Biological Forum – An International Journal **15(6): 690-696(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Trends in Fertilizer Nutrients (N, P_2O_5 and K_2O) Consumption in India

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(Received: 29 March 2023; Revised: 07 May 2023; Accepted: 22 May 2023; Published: 20 June 2023)
(Published by Research Trend)

ABSTRACT: The growth and yields of crops depend on the availability of the necessary amounts of the fertilizer components nitrogen (N), phosphorus (P_2O_5), and potassium (K_2O). Better yields and sustainability of the environment are achieved by balanced fertilizing. Application of fertilizers in accordance with crop needs will increase crop production, but excessive fertilizer use will have a negative impact. The current study examined trends in the consumption of fertilizer nutrients. The secondary data on consumption of fertilizer nutrients (nitrogen, phosphorus and potassium) was collected for 72 years from 1950-1951 to 2021-2022. Different linear and non linear growth models were fitted to the data and examined the consumption pattern. Best fitted model was selected based on the highest *$AdjR^2$*, lowest *MAPE*, *RMSE* and *Theil's U-Statistic*. The consumption of nitrogen, phosphorus and total fertilizers was best fitted with the cubic model, where as the potassium consumption was best fitted the power model. The projection for four years from 2022-23 to 2025-26 was made for consumption of fertilizer nutrients. The linear and compound growth rates for the fertilizer nutrients consumption were calculated. The consumption of nitrogen, phosphorus, potassium and total fertilizer nutrients were recorded the linear growth rate of 4.155%, 4.397%, 4.188% and 4.219% and compound growth rate of 8.372%, 9.900%, 8.877% and 8.714% respectively.

Keywords: Fertilizer consumption, growth model, R^2, *adjusted* R^2, *RMSE*, *MAPE*, *Theil's U-Statistic*, trends, linear growth rate and compound growth rate.

INTRODUCTION

Agriculture is the principal occupation and source of income for approximately half of India's population. During the last seven decades, the Green Revolution in India increased food grain production by 5.6 times and horticulture crop productivity by 10.5 times (Arvind *et al*., 2022). Agricultural inputs are critical to achieving greater productivity and long-term agricultural growth in an economy (Sujan and Ananta 2021). The introduction of the green revolution, modernization of agriculture, and support of agricultural research and extension are some of the reasons that have contributed to this expansion. As per capita land availability decreases, increasing soil productivity is critical. Farmers were solely reliant on available nutrients in soil and farm yard manures for yield enrichment during the early independence period. Fertilizer is a synthetic chemical and an important input that improves the nutrient content of the soil for enhancing the productivity of land (Saswat *et al*., 2021). The use of the right amount of chemical Fertilizer at the right time, as well as the cultivation of high responsive and high yielding or improved seed varieties and efficient water management, resulted in a significant improvement in agricultural output (Rajendra, 2009). Poland and Czech Republic have shown distinct differences in yield responses, due to inherent soil fertility. The better yields are obtained by the application of the fertilizer nutrients (Witold *at al.*, 2010).

Fertilization strategies that incorporate the application of macronutrients and micronutrients according to crop requirements might enhance Fertilizer efficiency. Variances in fertilizer usage between districts and States can be due to differences in basic agro-climatic conditions, unequal irrigation facility development, Infrastructure development, fertilizer supply, and the availability or non-availability of appropriate production technologies. Irrigation and high yielding or improved seed varieties are the two most important elements that influence fertilizer consumption (Deepali and Meena 2019). Thus, fertilizers play a vital role in the achievement of self-reliance in food-grain production. However, there are other factors also which affect the fertilizer consumption such as supply of fertilizer, availability of credit for input purchase and the relative prices of fertilizers (Yuan *et al*. 2010, Vilas and Ramappa 2021). There is a well-established relationship between food grains production and consumption of fertilizer across the world (Sunil *et al*., 2014). The usage of fertilizer nutrients to the extents of soil requirements accounts for 50% increase in the food grain production in country.

