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Trends in area, production, productivity and market prices of maize in Telangana state

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Abstract
Maize is widely cultivated across India due to its adaptability to diverse geographical regions. Maize has diverse applications, serving as feed for poultry and livestock, as well as for food and industrial purposes. To analyze trends in maize cultivation within Telangana state over a 20-year period (2001-02 to 2020-21), various growth models were applied to the data on maize area, production, productivity, and market prices. The best model was chosen based on the highest R^2 value. The cubic model provided the highest accuracy (0.53) compared to other models. This suggests a more complex growth pattern with multiple phases of growth and decline. The power model had the highest accuracy (0.41) for maize production, implying a moderate increase over time. The cubic model also best explained maize productivity trends with an accuracy of (0.59), indicating a more complex growth pattern. These findings suggest that maize cultivation in Telangana follows intricate growth patterns, possibly influenced by a combination of factors.

Keywords: Maize, area, production, productivity, market prices, CAGR, trend analysis

Introduction
Corn, referred to as the "Queen of Cereals," is a crucial crop in India, ranking third in profitability after wheat and rice. With 16 million Indian farmers engaged in its cultivation, the leading corn-producing states of Karnataka, Rajasthan, Madhya Pradesh, and Telangana play a significant role in the nation's overall corn output (IIMR, 2023-24) [4].

In Telangana, corn is the third-most important crop, spanning 12.74 lakh acres. During the 2022-23 harvest, the state saw a considerable increase in corn production, reaching 28.65 lakh tonnes (DES, 2022-23) [2]. The top corn-producing areas in Telangana include Warangal Rural, Khammam, Nirmal, Siddipet, Kamareddy, Mahabubabad, Nizamabad, Warangal Urban, Jagityal, and Karimnagar. Over the past decade, both the area under corn cultivation and production have expanded significantly in the state (TS agriculture, 2022-23) [3].

Price instability, exploitation of farmers by middlemen in marketing activities and lack of market integration system, *etc.* are a few of the pressing problems faced by the farmers cultivating maize. Keeping this in view, Telangana Government has urged the farmers not to go for maize cultivation during *kharif* 2020-21 under the Regulated farming policy. Accordingly, maize acreage has reduced from 6.50 lakh hectares to 2.61 lakh hectares in Telangana State even though the agro-climatic conditions are favourable for its cultivation (DES, 2021-22) [5].

Under these circumstances, it is felt that there is need to formulate appropriate ways and means for sustenance of the crop in the state and reduce price fluctuations, such that both producer's profit and consumer's benefits will increase and lead for overall economic development of the state.

Materials and Methods
Data source
Time series data on area, production and productivity of maize for the period from 2001-02 to 2021-22 for Telangana state were collected from Directorate of Economics and Statistics, Telangana.

For the period of 2001-02 to 2020-21, monthly time series data on the modal maize prices that prevailed in Telangana's major markets were gathered from www.agmarknet.gov.in.

Trend analysis
Using known values from the past, trend lines were used to forecast potential future trends. For detecting the trends in area, production and productivity of maize crop based on secondary data from 2001-02 to 2020-21, various trend lines were fitted using linear and non-linear models.

Linear function
The function is given by $Y_t = a + bt$

Where,
'Y_t' is the dependent variable i.e., area or production or productivity
't' is the independent variable, time in years
'a' is the intercept
'b' is the regression coefficient

Quadratic function
This function is useful when there is peak or trough in the data of past periods.
Quadratic function is

$Y_t = a + bt + ct^2$

Where,
'Yt' is the dependent variable i.e., area or production or productivity
't' is the independent variable, time in years
'a' is the intercept
'b' and 'c' are the regression coefficients

Cubic function
This function is useful when there are two peaks or two troughs in the data of past periods.
Cubic fit or third-degree curve is given by the equation:

$Yt = a + bt + ct^2 + dt^3$

Where,
'Yt' is the dependent variable i.e., area or production or productivity
't' is the independent variable, time in years
'a' is the intercept
'b', 'c' and 'd' are the regression coefficients

Logarithmic function
The function of this fit can be given by

$Y_t = a + b \ln (t)$

Where,
'Y_t' is the dependent variable i.e., area or production or productivity
't' is the independent variable, time in years
'a' is the intercept
'b' is the regression coefficient

Power function
The function of this fit can be given by

$Yt = at^b$

(or)

$\ln (Yt) = \ln (a) + b \ln(t)$

Where,
'Yt' is the dependent variable i.e., area or production or productivity
't' is the independent variable, time in years
'a' is the intercept
'b' is the regression coefficient
The fit is similar to exponential fit, but produces a forecast curve that either increase or decrease at different rates.

