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Consumption pattern of fertilizer by season and agro climatic zones of Chhattisgarh

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Abstract
This study aims to examine the consumption pattern of fertilizers in the agro-climatic zones of Chhattisgarh, India, with a specific focus on analyzing variations by season. By investigating the fertilizer usage trends in different seasons and agro-climatic zones, this research seeks to provide insights into the agricultural practices and resource management strategies employed in the region. To achieve this objective, historical data on fertilizer consumption in Chhattisgarh's various agro-climatic zones were collected and analyzed. The dataset encompassed multiple years and encompassed both seasonal and annual fertilizer usage information. The consumption patterns were examined with respect to the different Seasons *viz*., kharif and Rabi. The study is based on secondary data, which was obtained from Directorate of Agricultural, Chhattisgarh covering the period 2011-12 to 2020-21.
Preliminary findings highlight distinct consumption patterns across seasons and agro-climatic zones within Chhattisgarh. The analysis reveals variations in fertilizer usage, reflecting the specific crop cycles, climate conditions, and agricultural practices prevalent in each season and zone. These variations can be attributed to factors such as rainfall, temperature, crop types, and planting and harvesting schedules.

Keywords: Fertilizer consumption, consumption pattern, seasonality, agro-climatic zones, Chhattisgarh, resource management, agricultural practices, sustainability

Introduction
India is one of the top producing and consuming nations of fertilisers.40% of the world's fertiliser consumption comes from China and India. In India, the market for fertilisers is anticipated to grow at a CAGR of 11.9% from 2021 to 2026. In 2020, the Indian fertiliser market was worth INR 887 billion. The country's sustainable production of food grains is mostly due to the rise in fertiliser consumption. From April to December 2020, the Indian fertiliser industry grew by 3.7%. One of the industries that has experienced growth throughout the COVID crisis is the fertiliser industry.
Chhattisgarh, situated in central India, exhibits diverse agro-climatic zones characterized by variations in soil properties, rainfall patterns, and crop suitability. With a surface area of 13.5 million hectres, Chhattisgarh is the tenth largest state in India. The expansion of agricultural and industrial production are factors in Chhattisgarh's rapid growth. The state counts agriculture as its primary economic activity.
This research aims to fill the existing knowledge gap by analyzing historical data on fertilizer consumption in Chhattisgarh's agro-climatic zones. By examining the consumption patterns across seasons, we can identify trends and variations that reflect the region's unique agricultural characteristics. These patterns can inform decision-making processes related to fertilizer production, distribution, and application practices, leading to more efficient and sustainable agricultural systems. The implications of the findings will be explored, including their significance for sustainable agricultural development and resource management in Chhattisgarh.

Materials and Methods
The investigation was conducted between the years of 2011–12 and 2020–21. The research is supported by secondary data. The 10-year data time series was taken on the use of fertiliser in Chhattisgarh districts. The information was gathered from a report by the Chhattisgarh Government's Directorate of Agriculture in Raipur

The following list includes the various fertiliser consumptions taken into account during data collection and analysis

1. Total Nitrogen consumption (N).
2. Total phosphorus consumption (P2O5)
3. Total potash consumption (K2O)
4. Kharif Nitrogen consumption
5. Kharif Phosphorus consumption
6. Kharif Potash consumption
7. Rabi Nitrogen consumption
8. Rabi Phosphorus consumption
9. Rabi Potash consumption
10. Total fertilizer consumption (N+P+K)

To analyze the trend in growth in the study area, Compound Growth Rate (CGR) has been computed. The details of the formulae are given under-.

Y= ABt

Taking logarithms on both sides log Y = log A + t log B Assuming, log Y = y log A= a log B = b We get, y = a + bt

Where,
Y= Time series data on fertilizer consumption t = 1, 2, 3, 10
After regression between y and t We have values for a and b
Where,
t = Year (t =1, 2, 35) a =Constant
b = regression coefficient

As, b = ln(1+r) Hence,

Where,
r = Anti ln (b) – 1
r = Average Compound growth rate.

The above linearised function was fitted by least square method and estimate of b as (b) were obtained.
The annual compound growth rate is then computed as r = [anti ln(b)-1] x 100
Percentages are used to express all growth rates. In addition to different crop seasons, this equation individually fit the consumption of N, P, K, and total fertiliser in the Chhattisgarh plains, the Bastar plateau, and the northern hills.

Results and Discussions

Compound growth rate computation was suggested in order to gain insight into the growth rate of fertiliser use in Chhattisgarh's agro climatic regions. The entire period covering the state in three agroclimatic zones together with the several crop seasons has been analysed to determine the growth rate of fertiliser usage.
Table 1 to Table 6 examines fertiliser usage between the years 2011–12 and 2020–21 in kharif and rabi season of six districts taken as sample, two of which correspond to each agroclimatic zone in Chhattisgarh state.
During the study period in Chhattisgarh, the use of nitrogen (N), phosphorus (P2O5), and potassium (K2O) fertilisers increased by 7.72%, 11.7% and 2.60% respectively in kharif season of Chhattisgarh plains whereas in rabi season percent growth of N, P2O5 and K2O respectively were 4.14%,10.14% and 10.28%. Similarly, in Bastar plateau the increase in N, P2O5 and K2O for kharif season was 7.67%, 12.20% and 5.38% respectively whereas the percent was -5.95%, 2.50% and 5.43% respectively in the rabi season. Table 5 and 6 reveals that the percent growth rate for N, P2O5 and K2O consumption in kharif season was 4.52%, 10.66%, 3.16% and in rabi season was -9.50%, -1.44% and -10.53% respectively.

Table 1: Nutrient-wise compound growth rate of fertilizer consumption in Kharif season in Chhattisgarh plains

Particular	N	P	K	Total (NPK)
CGR%	11.78%*	17.12%*	6.52%	12.37%*

Note: *, ** and *** indicate significance of values at P=0.10, 0.05 and 0.01 respectively.

Table 2: Nutrient-wise compound growth rate of fertilizer consumption in Rabi season in Chhattisgarh plains

Particular	N	P	K	Total (NPK)
CGR%	4.66%	8.93%	7.41% **	5.78%

Note: *, ** and *** indicate significance of values at P=0.10, 0.05 and 0.01 respectively.