There was very meager average fertilizer consumption (per hectare) amounting to 2 kg in 1950; it was increased to 5 kg in 1965-66. The consumption pattern after the Green Revolution, increased to 128 kg per hectare in 1980-81. It has been increased to 128 kg per hectare in 2012-13 (Agriculture situation in India 2019). The world compound annual growth rate was estimated for the consumption of nitrogen, phosphorus and potassium as 1.54%, 2.19% and 2.44% respectively between 2015 to 2020 (World fertilizer trend and outlook to 2020 FAO). The total fertilizer nutrients consumption in India in the year 2050-51 was only 69,800 tons, it has reached to 2,97,96,250 tons in the year 2021-22. The similar increases were noticed in the individual nitrogen, phosphorus and potassium. The production of NPK Complex totally depends on the profitability and market realization compare to DAP. NPK Complex fertilizers ranked second in consumption with a share of 19.6% in major consumed fertilizer (Urea, DAP, MOP & NPK), in India. The consumption of NPK complex fertilizers is increasing in India year over year and touched a level of 12.2 million tons, in FY' 2020-21, with the growth of 41.8% in last 5 years, as per iFMS data.

Coming to the imports of fertilizers, except DAP, import of major fertilizers declined during 2021-22. Import of urea at 9.14 million MT, MOP at2.46 million MT and NP/NPK complex fertilizers at 1.17 million MT during 2021-22 declined by 7.1%, 41.8% and 15.8%, respectively, over 2020-21. However, import of DAP at 5.46 million MT recorded an increase of 11.9% during the period and import of NPK complex fertilizers touched 1.7 million tons, with 240% increase. The huge agricultural demands and the rising size of the potential consumer base are expected to drive the market demand for fertilizer due to increasing consumption of fertilizer.

MATERIALS AND METHODS

The present study was based on the data for 72 years from 1950-1951 to 2021-2022 pertaining to the consumption of fertilizer nutrients (N, P_2O_5 and K_2O) in India. The data was collected from the Ministry of Agriculture & Farmers Welfare, Government of India in the website *https://www.indiastat.com*. The data was analyzed the SPSS (Version 20.0) software.

A. Growth Rates

The linear growth rate (LGR) and compound growth rates (CGR) were calculated by fitting the functions given below.

(i) Linear Function. The function given below is called the linear function

$$y = a + bt \qquad (1)$$

where, y = quantity of fertilizer nutrients consumption in (1000 tons), the dependent variable;

t = time in years, independent variable;

a and b are parameters and these parameters are estimated by the method of Ordinary Least Squares (OLS).

The linear growth rate is calculated by using the formula:

$$\text{Linear Growth Rate (LGR)} = \frac{b}{\bar{y}}.100 \qquad (2)$$

(i) Compound Function. The exponential function given below is called the compound function

$$y = a.b^t \qquad (3)$$

Where, y = quantity of fertilizer nutrients consumption in (1000 tons), the dependent variable;

t = time in years, independent variable;

a and b are parameters and these parameters are estimated by the method of Ordinary Least Squares (OLS).

Representing the equation (3) in logarithmic form,

$$\log y = \log a + t \log b \qquad (4)$$

The Compound Growth Rate (CGR) is calculated by the following formula (Nitin *et al.*, 2022):

$$\text{Compound Growth Rate (CGR)} = (b - 1).100 \qquad (5)$$

The significance of these growth rates can be tested using student *t*-test

$$t = \frac{r}{SE(r)} \text{ with } (N-2) \text{ degrees of freedom,} \qquad (6)$$

where r is the growth rate; N is the total no of years taken under study and

$SE(r)$ is the standard error of the growth rate.

B. Trend Analysis

The present study analyzes the trends in the quantity of the consumption of fertilizer nutrients (nitrogen, phosphorus, Potassium)in India from 1950-51 to 2021-2022. To identify the best fitted model, the following models were fitted for the data using the method of Ordinary Least Square (OLS) (Table 1).

