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Comparative assessment of the distribution of soil fertility indictators under different land use covers in Tarikere taluk of Karnataka

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Abstract

The study was carried out to assess the physical, chemical and biological properties of soils under different land use cover in the southern transition zone of Karnataka, specifically within Tarikere taluk of Chikkamagaluru district. This region, with diverse topography, soil types and cropping patterns, represents complex interactions between land use practices and soil health. Totally 100 surface soil samples (0-20 cm) were collected from five different land use cover viz., natural forest, arecanut, paddy, maize and barren land. Standard analytical protocols were employed to determine the soil physical, chemical and biological properties. The results revealed significant variations in soil properties across the different land use covers. The soil texture varied from sandy loam to clay loam. The pH values ranged from 5.50 to 8.17, indicating slightly acidic to moderately alkaline soil reaction, while electrical conductivity remained within the safe limits across the land use cover. Soil organic carbon content varied from 3.22 to 8.97 g kg⁻¹, while cation exchange capacity ranged from 6.18 to 27.82 cmol (p⁺) kg⁻¹ and soil microbial biomass carbon varied from 183.92 to 575.11 mg kg⁻¹, indicating substantial variation among land use covers. Available nitrogen, phosphorus and potassium varied from 149.63 to 432.41 kg ha⁻¹, 8.97 to 41.03 kg ha⁻¹ and 85.93 to 421.38 kg ha⁻¹, respectively. DTPA-extractable micronutrients also differed significantly among land use types, among the micronutrients Fe, Mn, Zn and Cu were generally sufficient, although a few soil samples exhibited zinc deficiency. The findings emphasize the need for land use-specific soil management practices to maintain and enhance soil health in the region.

Keywords: Soil properties, soil organic carbon, land use cover, southern transition zone

1. Introduction

Soil is a vital component of the earth's terrestrial ecocover and serves as the foundation for agricultural productivity, biodiversity maintenance and ecological stability. It functions as a natural medium for plant growth, regulates the hydrological cycle, recycles essential nutrients and supports countless microorganisms. As the global population continues to rise, pressure on soil resources has intensified, leading to land degradation, loss of soil fertility and reduced ecological services (Lal, 2020)^[8].

Land use and management practices have influence on available status of nutrients especially major nutrients. Land use covers play an important role in nutrient availability and transformation. Change in land use affects soil properties, which may alter the availability and forms of nutrients in soil.

Soil physical and chemical properties are vital indicators of soil quality as they directly regulate water retention, aeration, nutrient availability and biological activity. In Indian agro-ecocovers, these properties vary considerably with land use and management practices, as forest and plantation soils generally maintain higher soil organic carbon, CEC and nutrient status compared to continuously cultivated lands, where intensive cropping often leads to nutrient depletion and soil degradation (Bhattacharyya *et al.*, 2015)^[3]

The southern transition zone (STZ) of Karnataka represents a geographically and ecologically significant region within the state's agro-climatic classification. Located between the humid Western Ghats and the arid interior plateau, the STZ is characterized by varied soil types

including red loam and black clay, moderate rainfall and diverse cropping patterns. The heterogeneity of land uses ranging from forests and plantation crops to annual agricultural fields makes it an ideal setting to study how land use changes affect soil properties. However, this transition zone is ecologically sensitive and land use intensification may pose risks to its soil health and long-term sustainability (Reddy *et al.*, 2015)^[17].

Tarikere taluk, located in the Chikkamagaluru district of Karnataka, forms an important part of the southern transition zone (STZ). The region, with red loamy and clay soils and annual rainfall of 950-1200 mm, supports diverse land uses including paddy, arecanut, maize, natural forest and barren land,

where such heterogeneity provides an ideal setting to study the impact of land use changes on soil properties and long-term agro-ecocover sustainability.

2. Materials and Methods

The selected study area lies in the 13°48'58"N and 13.816244°N latitude and 76°02'00"E and 76.033287°E longitude of southern transition zone of Karnataka, specifically within Tarikere taluk of Chikkamagaluru district as shown in fig. 1. This region is characterized by a diverse of land use covers encompassing natural forests, plantations and agricultural fields, reflecting varied management practices.

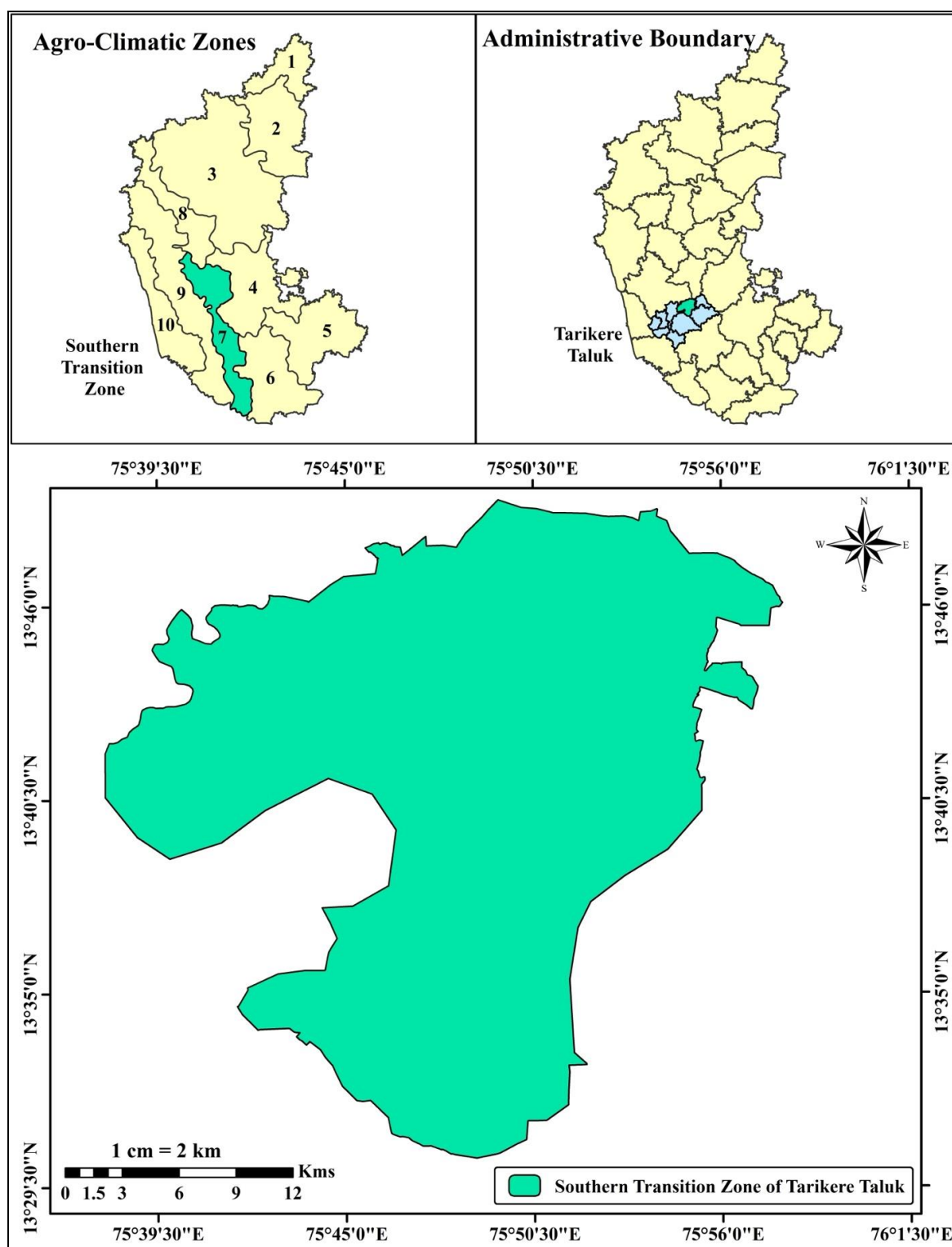


Fig 1: Location map of the study area

Geologically, Tarikere taluk falls within the Dharwar Craton and is underlain by a complex assemblage of Peninsular gneiss and Dharwar Supergroup schist belts. Over 50 per cent of the area is occupied by banded biotite-hornblende gneiss, while the remainder comprises alternating bands of metavolcanics (chlorite schist and quartzite), phyllite and ferruginous quartzite. Localised quartz veins and pegmatite intrusions are common along major lineaments.

