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Trend analysis of production and utilization of chemical fertilizers in India

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Abstract

The study analyzed the trend in production and utilization of chemical fertilizers in selected Indian states using a cubic trend function. Production trends were strong in Gujarat for urea ($R^2 = 0.90$), DAP (0.99) and complex fertilizer (0.99). In Tamil Nadu, DAP and complex fertilizer production also exhibited strong trends, with R^2 values of 0.98 and 0.97, respectively. Maharashtra recorded strong trends for urea and complex fertilizer production, while Uttar Pradesh showed a comparatively stronger trend for DAP than urea. In fertilizer utilization, Uttar Pradesh exhibited strong trends for urea (0.88), DAP (0.73) and complex fertilizer (0.78), while Haryana recorded a high R^2 for urea (0.82). Gujarat showed moderate trends for urea (0.74) and complex fertilizer (0.69), whereas Telangana recorded 0.71 for DAP. Overall, the findings indicate that fertilizer production and utilization followed increasing but non-linear trends, with considerable differences across states and fertilizer types.

Keywords: Chemical fertilizer, production, utilization, instability, urea and DAP

Introduction

Agriculture plays a vital role in Indian society and contributes significantly to the country's economy. Its importance stems from the fact that agricultural development is essential for achieving overall economic growth and development. Over the past few decades, Indian agriculture has witnessed substantial progress, particularly following the introduction of the Green Revolution. The adoption of high-yielding varieties, increased use of fertilizers and pesticides, and the expansion of irrigation facilities have contributed considerably to improvements in agricultural production and productivity across the country.

As an agrarian economy, India has experienced a substantial rise in both the production and consumption of chemical fertilizers over the past several decades. Fertilizer consumption increased from approximately 385.35 lakh metric tons (LMT) in 2014-15 to 503.35 LMT in 2023-24, representing an increase of about 30.6 per cent. India is currently the second-largest consumer and the third-largest producer of chemical fertilizers in the world. Within the country, Gujarat is a leading state in chemical fertilizer production, contributing more than 25 per cent of India's nitrogenous and phosphatic fertilizer output. In terms of

fertilizer utilization, Punjab ranks first, largely because of its highly intensive agricultural practices and greater dependence on chemical fertilizers to sustain crop productivity.

The application of essential plant nutrients, particularly chemical fertilizers, in the right quantity and appropriate proportion is crucial for maintaining and improving crop production over the long term. Modern agriculture largely depends on various external inputs, among which chemical fertilizers play a significant role. The use of chemical fertilizers became increasingly widespread among Indian farmers after independence. Understanding fertilizer consumption patterns at the district level and the ways in which farmers use fertilizers requires a closer examination of farmers' individual practices and decisions. Such studies are important as they provide valuable insights and feedback for researchers and policymakers in developing appropriate agricultural strategies. Therefore, the present study attempts to examine the trend in production and utilization of chemical fertilizers in India.

Materials and Methods

The study is based on time series secondary data of

production and utilization of chemical fertilizers latest 5 years (2020-21 to 2024-25) and 20 years (2005-06 to 2024-25) data respectively, of major states in India was used for the present study. To meet the objective of this study, secondary data was collected from the Indiastat, Fertilizersindia.com and Ministry of Chemicals and Fertilizers. The major four chemical producing states are Gujarat, Uttar Pradesh, Maharashtra and Tamil Nadu and utilizing states are Punjab, Uttar Pradesh, Haryana and Telangana.

Analysis of Data

To study the trend analysis in production and utilization of chemical fertilizers in India was computed for the time series data of latest 5 years for production and 20 years for utilization of chemical fertilizers. To trace the path of process, different parametric trend functions as given in table were used. Among the competitive trend functions, the best fitted function was selected based on their goodness of fit (measured in terms of R^2 Value) and significance of coefficients.

Table 1: List of different parametric models with their equation

Sr. No.	Name of Function	Equation
1	Linear	$y_t = a + bt$
2	Quadratic	$y_t = a + bt + ct^2$
3	Cubic	$y_t = a + bt + ct^2 + dt^3$
4	Exponential	$y_t = a \cdot e^{bt}$
5	Logarithmic	$y_t = a + b \ln(t)$
6	Power	$y_t = a \cdot t^b$

Where, Y is Production/ utilization, a, b, t is constant, coefficient and time, respectively in the model.