Table 1

Sr. No.	Function	Equation
1.	Linear	$Y_t = a + bt$
2.	Exponential	$Y_t = a + e^{bt}$
3.	Logarithmic	$Y_t = a + b\ln(t)$
4.	Quadratic	$Y_t = a + bt + ct^2$
5.	Cubic	$Y_t = a + bt + ct^2 + dt^3$
6.	Compound	$Y_t = a.b^t$
7.	Inverse	$Y_t = a + \frac{b}{t}$
8.	Power	$Y_t = a.t^b$
9.	Square root	$Y_t = a + b\sqrt{t}$
10.	Growth	$Y_t = e^{a+bt}$

Where, y = quantity of fertilizer nutrients consumption in (1000 tons), the dependent variable;
t = time in years, independent variable;
a and b are parameters to be estimated using the method of Ordinary Least Squares (OLS) .
It was observed that R^2 is not enough to examine goodness of fit of a model. Hence, in addition to R^2, the Residual Mean Square Error (*RMSE*), Mean Absolute Percentage Error (*MAPE*) and *Theil'sU-Statistic* were calculated and these are used to choose a model from among the alternatives methods (Ramana and Hari 2018).

$$Adj.R^2\left(or\ \overline{R}^2\right) = 1-(1-R^2)\frac{n-1}{n-p-1}, \quad (7)$$

where, n is the number of observations and p is the number of parameters in the model.

$$MAPE = \frac{1}{n}\sum_{t=1}^{n}\left(\left|\frac{A_t - F_t}{A_t}\right|\right).100, \quad (8)$$

where, A_t is the actual value at time t and F_t is the forecasted value at time t

$$RMSE = \sqrt{\frac{\sum_{t=1}^{n}(A_t - F_t)^2}{n}} \quad (9)$$

Theil's U-Statistic: This statistics allows a relative comparison of normal forecasting methods with naive approaches and also squares the errors involved so that large errors are given much more weight than small errors. The positive characteristic that is given up in moving to Theil's U-Statistic as a measure of accuracy is that of intuitive interpretation. It is given by

$$U = \sqrt{\frac{\sum_{t=1}^{n-1}\left(\frac{P_{t+1} - A_{t+1}}{A_i}\right)^2}{\sum_{t=1}^{n-1}\left(\frac{A_{t+1} - A_t}{A_t}\right)^2}}, \quad (10)$$

where, P_{t+1} are the predicted values at time period $t+1$; A_{t+1} is the actual value at time period $t+1$; A_t is the actual value of a point for a given time period t; and n is the number of observations.
If $U = 1$, there is no difference between a naive forecast and the technique used.
If $U < 1$, the technique is better than a naive forecast and If $U > 1$, then the technique is no better than a naive forecast.
The model will be considered for which the U value is smallest. The model which showed relatively the least *MAPE*, *RMSE* and *Theil's U- Statistic*, highest Adj.R^2 and significant is chosen for the purpose of trend fitting.

RESULTS AND DISCUSSION

The linear and nonlinear growth models (*viz.*, Linear, Logarithmic, Inverse, Quadratic, Cubic, Compound, Power, S curve, Growth, Exponential and Logistic) were fitted for the data (in '000 tons) of the consumption of fertilizer nutrients nitrogen, phosphorus, potassiumand total fertilizer nutrientsand identified the best fitted model. The best fitted model was found based on the relatively highest *Adj.*R^2 value, least *MAPE*, *RMSE* and *Theil's U- Statistic* values for the nutrients and found the trends in the fertilizer nutrients consumption from 1950-51 to 2021-22. The results are as give below:

A. Trends in thenitrogen consumption

The nitrogen consumption data was subjected to the different growth models mentioned and the results are presented in the Table 2. The results reveal that highest *Adj.*R^2 value (0.992); relatively lowest *MAPE*, lowest *RMSE* and *Theil's U- Statistic* are 30.77, 551.67 and 8.05 respectively were found to the cubic model, which are significant at 1% level. Hence the cubic model was found to be the best fitted for nitrogen consumption and this model given below in the equation (11) can be used for future projections. It was observed from the Fig. 1 that the consumption of nitrogen is gradually increasing from 1950-51 to 2021-22. The fitted cubic model is given by

$$y_t = 510.27 - 143.18t + 10.206t^2 - 0.063t^3, \quad (11)$$

where t is the time in years

Table 2: Model Summary for nitrogen.