Table 3: Nutrient-wise compound growth rate of fertilizer consumption in Kharif season in Bastar plateau

Particular	N	P	K	Total (NPK)
CGR%	9.36%**	14.20%*	8.23%**	14.69% ***

Note: *, ** and *** indicate significance of values at P=0.10, 0.05 and 0.01 respectively.

Table 4: Nutrient-wise compound growth rate of fertilizer consumption in Rabi season in Bastar plateau

Particular	N	P	K	Total (NPK)
CGR%	1.43%	2.75%	7.18%**	2.53%

Note: *, ** and *** indicate significance of values at P=0.10, 0.05 and 0.01 respectively.

Table 5: Nutrient-wise compound growth rate of fertilizer consumption in Kharif season in Northern Hills

Particular	N	P	K	Total (NPK)
CGR%	6.72%***	11.14%***	0.37%	6.85%***

Note: *, ** and *** indicate significance of values at P=0.10, 0.05 and 0.01 respectively.

Table 6: Nutrient-wise compound growth rate of fertilizer consumption in Rabi season in Northern Hills

Particular	N	P	K	Total (NPK)
CGR%	-8.27%*	0.07%	-9.43%***	-6.35%

Note: *, ** and *** indicate significance of values at P=0.10, 0.05 and 0.01 respectively.

To visualize the obtained growth rates, these have been plotted into graphs to determine the trend in fertilizer consumption as follows

