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Impact of Various Land Use Systems on the Physico-Chemical Properties and Major Nutrient Status of Soils in Hassan District

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Abstract

The soil samples were collected from various land use systems in Hassan District, Karnataka, India to investigate the influence of these systems on the physical, chemical properties and major nutrient status of soils. Six land use systems were considered: forest land, coffee land, fallow land, ginger land, potato land and maize land. Soil samples were collected from each land use type and analysed for their physical properties and chemical properties and availability of major nutrients. There was a significant difference in the physico-chemical properties and availability of major nutrients among the various land use systems. The soil texture varies from sandy loam to sandy clay loam. Forest soils exhibited lower bulk density (1.09 Mg m^{-3} at 0-15 cm and 1.22 Mg m^{-3} at 15-30 cm depth), higher porosity (56.59 % and 50.27 % at 0-15 cm and 15-30 cm depth, respectively) and better moisture retention compared to agricultural lands, indicating favourable soil structure. Coffee and ginger lands showed relatively higher organic carbon content, contributing to improved soil fertility. However, continuous cultivation in ginger, potato and maize lands resulted in soil deterioration in soil fertility, which is evident from lower organic carbon levels and decreased nutrient availability, particularly nitrogen. Fallow lands exhibited moderate soil properties due to the absence of cultivation pressure. Overall, land use systems involving intensive agriculture, such as ginger and maize, negatively affected soil health, while forest land and coffee land contributed to better soil quality. These findings underscore the need for sustainable land management practices to maintain soil fertility and productivity in Hassan district.

Keywords : Land use System, Organic carbon, Texture, Physico-chemical properties

Soil is a vital natural resource that underpins agricultural productivity, ecosystem sustainability and environmental health. The interaction between soil properties and land use systems is a crucial factor in determining soil quality and its capacity to support various land uses. In Hassan District, Karnataka, diverse land use systems such as forest land, coffee plantations, fallow land and various crop lands (including ginger, potato and maize) create a complex mosaic of soil conditions that influence the physico-chemical properties and nutrient status of the soils (Pradeep and Krishnamurthy, 2023).

Land use systems play a significant role in shaping soil characteristics through processes such as organic matter addition, nutrient cycling and physical disturbance. Forest lands with their rich organic matter and minimal disturbance, often exhibit favorable soil conditions, including higher organic carbon content and better soil structure (Paul *et al*., 1997). Conversely, intensive agricultural practices associated with crops like ginger, potato and maize can lead to soil degradation, characterized by reduced organic matter, increased soil compaction and diminished nutrient availability. Understanding the impact of these varying land use systems on soil properties is essential for developing sustainable land management practices. Forest lands and coffee plantations, which typically maintain higher soil fertility and better structure, can provide insights into effective soil conservation strategies. On the other hand, lands subjected to continuous cropping may require targeted interventions to mitigate soil degradation and restore fertility.

This research aimed to systematically analyse the effects of different land use systems on the physico-chemical properties and major nutrient status of soils in Hassan district. By comparing forest land, coffee land, fallow land and crop lands, this study seeks to elucidate the relationship between land use practices and soil health, providing valuable information for enhancing soil management practices and promoting sustainable agriculture in the region.

