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Trend Pattern of Pulse Production in Major State in India

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Abstract: Agriculture significantly impacts the Indian economy, with 50% of the population depending on it and contributing 20.20 % to the GDP in 2020-21. Pulses, essential to Indian agriculture, provide high-quality protein, essential amino acids, fibers, minerals, and vitamins. This study examines the trend patterns of pulse production in Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh and India from 1950 to 2022. Data were collected from www.indiastat.com and Agricultural Statistics at a Glance, was used to determine the trend in production various parametric model such as linear, exponential, logarithmic, quadratic, cubic, and compound model. Results show a substantial increase in pulse production due to enhanced agronomic practices, improved pulse varieties, and government support programs. However, production trends indicated that Karnataka, Madhya Pradesh, Maharashtra, and Rajasthan have seen increases, while in Uttar Pradesh experienced fluctuations due to shifts in crop choices.

Keywords: trend, descriptive statistics.

INTRODUCTION

Pulses serve as crucial protein sources for vegetarians in India. It complements the main grains in the diets by providing proteins, vital amino acids, vitamins, and minerals (Mishra et al., 2021). It has a protein content of 22-24%, which is about twice as much as wheat and three times that of rice (Bouchard, *et al.,* 2022). Pulses provide substantial nutritional and health advantages and have been shown to decrease the risk of several non-communicable illnesses, including colon cancer and cardiovascular disorders (Curron, 2012). The plant can be cultivated in various climatic conditions, but it flourishes best in a temperate climate that is mild, cool, and somewhat dry, with temperatures ranging from 20 to 25 degrees Celsius and an annual rainfall of 40 to 50 centimeters. It plays a crucial role in agricultural practices such as crop rotation, mixed and inter-cropping, as well as in maintaining soil fertility through nitrogen fixation and the release of soil-bound phosphorus (Kumar *et al.,* 2023). Consequently, it makes a substantial contribution to the sustainability of farming systems. The main pulses cultivated in India are chickpea, pigeonpea (also known as red gram), and lentil. These crops are mostly produced during two seasons: the Kharif season, which lasts from June to October, and the Rabi season, which spans from October to April. Chickpea, lentil, and dry peas are cultivated throughout the rabi season, whilst pigeonpea, urdbean, mungbean, and cowpea are cultivated during the kharif season.

In recent times, India has witnessed a noteworthy revival in the production of pulses, fueled by technological breakthroughs and strategic interventions. The nation's production of pulses increased from 14.76 million tonnes in 2000–01 to 26.96 million tonnes in 2020–21, almost doubling, according to data from the Directorate of Pulses Development (Directorate of Pulses Development, 2022). The area planted to pulses has increased, from 22.39 million hectares in 2000–01 to 29.56 million hectares in 2020–21 (Directorate of Pulses Development, 2022). This expansion has been the primary driver of the

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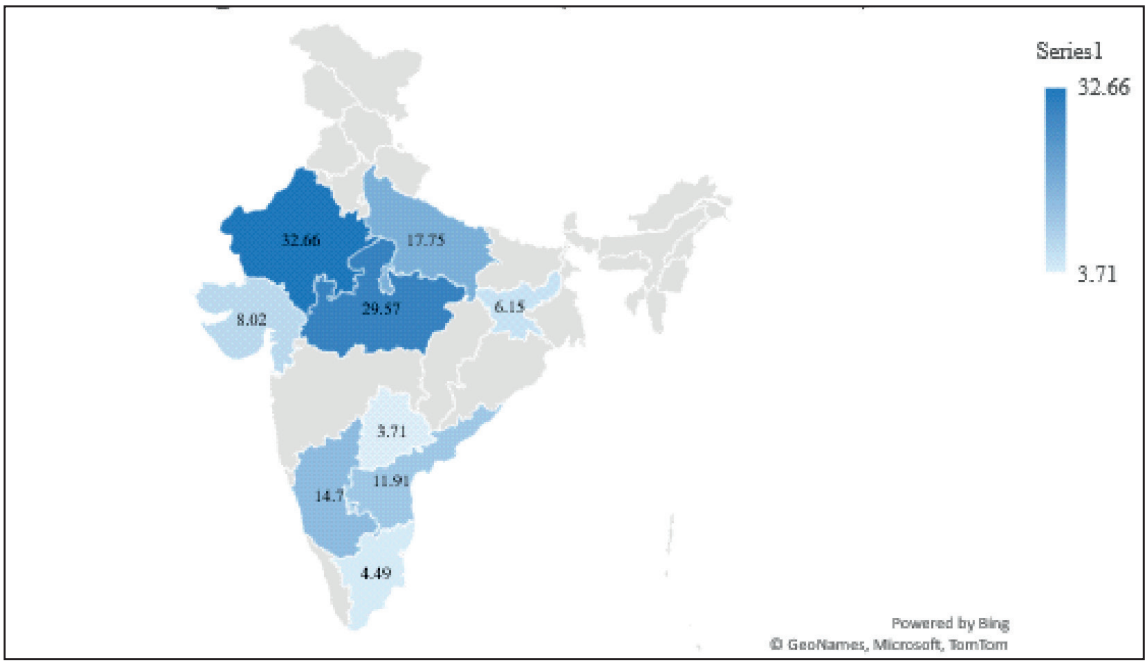