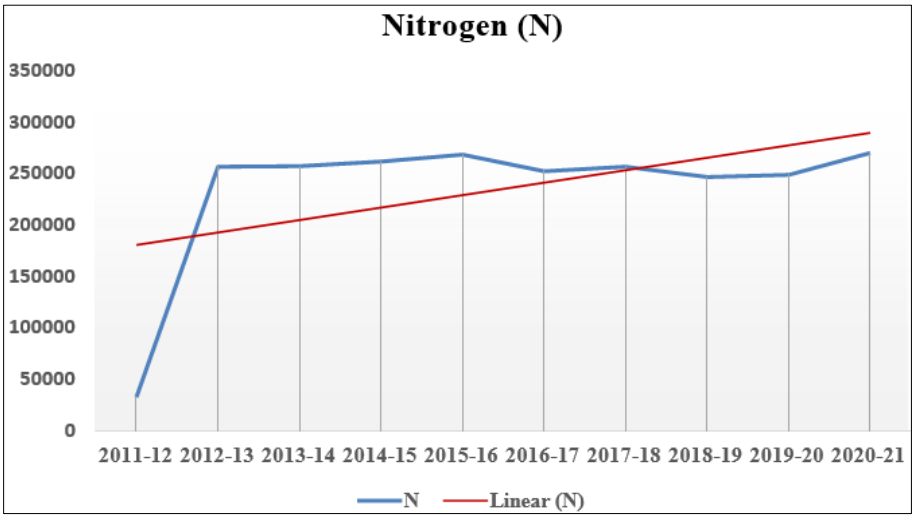

Fig 1: Trend of N fertilizer consumption in kharif season Chhattisgarh plains

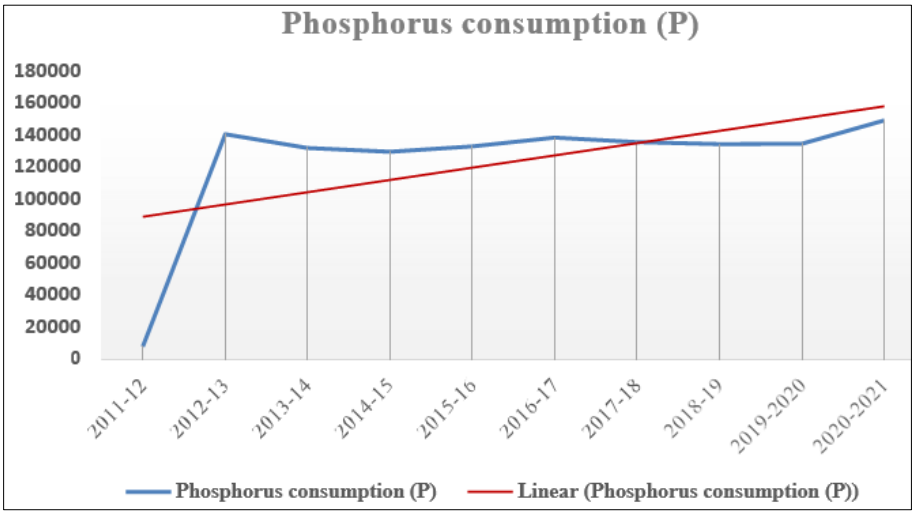

Fig 2: Trend of P fertilizer consumption in kharif season Chhattisgarh plains

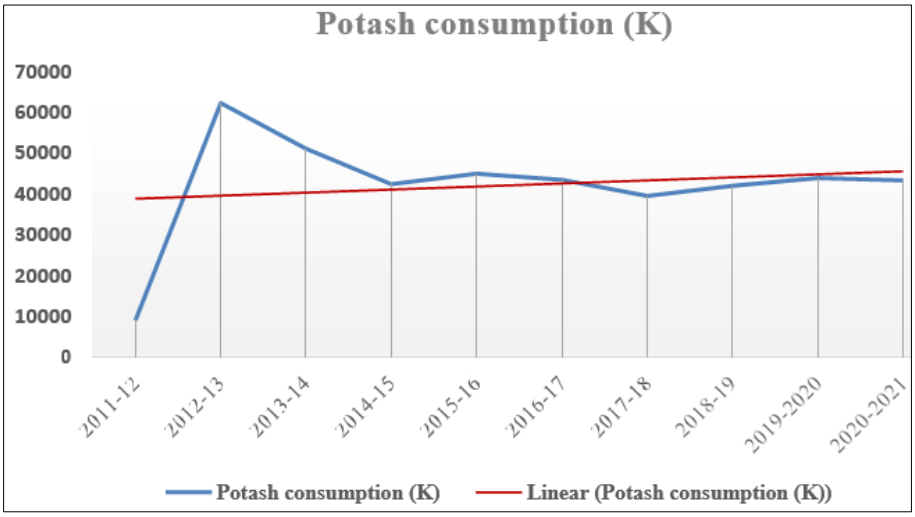

Fig 3: Trend of K fertilizer consumption in kharif season Chhattisgarh plains

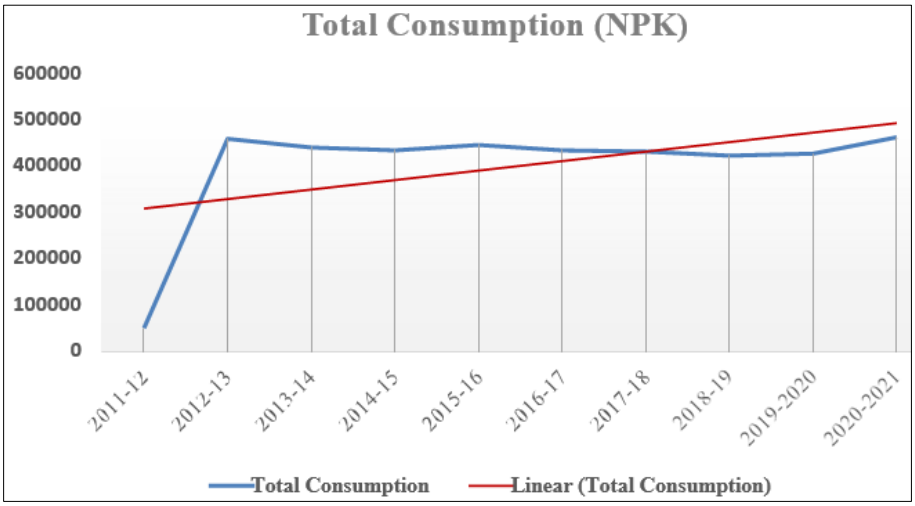

Fig 4: Trend of Total fertilizer consumption in Kharif season in Chhattisgarh plains'