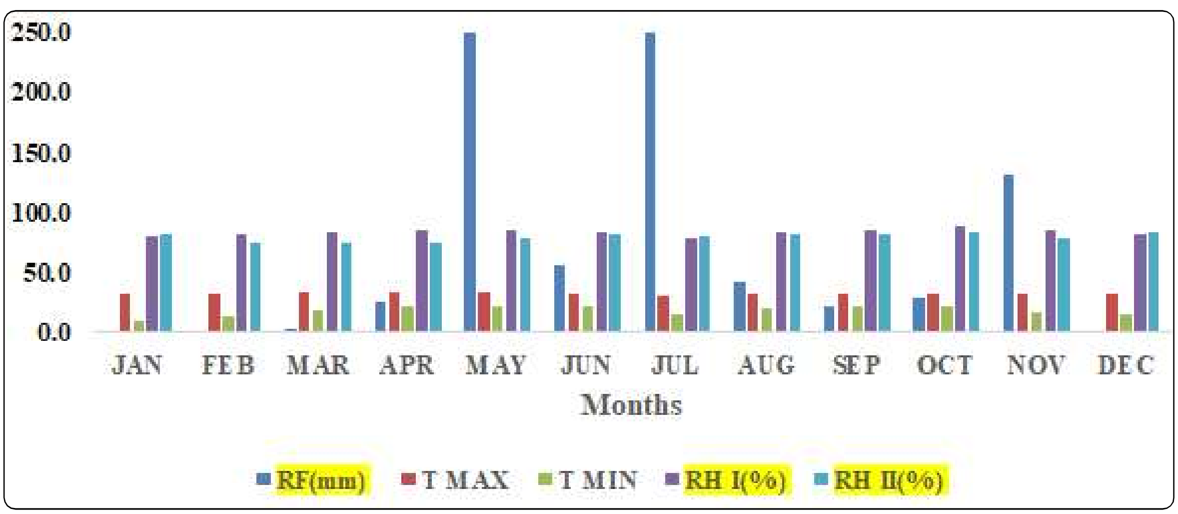
Material and Methods

General Description of Area

Hassan district is situated in the Karnataka state between latitude of 12°33' and 13°33' N, longitude of 75°33' and 76°38' East with altitude of 943.05 m and rainfall of 718-1200 mm. Administratively the district is divided into eight taluks, 38 hoblies and 2559 villages. The entire district comes under four Agro climatic zones namely, Central dry zone, Southern dry zone, Southern transitional zone and Hilly zone. Arasikere taluk comes under Central dry zone, Channarayapatna taluk comes under Southern dry zone, Holenarsipur, Arkalgud, Alur and Belur lies under Southern transitional zone where as Sakleshpur taluk comes under Hilly zone. These eight taluks are divided into four agro-climatic zones with a geographical area of 6.63 lakh ha. The total cultivable area of the district is 4.48 lakh ha of which 79 per cent of the area is under rainfed agriculture. The area under forest is 58775 hectares (21.70%). The major irrigation projects are Hemavathi, Harangi, Vatehole and Yagachi which supports irrigation to the extent of 46672 ha in Hassan district.

Climatic Condition of Study Area

The Hassan district of Karnataka has a tropical climate with distinct wet and dry seasons. The maximum and minimum temperature is 29.6 & 18.2ºC, respectively. The annual rainfall for the period 1978 to 2021 ranged from 461 mm to 873 mm with a mean of 733 mm. The average relative humidity at 7:00 am and 2:00 pm ranged from 89 per cent and 47 per cent,



* Source : AICRP on Agro Meteorology, UAS, Bangalore (2023)

Fig. 1 : The climatic data of study area from January 2023 to December 2023

respectively. The average wind speed recorded was 6.4 kmph. The annual mean sunshine hours are 6.7 hours.

Soil Sample Collection from different Land Use Systems

The study area selected was Hassan district of Karnataka. The major land use systems identified as forest, coffee, fallow, ginger, potato and maize. In each of the selected land use system, the soil samples were collected from surface (0-15cm) and subsurface (15-30cm) depth in ten locations selected randomly for each land use systems. At each location 4 to 5 sub samples were collected to get one composite samples for each depth. Totally one twenty samples, sixty from surface and sixty from subsurface depth were collected. Representative soil samples were collected which were geo-referenced and placed in polythene cover with proper labelling.