Equation	Model		Parameter Estimates					Adj.R^2	MAPE	RMSE	Theil's U-Statistic
	F	Sig.	Constant	b1	b2	b3	R^2				
Linear	1286.33	.000	-3739.08	300.81			.948	0.948	414.20	1458.36	74.91
Logarithmic	120.74	.000	-11490.34	5643.28			.633	0.628	866.38	3888.95	143.07
Inverse	12.94	.001	8513.05	-18849.37			.156	0.144	1000.62	5897.44	124.67
Quadratic	2799.53	.000	-767.19	59.85	3.301		.988	0.987	93.92	708.28	16.20
Cubic	**3046.59**	**.000**	**510.27**	**-143.18**	**10.206**	**-.063**	**.993**	**0.992**	**30.77**	**551.67**	**8.05**
Compound	550.74	.000	157.70	1.08			.887	0.886	56.35	7864.05	10.04
Power	1097.69	.000	5.41	1.90			.940	0.939	29.25	1364.75	8.84
S	50.34	.000	8.57	-8.53			.418	0.41	214.19	6642.63	34.26
Growth	550.74	.000	5.06	.08			.887	0.886	56.35	7864.05	10.04
Exponential	550.74	.000	157.70	.08			.887	0.886	56.35	7864.05	10.04
Logistic	550.74	.000	.01	.92			.887	0.886	56.35	7864.05	10.04

B. Trends in the phosphorus consumption

The data on consumption of phosphorus was analyzed with growth models and presented the results in Table 3. It was observe the highest *Adj.*R^2 value (0.966); relatively lowest *MAPE*, lowest *RMSE* and *Theil's U-Statistic*are 39.92, 480.68 and 4.93 respectively were found to the cubic model, which are significant at 1% level. Hence the best fitted model for phosphorus consumption during the study period was cubic model and this model given by the equation (12) can be used for future projections. From the Fig. 2. It was observed that the consumption of phosphorus is gradually increasing during the study period. The fitted cubic model is given by

$$y_t = 286.02 - 71.9t + 4.093t^2 - 0.022t^3 \quad (12)$$

where t is the time in years

Table 3: Model Summary for Phosphorus.

Equation	Model		Parameter Estimates					Adj.R^2	MAPE	RMSE	Theil's U-Statistic
	F	Sig.	Constant	b1	b2	b3	R^2				
Linear	662.32	.000	-1682.31	122.27			.904	0.903	1566.79	826.07	183.68
Logarithmic	97.31	.000	-4692.56	2251.46			.582	0.576	2739.55	1728.26	280.75
Inverse	11.15	.001	3277.37	-7361.87			.137	0.125	2492.14	2481.57	234.22
Quadratic	931.75	.000	-158.07	-1.32	1.693		.964	0.963	188.52	504.87	20.95
Cubic	**677.69**	**.000**	**286.02**	**-71.90**	**4.093**	**-.022**	**.968**	**0.966**	**39.92**	**480.68**	**4.93**
Compound	443.11	.000	28.42	1.10			.864	0.862	81.97	4289.49	8.23
Power	1210.22	.000	.47	2.28			.945	0.945	29.81	651.64	5.55
S	53.06	.000	7.50	-10.34			.431	0.423	323.90	2865.62	36.11
Growth	443.11	.000	3.35	.10			.864	0..862	81.97	4289.49	8.23
Exponential	443.11	.000	28.42	.10			.864	0.862	81.97	4289.49	8.23
Logistic	443.11	.000	.04	.91			.864	0.862	81.97	4289.49	8.23

C. Trends in the potassium consumption

The consumption data on phosphorus during the study period was used to fit the growth models and the results obtained are given in Table 4. The power model was best fitted for the potassium consumption data in the study period as this model has highest *Adj.*R^2 value (0.936); lowest *MAPE*(31.45), *Theil's U- Statistic* (5.09) and relatively lowest *RMSE* (354.65), and these are significant at 1% level. For future projections, this model given by the equation (13) can be used. It was observed in fig 3 that the potassium consumption in study period is gradually increasing. The fitted power model is given by

$$y_t = 0.48t^{2.04}, \text{ where } t \text{ is the time in years} \quad (13)$$

Table 4: Model Summary for Potassium.