Collection of soil samples

The soil samples were collected from different land use cover viz., natural forest, arecanut, paddy, maize and barren land. Twenty (20) surface soil samples (0-20 cm) collected from each land use which makes to 100 surface samples across five land use cover as shown in fig. 2. The soil samples were brought to the laboratory, dried under shade, powdered using wooden pestle and mortar, passed through 2 mm sieve and preserved for analysis of physical and chemical parameters.

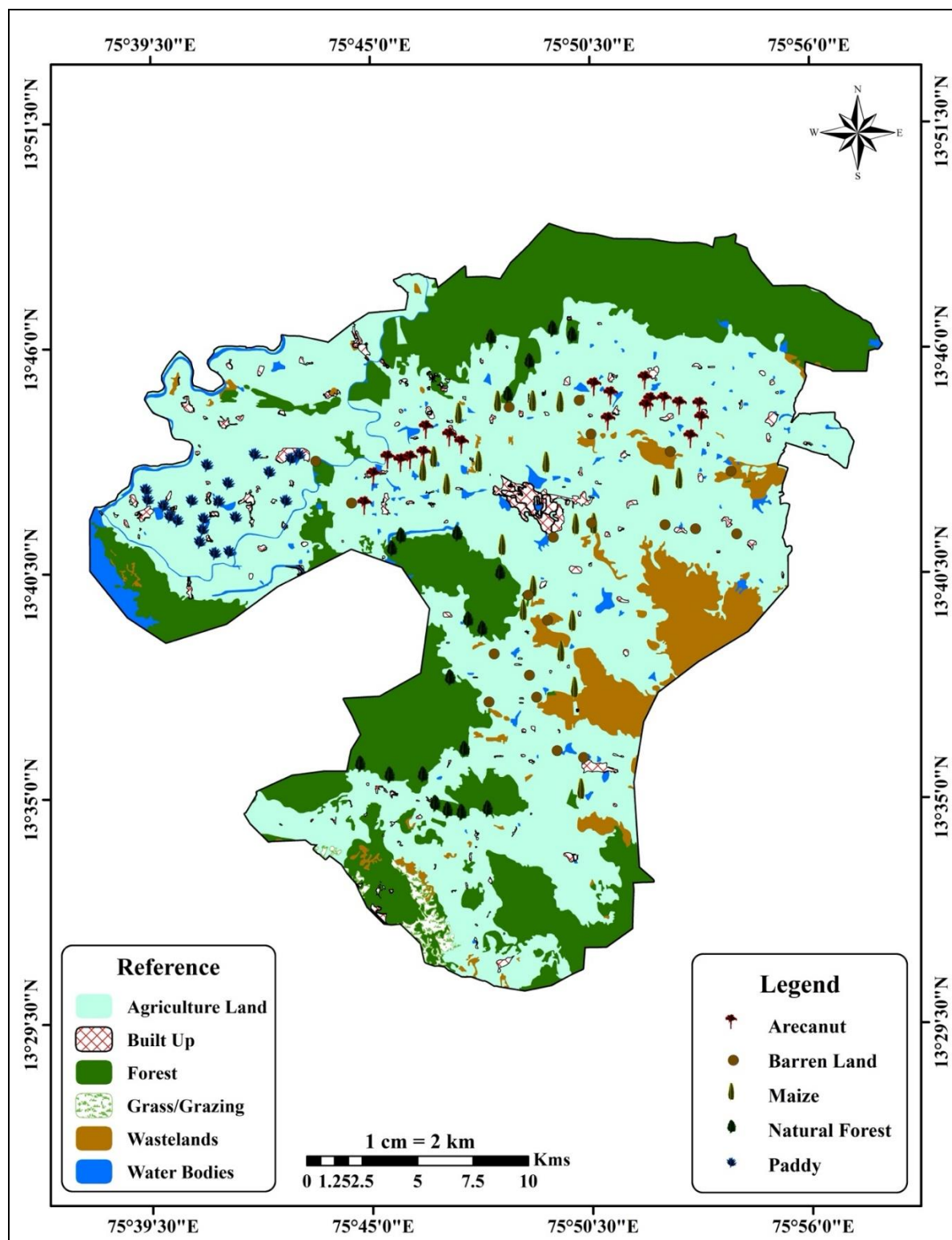


Fig 2: Sampling distribution of the study area

Preparation of soil samples

Particle size distribution of soil samples was determined by International pipette method as described by Piper (1966) [14]. Soil pH was determined in 1:2.5 soil to water suspension by dipping the combined electrode (glass electrode plus calomel electrode) of digital pH meter as outlined by Jackson (1973). The electrical conductivity (EC) of soils was measured in 1:2 soil to water extract using conductivity bridge (Jackson, 1973). The results of EC were expressed in terms of dS m^{-1} at 25 °C.

Soil organic carbon in soil samples was determined by treating a known weight (0.50 g) of 0.2 mm sieved soil with known and excess quantity of chromic acid (Sulphuric acid and potassium dichromate) to oxidize the organic carbon present in the soil to carbon dioxide. After oxidation, the untreated potassium dichromate left in the contents was back titrated against standard ferrous ammonium sulphate using diphenylamine indicator (Walkely and Black, 1934) [23]. The cation exchange capacity (CEC) of soils was estimated by taking a known quantity of soil which was leached several times with neutral normal ammonium acetate solution and washed with alcohol to remove the excess electrolyte. Potassium ions displaced the adsorbed NH_4^+ ion by leaching the soil with a 10 per cent KCl solution. Finally, the NH_4^+ ion present in the leachate was determined by the distillation method as described by Page *et al.* (1982) [13]. Soil microbial biomass carbon was measured by the chloroform fumigation extraction method (Vance *et al.*, 1987) [22]. 10 g of fresh soil samples (maintained at 4°C) was fumigated for 24 hours under vacuum in vacuum desiccators using ethanol free chloroform. After fumigation chloroform fumes were removed by excavation. Unfumigated soils (10 g) and fumigated soil were extracted using 50 ml 0.5 M K_2SO_4 and the extract from unfumigated soils (10 g) and fumigated soil were subjected to wet oxidation separately with potassium persulphate and H_2SO_4 by heating the content on a digestion block at 120°C for 30 minutes. The solution was allowed to cool and 20-25 ml distilled water was added, 2-3 drops of ferroin indicator solution and then titrated with ferrous ammonium sulphate solution.

Available nitrogen in soil was determined by the alkaline

potassium permanganate method as described by Subbaiah and Asija (1956) [19]. Available phosphorus in soil samples was extracted by Brays method for soils having pH less than 6.5 ($0.03 \text{ N NH}_4\text{F} + 0.025 \text{ N HCl}$) and Olsen's method for soils having pH more than 6.5 (0.5 M NaHCO_3) as described by Jackson (1973) [5]. The extract was treated with chloromolybdic acid and stannous chloride and the intensity of colour developed was measured by spectrophotometer at 660 nm. Available potassium was extracted from the soils using neutral N ammonium acetate and the concentration of potassium present in the extract was determined by the flame photometric method (Jackson, 1973) [5].

