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RESEARCH

Assessment of Soil Fertility Status in Rupani Rural Municipality, Saptari, Nepal

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Abstract

As soil fertility is one of the most important factors for soil productivity, soil fertility management is important for sustainable soil management. This study was conducted to determine the soil fertility status of Rupani Rural Municipality, Saptari, Nepal. A total of 60 soil samples were collected randomly from 0-30 cm depth. The exact location of the samples was recorded using a handheld GPS device. All collected samples were analyzed at a regional soil testing laboratory in Saptari to determine their pH, soil texture, nitrogen, phosphorus, potassium, and organic matter status. In addition, fertility status maps were prepared using ArcGIS 10.8 software. The study area consists mainly of 51.66% clay and 18.33% sandy loam soils. The soil pH ranged from highly acidic to slightly alkaline, with pH values ranging from 4.5 to 8.0. Soil organic matter (0.42-3.21%), nitrogen (0.02-0.16%), available phosphorus (40.1-282.35 kg P_2O_5/ha) and exchangeable potassium (64.8-729.6 kg K_2O/ha) are present in the soil with the status of low to high in the study area. In order to improve crop potential and maintain soil nutrient status through the use of site-specific fertilizers, a reduction in the use of chemical fertilizers and various sustainable soil management practices were adopted. This research provides valuable information to policymakers, farmers, and agricultural stakeholders, facilitating evidence-based decision-making for agricultural development and food security in Rupani Rural Municipality, Saptari, Nepal.

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Statement of Sustainability: This research aims to achieve sustainable development goals by addressing key aspects of sustainability in the soil ecosystem. It contributes to Goal 2 (Zero Hunger) by improving soil productivity. It also aims to support SDG 1 (Zero Poverty) by securing the livelihoods of farmers by improving their standard of living. Overall, our research aims to achieve multiple SDGs, no poverty, and zero hunger.

1. Introduction

According to the World Map on the Status of Human-induced Soil Degradation, removal of natural vegetation, deforestation and overgrazing are the major causes of topsoil degradation. Similarly, the degradation of land resources in the Himalayan regions is mainly caused by landslides, mudslides, the collapse of man-made terraces, and the reduction of forest or pastureland (Shrestha, 1997). All the threats to sustainability are due to the depletion of soil fertility. In addition, poor soil fertility has sparse plant cover, which promotes vulnerability to erosion (Mairura et al., 2007). It has been studied that farmers nowadays have increased the use of chemical fertilizers and herbicides, and fallow cycles have disappeared or decreased Zhang and Zhang (2007). Therefore, the loss of soil productivity is increasing day by day.

Although the decline in soil fertility is a major concern for most farmers, their adaptation to improved techniques has been limited (Khadka et al., 2017). The sustainability of any system has become a major concern nowadays. Soil fertility assessment is perhaps the most fundamental decision-making tool for an appropriate management strategy (Desbiez et al., 2004). In addition, soil erosion, flood landslides, and many other soil nutrient degradation factors cause rapid nutrient depletion and pose a great challenge to nutrient management strategies (Havlin et al., 2010). In addition, soil fertility data are sparse, information on nutrient inputs is limited, and maintaining long-term soil fertility is a major concern (Brown et al., 2000; Yadav et al., 2023).

Nepal is an agricultural country, with approximately 66% of the population engaged in agriculture. While it is estimated that nearly 2 billion people are moderate to severely food insecure, in the case of Nepal, 52% of households are food insecure. In addition, two million people in Nepal are undernourished. Thus, soil fertility plays a crucial role in achieving self-sufficiency in crop production (Oli et al., 2020). Therefore, nowadays there are many techniques for soil fertility assessment, among which soil testing is the most widely used in the world (Havlin et al., 2010). Through soil testing, the status of soil fertility and information about nutrient availability in the soil can be properly revealed. It also provides the basis for fertilizer recommendations to increase crop yields and maintain fertility.