Details of different Land Use System in Hassan district, Karnataka

1. Forest land use system
2. Coffee land use system
3. Fallow land use system
4. Ginger land use system
5. Potato land use system
6. Maize land use system

Processing and Analysis of Soil Samples

Collected soil samples were air-dried, powdered using wooden pestle and mortar and sieved using 2 mm sieve. Processed samples were analysed for physico-chemical parameters by using standard analytical procedures as described below.

Particle size analysis was conducted using the International Pipette Method, as outlined by Jackson (1973), which provides a precise measurement of soil texture by separating soil particles into various size fractions. To determine the bulk density of the soil, the Keen's Cup Method was employed, based on the principle that the bulk density of soil can be accurately assessed when the soil is saturated, following the procedures described by Piper (1966). Additionally, the Keen's Box Method, as detailed by Piper (1966) was utilized for measuring the water holding capacity and porosity of the soil samples. This method involves assessing the soil's ability to retain water and its overall porosity, offering insights into the soil's structural properties and its capacity to support plant growth. Each of these techniques contributes to a comprehensive understanding of soil physical properties, essential for evaluating soil health and optimizing land use practices.

The Bulk Density was Calculated using The Following Formula :

$$\text{B.D (Mg m}^{-3}) = \frac{\text{(Weight of keen's cup + dry soil)} - \text{(Weight of keen's cup)}}{\text{Volume of keen's cup}}$$

The Water holding Capacity and Porosity of Soil was Determined by the following Calculation Method

$$\text{Water holding capacity (\%)} = \frac{\text{(weight of saturated soil)} - \text{(weight of oven dried soil)}}{\text{Volume of keen's cup}} \times 100$$

$$\text{Porosity (\%)} = \left(1 - \frac{\text{Bulk density}}{\text{Particle density}}\right) \times 100$$

Statistical Analysis

Analysis of variance (ANOVA) at 95 per cent confidence level was analyzed taking sampling sites as replicates (random effects) and land use types as treatments (fixed effects) using MS EXCEL and using SPSS for windows (IBM SPSS ver. 17.0).

RESULTS AND DISCUSSION

Physical Properties Soil as Influenced by different Land use Systems at Surface (0-15 cm depth) and Subsurface (15-30 cm depth)

Particle Size Distribution

The soil texture (Table 1) under various land use systems ranged from sandy loam to sandy clay loam. Across all systems, surface soils exhibited higher sand content which decreased with soil depth. Sand content at the surface ranged between 58.81 and 75.18 per cent, while at subsurface depths, it ranged

TABLE 1

Particle size distribution of soils under different land use systems at surface and subsurface depths

Land use systems	Sand (%)		Silt (%)		Clay (%)		Textural class	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Natural Forest	58.81	55.79	16.92	15.56	24.27	28.65	SCL	SCL
Coffee	59.10	56.28	18.79	17.59	22.11	26.13	SCL	SCL
Fallow	75.18	67.61	12.59	17.85	12.23	14.54	SL	SL
Ginger	71.23	64.49	12.08	15.30	16.69	20.21	SL	SCL
Potato	72.10	64.09	11.15	15.79	16.75	20.12	SL	SCL
Maize	73.27	66.32	8.32	13.20	18.41	20.48	SL	SCL
Range	58.81-75.18	55.79-67.61	8.32-18.79	13.20-17.85	12.23-24.27	14.54-28.65		
Mean	68.28	62.43	13.31	15.88	18.41	21.69		
SD	7.35	5.12	3.86	1.70	4.29	5.01		

Note : SL- Sandy loam, SCL- Sandy clay loam

from 55.79 to 67.61 per cent. Fallow land showed the highest sand content (75.18% at the surface and 67.61% at subsurface), followed by maize, potato, ginger and coffee systems. Forest land use recorded the lowest sand content (58.81% at surface, 55.79% at subsurface). Dominance of sand in surface layer is likely due to clay eluviation and surface runoff, as noted by Pulakeshi *et al.* (2014).