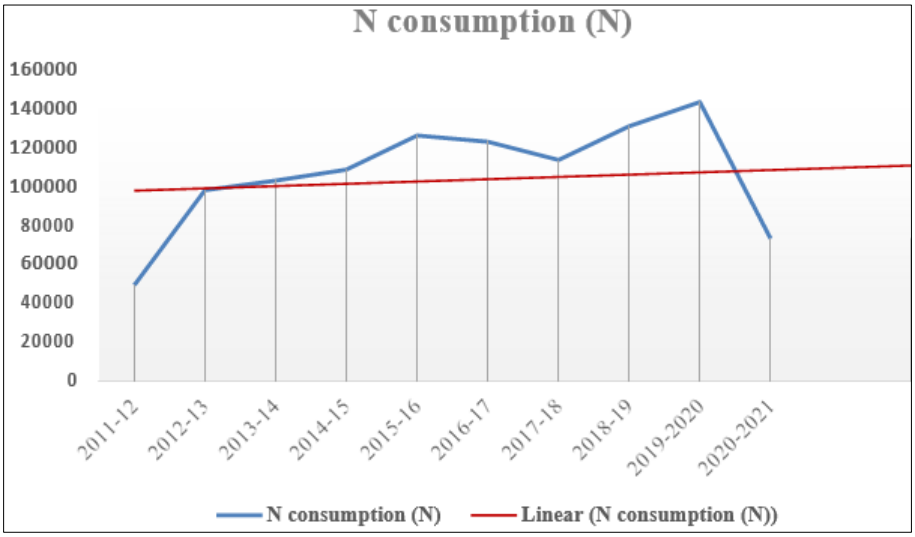

Fig 5: Trend of N fertilizer consumption in Rabi season Chhattisgarh plains

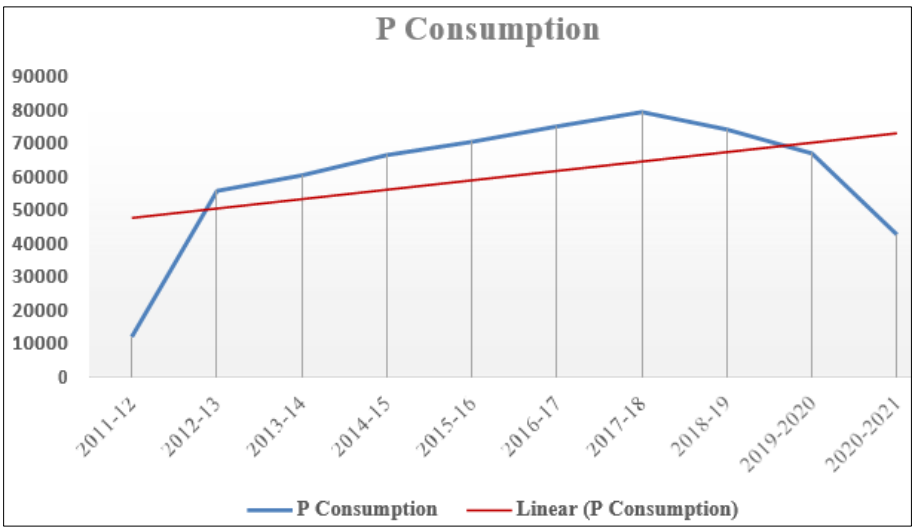

Fig 6: Trend of P fertilizer consumption in Rabi season Chhattisgarh plains

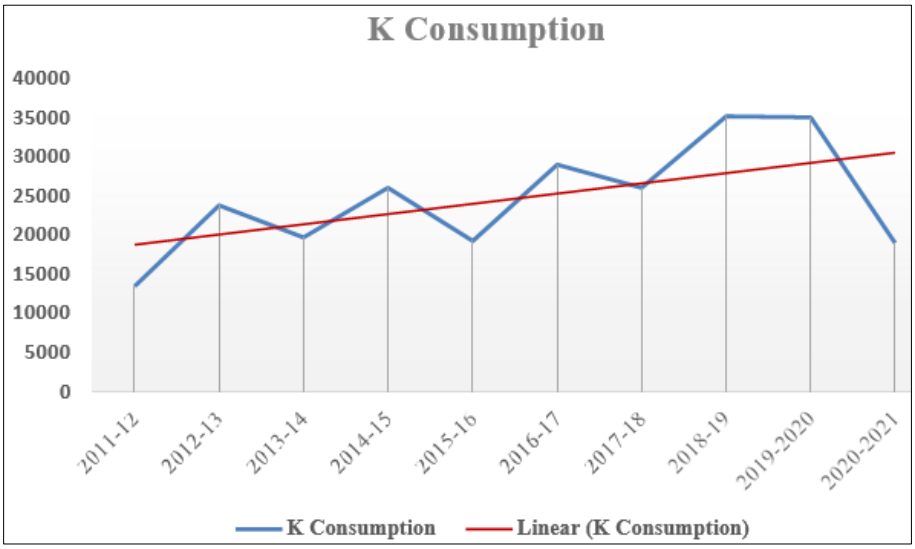

Fig 7: Trend of K fertilizer consumption in Rabi season Chhattisgarh plains

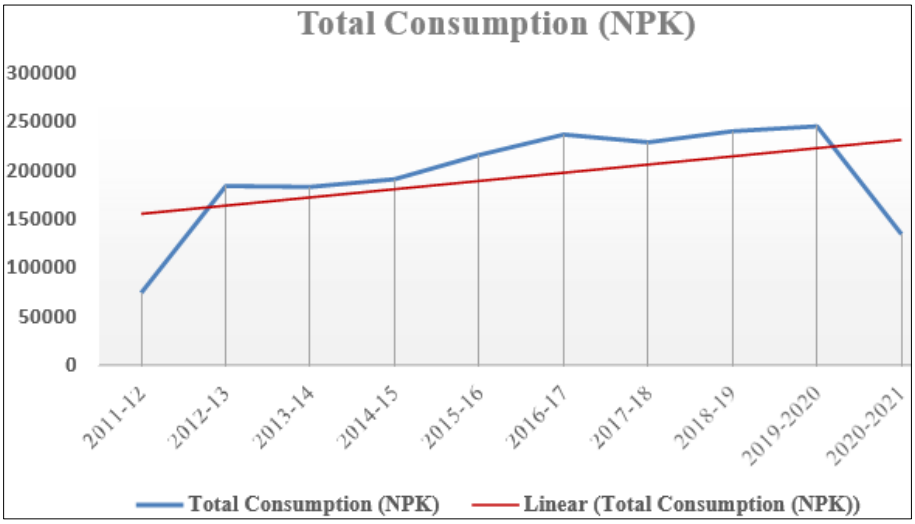

Fig 8: Trend of Total fertilizer consumption in Rabi season in Chhattisgarh plains