New technologies such as Global Positioning System (GPS) and Geographic Information System (GIS) have been developed to describe the spatial variability of soil fertility. The ultimate use of GIS and GPS for soil fertility mapping is popular and gaining acceptance worldwide. The construction of thematic soil fertility maps through the collection of soil samples using GPS is very important (Mishra, 2016). It helps in formulating site-specific nutrient management. In addition, both GPS and GIS technologies play a crucial role in better land management (Palaniswami et al., 2011). Moreover, the soil fertility maps extracted from the GIS are more useful for developing solutions related to land management, soil erosion, soil degradation, water quality, and urban planning (Becker et al., 2015). Although the maps generated from GIS support the qualitative and quantitative nutrient management strategy (Wojciech, 2009). There are various geostatistical methods, but ordinary kriging is widely used for the spatial variability of soil fertility because it provides a higher level of prediction accuracy. In addition, the distribution of terrestrial ecosystems, ecological modeling, environmental prediction, precision agriculture, and natural resource management are important indicators of soil quality, which can only be achieved through spatial variability (Wang et al., 2008). Therefore, knowledge of the spatial variation of soil properties is important for good farm management practices, landscape modeling, and assessment of the impact of agriculture on the environment (Xu et al., 2021).

In addition, soil tests determine current fertility status and nutrient availability information, particularly the nitrogen, phosphorus, and potassium available in soils. As such, they provide a baseline for fertilizer recommendations to maximize crop yields and maintain optimum soil fertility year after year. Considering the aforementioned, this study aims to assess the soil fertility status in Rupani Rural Municipality, Saptari, Nepal, to provide vital insights for sustainable agricultural practices in the region.

2. Materials and Methods

2.1. Study Area

The research was conducted in Rupani Rural Municipality, Saptari, Nepal. It is located at 26.62° N and 86.69° E. Rupani Rural Municipality is located in the Saptari District of Sagarmatha Zone (Figure 1). There are a total of six wards in this rural municipality. The soils are mainly of alluvial deposits, and the soil association of the micro-topographies has been developed by changing river morphology. The climate of the study area is mainly tropical and subtropical monsoon type. In addition, summers are hot and humid, while winters are mild and dry. There are mainly three to four cropping patterns followed in Rupani Rural Municipality, such as paddy-paddy-legumes, paddy-wheat-maize, paddy/wheat, mustard/mustard/legumes-fallow. The major crops of Rupani Rural Municipality are rice, wheat, maize, vegetables, mango, mustard, and pulses. Rice production is high in Rupani Rural Municipality as there is an increase in the area under Chaitra rice cultivation. Mango is the major crop in some parts. There is also a high production of winter vegetables in this area.

2.2. Soil Sampling Technique

A total of 60 soil samples from the top 0-30 cm were collected from six wards of Rupani Rural Municipality using a simple random sampling technique (Figure 2). Soil samples were systematically mapped using Google Earth Pro (GEP) and ArcGIS software based on land cover/land use slope and aspect. The soil sampling location was determined based on the land system units, morphology, geology, and land use conditions. The exact location (latitude and longitude) of the soil sampling pits was recorded using a handheld GPS device for the preparation of a thematic soil fertility map and finally imported into ArcGIS software. The soil survey included identification, examination, classification, mapping of soil and land units, and characterization of the physical and chemical properties of the soil units. Soil primary nutrients (NPK), soil pH, and soil texture were analyzed in a regional soil testing laboratory.

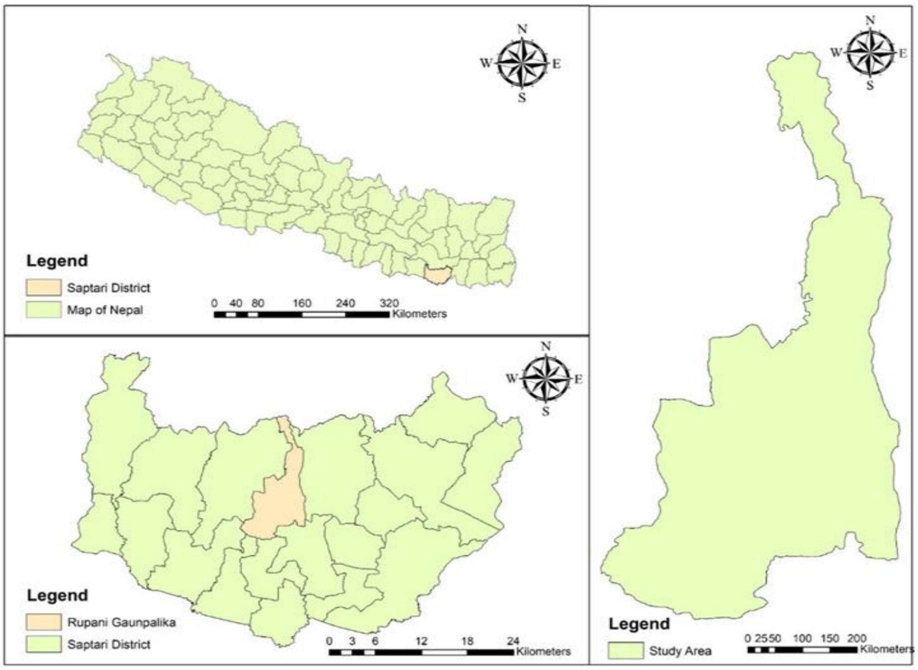

Figure 1. Location map of the study area.