Exponential function
The function of this fit can be given by

$Yt = ae^{bt}$ (or)

$\ln Yt = \ln a + (bt) \log e$
Where,
'Yt' is the dependent variable i.e., area or production or productivity
't' is the independent variable, time in years
'a' is the intercept
'b' is the regression coefficient

Compound Annual Growth Rate
The compound annual growth rates in area, production and productivity for the maize crop were worked out from 2001-02 to 2020-21.
The computational formula is specified below.

$Yt = ab^te^u$ (1)

Where,
'Yt' is the Area /Production / Productivity
't t' is the time period
'b' is the (1+r),
'r' is the growth rate
' a' is the intercept
'e' is the error term

Equation (1) was converted into the logarithmic form by taking log on both sides to run linear regression.

$Ln\ Yt = Ln\ a + t\ Ln\ b + u$ (2)

From equation (2) a and b were obtained on application of ordinary least squares (OLS) and the growth rate 'r' was computed as:
r = (Anti log of b - 1) X 100 (3)

Results and Discussion
The data in Table 1 represents the growth in maize area, production, yield, and market prices in Telangana from the agricultural year 2000-2001 to 2020-2021. The data in the table shows that the maize cultivation area in Telangana has experienced fluctuations over the years. It started at 3.7 lakh hectares in 2001-02 and increased to 8.02 lakh hectares in 2016-17 before decreasing again. This fluctuation could be due to various factors such as changes in cropping patterns, weather conditions, and market demand.

Table 1: Area, production, productivity and average market prices of maize in Telangana State 2001-02 to 2020-21

Year	Area (Lakh hectares)	Production (Lakh tonnes)	Productivity (Kg/ha)	Average market price (₹/qtl)
2001-02	3.70	11.86	3204	555
2002-03	4.51	11.62	2579	533
2003-04	5.99	19.82	3306	538
2004-05	5.32	13.51	2539	530
2005-06	6.38	23.39	3666	579
2006-07	5.91	16.26	2750	715
2007-08	6.04	28.72	4752	765
2008-09	6.01	21.93	3652	820
2009-10	5.69	13.66	2400	875
2010-11	5.10	20.69	4056	988
2011-12	5.91	18.92	3200	1198
2012-13	6.63	29.44	4440	1302
2013-14	7.50	35.12	4681	1200
2014-15	6.91	23.08	3338	1285
2015-16	5.73	17.51	3057	1340
2016-17	8.02	28.82	3595	1374
2017-18	6.30	27.52	4363	1438
2018-19	5.43	20.82	3835	1849
2019-20	6.50	40.78	6274	1587
2020-21	2.61	17.56	6713	1669
CAGR	0.39	3.42	3.01	7.24

Source: www.indiastat.com

The maize production in Telangana has shown an overall increasing trend over the years. It started at 11.86 lakh tonnes in 2001-02 and reached 40.78 lakh tonnes in 2019-20, indicating a significant increase in production. This growth reflects advancements in agricultural practices, including better seeds, improved irrigation, and pest management.

Productivity, measured in kg/ha, reflects the efficiency of maize cultivation. The data indicates an improvement in maize productivity in Telangana. The productivity increased from 3204 kg/ha in 2001-02 to 6713 kg/ha in 2020-21. This increase could be attributed to the adoption of modern farming techniques, better agronomic practices, and increased usage of fertilizers and other technologies.

The average market price of maize in Telangana has generally shown an upward trend, with some fluctuations. It started at Rs. 555/qtl in 2001-02 and rose to Rs. 1669/qtl in 2020-21. This increase could be contributed by factors like demand-supply dynamics, inflation, changes in consumption patterns, and market integration. The rising average market price suggests that maize has been in demand, potentially due to its various uses in food, animal feed, and industrial applications.