DTPA extractable Fe, Mn, Cu and Zn of soil were extracted with DTPA extractant (0.005 M Diethylene Triamine Penta Acetic acid and $0.01 \text{ M CaCl}_2 + 0.1 \text{ N}$ Tri Ethanol Amine with pH 7.3) and concentrations of Zn, Fe, Mn and Cu in the extract was measured by using Atomic Absorption Spectrophotometer (Lindsay and Norvell, 1978) [9].

3. Result and Discussion

Soil Physical and Chemical Properties of Soil Under Different Land Use Covers

Particle Size Distribution

Data depicted in Table 1 indicates the proportions of sand, silt and clay in soils under different land use covers in Tarikere taluk of Chikkamagaluru district. Across the different land use covers, the soils exhibited distinct variations in their textural classes. Soils under natural forest were classified from loam to clay loam, while those under arecanut ranged from sandy loam to clay loam. Similarly, soils under paddy were grouped between sandy loam and clay loam. In contrast, maize and barren land soils exhibited relatively coarser textures, varying from sandy loam to sandy clay loam. This variation in texture can be attributed to the combined influence of parent material, land use practices and topographic position. Similar textural variability across land use covers was also reported by (Anand *et al.*, 2025; Ravikumar and Govindaraju, 2019) [1, 16].

Table 1: Soil particle size distribution and textural class under different land use cover in Tarikere taluk of Chikkamagaluru district

Land use cover		Range	Mean	SD	Textural class
Natural forest	Sand (%)	39.32-63.50	54.37	6.79	loam to clay loam
	Silt (%)	7.90-28.40	18.21	5.60	
	Clay (%)	21.10-35.70	27.43	4.10	
Arecanut	Sand (%)	43.10-63.70	56.33	5.93	sandy loam to clay loam
	Silt (%)	10.80-24.00	18.00	3.64	
	Clay (%)	17.30-34.90	25.67	4.38	
Paddy	Sand (%)	41.30-54.31	47.52	3.50	sandy loam to clay loam
	Silt (%)	25.60-35.80	29.98	3.07	
	Clay (%)	13.50-24.80	22.51	2.85	
Maize	Sand (%)	58.90-76.20	66.55	5.59	sandy loam to sandy clay loam
	Silt (%)	9.02-18.30	14.34	2.84	
	Clay (%)	13.50-23.80	19.11	3.23	
Barren land	Sand (%)	55.60-70.00	62.40	4.54	sandy loam to sandy clay loam
	Silt (%)	10.20-29.57	16.12	5.13	
	Clay (%)	11.50-24.90	21.49	2.89	

Chemical properties such as soil pH, EC, soil organic carbon, cation exchange capacity and soil microbial biomass carbon under different land use cover in Tarikere taluk of Chikkamagaluru district are being depicted in Table 2.

Soil reaction (pH)

Soil pH across the study area varied widely, ranging from 5.50 to 8.17, reflecting slightly acidic to moderately alkaline conditions depending on the land use cover. The highest mean

pH was observed in arecanut plantations (7.23 ± 0.55), followed by natural forest soils (7.00 ± 0.72). The lowest mean pH was recorded in barren lands (6.36 ± 0.58). The variation in soil pH is primarily influenced by parent material, rainfall and management practices. Lower pH values in paddy and maize soils could be attributed to leaching of basic cations under high rainfall, while relatively higher pH values in arecanut plantations may be due to the accumulation of basic salts from parent material weathering (Ravikumar *et al.*, 2019; Gurumurthy *et al.*, 2019)^[16, 4]. Overall, soils in the study area were slightly acidic to slightly alkaline in nature, which is favorable for nutrient availability.

Electrical Conductivity (EC)

Electrical conductivity values across land use covers ranged between 0.12 and 0.95 dS m⁻¹ at 25 °C, well within the permissible limit (<1.0 dS m⁻¹). The highest mean EC was observed under maize land use cover (0.57 ± 0.23 dS m⁻¹), followed by arecanut plantations (0.51 ± 0.16 dS m⁻¹). Natural forest (0.33 ± 0.17 dS m⁻¹) and paddy soils (0.36 ± 0.14 dS m⁻¹) recorded moderate EC values, while barren soils showed the lowest mean EC (0.24 ± 0.07 dS m⁻¹). These results confirm that the soluble salt concentrations are within safe limits for crop growth. The relatively low EC in all land use covers may be attributed to well-distributed rainfall, which prevents salt accumulation through leaching, a trend consistent with earlier studies in Karnataka (Ravikumar *et al.*, 2019; Gurumurthy *et al.*, 2019)^[4, 16].

Soil Organic Carbon (SOC)

SOC content across land use covers varied from 3.22 to 8.97 g kg⁻¹, reflecting differences in vegetation type and management. Natural forest soils recorded the highest mean SOC (7.12 ± 1.05 g kg⁻¹), followed by arecanut plantations (6.48 ± 1.11 g kg⁻¹) (fig. 3). This enrichment can be linked to continuous litter deposition, minimal soil disturbance and high microbial activity that enhance organic matter turnover (Jahnavi *et al.*, 2020a)^[6]. In contrast, maize soils exhibited the lowest mean SOC (4.70 ± 0.94

g kg⁻¹), largely due to residue removal, intensive tillage and accelerated decomposition under tropical conditions (Subramanyan *et al.*, 2023; Madivalappa *et al.*, 2025a; Anand *et al.*, 2025)^[20, 10, 1]. Paddy (4.90 ± 0.82 g kg⁻¹) and barren soils (5.47 ± 0.73 g kg⁻¹) showed moderate levels. These findings emphasize the critical role of vegetation cover and management in maintaining soil carbon stocks.

Cation Exchange Capacity (CEC)

Cation Exchange Capacity ranged from 6.18 to 27.82 cmol (p⁺) kg⁻¹ across land use covers. The highest mean CEC was recorded in natural forest soils (21.59 ± 4.21 cmol (p⁺) kg⁻¹), closely followed by arecanut plantations (20.39 ± 4.54 cmol (p⁺) kg⁻¹) (fig. 4). This trend reflects the positive influence of organic matter inputs and stable clay humus complexes that enhance nutrient retention. Paddy (17.46 ± 3.99 cmol (p⁺) kg⁻¹) and maize soils (13.77 ± 3.17 cmol (p⁺) kg⁻¹) showed moderate CEC, while barren soils exhibited the lowest mean (8.93 ± 2.21 cmol (p⁺) kg⁻¹), which might be due to the absence of vegetation, poor organic input and often coarser soil texture that limits cation retention. These results are in line with findings by (Seema *et al.*, 2022; Ravikumar and Govindaraju, 2019)^[18, 16].

Soil Microbial Biomass Carbon (SMBC)

SMBC values varied from 183.92 to 575.11 mg kg⁻¹, indicating substantial variation among land use covers. The highest microbial biomass was recorded in natural forest soils (469.80 ± 65.68 mg kg⁻¹), followed by arecanut plantations (373.49 ± 28.73 mg kg⁻¹). Paddy (349.22 ± 51.61 mg kg⁻¹) and barren soils (285.96 ± 48.78 mg kg⁻¹) exhibited moderate levels, while maize soils showed the lowest (278.35 ± 57.93 mg kg⁻¹) (fig. 5), which might be due the differences reflect variations in SOC availability, organic residue input and land management practices. Forest and perennial plantations maintain higher microbial biomass due to continuous organic additions, whereas intensive annual cropping covers reduce microbial activity (Jahnavi *et al.*, 2020b)^[7].