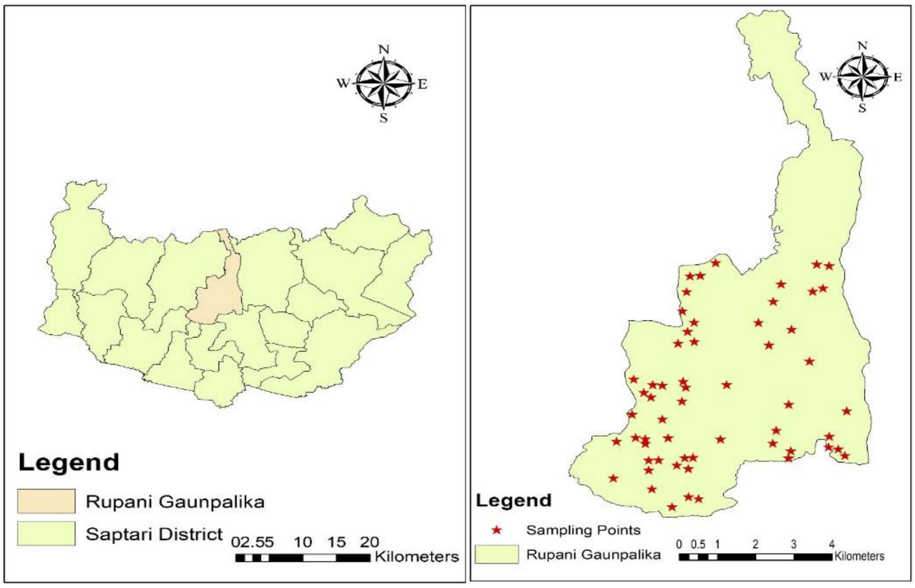

Figure 2. Map of Rupani Rupani Rural Municipality showing soil sampling pits.

2.3. Digital Elevation Model

A Digital Elevation Model (DEM) is a representation of the bare earth topographic surface of the earth, excluding trees, buildings, and other surface objects. DEMs are produced from a variety of sources. USGS (United States Geological Survey) DEMs (https://earthexplorer.usgs.gov) are derived primarily from topographic maps. Terrain attributes such as elevation at any point, slope aspects, drainage basins, and channel networks can also be identified from DEMs (Figure 3). Here, elevations range from 87 to 401 m above sea level.

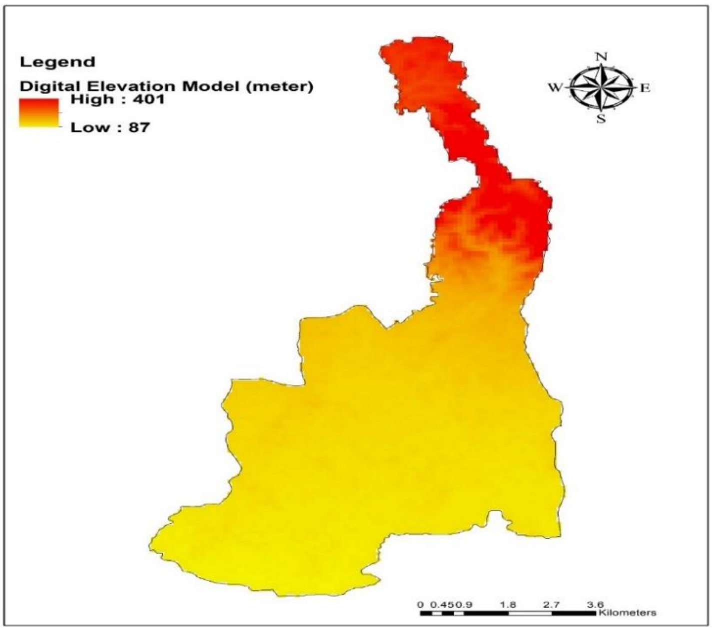

Figure 3. Digital Elevation Model Map of Rupani Rural Municipality, Saptari, Nepal.