Equation	Model		Parameter Estimates					Adj.R^2	MAPE	RMSE	Theil's U-Statistic
	F	Sig.	Constant	b1	b2	b3	R^2				
Linear	462.31	.000	-586.36	46.44			.868	0.867	687.29	375.59	73.98
Logarithmic	95.50	.000	-1776.57	869.33			.577	0.571	1365.39	673.59	126.44
Inverse	11.55	.001	1304.49	-2897.73			.142	0.129	1443.71	959.58	116.84
Quadratic	332.56	.000	-118.71	8.53	.519		.906	0.903	148.79	317.53	14.77
Cubic	242.58	.000	156.47	-35.21	2.007	-.014	.915	0.911	108.67	302.77	10.75
Compound	422.12	.000	18.80	1.09			.858	0.856	69.82	1412.67	6.69
Power	**1027.76**	**.000**	**.48**	**2.04**			**.936**	**0.935**	**31.45**	**354.65**	**5.09**
S	51.81	.000	6.66	-9.25			.425	0.417	255.84	1083.16	24.59
Growth	422.12	.000	2.93	.09			.858	0.856	69.82	1412.67	6.69
Exponential	422.12	.000	18.80	.09			.858	0.856	69.82	1412.67	6.69
Logistic	422.12	.000	.05	.92			.858	0.856	69.82	1412.67	6.69

D. Trends in the consumption all fertilizer nutrients (N, P_2O_5 and K_2O)

The data on consumption of all fertilizer nutrients (N, P_2O_5 and K_2O) was used to fit the growth models and the estimated parameters for different models are given in Table 5. The results in the table reveal that the best fitted model for the total fertilizer nutrients consumption during the study period was the cubic model, as it has the highest *Adj.*R^2 value (0.987); lowest *MAPE* (47.49), *RMSE* (1129.88) and *Theil's U- Statistic* (9.36) values and these are significant at 1% level. The cubic model given by the equation (14) can be used for future projections of fertilizer consumptions. It was noticed in Fig. 4 that the consumption of total fertilizer nutrients is also continuously decreasing in entire study period. The fitted power model is given by

$$y_t = 951.28 - 250.14t + 16.302t^2 - 0.099t^3 \quad (14)$$

where t is the time in years

E. Growth rates in fertilizer consumption

The linear and compound growth rates of were calculated and presented in Table 6. The fertilizer nutrients nitrogen, phosphorus, potassium and total fertilizer nutrients were recorded the linear growth rate of 4.155%, 4.397%, 4.188% and 4.219% respectively and compound growth rate of 8.372%, 9.900%, 8.877% and 8.714% respectively.

Table 5: Model Summary for Total Fertilizer Nutrients.

Equation	Model		Parameter Estimates					Adj.R^2	MAPE	RMSE	Theil's U-Statistic
	F	Sig.	Constant	b1	b2	b3	R^2				
Linear	1059.42	.000	-6008.09	469.52			.938	0.937	552.27	2508.25	96.12
Logarithmic	114.13	.000	-17960.37	8764.26			.620	0.6.14	1105.60	6212.11	174.62
Inverse	12.46	.001	13094.77	-29110.79			.151	0.139	1203.71	9282.87	145.88
Quadratic	1957.10	.000	-1044.74	67.09	5.513		.983	0.982	107.10	1326.04	17.61
Cubic	**1779.60**	**.000**	**951.28**	**-250.14**	**16.302**	**-.099**	**.987**	**0.987**	**47.79**	**1129.88**	**9.36**
Compound	528.20	.000	205.25	1.09			.883	0.881	60.44	13105.23	9.94
Power	1147.11	.000	6.02	1.98			.942	0.942	51.95	2219.23	9.39
S	51.16	.000	8.98	-8.93			.422	0.414	232.50	10515.30	35.83
Growth	528.20	.000	5.32	.08			.883	0.881	60.44	13105.23	9.94
Exponential	528.20	.000	205.25	.08			.883	0.881	60.44	13105.23	9.94
Logistic	528.20	.000	.00	.92			.883	0.881	60.44	13105.23	9.94

Table 5: Forecasting of fertilizer nutrients consumption in India.