Figure 1: Pulse Production (State wise share in %)

pulse production increase. According to the Directorate of Pulses Development (2022), pulse crop production has also increased, rising from 658 kg/ha in 2000–01 to 912 kg/ha in 2020–21.

According to (Choudhary, et al., 2022; and Jat, et al., 2019), enhanced agronomic methods, the introduction of improved pulse varieties, and government support programs have all been identified as contributing contributors to the rise in pulse production. India's production of pulses has increased dramatically as a result of these calculated initiatives, improved nutrition, and increased food security. In India, pulse production is concentrated in a few important states. Ninety-five percent of India's masur (lentil) comes from Madhya Pradesh, West Bengal, Bihar, and Jharkhand; eighty percent comes from Maharashtra, Karnataka, Uttar Pradesh, Gujarat, and Jharkhand; and seventy-five percent comes from Madhya Pradesh, Andhra Pradesh, Uttar Pradesh, Tamil Nadu, and Maharashtra (ICAR,2023). India still has to import pulses in order to meet its own demand, notwithstanding recent progress. The government has been encouraging the production of pulses through incentives and procurement efforts to meet its aim of becoming self-sufficient in pulses by 2027 (NITI Aayog, 2022). With consideration of the necessity of pulses, the present study was carried out to examine the trend pattern of pulse production in major state in India.

MATERIALS AND METHODS

The collected information are purely secondary. The information on Production of Pulse for the period 1950-2022 were collected from *www.indiastat.com* and *Agricultural Statistics at a Glance.*

DESCRIPTIVE STATISTICS

Descriptive statistics offer a structured and comprehensible structure for numerical information. When assessing a large number of participants in a research study, various methodologies may be employed, or a single metric may suffice. With descriptive statistics, it is simpler to interpret massive amounts of data. Descriptive statistics simplify voluminous amounts of information into a more manageable form. Maximum, minimum, mean, skewness, and kurtosis analyses were utilized by researchers to characterize the series pattern in Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, and India,.

TREND MODELS

An approach to visualizing a system or process is called a model. Statistical models often track both the trajectory of a process and its statistical

characteristics and consequences. Currently, we aim to examine the trajectory and characteristics of the series in question by employing various models, which are outlined below:

Linear Model: $Y_t = b_0 + (b_1 t)$

Quadratic Model: $Y_t = b_0 + (b_1 t) + (b_2 t^2)$

The quadratic model can be used to model a series which "takes off" or a series which "dampens".

Compound Model: $Y_t = b_0 (b_i^t)$ Or, $\ln (Y_t) = \ln (b_0) + t \ln (b_1)$

Cubic Model: The equation of cubic model is given by $Y_t = b_0 + (b_1 t) + (b_2 t^2) + (b_2 t^3)$

Exponential Model: The equation of exponential model is given by $Y_t = b_0 e^{(b1t)}$ or,

$\ln(Y_t) = \ln (b_0) + (b_1 t)$

Logarithmic Model: The equation of logarithmic model is given by $Y_t = b_0 + b_1 \ln (t)$

Where Y_t is the value of the series at time t and b_0, b_1, b_2, b_3 are the parameters.

Among the competitive models, best model for each of the series is fixed on the basis of maximum R^2, minimum standard error and the significance of the coefficient. If, in any case the competitive models show equality in the above cases then, the model having minimum parameter is selected. The best fitted models have also been presented in graphical form along with observed values (Supriya *et al.*, 2023).

RESULTS AND DISCUSSION

Per se performance of pulse production

Table 1 shows descriptive information for the nation's total pulse production from 1950 to 2022 for Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, and India. Between 1950 and 2019, the total amount of pulse produced in India ranged from 8347.00 to 27690.00. As a result, total pulse production in India has increased by nearly 231 percent since 1950. Furthermore, production climbed by 766 percent, 829 percent, 1050 percent, 1772 percent, and 531 percent in Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, and Uttar Pradesh, respectively. As a result, India's average total pulse production is 13664.20. Madhya Pradesh has the highest average pulse production (2929.89), while Karnataka has the lowest at 748.36. When looking at the standard deviations of pulse production, India has the largest standard deviation at 4405.04, indicated that there is a lot of variance in the observed data around the average.