Table 1. Rating of soil pH adapted by regional soil testing Laboratory, Saptari, Nepal.

pH (Range)	Soil Reaction
<4.5	Extremely acidic
4.5-5.5	Acidic
5.5-6.5	Slightly acidic
6.5-7.5	Neutral
>7.5	Alkaline

Table 2. Different rating classes of soil test data adapted by soil testing laboratory, Saptari, Nepal.

Classes	Organic Matter (%)	Total Nitrogen (%)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
Very Low	< 1.25	<0.05	<10	<55
Low	1.25-2.5	0.05-0.1	10-31	55-110
Medium	2.5-5.0	0.1-0.2	31-55	110-280
High	5.0-10.0	0.2-0.4	55-110	280-500
Very High	>10	>0.4	>110	>500

2.4. Laboratory Analysis

The collected soil samples were analyzed at the Regional Soil Testing Laboratory, Rajbiraj, Saptari. The different soil classes and pH were rated based on the rating scale adopted by the laboratory as shown in Tables 1 and 2. All soil physiochemical data including pH, soil organic matter, nitrogen, phosphorus, and potassium were quantitative while soil texture was qualitative. The various soil parameters tested, and the methods used to analyze the physical and chemical parameters are presented in Table 3.

Table 3. Parameters and methods adopted for the laboratory analysis.

Parameters	Analysis Method
Soil organic matter	Walkey and Black Method (Walkey and Black, 1934)
Total nitrogen in soils	Kjeldahl Distillation Unit (Bremner and Mulvaney, 1982)
Available Phosphorus	Modified Olsen's Bicarbonate Method (Olsen et al, 1982)
Available Potassium	Ammonium acetate (Jackson, 1967)
Soil texture	Hydrometer Method (Bouyoucos, 1962)
Soil pH	Digital pH meter (Mashud et al., 2014)

2.5. Data Analysis

The analysis of all collected soil samples was done at a regional soil testing laboratory, Rajbiraj, Saptari. The data were compiled and analyzed using Microsoft Excel. The data were analyzed using different statistical tools, viz. MS Excel 2013 (Microsoft Corp., USA) and Gen-Stat 15th edition (VSN International Ltd., Hemel, Hempstead, UK). ArcMap 10.8 (ESRI Inc., Redlands, CA, USA) was used for spatial analysis through Kriging method.

3. Results and Discussion

3.1. Soil Texture

The assessment of soil texture is crucial as it directly affects various soil properties and agricultural productivity (Berry et al., 2007). In this study, soil texture analysis in Rupani Rural Municipality, Saptari, Nepal revealed five different classes of soil texture: clay, sandy loam, loamy sand, loamy loam, and loam. The relative proportions of these soil textures were as follows: clay (51.66%), sandy loam (18.3%), loamy sand (13.33%), clay loam (13.33%), and loam (3.33%) (Figure 4a). The trend of the results shows that clay-rich soils dominate the study area, accounting for more than half of the sampled soils. The high clay content contributes to their water-holding capacity but may also affect drainage and aeration. Sandy loam and loamy sand soils together make up a significant proportion and provide good drainage and aeration while retaining some water. Clay loam, which has similarities to loamy sand, offers a balanced combination of clay and sand, providing moderate water retention and drainage. Finally, loam, the smallest proportion observed, represents the most desirable soil texture for agriculture, combining the benefits of sand, silt, and clay in optimal proportions. The reasons for these variations in soil texture can be attributed to geologic history and local environmental factors. Factors such as parent material, weathering, and topography influence soil texture. In the study area, the dominance of clay soils may be related to the specific geological processes that have shaped the landscape over time.

Table 4. Summary of the statistical overview of soil chemical properties of the study area.

Parameter	Mean	SD	CV (%)	Min	Max	SE	Skew	Kurtosis
pH	5.83	0.76	13.06	4.50	7.70	0.33	0.28	-0.54
OM (%)	1.41	0.52	37.52	0.42	3.21	0.48	0.64	1.31
N (%)	0.07	0.02	40.63	0.021	0.16	0.002	0.50	-0.03
K_2O (kg/ha)	298.4	115.63	38.75	64.80	729.6	14.92	0.67	2.93
P_2O5 (kg/ha)	151.73	69.00	45.47	40.10	282.35	8.90	0.27	-1.17

SD: standard deviation, CV: coefficient of variation, Min: minimum, max: maximum, SE: standard error, OM: organic matter, N: nitrogen, K_2O: Di-potassium oxide, P_2O_5: phosphorus pentoxide.