Year	Nitrogen consumption (in '000 tons)	Phosphorus consumption (in '000 tons)	Potassium consumption (in '000 tons)	Total fertilizer nutrients consumption (in '000 tons)
2022-2023	19937.83	8290.54	3036.83	31051.74
2023-2024	20273.89	8463.76	3122.30	31593.50
2024-2025	20602.40	8635.40	3208.97	32123.91
2025-2026	20922.96	8805.32	3296.86	32642.37

Table 6: Linear and Compound growth rates of the fertilizer nutrient.

Fertilizer nutrient	LGR %	CGR %
Nitrogen	4.155	8.372
Phosphorus	4.397	9.900
Potassium	4.188	8.877
Total fertilizer nutrients	4.219	8.714

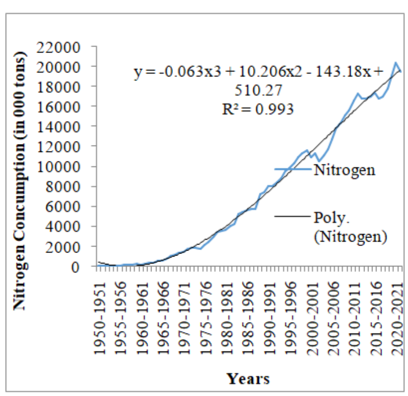

Fig. 1. Actual and forecasted values of consumption of nitrogen.

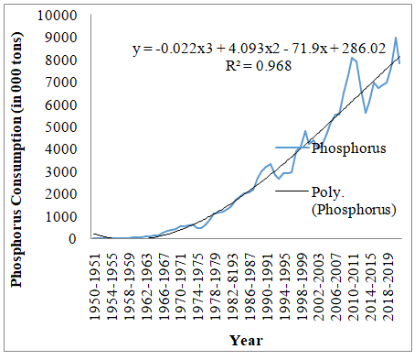

Fig. 2. Actual and forecasted values of consumption of phosphorus.

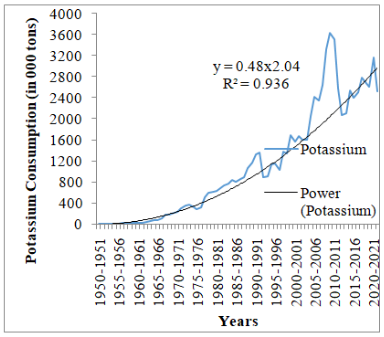

Fig. 3. Actual and forecasted values of consumption of potassium.

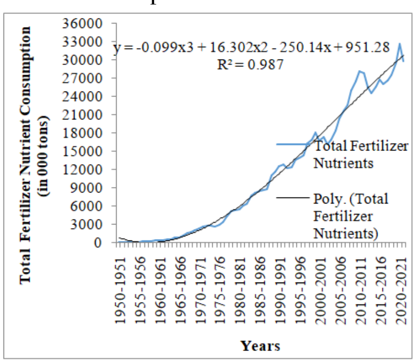

Fig. 4. Actual and forecasted values of consumption of Total Fertilizer Nutrients.

CONCLUSIONS

The present study revealed that the consumption of all the fertilizer nutrients (nitrogen, phosphorus, potassium and total fertilizers) is showing increasing trend with a positive growth rates. These results are in accordance with the results of Singh and Jai (2018) and the projection made by Borkar (1982) up to 2030. The best fitted models for nitrogen, phosphorus, potassium and total fertilizer nutrients consumption were estimated the consumption at 20922.96, 8805.32, 3296.86 and 32642.37 metric tons respectively by 2025-26. Consumption of the fertilizer nutrients nitrogen, phosphorus, potassium and total fertilizer have recorded positive linear growth rates of 4.155%, 4.397%, 4.188% and 4.219% respectively and compound growth rates of 8.372% 9.900%, 8.877% and 8.714% respectively. The usage of fertilizer nutrients as per soil requirements enhances the productivity, whereas the excessive usage of fertilizers will lead to the negative results (Avinash *et al.*, 2022). The technologies like variable rate of fertilizer application can be utilized for the optimum usage of fertilizers for the sustainable agriculture.