Table 2: Chemical properties of soils under different land use cover in Tarikere taluk of Chikkamagaluru district

Soil Properties		Natural forest	Arecanut	Paddy	Maize	Barren land
pH	Range	5.90-8.17	6.32-8.12	5.52-7.69	5.55-7.68	5.50-7.54
	Mean	7.00	7.23	6.43	6.58	6.36
	SD	0.72	0.55	0.61	0.69	0.58
EC (dSm ⁻¹)	Range	0.12-0.71	0.22-0.77	0.13-0.67	0.21-0.95	0.14-0.38
	Mean	0.33	0.51	0.36	0.57	0.24
	SD	0.17	0.16	0.14	0.23	0.07
SOC (g kg ⁻¹)	Range	4.50-8.97	4.67-8.04	3.52-5.98	3.22-6.06	4.18-6.58
	Mean	7.12	6.48	4.90	4.70	5.47
	SD	1.05	1.11	0.82	0.94	0.73
CEC (cmol (p ⁺) kg ⁻¹)	Range	12.24-27.68	13.97-27.82	10.19-23.76	8.99-18.42	6.18-13.42
	Mean	21.59	20.39	17.46	13.77	8.93
	SD	4.21	4.54	3.99	3.17	2.21
SMBC (mg kg ⁻¹)	Range	384.27-575.11	326.47-419.82	275.81-427.59	183.92-352.84	215.83-360.01
	Mean	469.80	373.49	349.22	278.35	285.96
	SD	65.68	28.73	51.61	57.93	48.78

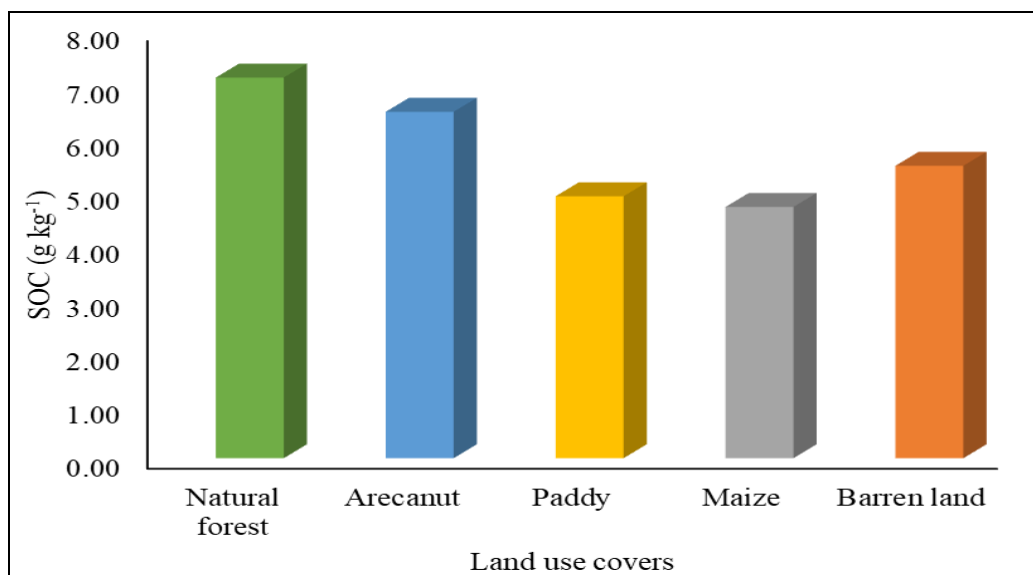


Fig 3: Soil organic carbon (SOC) status in soils under different land use cover

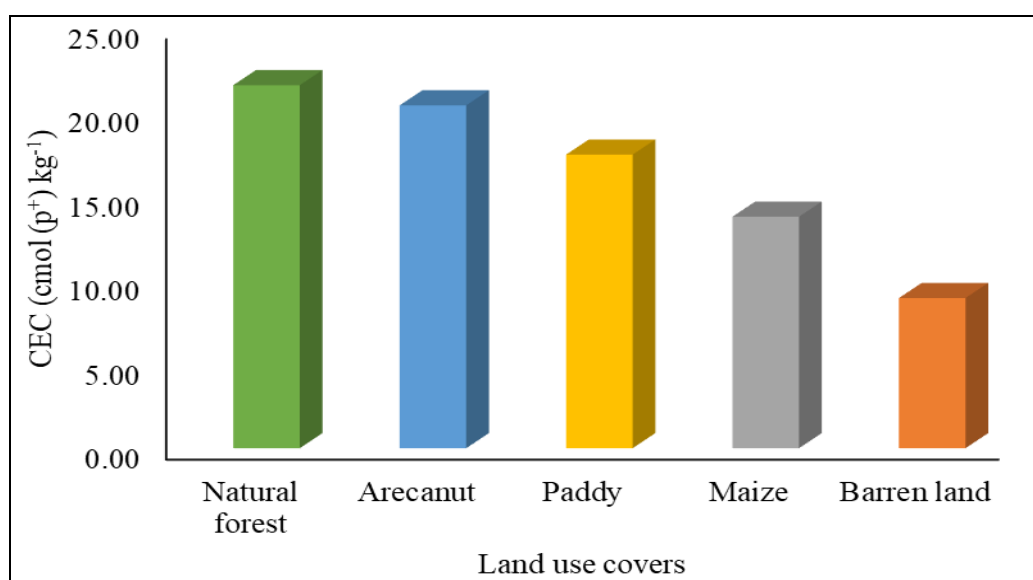


Fig 4: Cation exchange capacity (CEC) status in soils under different land use cover

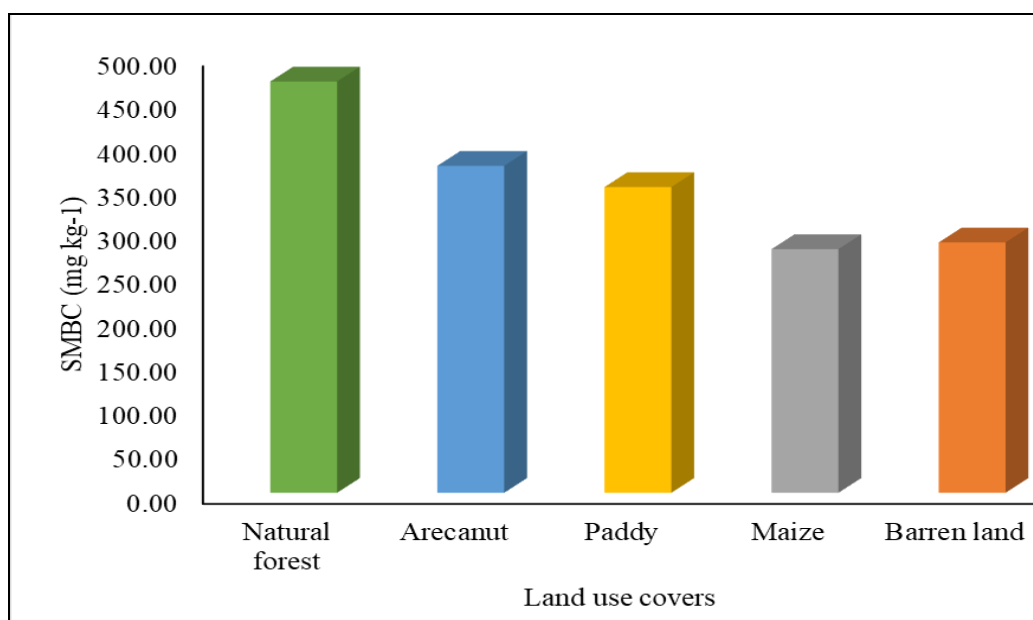


Fig 5: Soil microbial biomass carbon status in soils under different land use cover

Available nitrogen (N), phosphorus (P₂O₅) and potassium (K₂O) status of soils under different land use covers

The results on the status of available nitrogen (N), phosphorus (P₂O₅) and potassium (K₂O) in soils under different land use cover in Tarikere taluk of Chikkamagaluru district are presented in Tables 3.