In a study by Oli et al. (2020) investigating soil texture in Rapti, they reported similar proportions of clay and sandy loam soils. However, their study area had a higher proportion of loamy sand than in our study. The differences may be due to local variations in topography and land use practices. Furthermore, a study by Rawal et al. (2018) in the Sunsari district of Nepal found that clay loam was the most common soil texture, followed by sandy loam and loam. Their results differed from ours, possibly due to differences in climate, vegetation, and geological characteristics between the two study areas. Similarly, a study by Prabhavati et al. (2015) in Belgaum identified clay loam as the dominant soil texture, which is consistent with our findings. However, their study reported higher proportions of loam and sandy loam soils compared to our study area, which may be due to differences in soil-forming factors and management practices.

3.2. Soil pH

Soil pH is a critical factor in determining the availability of nutrients in the soil. Maintaining the correct pH level is essential to optimize plant nutrient availability, minimize the solubility of toxic elements, and promote the activity of beneficial soil organisms (Gondal et al., 2021). In the study area, farmers predominantly use ammonium-based fertilizers, which can directly contribute to soil acidity. Soil pH in the study area exhibited a considerable range, varying from 4.0 to 7.5, with a mean of 5.83 and a standard deviation of 0.76 (Table 4). This wide range indicates diverse soil conditions in the study area. The pH values were distributed over a spectrum from extremely acidic to slightly alkaline. Most of the area (31.67%) falls under highly acidic soil conditions. Such highly acidic soils may impede nutrient availability to plants and may require appropriate soil pH correction measures. In addition, about 25% of the study area was classified as slightly acidic. Slightly acidic soils can generally support a wider range of crops but still require careful attention to manage pH for optimal nutrient availability. About 15% of the study area had moderately acidic soil conditions.

Moderately acidic soils are typically suitable for certain crops, and adjustments in soil management practices may be needed to ensure optimal nutrient uptake by plants. Approximately 10% of the area had near-neutral soil pH (Figure 4b). These soils are generally preferred for agriculture because they provide favorable conditions for nutrient availability to plants.

The observed variation in soil pH can be attributed to several factors, including the type of parent material, climate, and agricultural practices in the region. Soil acidification due to excessive use of ammonium-based fertilizers may also contribute to the prevalence of acidic soils. In a study by Malla et al. (2020) in the Sarlahi district of Nepal, they reported similar results with a significant proportion of highly acidic soils. However, their study also identified a larger proportion of slightly acidic soils compared to our results. These differences may be due to differences in local soil management practices and land use patterns. Similarly, a study by Gasmi et al. (2022) in Morocco highlighted the effect of specific soil amendments on soil pH, resulting in a higher proportion of near-neutral soils. Their research underscores the importance of soil management practices in regulating soil pH for improved agricultural productivity.

