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Temporal assessment of available NPK status in agricultural soils of Omerga Taluka, Maharashtra: A comparative study of 2022 and 2026

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Abstract

The present Research paper aims to assess the temporal changes in the status of available Nitrogen (N), Phosphorus (P) and Potassium (K) in agricultural soils of Omerga taluka, Maharashtra, by comparing soil-test data from 2022 and 2026. The study is based on primary soil-testing data comprising 157 soil samples collected and analysed in 2022 and 64 samples analysed in 2026. The available N, P and K contents were classified into six fertility categories ranging from very low to very high, and their percentage distribution was comparatively assessed to identify changes in soil fertility status over the study period. The results reveal a considerable decline in available nitrogen status. The proportion of soils under very-low and low nitrogen categories increased from 64.90% in 2022 to 78.13% in 2026, indicating increasing nitrogen deficiency. Similarly, the proportion of soils classified as very-low and low in available phosphorus increased from 46.50% to 53.10%, while the very-low phosphorus category increased from 10.20% to 23.40%. In contrast, available potassium showed a marked increase, with the very-high category rising from 29.30% in 2022 to 92.18% in 2026. The findings indicate that nitrogen and phosphorus have emerged as important soil fertility concerns, whereas potassium is generally abundant and is unlikely to be a major limiting nutrient in the analysed soils. The study emphasizes the importance of periodic soil testing, soil-test-based fertilizer application, integrated nutrient management, organic matter incorporation and balanced nutrient management for maintaining sustainable soil fertility and improving nutrient-use efficiency in the study area.

Keywords: Available nitrogen, available phosphorus, available potassium, soil fertility, temporal assessment, soil testing

Introduction

Soil fertility is an important determinant of agricultural productivity and sustainable crop production. The availability of essential macronutrients such as Nitrogen (N), Phosphorus (P) and Potassium (K) plays a significant role in plant growth, yield and overall soil health. However, continuous cultivation and variations in nutrient management practices may lead to changes in the availability of these nutrients over time. Therefore, periodic assessment of soil fertility is essential for developing balanced and site-specific nutrient management strategies. The present study focuses on the agricultural soils of Omerga Taluka, Maharashtra, and comparatively assesses the available N, P and K status during 2022 and 2026. The study analyses changes in different nutrient-fertility categories and identifies the major shifts in soil nutrient availability. The comparative assessment is expected to provide useful insights for soil-test-based fertilizer recommendations, balanced nutrient management and sustainable agricultural development in the study area.

Study Area

Omerga taluka is located on the map to south east of Maharashtra. on the border of Maharashtra and Karnataka. The taluka of Omerga lies between 17°38' 32" North latitude to 18°02'10" north latitude and 76°24'30" east longitude to 76°47'17" east longitudes.it has a total area of 998.63 sq kms.omerger taluka is well inhabited and total population is 269519 in 01 urban centre and 96 villages.

Objective

1. To assess the status of available Nitrogen (N), Phosphorus (P) and Potassium (K) in

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agricultural soils of Omerga Taluka during 2022 and 2026.

- To compare the distribution of different NPK fertility categories between 2022 and 2026.
- To identify the major changes in available N, P and K status during the study period.
- To assess the implications of the observed changes in NPK status for soil fertility management in the study area.

Research Methodology and Data Collection

For this study, soil samples will be collected from selected agricultural fields in Omerga Taluka during the years 2022 and 2026. From each field, topsoil samples will be collected using the zigzag method, mixed thoroughly and prepared as representative composite samples. The samples will be shade-dried, cleaned to remove debris and sieved before laboratory analysis.

The available quantities of Nitrogen (N), Phosphorus (P) and Potassium (K) in the soil samples will be determined

using standard laboratory methods. The obtained values will be compared with the relevant soil-fertility classes and classified into low, medium and high categories. A comparative presentation of the data from 2022 and 2026 will be prepared to determine changes in nutrient availability, percentage differences and major trends. Based on this analysis, graphs will be prepared to illustrate the variations and comparative trends in the availability of N, P and K during the study period.