Available Nitrogen (N)

Among the different land use cover available nitrogen content ranged from 149.63 to 432.41 kg ha⁻¹. The highest mean nitrogen was recorded in arecanut soils (325.14±62.15 kg ha⁻¹), followed by natural forest soils (305.77±63.84 kg ha⁻¹). Maize soils showed the lowest mean nitrogen content (216.30±42.47 kg ha⁻¹) (fig. 6). The higher nitrogen availability in arecanut and forest soils can be attributed to greater organic matter accumulation and minimal soil disturbance, whereas intensive cultivation and crop uptake deplete nitrogen in maize covers (Jahnavi *et al.*, 2020a; Anand *et al.*, 2024)^[6, 2].

Available Phosphorus (P₂O₅)

Available phosphorus content ranged between 8.97 and 41.03 kg ha⁻¹. The arecanut land use cover recorded the highest mean phosphorus (32.58±5.28 kg ha⁻¹), followed by paddy (26.68±5.69 kg ha⁻¹) and natural forest soils (26.27±5.10 kg ha⁻¹). The lowest phosphorus availability was in barren soils

(15.30±4.44 kg ha⁻¹) (fig. 7), which may be due to regular organic inputs and fertilizer application in arecanut plantations enhance phosphorus availability, while waterlogged paddy conditions facilitate P release by reducing iron-phosphate complexes. Conversely, barren soils lack organic inputs and microbial activity, reducing P availability (Menasinakai *et al.*, 2024; Madivalappa *et al.*, 2025b and Syed *et al.*, 2023)^[12, 11, 21].

Available potassium (K₂O)

Available potassium content varied from 85.93 to 421.38 kg ha⁻¹ significantly among the land use covers. The highest mean potassium content was recorded in the arecanut land use cover (327.20 ± 56.04 kg ha⁻¹), followed by the natural forest cover (262.37 ± 56.26 kg ha⁻¹). In contrast, the lowest mean potassium level was observed in the barren land use cover, with a value of (127.61 ± 28.73 kg ha⁻¹) (fig. 8). The higher available potassium status in arecanut soils may be attributed to organic carbon enrichment, permanent ground cover that reduces leaching and regular application of potassic fertilizers, along with the upward movement of K from subsoil layers through capillary rise. On the contrary, the lower available potassium status in barren soils reflects the combined effects of nutrient depletion, lack of organic matter and parent material limitations (Madivalappa *et al.*, 2025b; Syed *et al.*, 2023)^[11, 21].

Table 3: Soil available nitrogen, phosphorus (P₂O₅) and potassium (K₂O) status of soils under different land use cover in Tarikere taluk of Chikkamagaluru district

Soil Properties		Natural forest	Arecanut	Paddy	Maize	Barren land
Available N (kg ha ⁻¹)	Range	226.91-432.41	236.91-412.57	223.57-310.12	149.63-271.56	182.97-268.41
	Mean	305.77	325.14	269.80	216.30	228.39
	SD	63.84	62.15	30.50	42.47	27.79
Available P ₂ O ₅ (kg ha ⁻¹)	Range	18.95-38.34	24.98-41.03	18.92-36.18	12.89-25.37	8.97-22.41
	Mean	26.27	32.58	26.68	19.16	15.30
	SD	5.10	5.28	5.69	4.23	4.44
Available K ₂ O (kg ha ⁻¹)	Range	192.85-344.85	256.98-421.38	180.95-290.42	139.82-248.12	85.93-187.36
	Mean	262.37	327.20	237.89	192.26	127.61
	SD	56.26	56.04	39.31	37.42	28.73