The Compound Annual Growth Rate (CAGR) provides insights into the average annual growth rate of the various parameters. From the given CAGR values, it is evident that the area, production, and productivity of maize have been growing, albeit at varying rates. The maize area, production and productivity have increased at CAGR of 0.39 per cent, 3.42 per cent, and 3.01 per cent respectively. Whereas CAGR for market prices was much higher at 7.24 per cent, indicating significant price growth over the years. The growth in maize production and rising prices could have positive economic impact on farmers' income and the state's economy as a whole.

Different trend/growth models fitted for area, production, productivity and market prices of maize in Telangana

To understand the trends in area, production, productivity and market prices of maize in Telangana state different growth models were fitted for the area, production, productivity and market prices of maize in Telangana considering the data for the time period of 20 years (2001-02 to 2020-21) and the results are presented in Table 2 to 5. The best model was chosen based on the highest R^2 value.

Table 2: Different trend models for area under maize cultivation in Telangana

Trend model	Intercept	b	c	d	R2
Linear	5.542	0.290			0.022
Logarithmic	4.857	0.469			0.104
Exponential	5.563	0.003			0.005
Quadratic	3.634	0.550**	-0.025**		0.428
Cubic	5.011	-0.153**	0.057**	-0.003**	0.539
Power	4.899	0.073			0.072
Inverse	6.245	-2.194			0.172
Compound	5.563	1.003			0.005
S	1.1815	-0.391			0.154
Growth	1.716	0.003			0.005
Logistic	0.180	0.997			0.005

0.05>* ---5% level of significance, 0.01>** ---1% level of significance

Table 3: Different trend models for production of maize crop in Telangana

Trend model	Intercept	b	c	D	R2
Linear	14.668	0.717**			0.304
Logarithmic	10.605	5.478**			0.335
Exponential	14.756	0.034**			0.340
Quadratic	11.230	1.655*	-0.045*		0.335
Cubic	11.297	1.621	-0.041	0.000	0.335
Power	11.854	0.270**			0.415
Inverse	25.332	-17.413**			0.256
Compound	14.756	1.034**			0.340
S	3.208	-0.907**			0.353
Growth	2.692	0.034**			0.340
Logistic	0.068	0.967**			0.340

0.05>* ---5% level of significance, 0.01>** ---1% level of significance

Table 4: Different trend models for productivity of maize crop in Telangana

Trend model	Intercept	b	c	D	R2
Linear	2528.216	123.027**			0.402
Logarithmic	2251.973	740.760*			0.275
Exponential	2690.281	0.030**			0.400
Quadratic	3375.821	-108.138**	11.008**		0.487
Cubic	2051.363	567.677**	-67.517**	2.493**	0.597
Power	2493.190	0.183*			0.287
Inverse	4140.448	-1781.385*			0.120
Compound	2690.281	1.030**			0.400
S	8.289	-0.444*			0.127
Growth	7.897	0.030**			0.400
Logistic	0.000	0.000**			0.400

0.05>* ---5% level of significance, 0.01>** ---1% level of significance

Table 5: Different trend models for average annual market prices of maize crop in Telangana

Trend model	Intercept	b	c	D	R2
Linear	331.545	69.140**			0.946
Logarithmic	103.122	450.864**			0.759
Exponential	467.687	0.070**			0.950
Quadratic	385.096	54.534**	0.696**		0.949
Cubic	528.218	-18.492**	9.181**	-0.269**	0.958
Power	355.919	0.476**			0.830
Inverse	1265.279	-1155.019**			0.377
Compound	467.686	1.072**			0.950
S	7.110	-1.268**			0.446
Growth	6.148	0.070**			0.950
Logistic	0.002	0.932**			0.950