Results and Discussion

To synthesize the data of chemical fertilizers regarding production and utilization, a better statistical tool has been used in this section. The results of this analysis provided growth trends in Cubic form.

It was evident from Table 2 that, fertilizer production followed a non-linear pattern across the selected states. Gujarat exhibited a strong trend for urea, DAP and complex fertilizers, with R^2 values of 0.90, 0.99 and 0.99, respectively. Tamil Nadu showed a weak trend for urea ($R^2 = 0.33$). Uttar Pradesh showed a comparatively stronger trend for DAP ($R^2 = 0.84$) than for urea ($R^2 = 0.54$). In Maharashtra, the fitted trend explained 89 per cent of the variation in urea production and 96 per cent in complex fertilizer production. The results indicate that DAP and complex fertilizer production generally followed more pronounced trends, while urea production showed greater variation in some states.

From Table 3 for utilization, Uttar Pradesh recorded relatively strong trends for urea, DAP and complex fertilizers, with R^2 values of 0.88, 0.73 and 0.78, respectively. Haryana showed a strong trend for urea utilization ($R^2 = 0.82$), whereas DAP utilization exhibited a weak trend ($R^2 = 0.19$). In Gujarat, urea and complex fertilizer showed moderate trends with R^2 values of 0.74 and 0.69, respectively, while DAP recorded a lower R^2 of 0.36. In Telangana, DAP showed the strongest trend ($R^2 = 0.71$), followed by urea ($R^2 = 0.60$) and complex fertilizer ($R^2 = 0.42$). Overall, the results indicate that fertilizer utilization increased over time but the rate of change was not constant. The differences in R^2 across states and fertilizer categories further suggest that the pattern of utilization varied considerably.

Table 2: Trend in Production of Chemical Fertilizers

Sr. No.	State	Fertilizers	Functions	Constants	Coefficients			R^2
				a	b ₁	b ₂	b ₃	
1	Gujarat	Urea	Cubic	2363886000	3506792	1734.092	0.2858	0.90
2		DAP	Cubic	-1440212000	213620	-1056.59	0.1741	0.99
3		Complex fertilizer	Cubic	-193130400	286426	-141.59	0.023	0.99
4	Uttar Pradesh	Urea	Cubic	20677410	-3067365	1516.748	-0.25	0.54
5		DAP	Cubic	-674495700	1000710	-4948.97	0.815	0.84
6		Complex fertilizer	-	-	-	-	-	-
7	Maharashtra	Urea	Cubic	209404100	-3407007	1536.661	-0.2533	0.89
8		DAP	-	-	-	-	-	-
9		Complex fertilizer	Cubic	-10187090	151868.3	-75.466	0.0125	0.96
10	Tamil Nadu	Urea	Cubic	-43513660	645047.9	-318.74	0.0525	0.33
11		DAP	Cubic	-22062100	327246.6	-161.801	0.0266	0.98
12		Complex fertilizer	Cubic	304364800	-451645	223.398	-0.0368	0.97

Note: The data of production of complex fertilizers in Uttar Pradesh and DAP fertilizers in Maharashtra are not available

Table 3: Trend in Utilization of Chemical Fertilizers

Sr. No.	State	Fertilizers	Functions	Constants	Coefficients			R^2
				a	b ₁	b ₂	b ₃	
1	Punjab	Urea	Cubic	-18221750	27158.25	-13.492	0.00223	0.74
2		DAP	Cubic	-18176780	27057.22	-13.425	0.0022	0.36
3		Complex fertilizer	Cubic	-46689180	6960.13	-3.458	0.00057	0.69
4	Uttar Pradesh	Urea	Cubic	-72049530	107371.7	-53.337	0.0088	0.88
5		DAP	Cubic	-7982426	11789.5	-5.803	0.00095	0.73
6		Complex fertilizer	Cubic	-4481637	66750.21	-33.139	0.0054	0.78
7	Haryana	Urea	Cubic	-8799721	13093.35	-6.494	0.0010	0.82
8		DAP	Cubic	-22219540	33079.08	-16415	0.0027	0.19
9		Complex fertilizer	Cubic	-4395447	6550.98	-3.254	0.00053	0.70
10	Telangana	Urea	Cubic	-19801230	294911.1	-146.408	0.0242	0.60
11		DAP	Cubic	-84264480	12551.3	-62.318	0.0103	0.71
12		Complex fertilizer	Cubic	-11501380	171318.3	-85.061	0.014	0.42