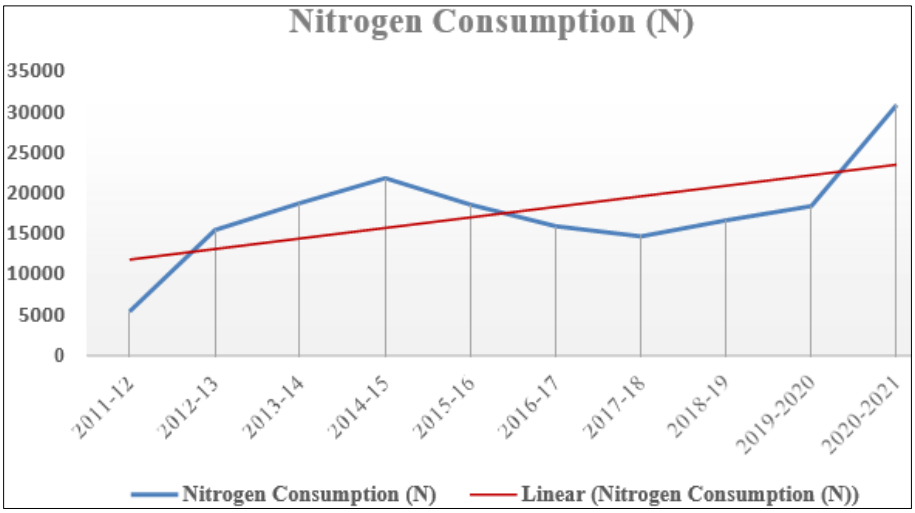

Fig 9: Trend of Nitrogen consumption in Kharif season in Bastar plateau

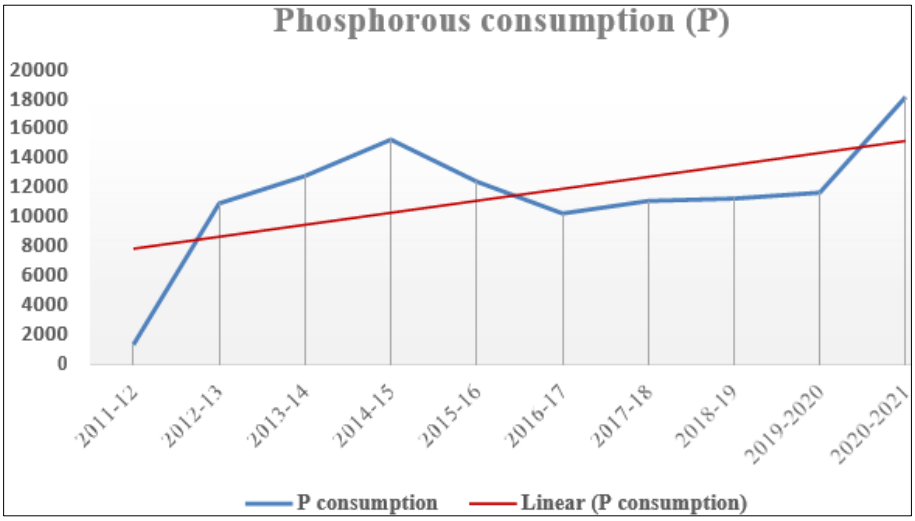

Fig 10: Trend of Phosphorous consumption in Kharif season in Bastar plateau

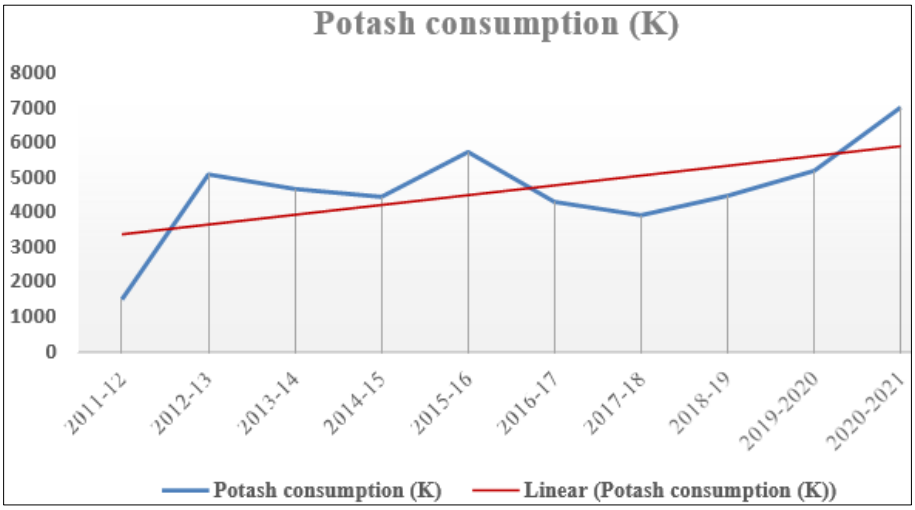

Fig 11: Trend of Potash consumption in Kharif season in Bastar plateau

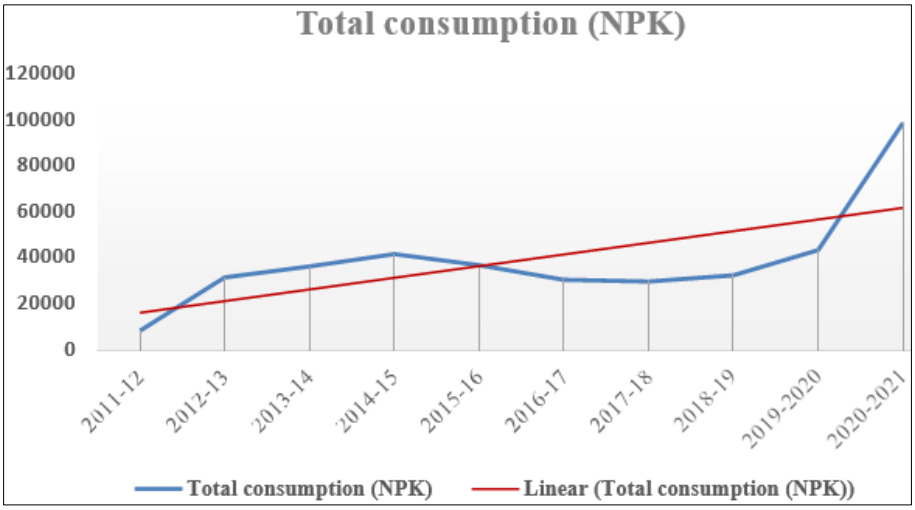

Fig 12: Trend of Total fertilizer consumption in Kharif season in Bastar plateau

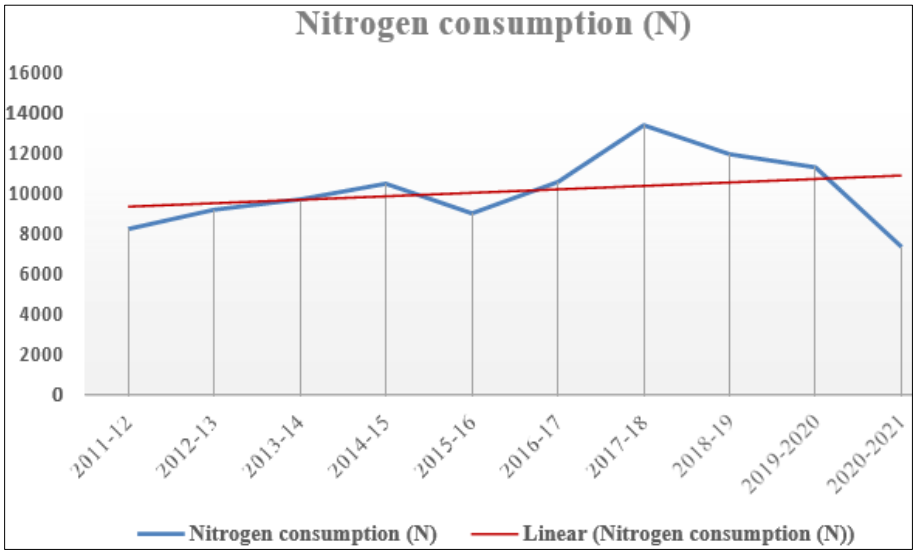

Fig 13: Trend of Nitrogen consumption in Rabi season in Bastar plateau