The silt content across different land use systems ranged from 8.32 to 18.79 per cent at the surface and 13.20 to 17.85 per cent at subsurface depth. Coffee land use had the highest silt content at the surface (18.79%), followed by forest (16.92%), fallow (12.59%), ginger (12.08%), potato (11.15%) and maize (8.32%). At subsurface depth, fallow land had the highest silt content (17.85%), followed by coffee (17.59%), potato (15.79%), forest (15.79%), ginger (15.30%) and maize (13.20%). These variations are likely due to differences in weathering of parent material as suggested by Denis and Patil (2015).

Clay content across different land use systems ranged from 12.23 to 24.27 per cent at the surface and 14.54 to 28.65 per cent at subsurface depth. Forest land had the highest clay content (24.27% surface, 28.65% subsurface), followed by coffee, maize, potato and ginger systems with fallow land having the lowest (12.23% surface, 14.54% subsurface). Clay content increased with depth, likely due to illuviation during soil formation. The varied textures are due to coarse-grained parent materials with sand dominating the surface and clay and silt accumulating in deeper layers, consistent with Joshi *et al.* (2004).

Bulk Density (Mg m^{-3})

The soil bulk density differed among land use and soil depth (Table 2) was in the range of (1.09 -1.50 Mg m^{-3}) and (1.22-1.81 Mg m^{-3}) at surface and subsurface depth. Considering the land use types, the highest mean value of bulk density (1.50 and 1.81 Mg m^{-3}) at surface and subsurface depth was recorded in fallow land use system followed by maize land use system (1.30 and 1.49 Mg m^{-3}), potato land use system (1.32 and 1.44 Mg m^{-3}), ginger land use system (1.24 and 1.36 Mg m^{-3}), coffee land use system (1.13 and 1.29 Mg m^{-3}) and lowest mean value of bulk density (1.09 and 1.22 Mg m^{-3}) was recorded in forest land use system. The lower bulk density in forest land use systems, compared to others is likely due to continuous organic matter addition, lower sand content and zero tillage, which preserves soil aggregates. Higher bulk density values were recorded in subsurface layers (15-30 cm), likely due to lower organic matter. Studies by Abad *et al*. (2014) also

TABLE 2

Bulk density, porosity and maximum water holding capacity of soils under different land use systems at surface and subsurface depths

Land use systems	BD (Mg $^{m-1}$)		Porosity (%)		MWHC (%)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Natural forest	1.09	1.22	56.59	50.27	47.12	40.54
Coffee	1.13	1.29	54.16	47.48	43.74	36.09
Fallow	1.50	1.81	29.27	19.08	20.20	12.34
Ginger	1.24	1.36	48.75	40.16	38.26	29.15
Potato	1.32	1.44	45.27	37.19	32.35	26.76
Maize	1.30	1.49	40.87	32.76	30.52	24.09
Range	1.09-1.50	1.22-1.81	29.27-56.59	19.08-50.27	20.20-47.12	12.34-40.54
Mean	1.26	1.44	45.82	37.82	35.37	28.16
SD	0.15	0.21	9.93	11.23	9.79	9.86

Note : BD-Bulk density, MWHC- Maximum water holding capacity

found higher bulk density in cultivated land than in grazing and forest lands at 0-30 cm depth due to continuous cutivation, increased sand content and reduced organic matter. Bulk densities of 0.98 to 1.27 Mg m^{-3} in surface soils of forest ecosystems and 1.15 to 1.36 Mg m^{-3} in coffee plantations. Continuous cultivation in annual crops increases bulk density by breaking down soil aggregates into smaller particles, aligning with findings by Gajri and Majumdar (2002).

Total Porosity (%)

The total porosity differed among land use and soil depth (Table 2) was in the range of (29.27-56.59%) and (19.08-50.27%) at surface and subsurface depth. Considering the land use types, the highest mean value of total porosity (56.59 and 50.27%) at surface and subsurface depth was recorded in forest land use system followed by coffee land use system (54.16 and 47.48%), ginger land use system (48.75 and 40.16%), potato land use system (45.27 and 37.19%), maize land use system (40.87 and 32.76%) and lowest mean value of total porosity (29.27 and 19.08%) was recorded in fallow land use system.