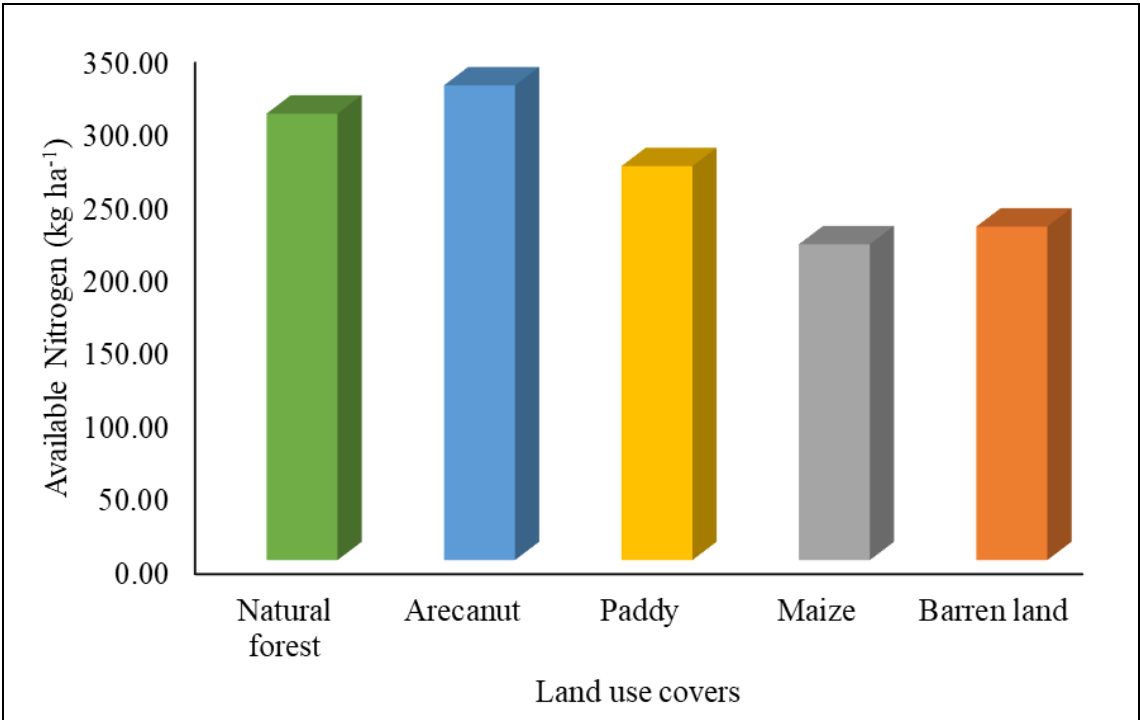


Fig 6: Available nitrogen content of soils under different land use cover

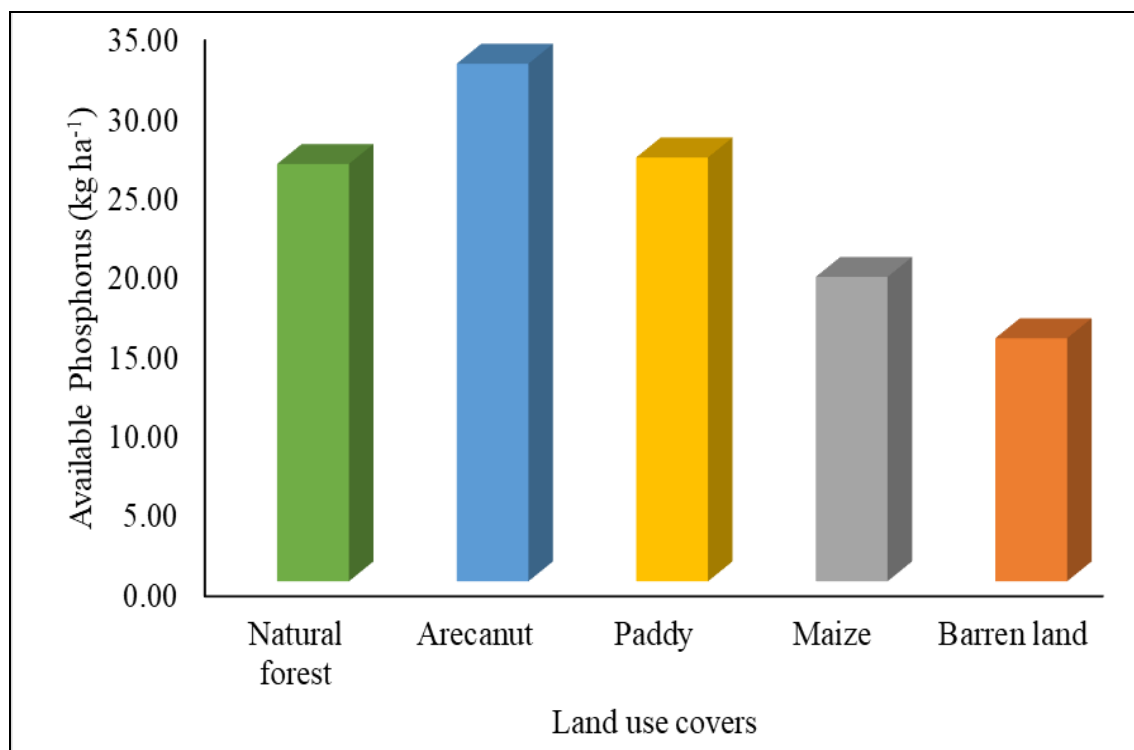


Fig 7: Available phosphorus content of soils under different land use cover

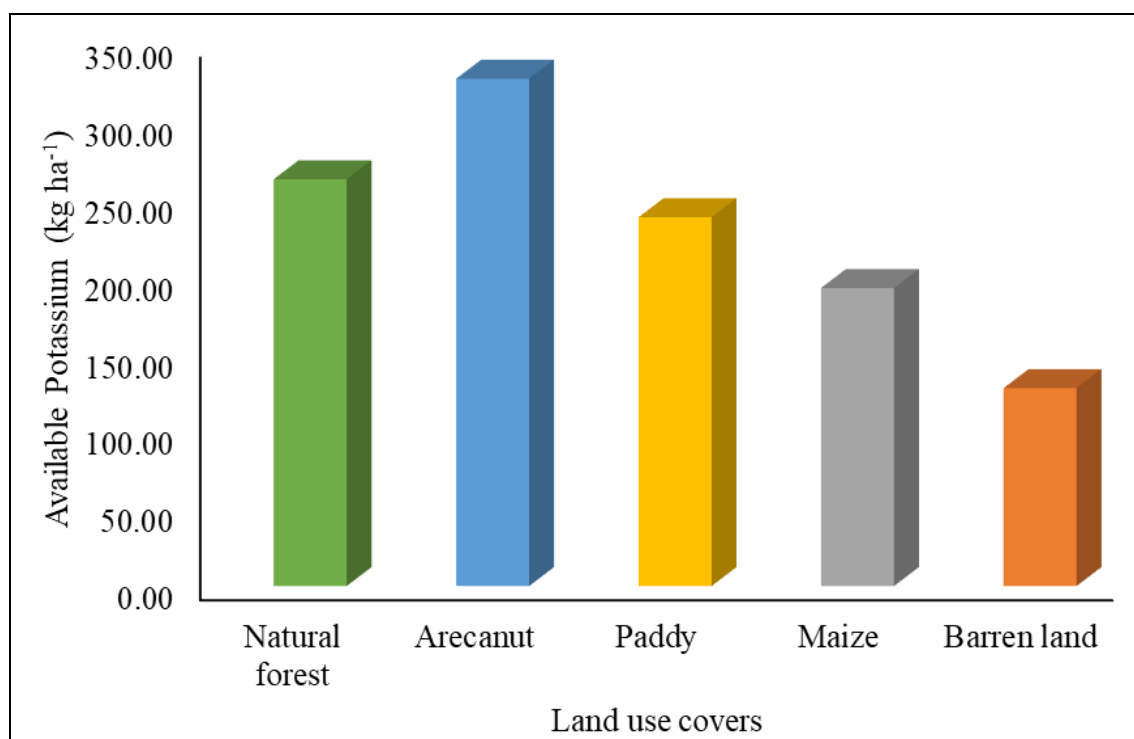


Fig 8: Available potassium content of soils under different land use cover

DTPA-extractable micro nutrients status of soils under different land use cover

The data presented in Table 4 indicate the status of various micronutrients under different land use covers in Tarikere taluk of Chikkamagaluru district.

Iron (Fe)

The DTPA-extractable iron (Fe) content across land use covers ranged from 4.98 to 22.42 mg kg⁻¹. Among the land use covers, the arecanut land use cover recorded the highest mean Fe content (15.73±4.06 mg kg⁻¹), followed closely by paddy

(15.51±5.02 mg kg⁻¹) and natural forest (13.35±2.31 mg kg⁻¹). The lowest mean Fe content was observed under maize land use cover (8.84±2.52 mg kg⁻¹) (fig. 9). Overall, Fe availability was sufficient across all land use covers, which can be attributed to the granite gneiss parent material of the study area, inherently rich in iron (Ravikumar *et al.*, 2019)^[16].

Manganese (Mn)

The concentration of DTPA-extractable manganese (Mn) varied from 2.06 to 17.41 mg kg⁻¹ across the different land use covers.

The arecanut land use cover recorded the highest mean Mn content ($11.50 \pm 4.02 \text{ mg kg}^{-1}$), followed by paddy ($9.87 \pm 3.10 \text{ mg kg}^{-1}$) and natural forest ($9.51 \pm 2.62 \text{ mg kg}^{-1}$), while the lowest was in maize land use cover ($4.10 \pm 1.40 \text{ mg kg}^{-1}$) (fig. 10). Higher Mn availability in arecanut soils may be due to organic matter recycling through frond and husk additions, coupled with moist soil conditions that favor Mn mobilization and solubility. Plantation soils are also moderately acidic, which enhances Mn availability (Seema *et al.*, 2022) [18].

Zinc (Zn)

The DTPA-extractable zinc (Zn) content across land use covers ranged from 0.18 to 1.70 mg kg^{-1} . The highest mean Zn content was observed in paddy soils ($1.00 \pm 0.45 \text{ mg kg}^{-1}$), whereas the lowest was recorded in maize soils ($0.66 \pm 0.19 \text{ mg kg}^{-1}$) (fig. 11). Although Zn availability was marginal in a few samples, the majority of soils fell within the sufficient range. Variability in Zn content may be explained by differences in soil pH and

organic matter content. Soils with higher organic matter facilitate Zn mineralization, thereby increasing its availability (Ravikumar *et al.*, 2019) [16].

Copper (Cu)

The availability of DTPA-extractable copper (Cu) ranged from 0.44 to 4.83 mg kg^{-1} , with sufficient levels observed across all land use covers. The arecanut land use cover recorded the highest mean Cu content ($2.74 \pm 1.29 \text{ mg kg}^{-1}$), followed by natural forest ($2.21 \pm 1.05 \text{ mg kg}^{-1}$), while the lowest was in maize soils ($0.97 \pm 0.34 \text{ mg kg}^{-1}$) (fig. 12). The higher Cu levels in arecanut plantations may be attributed to the regular application of copper sulphate for disease management, along with the contribution from organic manures (Seema *et al.*, 2022) [18]. Soil pH and organic matter are key factors regulating the solubility and availability of Cu and other micronutrients (Lindsay and Norvell, 1978; Ravikumar *et al.*, 2019) [9, 16].