The positively skewed and platykurtic form of the data for Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, and India show that there was a minor shift in the area in favor of pulse production during the early era, and that it stayed nearly moderate variability during the research period. The data for Uttar Pradesh was leptokurtic and positively skewed, indicating a relatively major change in the production during the early era and higher probability of observing extreme values in the pulse production dataset, which may point to greater variability or the presence of outliers. The measure of central tendency, namely, mean > median > mode (positive skewness) and mean< median< mode (negative skewness) confirms the criterion, implying that the data are asymmetric in nature.

Trend analysis of Pulse production

Knowing, the overall performance path of the series movement was traced to parametric trend using a parametric trend model. To determine the trend in production various parametric model such as linear, exponential, logarithmic, quadratic, cubic, compound and growth model were used. The best model is chosen from among the competing models based on its largest R^2 value, model significance, and coefficients. The results of these exercises are presented in the following section (Tables 2).

The non-linear patterns are visible in Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh and India in Figure 2. Thus, one can see from the trend analysis that quadratic trends and exponential trend are noticeable in the production of pulse in Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, India and Uttar Pradesh, indicating that in the recent past most likely series have reached maximum values and then either remained constant or decreased, which is cause for concern. From the figure one can see that production of pulse has

Table 1: Per se Performance of Pulse production in major state in India during 1950-2022

State or Country	*Maximum*	*Minimum*	*Mean*	*Standard Deviation*	*Skewness*	*Kurtosis*
KARNATAKA	2070.00	239.00	748.36	483.17	1.40	0.99
MADHYA PRADESH	8111.58	873.00	2929.89	1612.06	1.53	2.17
MAHARASHTRA	5190.00	451.00	1592.27	933.69	1.63	2.93
RAJASTHAN	4250.00	227.00	1577.16	851.43	1.05	1.00
UTTAR PRADESH	7850.00	1164.00	2602.62	843.43	3.30	20.05
INDIA	27690.00	8347	13664.20	4405.04	1.70	2.45

been increased during and after the nineties. The impact of the expansion of region can be seen in the pulse production scenario, which has increased from 1950 to 2022 with fluctuation 8411 thousand tonnes in 1950 to 26580 thousand tonnes during 2022 in India. But in Karnataka pulse showed some fluctuation from 1950 to 2003, then after it start rising throughout the year from 2003 (569.00) to 2020 (2070.00) with some fluctuation after 2020 start declined.

In Madhya Pradesh, pulse production increased from 1950 to 1997 after that there is huge declined 873 thousand tonnes during 1998 after that again drastic change that there production increased to 3781 thousand tonnes during 1999, after that increasing during 2022.

In Maharashtra, pulse production increased with minor fluctuation from 1950 to 1989 but after that the production is increased with more fluctuation 2206 thousand tonnes during 1990 to 5190 thousand tonnes during 2021 after that declined in 2022. Similarly in Rajasthan, pulse production is increased with huge fluctuation, 369 thousand tonnes during 1950 to 3181 thousand tonnes during 2022 because of extreme weather events.

However, in Uttar Pradesh, pulse production is decreasing with fluctuation from 3023 thousand tonnes during 1950 to 1234 thousand tonnes during 2019, after there is drastic change 7840 thousand tonnes during 2021 again in 2022 declined due to farmers' shift to other crops. Figure 1 clearly depicted that pattern of data that shows greater decrease with passing time, creating the curve of an exponential function.

As a consequence of the research, it is obvious that changes in area, per hectare yield, management, and other practices have influenced the production process.

The positive nature of the b2 coefficient indicates that the area and yield of pulse in India and Karnataka, Madhya Pradesh, Maharashtra, Rajasthan have increased in recent years. Farmers' interest in pulse production is increasing, as shown by the rising trend, except Uttar Pradesh. During the study period, overall production in major producing state in India increased, possibly due to the adoption of new technology such as hybrid crop, fertilizer usage, and so on.

Table 2: Trends in Production of Pulse in Major States in India

Model Summary and Parameter Estimates						
Equation	*Model summary*		*Parameter estimates*			
	R^2	*Significance*	*constant (b)*	*b1*	*b2*	*b3*
Karnataka						
Quadratic	0.923	0.000	314.190	3.166	0.296	-0.011
Madhya Pradesh						
Quadratic	0.842	0.000	1394.800	-11.461	3.6281	-0.105
Maharashtra						
Quadratic	0.780	0.000	1347.300	-107.850	6.019	-0.113
Rajasthan						
Quadratic	0.600	0.000	315.050	101.130	2.851	0.019
Uttar Pradesh						
Exponential	0.261	0.000	0.000	-0.007		
India						
Quadratic	0.901	0.000	9838.500	9838.500	47.211	5.500