Figures given below shows the trend line in production and utilization of chemical fertilizers among the states mentioned in

above given tables.

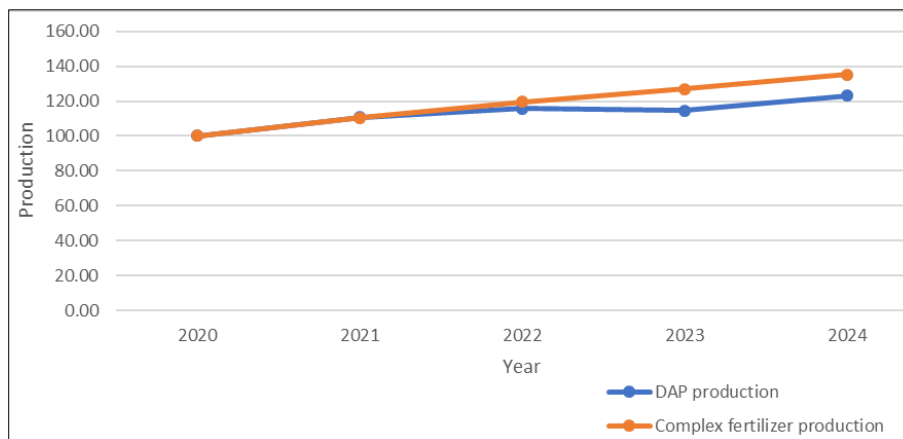


Fig 1: Trend in DAP and Complex fertilizer production in Gujarat

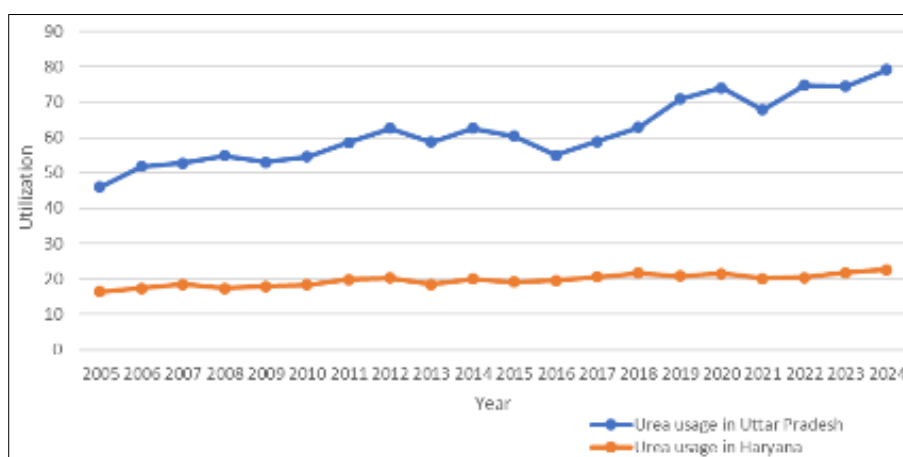


Fig 2: Trend in Urea utilization in Uttar Pradesh and Haryana

Conclusion

The trend analysis shows that chemical fertilizer production and utilization followed a generally increasing but non-linear pattern across the selected states. Production trends were particularly strong for DAP and complex fertilizers in Gujarat and Tamil Nadu, while Maharashtra showed a strong trend for complex fertilizer production. For utilization, Uttar Pradesh and Haryana exhibited relatively strong trends for urea, whereas DAP utilization showed greater variation in Gujarat and Haryana. Overall, the findings indicate that fertilizer demand and production changed over time at varying rates across states, highlighting the need for balanced fertilizer management and efficient utilization of different fertilizer types.

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