Soil Properties		Natural forest	Arecanut	Paddy	Maize	Barren land
Fe (mg kg^{-1})	Range	9.96-17.02	9.94-22.13	7.46-22.42	4.98-12.46	6.28-18.42
	Mean	13.35	15.73	15.51	8.84	12.69
	SD	2.31	4.06	5.02	2.52	4.00
Mn (mg kg^{-1})	Range	5.89-13.52	5.23-17.41	5.04-14.71	2.06-6.44	3.47-8.32
	Mean	9.51	11.50	9.87	4.10	6.00
	SD	2.62	4.02	3.10	1.40	1.64
Zn (mg kg^{-1})	Range	0.53-0.98	0.76-1.28	0.18-1.70	0.20-0.88	0.57-0.91
	Mean	0.74	0.96	1.00	0.66	0.75
	SD	0.15	0.17	0.45	0.19	0.12
Cu (mg kg^{-1})	Range	0.72-3.74	0.96-4.83	0.79-2.54	0.44-1.44	0.53-1.61
	Mean	2.21	2.74	1.56	0.97	1.08
	SD	1.05	1.29	0.55	0.34	0.36

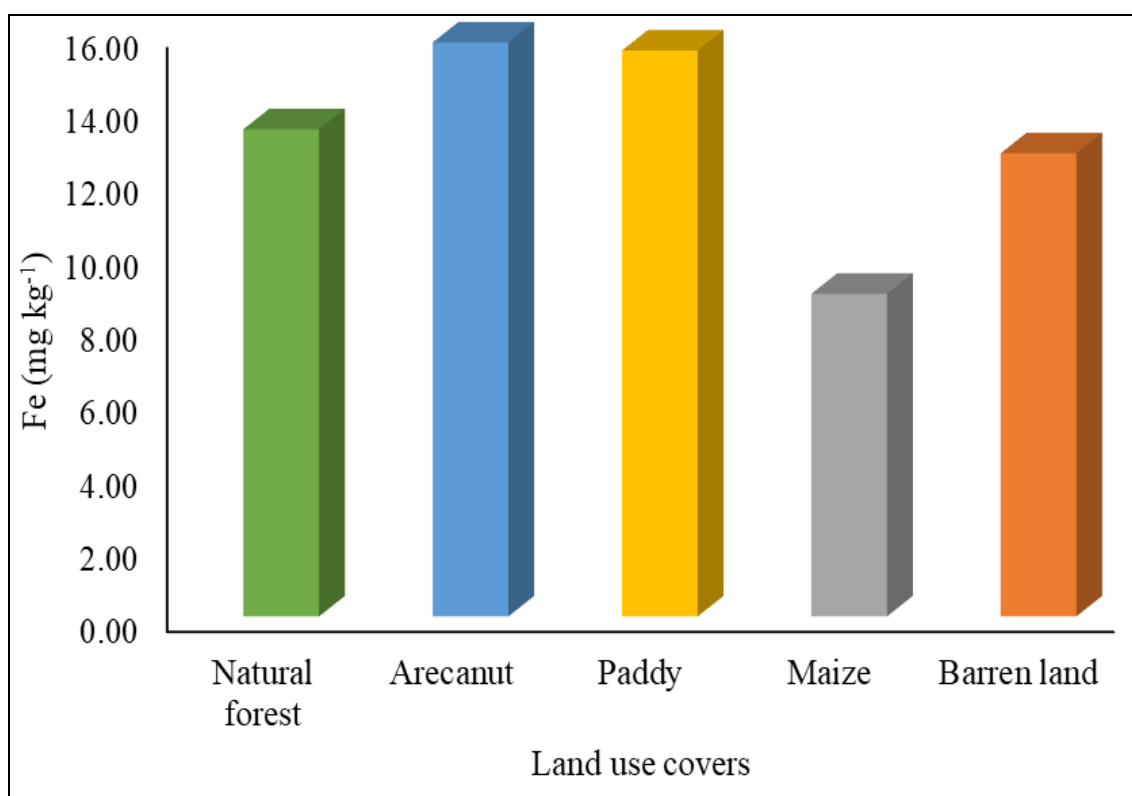


Fig 9: DTPA extractable iron (Fe) content of soils under different land use cover

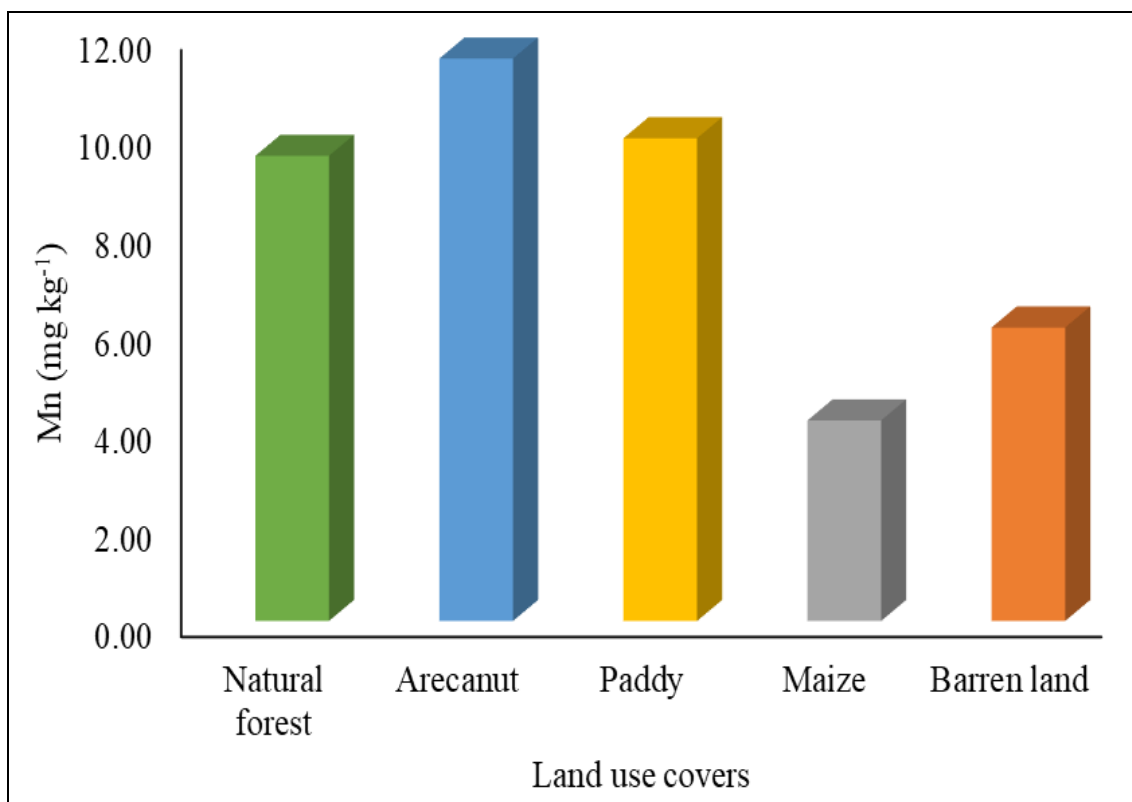


Fig 10: DTPA extractable manganese (Mn) content of soils under different land use cover

