Kumar, J. Yadav and T. Kumar conceived the idea and supervised the work.

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