FUTURE SCOPE

The present study is based on the time series data of 52 years and linear and non linear growth model were fitted to identify the trend in the fertilizer consumption. The time series forecasting techniques like ARIMA and ANN can be utilized to identify for the future forecast and compare with these results.

REFERENCES

Arvind, K. S., Sanjib, K. B., Chaudhari, S. K. and Gajendra, S. (2022). Fertilizer Use in Indian Agriculture and its Impact on Human Health and Environment. *Indian Journal of Fertilisers, 18* (3), 218-237.

Avinash, S, Chowlani, M., Hemant, S., Himanshu, P., Gaytri, S., Supriya, S., Nirupa, K. and Megha, R. (2022). Impacts of Fertilizer and Pesticide consumptions on Natural resources of India. *Ecology, Environment and Conservation, 28*(3), 1332-1336.

Borkar, P. (1982). Statistical Modeling for Forecasting Fertilizer Consumption in India. Plant Science Today (Early Access). https://doi.org/10.14719/pst.1982

Deepali, C. and Meena, G. L. (2019).Factors Affecting Fertilizer Consumption in Rajasthan. *Economic Affairs*, *64*(3), 547-551.

Nitin, S., Pannu, R. S., Malik, D. P., Veer, S. and Ratika, K. (2022). Analysis of Growth Trends of Production and Consumption of Fertilizer Nutrients in India. *Economic Affairs*, *67*(3), 189-196.

Rajendra, P. (2009). Efficient Fertilizer Use: The Key to Food Security and Better Environment. *Journal of Tropical Agriculture, 47*(1-2), 1-17.

Ramana, M. B. and Hari, B. O. (2018). A Statistical Trend Analysis of Mango Area, Production and Productivity in Andhra Pradesh, *Int. J. Agricult. Stat. Sci.*, 14, Supplement 1, pp. 337-342.

Saswat, K. P., Damodar, J., Rabi, N. S. and Jyoti, P. R. (2021). Nitrogen Fertilizer Use in Agriculture Among Marginal and Small Farmers in India: Review of Important Drivers, *International Journal of Modern Agriculture, 10*(2), 1746-1756.

Singh, R. P. and Jai, P. (2018). Assessing the Fertilizer Efficiency in Paddy Production, *Agro Economist - An International Journal*, *5*(1), 51-54

Sujan, G. and Ananta, D. (2021). Effects of Agricultural Inputs Use on Agricultural Productivity in Nepal: An Empirical Study. *International Journal of Agricultural Economics, 6*(5), 212-217.

Sunil, K., Gangwar, B., Jat, N. K. and Mohammad, S. (2014). Status and Prospects of Fertiliser Consumption in South India, *Progressive Agriculture*, *14* (2), 242-250

Vilas, J. and Ramappa, K. B. (2021). Growth & Determinants of Fertilizer Consumption in India: Application of Demand and Supply Side Models. *Economic Affairs*, *66*(3), 419-425.

Witold GRZEBISZ, Jean DIATTA, Rolf HARDTER, Katarzyna CYNA (2010). Fertilizer Consumption

Patterns in Central European Countries – Effect on Actual Yield Development Trends in 1986-2005 Years – A Comparative Study of the Czech Republic and Poland. *Journal of Current European Agriculture, 11*(1), 73-82.

World Fertilizer Trends and outlook to 2020 Summary Report, Food and Agriculture Organization of the United Nations - Rome, 2017.

Yuan, Z., Hong, Y., Hans-Joachim, M. and Karim C. A. (2010). Factors affecting farmers' decisions on fertilizer use: A case study for the Chaobai watershed in Northern China. *Consilience, 4,* 80-102.

How to cite this article: D. Srinivasa Chary, K. Supriya, T. Anjaiah, A. Meena and M. Ramesh (2023). Trends in Fertilizer Nutrients (N, P_2O_5 and K_2O) Consumption in India. *Biological Forum – An International Journal, 15*(6): 690-696.