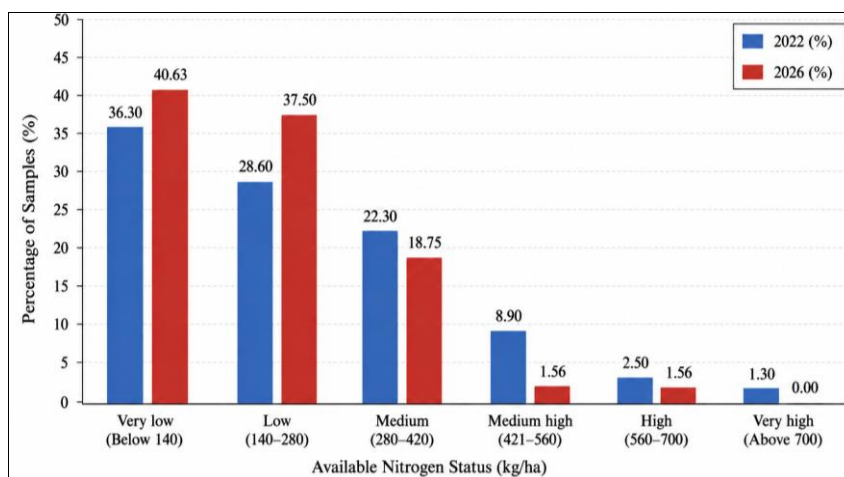
Comparative Analysis of Available Phosphorus

The comparative assessment of available nitrogen (N) status was carried out using soil-test data obtained during 2022 and 2026. A total of 157 soil samples were analysed in 2022, whereas 64 soil samples were analysed in 2026. The available nitrogen content was classified into six fertility categories, namely very low, low, medium, medium high, high and very high, based on the available nitrogen concentration in kg ha^{-1}

Table 1: Comparative distribution of available nitrogen status during 2022 and 2026

Sr. No.	Available Nitrogen	Nitrogen Range KG/ Ha.	No.of Samples 2022	% 2022	No.of Samples 2026	% 2026	Change in Percentage
1	Very low	Below 140	57	36.3	26	40.63	+4.33
2	Low	140-280	45	28.6	24	37.50	+8.90
3	Medium	280-420	35	22.3	12	18.75	-3.55
4	Medium high	421-560	14	8.9	01	1.56	-7.34
5	High	560-700	04	2.5	01	1.56	-0.94
6	Very high	Above 700	02	1.3	-	-	-1.30

Source: Compiled and analysed by the researcher based on primary soil testing data collected during field investigations, 2022 and 2026.



Source: Compiled and analysed by the researcher based on primary soil testing data collected during field investigations, 2022 and 2026.

Fig 1: Comparative distribution of available nitrogen status during 2022 and 2026

Comparative Interpretation

The comparative analysis reveals a noticeable deterioration in the available nitrogen status of agricultural soils between 2022 and 2026. In 2022, 36.30% of the analysed soil samples were categorized as very low in available nitrogen. This proportion increased to 40.63% in 2026, representing an increase of 4.33 percentage points. The increase in the very-low nitrogen category indicates that a greater proportion of the sampled soils had inadequate available nitrogen during the later assessment period.

A similar increasing trend was observed in the low nitrogen category. The proportion of samples classified as low increased from 28.60% in 2022 to 37.50% in 2026, showing

an increase of 8.90 percentage points. This was the largest increase among all nitrogen-fertility classes. The combined proportion of soils falling under the very-low and low nitrogen categories increased from 64.90% in 2022 to 78.13% in 2026

This finding is particularly significant from an agricultural perspective. It indicates that nearly four-fifths of the analysed soil samples in 2026 were characterized by inadequate available nitrogen. Therefore, nitrogen deficiency appears to be an important soil fertility constraint in the study area.

In contrast, the proportion of soils under the medium nitrogen category decreased from 22.30% in 2022 to

18.75% in 2026, a decline of 3.55 percentage points. A more substantial reduction was observed in the medium-high category, which declined from 8.90% to only 1.56%. The high nitrogen category also decreased from 2.50% to 1.56%. The very-high nitrogen category accounted for 1.30% of the samples in 2022, whereas no sample was recorded in this category in 2026. Thus, the proportion of soils having medium-high to very-high nitrogen status declined considerably during the period under comparison.

Overall Change in Nitrogen Fertility

The overall pattern indicates a shift from relatively better nitrogen availability towards lower nitrogen fertility status between 2022 and 2026. The proportion of soils belonging to the medium, medium-high, high and very-high categories collectively decreased from 35.00% in 2022 to 21.87% in 2026. Conversely, the combined very-low and low categories increased from 64.90% to 78.13%.

The increase of approximately 13.23 percentage points in the combined low-fertility classes demonstrates a substantial deterioration in the nitrogen status of the sampled soils. Such a trend may be associated with continuous cultivation, intensive cropping, inadequate incorporation of organic matter, removal of crop residues, insufficient application of organic manures, and an imbalance between nutrient removal and nutrient replenishment. However, these possible causes should be interpreted cautiously unless

supported by field-level information on fertilizer use, cropping intensity, organic manure application and crop yields.