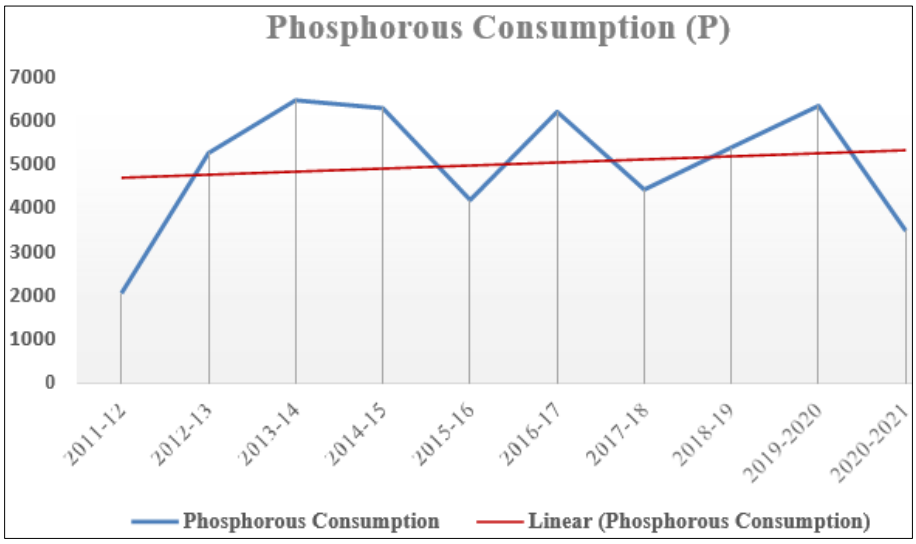

Fig 14: Trend of Phosphorous consumption in Rabi season in Bastar plateau

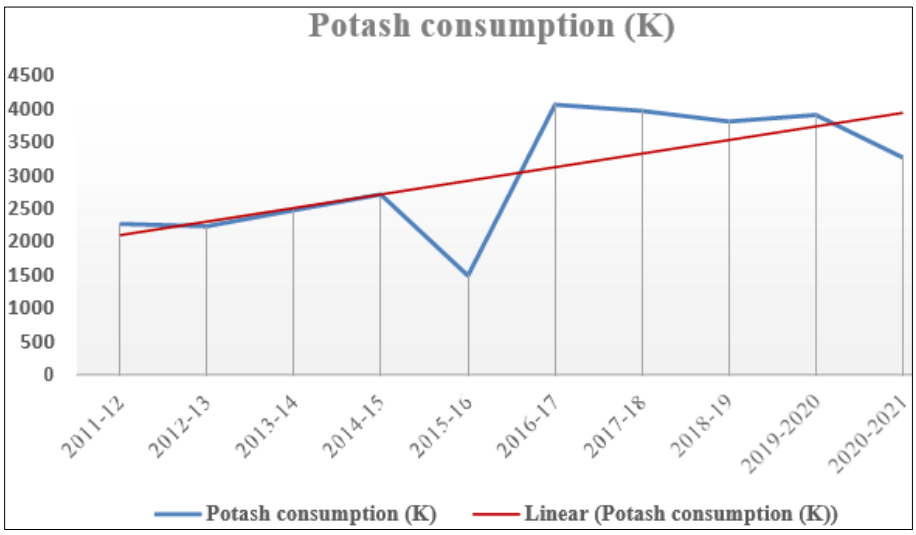

Fig 15: Trend of Potash consumption in Rabi season in Bastar plateau

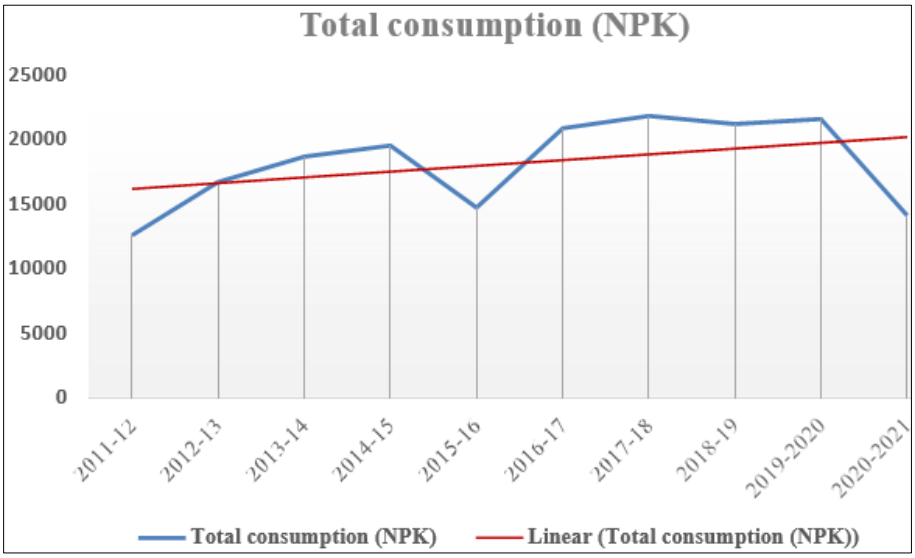

Fig 16: Trend of Total fertilizer consumption in Rabi season in Bastar plateau

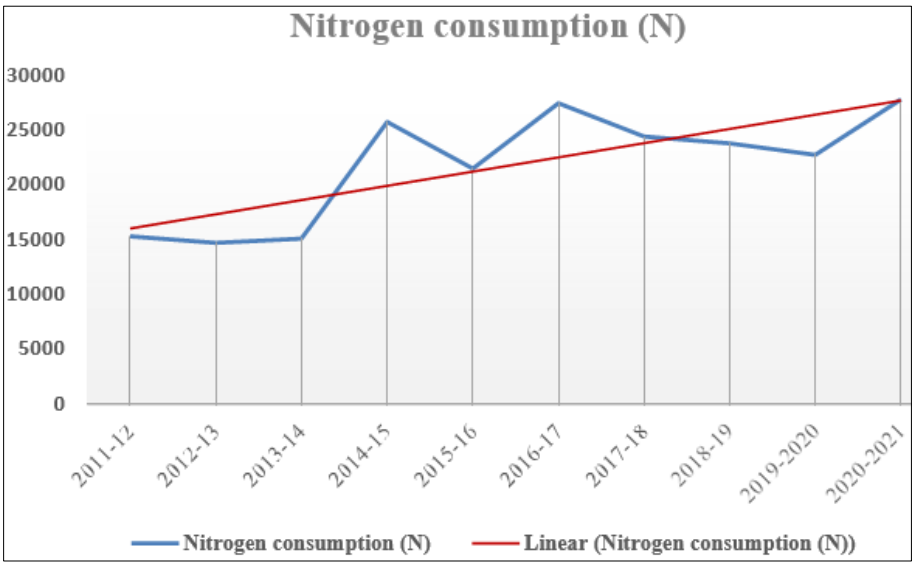

Fig 17: Trend of Nitrogen consumption in Kharif season in Northern hills

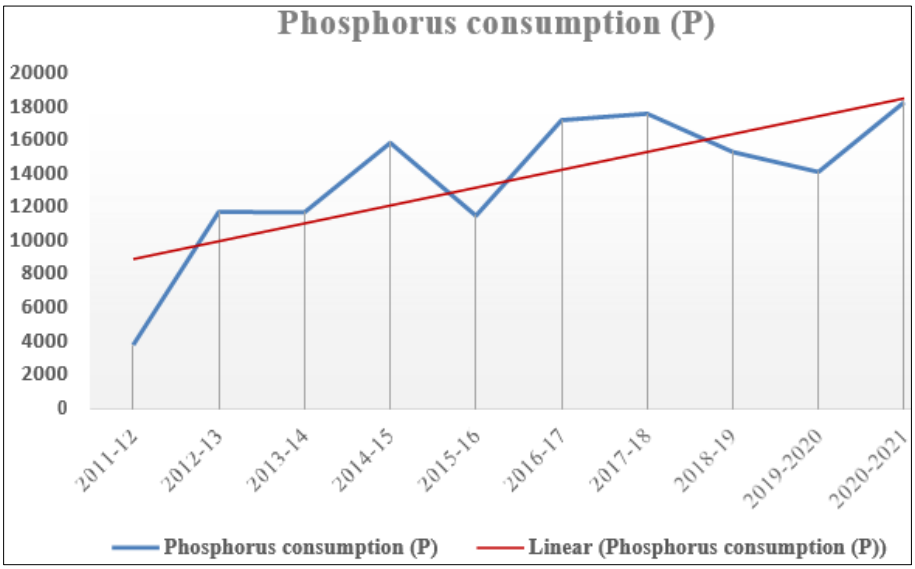

Fig 18: Trend of Phosphorus consumption in Kharif season in Northern hills