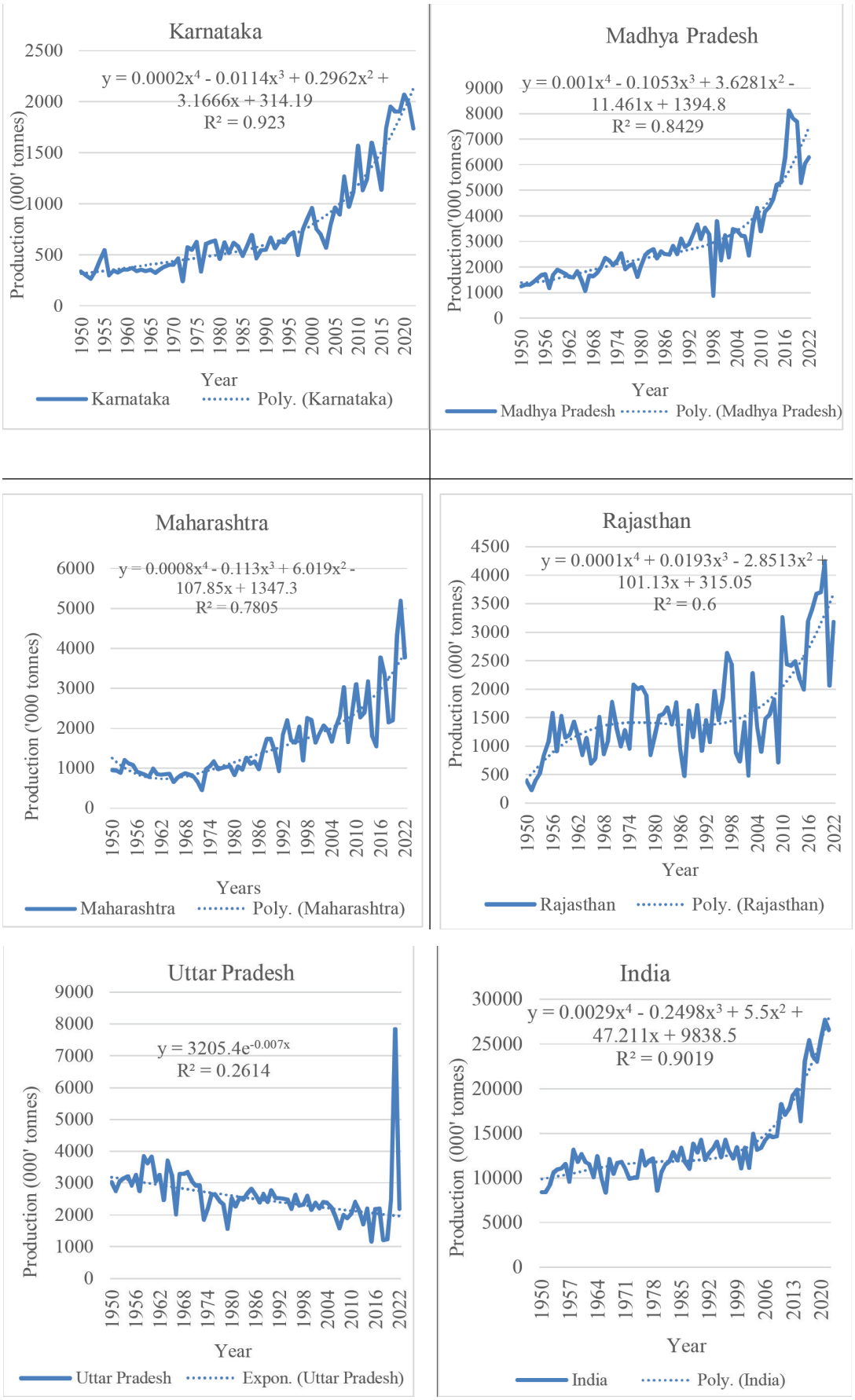

Figure 2: Observed and Expected Trends of Pulse Production in Major State in India

CONCLUSION

The analysis of pulse production in India from 1950 to 2022 reveals substantial growth, driven by technological advancements and improved agricultural practices. States such as Rajasthan and Madhya Pradesh exhibited remarkable increases, indicating successful adoption of innovations. However, Uttar Pradesh's fluctuating production and recent decline suggest challenges in maintaining consistent growth. Positive trend in Karnataka, Maharashtra, and Rajasthan highlight the potential for additional growth with ongoing support and investment in agricultural technologies. Despite fluctuation and external variables influencing output, the overall rise in pulse yield demonstrates the durability and flexibility of Indian agriculture. Future initiatives should prioritize stabilizing production in states with significant variability and resolving concerns in places experiencing decline. This detailed study emphasizes the significance of ongoing research and development to sustain and improve pulse production in India.

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