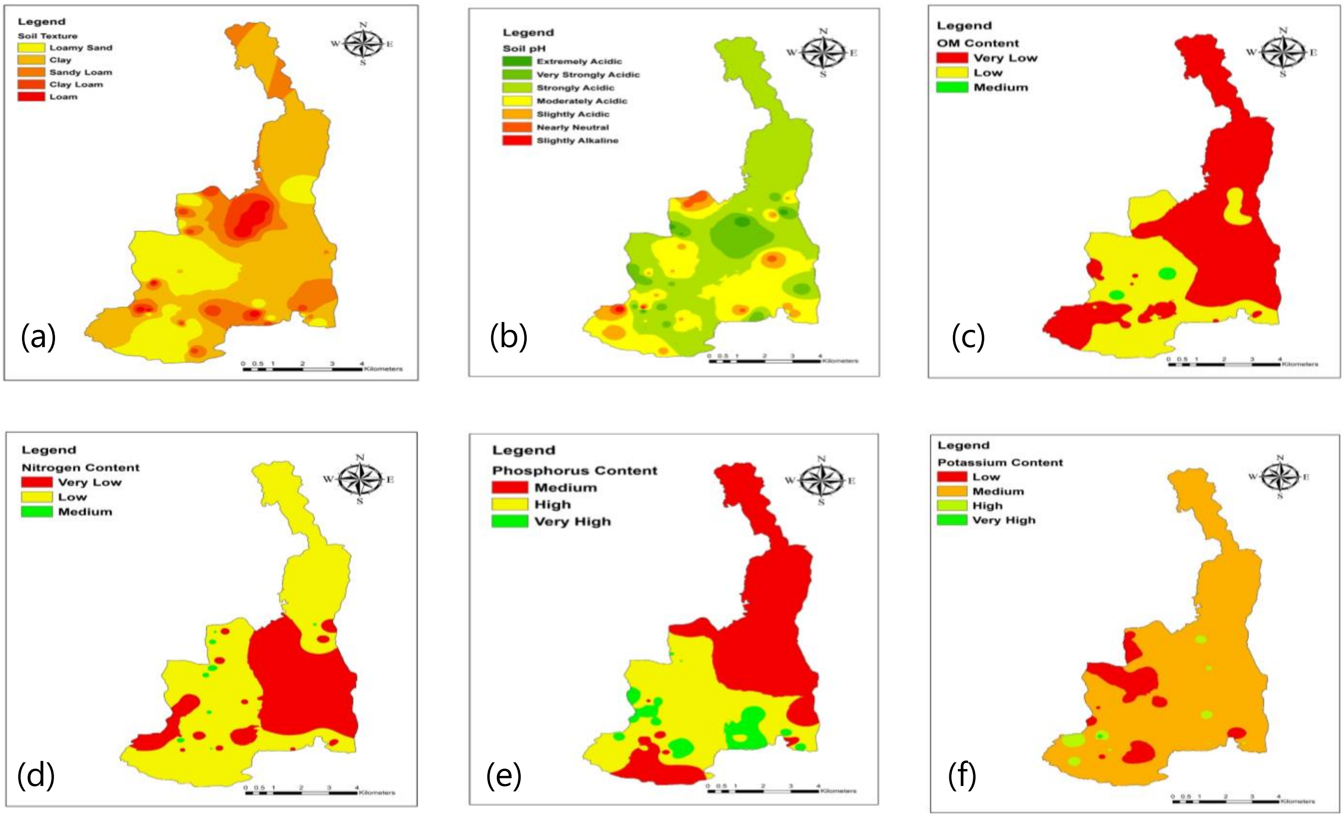

Figure 4. Spatial distribution of a) soil texture, b) pH, c) organic matter, d) nitrogen, e) phosphorus, and f) potassium in Rupani Rural Municipality, Saptari, Nepal.

3.3. Soil Organic Matter

Soil organic matter (OM) plays a critical role in providing essential nutrients to plants through the mineralization process. It also significantly affects water-holding capacity, soil structure, and pore space, all of which influence water availability for plant uptake (Shaji et al., 2021). In the study area, the level of soil organic matter was found to be relatively low mainly due to the limited application of organic sources such as farmyard manure (FYM), cow dung, poultry manure, and other organic materials. Analysis of soil organic matter content showed that the majority (58.33%) of the study area had relatively low levels of OM, ranging from 1.25 to 2.5% (Table 5). In addition, a significant portion of the area had very low OM content, less than 1.25%. A smaller proportion of the study area was in the medium range of OM content, falling between 2.5-5.0% (Figure 4c).

Several factors may account for the relatively low soil organic matter content. First, the limited use of organic inputs such as FYM and manure reduces the addition of organic carbon to the soil, leading to a decrease in soil organic matter content. Secondly, the presence of waterlogged conditions in some parts of the study area may have contributed to shallow rooting and reduced biological activity. Excess water can inhibit the decomposition of organic matter and result in lower soil organic matter levels. In addition, agricultural practices such as frequent tillage and removal of crop residues can also impede the accumulation of organic matter in the soil. A study conducted by Khadka et al. (2019) in Jumla, Nepal, highlighted the importance of organic matter management in improving soil fertility and crop productivity. Their study highlighted the positive impact of organic inputs on soil organic matter content and nutrient availability for plant growth. Similarly, a study conducted by Yudhana et al. (2021) in different agroecological zones of Lendah, Indonesia reported variations in soil organic matter content due to different land use practices. Their results showed the influence of land management strategies on soil organic matter content, highlighting the importance of sustainable soil management practices.

3.4. Total Nitrogen

Nitrogen is an essential nutrient for plant growth and plays a critical role in crop development and yield. In the study area, soil nitrogen availability is influenced by natural processes such as nitrogen fixation by soil bacteria or by legume crops (Pasley et al., 2019). In addition, nitrogen content is influenced by the application of farmyard manure (FYM) and synthetic fertilizers used in previous crop cycles. The study area showed variation in nitrogen content due to differences in organic matter content, mineralization rates, and application of nitrogen-based fertilizers. The low organic matter content can lead to increased mineralization rates, resulting in the depletion of soil nitrogen. In addition, inadequate application of nitrogen fertilizer can contribute to nitrogen deficiency. The effect of nitrogen on crop growth, quality, and yield is well documented. An adequate supply of nitrogen in the soil is essential to promote vigorous crop growth and improve the overall quality and yield of harvested produce. However, due to the observed nitrogen deficiencies, crop productivity may be limited in many areas of the study area. The analysis revealed that a significant portion of the study area (56.67%) had low nitrogen levels, ranging from 0.05 to 0.10, indicating nitrogen deficiency in these areas (Table 5). In addition, approximately 33.33% of the study area had very low nitrogen levels, further emphasizing the need to address nitrogen deficiencies in the soil (Figure 4d).