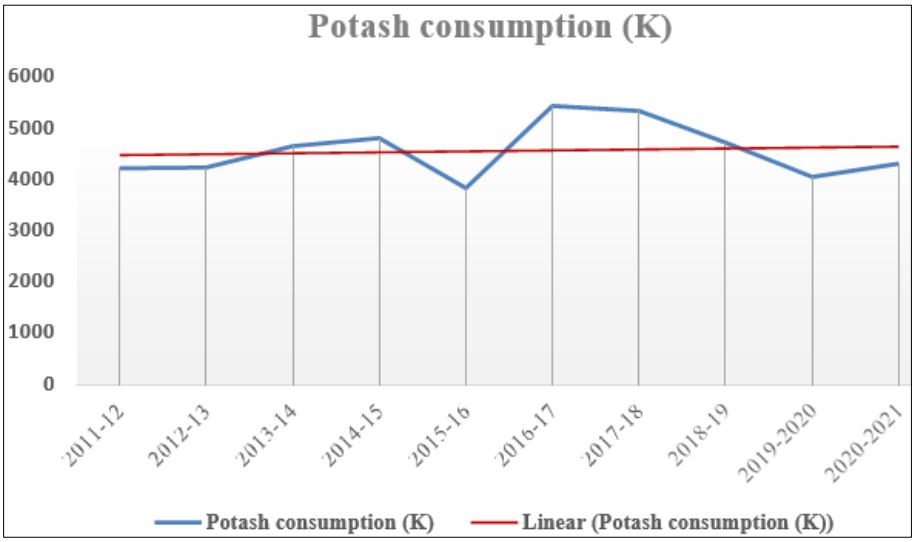

Fig 19: Trend of Potash consumption in Kharif season in Northern hills

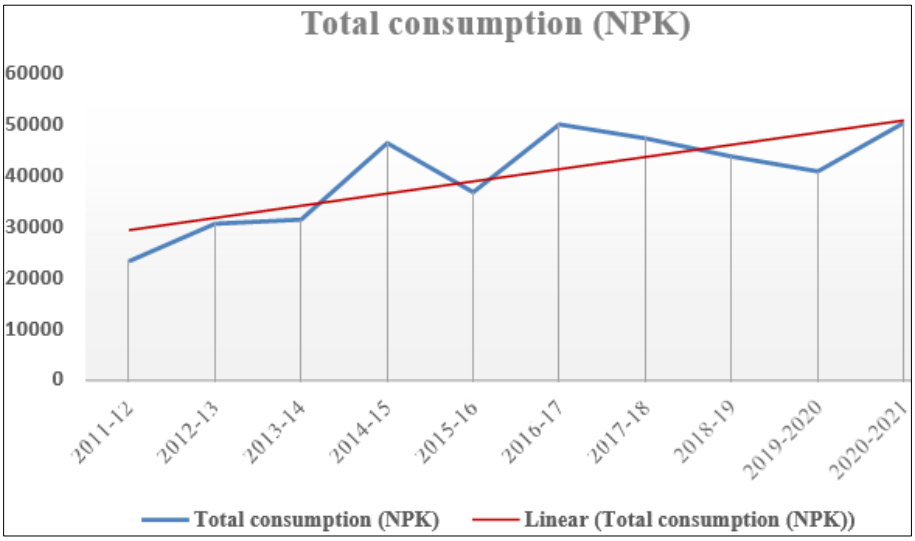

Fig 20: Trend of Total fertilizer consumption in Kharif season in Northern hills

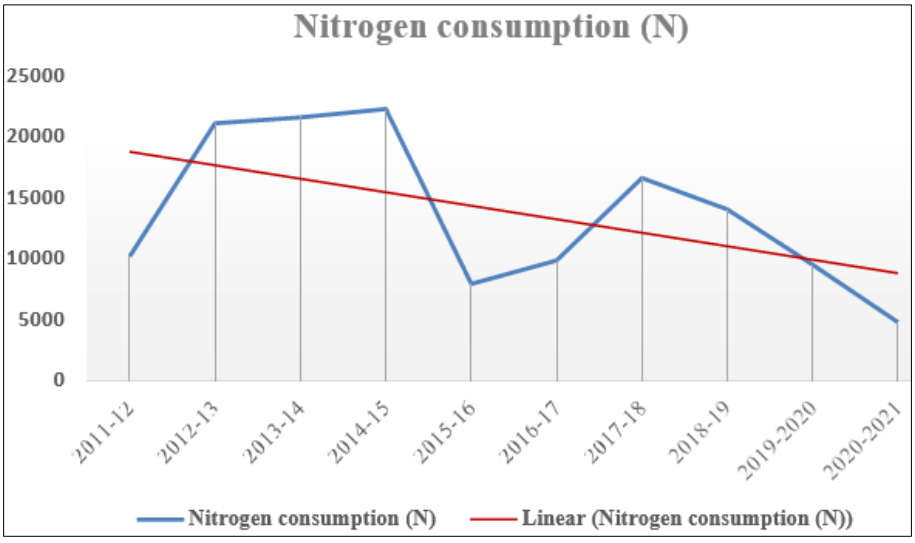

Fig 21: Trend of Nitrogen consumption in Rabi season in Northern hills

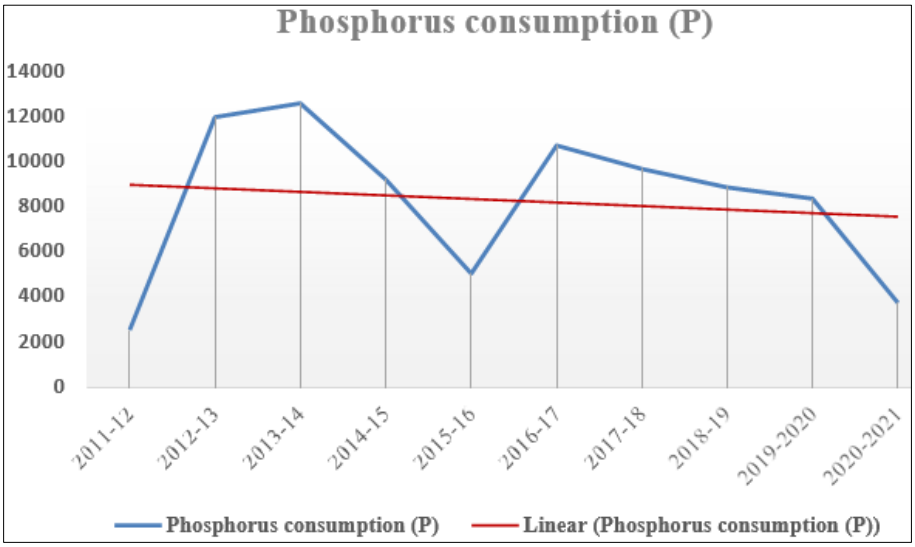

Fig 22: Trend of Phosphorus consumption in Rabi season in Northern hills

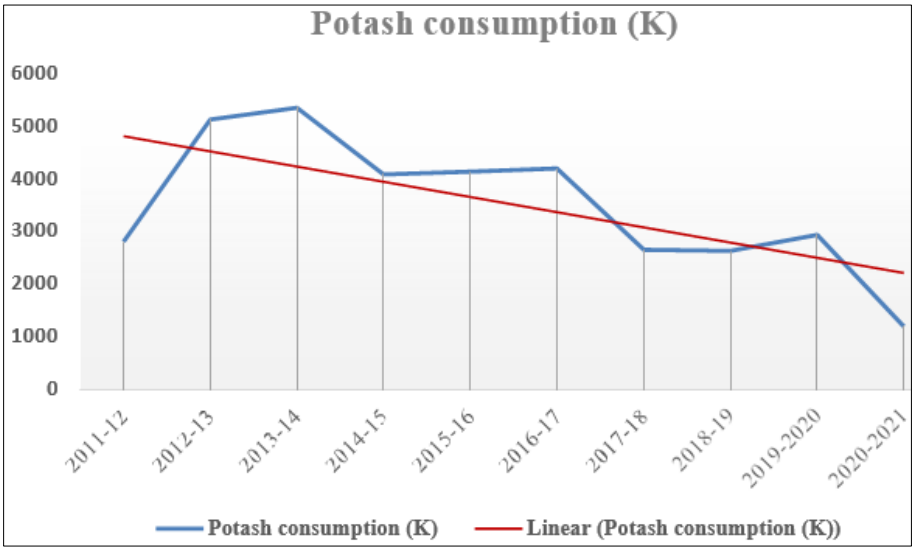

Fig 23: Trend of Potash consumption in Rabi season in Northern hills