Agricultural Implications

The observed increase in very-low and low available nitrogen classes has important implications for agricultural productivity and sustainable soil management. Nitrogen is one of the major macronutrients required for vegetative growth, chlorophyll formation, protein synthesis and yield development. A persistent deficiency of available nitrogen may adversely affect crop growth and productivity. The findings suggest the need for improved nitrogen management practices in the study area. Application of nitrogen fertilizers should preferably be based on soil-test results rather than uniform fertilizer recommendations. Split application of nitrogen, incorporation of farmyard manure and compost, use of crop residues, inclusion of leguminous crops in crop rotations, and adoption of integrated nutrient management practices may help improve nitrogen availability and maintain soil fertility.

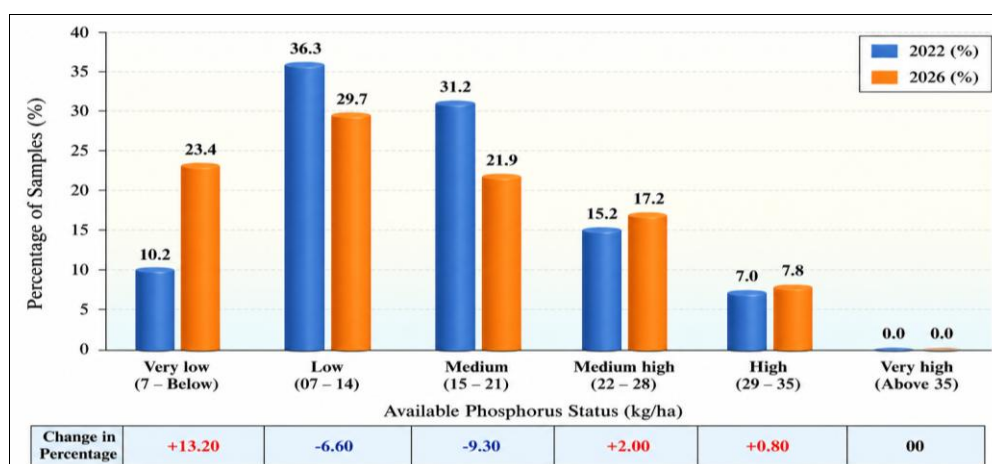
The results also emphasize the importance of periodic soil testing. Comparison of soil-test results over time can provide valuable information about changes in soil fertility and help farmers and agricultural agencies develop site-specific nutrient-management strategies.

Comparative Analysis of Available Phosphorus

Table 2: Comparative Distribution of Available Phosphorus Status in 2022 and 2026

Sr. No.	Available Phosphorus	Phosphorus Range KG/ Ha.	No. of Samples 2022	% 2022	No. of Samples 2026	% 2026	Change in Percentage
1	Very low	7-Below	16	10.2	15	23.4	+13.20
2	Low	07-14	57	36.3	19	29.7	-6.60
3	Medium	15-21	49	31.2	14	21.9	-9.30
4	Medium high	22-28	24	15.2	11	17.2	+2.00
5	High	29-35	11	7.0	05	7.8	+0.80
6	Very high	Above 35	-	-	-	-	00

Source: Compiled and analysed by the researcher based on primary soil testing data collected during field investigations, 2022 and 2026.



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Fig 2: Comparative distribution of available phosphorus status in 2022 and 2026

The comparative assessment of available phosphorus (P) was carried out using soil-testing data obtained during 2022 and 2026. A total of 157 soil samples were analysed in 2022, whereas 64 soil samples were analysed in 2026. The

available phosphorus status was classified into six categories: very low, low, medium, medium high, high and very high.

Comparative Interpretation

The comparative analysis of available phosphorus indicates a noticeable change in the phosphorus status of the sampled agricultural soils between 2022 and 2026. In 2022, 10.20% of the analysed soil samples were classified under the very-low phosphorus category. This proportion increased substantially to 23.40% in 2026, representing an increase of 13.20 percentage points. In contrast, the proportion of samples under the low phosphorus category declined from 36.30% in 2022 to 29.70% in 2026, showing a decrease of 6.60 percentage points. Similarly, the medium phosphorus category decreased from 31.20% in 2022 to 21.90% in 2026, indicating a decline of 9.30 percentage points. The combined proportion of very-low and low phosphorus soils was 46.50% in 2022 and increased to 53.10% in 2026. Thus the proportion of soils falling within the lower phosphorus fertility classes increased by 6.60 percentage points during the study period. This indicates a gradual shift towards lower phosphorus availability in a considerable proportion of the sampled soils.