To improve nitrogen availability and address soil nitrogen deficiencies, sustainable agricultural practices can be implemented. These practices may include the inclusion of nitrogen-fixing crops or the use of green manures to enhance natural nitrogen fixation. In addition, the judicious application of organic inputs such as FYM and appropriate nitrogen-based fertilizers can help replenish soil nitrogen levels and support healthy crop growth. A study by Oli et al. (2020) in Rapti, Nepal, emphasized the importance of nitrogen management practices in increasing crop productivity and minimizing nitrogen losses to the environment. Their research highlighted the importance of balanced nitrogen application for sustainable agriculture. Similarly, studies by Prabhavati et al. (2015) and Yudhana et al. (2021) in different agroecological zones of Karnataka and Belgaum explored the effects of organic and inorganic nitrogen sources on crop performance. Their findings highlighted the benefits of combining organic inputs with appropriate nitrogen-based fertilizers to optimize nitrogen availability for improved crop yields.

3.5. Available Phosphorus

Phosphorus is the second most important element after nitrogen in terms of its importance for plant growth and development. It plays a critical role in several essential processes, including energy transfer, photosynthesis, sugar and starch conversion, and the formation of genetic material (Glaser and Lehr, 2019). The availability of phosphorus in the soil is influenced by several factors, including the application of compost and green manure by farmers. These organic inputs can have a direct effect on the amount and state of phosphorus in the soil, positively affecting its availability to plants. In addition, the inherent pH of the soil plays a critical role in phosphorus availability, with soil pH values between 6 and 7.5 considered ideal for optimal phosphorus availability. In the study area, the analysis of available phosphorus indicated different levels in the sampled regions. Approximately 70% of the study area had moderate levels of available phosphorus. This soil may have an adequate supply of phosphorus for most crops but may require careful management to optimize phosphorus uptake. In addition, about 25% of the study area had high available phosphorus. Soils with high phosphorus availability can support improved plant growth and development, and thus higher crop yields. A smaller proportion, about 5% of the study area, had very high available phosphorus (Figure 4e). Soils with very high phosphorus availability provide ample nutrients for plant growth and are conducive to achieving exceptional crop performance.

The observed variation in available phosphorus levels can be attributed to differences in soil management practices, organic matter incorporation, and inherent soil characteristics. The application of compost manure and green manure can help maintain optimal phosphorus levels in the soil, thus ensuring sufficient nutrient availability for crops. A study by Rawal et al. (2018) in the Sunsari district of Nepal examined the impact of phosphorus management on crop productivity and nutrient use efficiency. Their study highlighted the importance of balanced phosphorus application and soil testing to optimize phosphorus availability for sustainable agriculture. Similarly, a study by Malla et al. (2020) in the Sarlahi agroecological zone evaluated the influence of organic and inorganic phosphorus sources on crop phosphorus uptake. Their findings emphasized the benefits of combining organic inputs with appropriate phosphorus-based fertilizers to enhance phosphorus availability and plant nutrient uptake.

3.6. Available Potassium

Potassium is one of the primary nutrients essential for plant growth, development, and enzyme activation. Adequate potassium levels in plants are critical for efficient nitrogen and water use and for improving disease resistance. Potassium deficiency can lead to impaired plant growth and reduced crop productivity (Kuzin and Soloychenko, 2021). In the study area, the availability of potassium in the soil is influenced by several factors, including the application of manure and compost. These organic inputs help to maintain optimal potassium levels in the soil, ensuring its availability for plant uptake. Potassium is the third most important plant nutrient after nitrogen and phosphorus and plays an important role in enzyme activation and various physiological processes in the plant. The study showed that the availability of K_2O was predominantly in the medium range of 110-280 kg/ha in about 36.6% of the study area (Figure 4f). This range indicates an adequate supply of potassium that can support optimal crop growth and development in these regions (Table 5). However, it is important to note that potassium availability can vary in different parts of the study area, influenced by factors such as soil type, agricultural practices, and potassium management strategies (Vaidya et al., 2021).