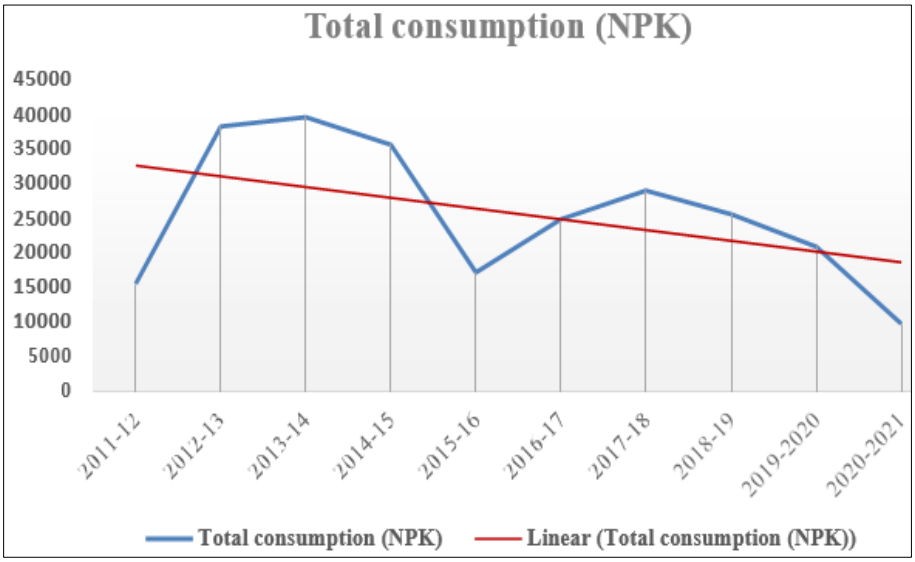

Fig 24: Trend of Total fertilizer consumption in Rabi season in Northern hills

Conclusion

For a period of ten years, the growth rate of fertiliser use in Chhattisgarh's various agro-climatic zones was assessed, and a comparison conclusion was drawn. In the Chhattisgarh the plains, the growth rate was higher throughout the kharif and rabi seasons followed by Bastar plateau; however, the growth

rate appeared to be negative in the Northern hills.

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