0.05>* ---5% level of significance, 0.01>** ---1% level of significance

Several trend models *viz.*, Linear, Logarithmic, Exponential, Quadratic, Cubic, Power, Inverse, Compound, S, Growth and Logistic models were fitted for the time series data of acreage under maize in Telangana and it was observed that the Cubic model had the highest percentage of accuracy (0.539) compared to other models. The linear model suggested that there was a minimal increase in maize area over time, as indicated by the low R-squared value, The logarithmic model indicated that the maize area was increasing at a decreasing rate. The relatively low R-squared value suggests that this model might not fully explain the growth pattern, The exponential model suggests a very slow increase in maize area over time. The low R-squared value implies that the model has limited explanatory power, The quadratic model indicates that the maize area growth follows a parabolic pattern, initially increasing and then possibly stabilizing. The relatively high R-squared value suggests a better fit compared to the previous models. The power model implies a moderate increase in maize area over time, but the low R-squared value indicates that the model might not capture the growth dynamics well. The cubic model suggests a more complex growth pattern, possibly with multiple phases of growth and decline. The higher R-squared value indicates that this model explains more variance in the data compared to simpler models. Similarly, the production and productivity of maize were best fitted with the power and cubic models with accuracy percentages of 0.415 and 0.597, respectively. Thus, the trend was better explained by the cubic and power models in comparison to other models. The pictorial representation for the same is given in Figure 4.6. The study conducted by Evangeline (2020) on ground nut crop, Greeshma *et al.* (2014) in sugarcane crop also witnessed the cubic model as the best fit as it analysed the growth of area, production and productivity with high accuracy.

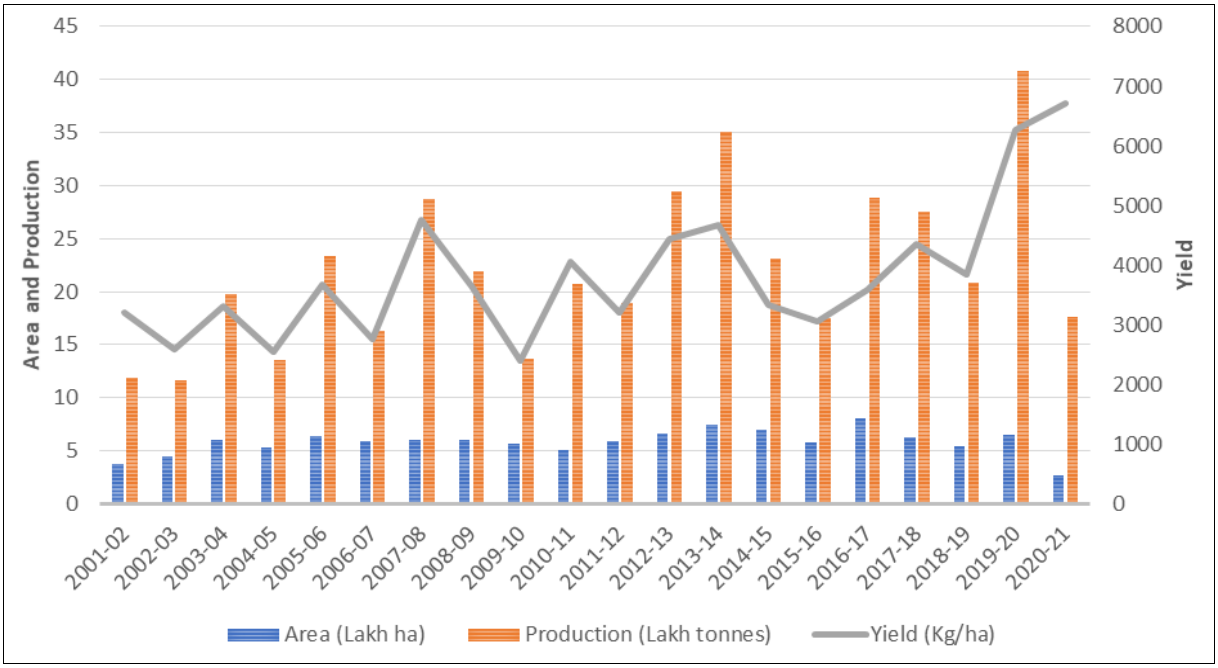

Fig 1: Trends in area, production and productivity of maize in Telangana from 2001-02 to 2020-21

Summary

The area cultivated under maize in Telangana has shown fluctuations over the years, ranging from 3.7 lakh hectares in 2001-02 to 8.02 lakh hectares in 2016-17 before declining again. These fluctuations might have influenced by factors such as changing cropping patterns, weather conditions, and market demand.