Sustainable agricultural practices that include the use of well-rooted manure, compost, and potassium-based fertilizers can play an important role in maintaining optimal potassium levels in the soil and promoting healthy plant growth. A study by Gasmi et al. (2022) examined the effects of potassium management on crop growth and yield. Their research highlighted the importance of balanced potassium application to achieve higher crop productivity and improved nutrient use efficiency. Similarly, a study by Khadka et al. (2019) in the Jumla agroecological zone evaluated the impact of organic and inorganic potassium sources on crop potassium uptake. Their findings highlighted the benefits of incorporating organic inputs with appropriate potassium-based fertilizers to enhance potassium availability and plant nutrient uptake.

The occurrence of soil erosion in Nepal is influenced by various factors, including high annual rainfall, soil characteristics, soil texture, steep slopes, and land cover (Buryak and Marinina, 2020). To address such challenges and ensure sustainable soil management, the use of Geographic Information System (GIS) tools is paramount (Barman et al., 2022). GIS tools help to map soil fertility and its spatial distribution, providing a solid basis for integrated crop nutrient management, land use planning, and site-specific nutrient management (Shayakhmetov et al., 2019). In addition, the use of GIS can help identify areas with nutrient deficiencies or toxicity in the soil, allowing farmers to implement corrective measures for better crop growth (Khan et al., 2021). For example, plants experiencing nutrient deficiency stress can be treated with appropriate fertilizers to improve their growth and development (Oli et al., 2020). In the study area, the distribution of soil organic matter is not uniform, which is influenced by the different cropping patterns adopted by farmers, leading to disturbances in soil fertility. In addition, heavy rainfall during certain seasons can cause nutrient leaching, which degrades the nutrient status of the soil. In addition, over-application of compost manure can result in the accumulation of high concentrations of nutrients such as ammonium, calcium, magnesium, potassium, and sodium, which can affect soil fertility.

Soil pH conditions, either highly acidic or alkaline, along with soil drought and waterlogging, can inhibit the uptake of soil nutrients by plants, resulting in nutrient deficiencies. As a result, plants may show poor flowering and fruiting due to a lack of essential nutrients. To promote sustainable soil fertility and productivity, farmers need to adopt soil management practices appropriate to local conditions and appropriate nutrient management strategies. This may include judicious use of organic inputs, proper fertilizer application, and soil conservation measures to reduce erosion. In conclusion, the use of GIS tools is essential for mapping soil fertility and its spatial distribution to support sustainable soil management practices. Understanding soil nutrient status and distribution is critical for addressing nutrient deficiencies, optimizing crop growth, and promoting sustainable agriculture in Rupani Rural Municipality, Saptari, Nepal.

Table 5. Area occupying different classes of soil parameters in Rupani Rural Municipality, Saptari Nepal.

Soil Parameters	Total Nitrogen	Available Phosphorus	Available Potassium	Soil Organic Matter
Very Low (%)	33.33	-	-	38.33
Low (%)	56.67	-	6.66	58.33
Medium (%)	10	70	36.67	3.34
High (%)	-	25	51.67	-
Very High (%)	-	5	5	-
Total (sq. km)	56.08	56.08	56.08	56.08

4. Conclusion

The study area is dominated by clay and sandy loam soils. It is also noted that the pH is highly acidic in most parts, while in some parts the pH falls to basic levels. To promote sustainability in crop production, proper liming and management of acid-tolerant crops are essential. Organic matter content is very low in the study area. Therefore, the addition of FYM, green manure, and other organic matter in the field is critical for its improvement in the soil. In addition, the total nitrogen content is low in most of the study areas. A higher level of phosphorus is found in these areas, which could be due to the continuous application of phosphate fertilizers. The available potassium content varied from 64.80 to 729.60 kg/ha, with a mean of 298.40 kg/ha. The use of potassium fertilizers and management practices increased crop production and product quality on K-deficient soils. Based on the soil test data and the use of interpolation tools in GIS, it was suggested that appropriate management practices and the use of organic matter should be followed. In addition, the study provides information on the assessment of soil fertility status in Rupani Rural Municipality. This will directly or indirectly help farmers, researchers, local government bodies, and students. The result of this research will soon provide the basis for soil fertility management, land use planning, and site-specific nutrient management. In addition, fertilizer application should be based on status and soil testing.

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