Changes in Medium and Higher Phosphorus Categories

The proportion of soils under the medium category declined considerably from 31.20% in 2022 to 21.90% in 2026. However, the medium-high category increased slightly from 15.20% to 17.20%, while the high category increased from

7.00% to 7.80%.

No soil sample was recorded in the very-high phosphorus category during either assessment year. Therefore, the study area did not show any significant representation of soils with very-high available phosphorus status. The decline in the medium phosphorus category, together with the increase in the very-low category, suggests a shift in the distribution of available phosphorus towards the lower fertility classes.

Overall Assessment

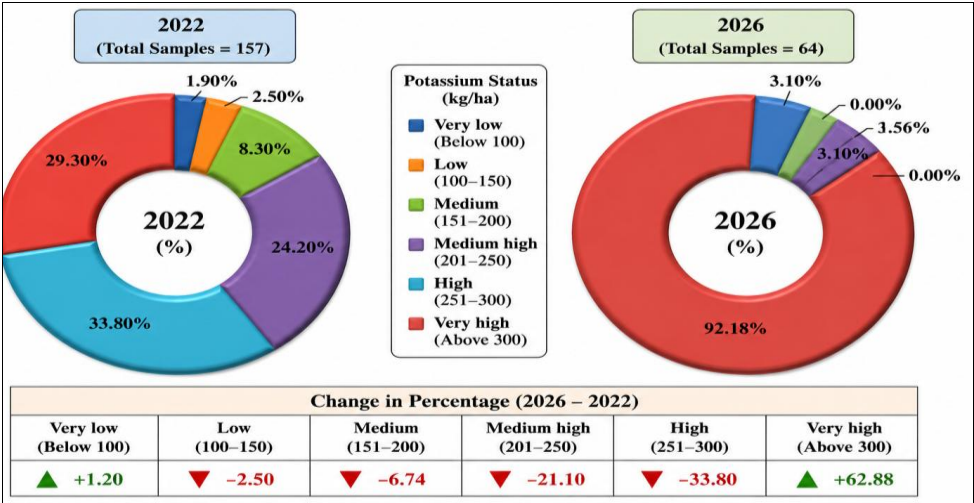
The comparative findings demonstrate that the phosphorus status of the analysed soils underwent a noticeable change between 2022 and 2026. The proportion of very-low phosphorus soils more than doubled, increasing from 10.20% to 23.40%. At the same time, the proportion of medium phosphorus soils declined from 31.20% to 21.90%. The increase in the combined very-low and low phosphorus categories from 46.50% to 53.10% is particularly important from the perspective of soil fertility management. It indicates that more than half of the soil samples analysed in 2026 belonged to the lower phosphorus fertility classes. Phosphorus is an essential macronutrient involved in root development, energy transfer, flowering, seed formation and crop maturity. The increasing proportion of soils with very-low and low available phosphorus indicates the need for appropriate phosphorus management in the study area.

Comparative Analysis of Available Potassium

Table 3: Comparative distribution of available potassium status in 2022 and 2026

Sr. No.	Available Potassium	Potassium Range KG/ Ha.	No.of Samples 2022	% 2022	No.of Samples 2026	% 2026	Change in Percentage
1	Very low	Below 100	3	1.90	2	3.10	+1.20
2	Low	100-150	4	2.50	0	0.00	-2.50
3	Medium	151-200	13	8.30	1	1.56	-6.74
4	Medium high	201-250	38	24.20	2	3.10	-21.10
5	High	251-300	53	33.80	0	0.00	-33.80
6	Very high	Above 300	46	29.30	59	92.18	+62.88

Source: Compiled and analysed by the researcher based on primary soil testing data collected during field investigations, 2022 and 2026.



Source: Compiled and analysed by the researcher based on primary soil testing data collected during field investigations, 2022 and 2026.

Fig 3: Comparative distribution of available potassium status in 2022 and 2026

The comparative assessment of available potassium (K) was carried out using soil-testing data collected during 2022 and 2026. A total of 157 soil samples were analysed in 2022,

while 64 soil samples were analysed in 2026. The available potassium status was classified into six categories: very low, low, medium, medium high, high and very high.

Comparative Interpretation

The comparative analysis reveals a substantial improvement in the available potassium status of the sampled agricultural soils between 2022 and 2026. The most prominent change was observed in the very-high potassium category. In 2022, 29.30% of the analysed soil samples were classified as very high in available potassium. This proportion increased sharply to 92.18% in 2026, representing an increase of 62.88 percentage points. Thus, the majority of the soil samples analysed in 2026 belonged to the very-high potassium category. A decline was observed in almost all the remaining potassium-fertility categories. The medium category decreased from 8.30% in 2022 to 1.56% in 2026. Similarly, the medium-high category declined substantially from 24.20% to 3.10%. The high potassium category accounted for 33.80% of the samples in 2022, whereas no sample was recorded in this category in 2026. The low potassium category also declined from 2.50% in 2022 to zero in 2026.