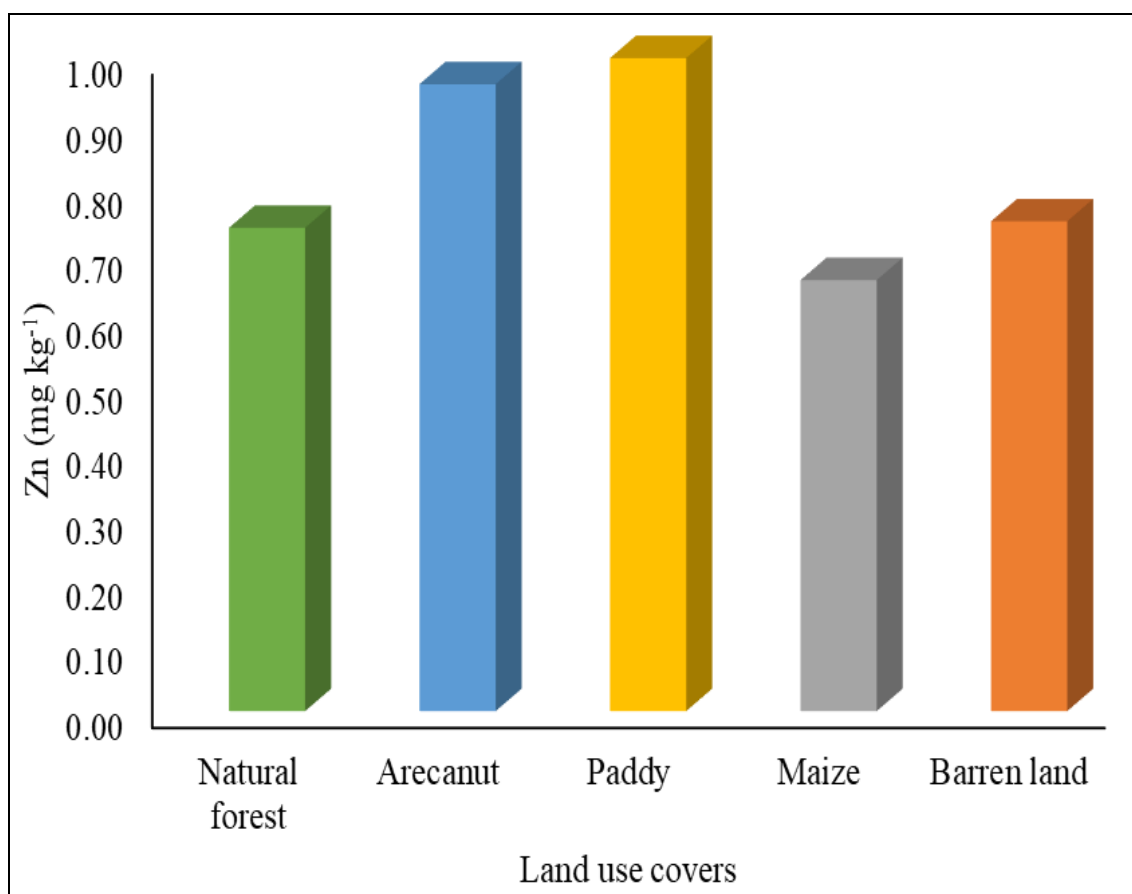


Fig 11: DTPA extractable zinc (Zn) content of soils under different land use cover

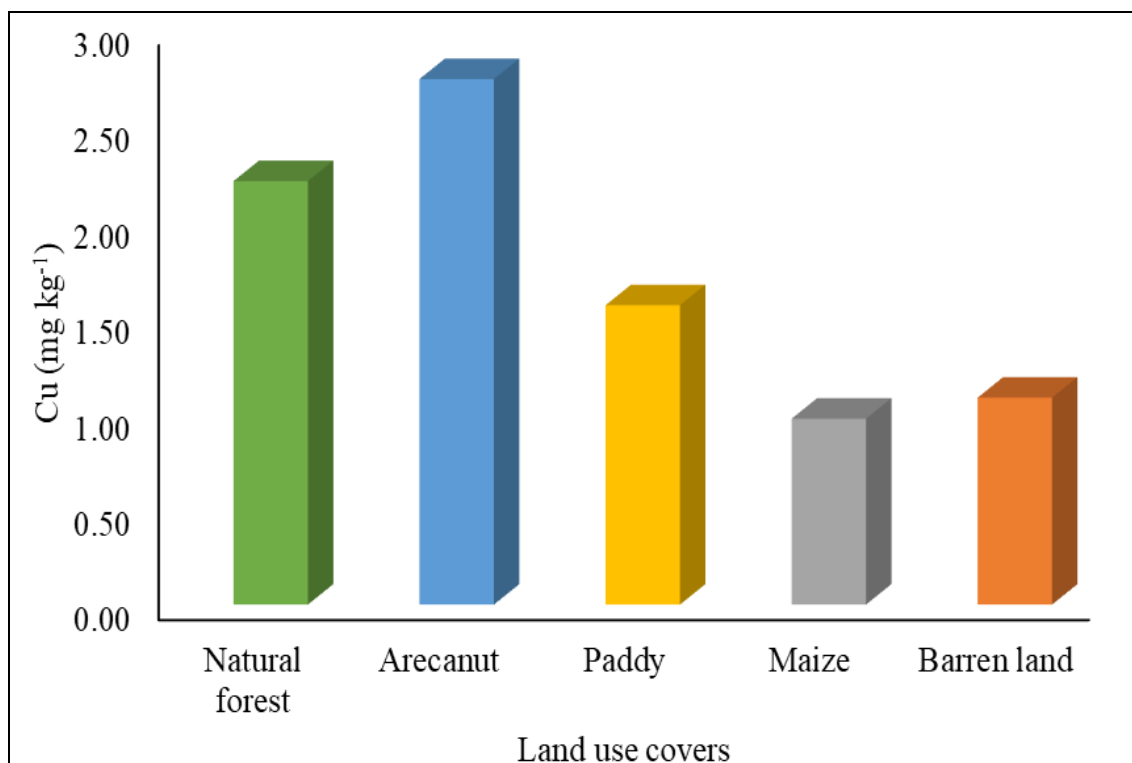


Fig 12: DTPA extractable copper (Cu) content of soils under different land use cover

Effect of Land Use on Nutrient Dynamics and Sustainable Land Management

The variations observed in nutrient availability and biological properties among different land use covers clearly reflect the influence of land management intensity and organic matter turnover on soil nutrient dynamics. The higher values of SOC, CEC, and microbial biomass carbon under natural forest and arecanut plantations indicate that continuous litter deposition, minimal disturbance, and efficient nutrient recycling maintain soil fertility and biological activity (Jahnavi *et al.*, 2020a; Jahnavi *et al.*, 2020b) [6, 7]. On the other hand, the comparatively lower nutrient status in maize and barren lands suggests depletion of nutrient reserves due to intensive cultivation, residue removal, and lack of organic inputs (Subramanyan *et al.*, 2023; Madivalappa *et al.*, 2025a) [20, 10]. These results highlight the strong interrelationship between land use pattern and soil nutrient cycling, where vegetation cover and management practices play a decisive role in sustaining nutrient pools (Bhattacharyya *et al.*, 2015; Ravikumar and Govindaraju, 2019) [3, 16].

The overall trend indicates that land use conversion from perennial systems to annual cropping or barren conditions reduces soil organic matter and impairs nutrient retention and microbial functions (Lal, 2020; Seema *et al.*, 2022) [8, 18]. This emphasizes the need for adopting sustainable nutrient management strategies tailored to specific land use types. Practices such as integrated nutrient management (INM), incorporation of crop residues, use of organic manures, green manuring, biofertilizers, and reduced tillage can enhance soil organic carbon, improve nutrient-use efficiency, and promote long-term soil fertility (Menasinakai *et al.*, 2024; Anand *et al.*, 2024) [12, 2]. In addition, adoption of agroforestry-based land use systems and site-specific nutrient management (SSNM) approaches would help in recycling nutrients, conserving soil moisture, and ensuring sustainable productivity in the southern

transition zone (Ravikumar *et al.*, 2019; Reddy *et al.*, 2015) [16, 17]. The findings of the present study suggest that maintaining continuous vegetation cover and promoting balanced nutrient management are key to sustaining soil fertility and ecological stability under varying land use systems of Tarikere taluk.

4. Conclusion

This study revealed that soil texture across the studied land use covers ranged from sandy loam to clay loam. Soil pH varied from slightly acidic to slightly alkaline, with electrical conductivity remaining within the normal range across all land use covers. Soil organic carbon (SOC) and cation exchange capacity (CEC) were highest under natural forest compared to other land use covers. Available nitrogen (N) and phosphorus (P₂O₅) were found to be in the low to medium range, whereas available potassium (K₂O) varied from medium to high. Among the DTPA extractable micronutrients Fe, Mn, Zn and Cu were generally sufficient, although a few soil samples exhibited zinc deficiency. Overall, the findings emphasize the need for land use-specific soil management practices to maintain and enhance soil health in the region.

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