Maize production in Telangana has displayed a consistent upward trend, increasing from 11.86 lakh tonnes in 2001-02 to 40.78 lakh tonnes in 2019-20. This growth can be attributed to advancements in agricultural practices, including better seeds, improved irrigation, and pest management.

Maize productivity in Telangana, measured in kg/ha, has also improved significantly, rising from 3204 kg/ha in 2001-02 to 6713 kg/ha in 2020-21. This increase may be a result of modern farming techniques, improved agronomic practices, and increased use of technology. The average market price of maize in Telangana has generally shown an upward trend, increasing from ₹ 555/qtl in 2001-02 to ₹ 1669/qtl in 2020-21. Factors contributing to this rise might include demand-supply dynamics, inflation, changes in consumption patterns, and market integration.

The Compound Annual Growth Rate (CAGR) values indicated that maize area (0.39), production (3.42), and productivity (3.01) have been growing, albeit at varying rates. Maize prices have shown a particularly high CAGR (7.24), indicating significant price growth over the years. The increasing maize production and rising prices are likely to have positive economic impacts on farmers' incomes and the state's overall economy.

The cubic model provided the highest accuracy (0.53) compared to other models. This suggests a more complex growth pattern with multiple phases of growth and decline. The power model had the highest accuracy (0.41) for maize production, implying a moderate increase over time. The cubic model also best explained maize productivity trends with an accuracy of 0.59, indicating a more complex growth pattern.

These findings suggest that maize cultivation in Telangana follows intricate growth patterns, possibly influenced by a combination of factors. The cubic and power models provided better insights into these trends compared to simpler models. Similar trends were observed in other agricultural studies, corroborating the suitability of these models for analysing growth patterns in crops.

Conclusion

The trends in area, production, productivity, and market prices of maize, the cultivation area had experienced fluctuations, while production and productivity have consistently increased. The upward trajectory can be attributed to advancements in agricultural practices. Market prices have also risen, influenced by demand-supply dynamics and market integration. The compound annual growth rates indicate positive economic impacts on farmers and the state's economy. This sheds light on the socio-economic profile of sample farmers and the dynamic trends in maize cultivation, offering a comprehensive understanding of the agriculture landscape in Telangana. The intricate interplay of socio-economic factors and complex growth patterns underscored the need for targeted interventions and policies to sustain and enhance the well-being of farmers and the agricultural sector in the region.

References

1. Indian Institute of Maize Research (IIMR). Indian Institute of Maize Research. Government of India; c2023-24.
2. Directorate of Economics and Statistics (DES). Directorate of Economics and Statistics. Government of Telangana; c2022-23.
3. TS Agriculture. [Internet]. Available from: www.tsagriculture.com; c2022-23.
4. Indian Institute of Maize Research (IIMR). Indian Institute of Maize Research. Government of India; c2023-24.
5. Directorate of Economics and Statistics (DES). Directorate of Economics and Statistics. Government of Telangana; c2021-22.
6. Anand M, Vivek K, Kavya D. Spatial and temporal trends in the yields of three major crops: wheat, rice, and maize in India. Int J Plant Prod. 2020;14:187-207.
7. Juselius K. A note on Johansen's cointegration procedure when trends are present. Empir Econ. 1990;18:777-789.
8. Jyothi K, Arti S, Anil B. Study on growth and instability of maize in Jammu and Kashmir. Econ Aff. 2013;58(1):21-28.
9. Kannan E, Sundaram S. Analysis of trends in India's agricultural growth. Working paper 276. Institute for Social and Economic Change (ISEC), India; c2011.
10. Maitra S, Shankar T, Manasa P, Sairam M. Present status and future prospects of maize cultivation in South Odisha. Int J Bioresour Sci. 2019;6(1):27-33.
11. Muralidhar M, Venkannanvara, Gaddi GM, Gracy CP. Growth performance and marketing of maize in Karnataka, India. Int J Curr Microbiol Appl Sci. 2019;8(10):380-387.