Change in Higher Potassium Fertility Classes

The combined proportion of soils classified as high and very high in available potassium was 63.10% in 2022 (33.80% high + 29.30% very high). In 2026, the corresponding proportion increased to 92.18%, as all 59 samples falling in the higher category were classified as very high.

This represents an increase of 29.08 percentage points in the combined high and very-high potassium classes. The sharp increase in the very-high potassium category indicates that potassium is generally not a major limiting nutrient in the analysed soils. Rather, the soils show a strong tendency towards potassium abundance.

Low and Medium Potassium Status

The combined proportion of very-low and low potassium samples was 4.40% in 2022, comprising 1.90% very low and 2.50% low. In 2026, the corresponding proportion was only 3.10%, with 2 samples classified as very low and no sample classified as low.

The medium and medium-high categories also showed a considerable decline. Their combined proportion decreased from 32.50% in 2022 to 4.66% in 2026. These changes further demonstrate the shift in the distribution of available potassium towards the very-high category.

Overall Assessment

The temporal comparison demonstrates a pronounced increase in available potassium in the sampled agricultural soils between 2022 and 2026. The most significant finding is the increase in the very-high potassium category from 29.30% to 92.18%. Unlike nitrogen and phosphorus, where a considerable proportion of samples may fall within low or very-low fertility classes potassium does not appear to be a major fertility constraint in the analysed samples. The very high proportion of potassium-rich soils suggests that indiscriminate application of potassium fertilizers may not be necessary in most parts of the study area. However, fertilizer recommendations should always be based on soil-test results, crop requirements and field-specific conditions rather than on generalized assumptions.

Potassium plays an important role in plant water regulation, enzyme activation, disease resistance, photosynthesis and overall crop quality. Although potassium is essential for crop production, excessive or unnecessary application of

potassium fertilizers in soils already having very-high available potassium may not provide additional agronomic benefits and may increase production costs.

Conclusion

1. The temporal comparison of available nitrogen between 2022 and 2026 demonstrates that soil fertility is not static and may change considerably over time under different agricultural management practices. The increasing share of soils in the very-low and low nitrogen categories highlights the need for continuous monitoring of soil fertility.
2. The major finding of the comparative analysis is that the proportion of soil samples with inadequate available nitrogen increased from 64.90% in 2022 to 78.13% in 2026, while the proportion of samples with medium to very-high nitrogen status declined from 35.00% to 21.87%. This indicates an overall shift towards lower available nitrogen status in the analysed agricultural soils during the study period.
3. Soil-test-based phosphorus application should be encouraged to avoid both deficiency and unnecessary fertilizer application. The use of suitable phosphorus fertilizers, incorporation of organic manures, recycling of crop residues and adoption of integrated nutrient management practices may contribute to maintaining phosphorus availability in agricultural soils.
1. Particular attention should be given to soils classified as very low in available phosphorus. Site-specific fertilizer recommendations based on soil-test results can improve phosphorus-use efficiency and support sustainable crop production.
4. The major finding of the comparative analysis is that the proportion of soil samples belonging to the very-low and low available phosphorus categories increased from 46.50% in 2022 to 53.10% in 2026. The very-low category alone increased from 10.20% to 23.40%. Conversely, the medium phosphorus category declined from 31.20% to 21.90%. These changes indicate a shift towards lower available phosphorus status in a considerable proportion of the analysed agricultural soils.
5. The findings therefore suggest the need for soil-test-based potassium management in the study area. Farmers should avoid unnecessary application of potassic fertilizers where soil-test results indicate very-high potassium availability. Instead, greater emphasis may be placed on maintaining soil fertility through balanced nutrient management and appropriate management of nitrogen and phosphorus.
6. The results also highlight the importance of periodic soil testing for identifying changes in nutrient availability and for developing site-specific fertilizer recommendations. The major finding of the comparative analysis is that the proportion of soil samples classified as very high in available potassium increased substantially from 29.30% in 2022 to 92.18% in 2026, an increase of 62.88 percentage points. At the same time, the combined proportion of high and very-high potassium soils increased from 63.10% to 92.18%.
7. Overall, the findings indicate that available potassium is abundant in the majority of the analysed agricultural soils and is unlikely to be a major limiting nutrient. Therefore, fertilizer management strategies should

focus on maintaining a balanced nutrient supply and avoiding unnecessary potassium fertilization in soils with very-high potassium status.

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