The higher total porosity in forest land, followed by coffee land use, reflects the lower bulk density, lower sand content and higher organic carbon content in these systems. Surface soil layers exhibited greater porosity due to higher organic matter and lower bulk density. The variation in porosity across different land use systems correlates with their respective bulk densities and organic matter. Continuous organic matter input in forest systems helps maintain soil structure, reduce crust formation and increase micro and macropores. Soil pore space is inversely related to bulk density. Bizuhoraho *et al.* (2018) also observed higher porosity in forest soils compared to cultivated lands.

Maximum Water Holding Capacity (%)

The soil moisture holding capacity is influenced by varying land use systems and depths (Table 2) was in the range of (20.20-47.12%) and (12.34-40.54%) at surface and subsurface depth. Highest mean maximum water holding capacity (47.12 and 40.54%) at surface and subsurface depth was recorded in forest land use system followed by coffee land use system (43.74 and 36.09%), ginger land use system (38.26 and 29.15%), potato land use system (32.35 and 26.76%), maize land use system (30.52 and 24.09%) and least maximum water holding capacity was recorded in fallow land use system (20.21 and 12.34%) at surface and subsurface depth.

Moisture holding capacity is closely linked to the characteristics of different land use systems. Natural forest land had the lowest soil bulk density and the highest porosity and water holding capacity compared to agricultural and horticultural systems. The continuous addition of litter, lower sand content and organic matter in forest systems increases soil organic carbon, enhancing moisture retention. Water holding capacity showed a direct relation with particle distribution. In contrast, horticultural and agricultural systems lack continuous organic matter input, leading to lower moisture holding capacity (Bhavya *et al.,* 2017).

Physico-chemical Properties of Soils at Surface (0-15 cm depth) and Subsurface (15-30 cm depth) as Influenced by the different Land-use Systems

Soil pH

The soil pH was influenced by different land use systems and soil depths (Table 3) was in the range of (5.60-6.98) and (5.86-7.21) at surface and subsurface depth. The highest mean soil pH (6.98 and 7.21) at surface and subsurface depth was recorded in maize land use system, which was followed by fallow land use system (6.34 and 6.48), potato land use system (6.18 and 6.23), ginger land use system (6.14 and 6.21) and coffee land use system (6.08 and 6.16), respectively. The lowest mean pH (5.60 and 5.86) at surface and subsurface was recorded in forest land use system.

The variation in soil pH across different land use systems is attributed to the significant litter biomass addition in forest and coffee land use system, as this organic matter decomposes, it releases acidic compounds, including carbonic acid and organic acids, which can lower the soil pH. Higher pH in cultivable land is attributed to liming, weathering of mineral and low organic matter. Soil pH, indicating acidity or alkalinity, significantly impacts soil physical and biological properties, influencing nutrient availability. It plays a key role in regulating biogeochemical processes, which in turn affects ecosystem structure and function (Hong *et al.,* 2018).

Electrical Conductivity (EC)

The electrical conductivity (EC) of soils varied across land use systems (Table 3) and soil depths, ranging from 0.41 to 0.74 dS m^{-1} at the surface and

TABLE 3

Electro-chemical properties of soils under different land use systems at surface and subsurface depths

Land use systems	pH		EC (ds m^{-1})	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Natural Forest	5.60	5.86	0.41	0.50
Coffee	6.08	6.16	0.74	0.80
Fallow	6.34	6.48	0.45	0.48
Ginger	6.14	6.21	0.64	0.69
Potato	6.18	6.23	0.60	0.66
Maize	6.98	7.21	0.53	0.58
Range	5.60-6.98	5.86-7.21	0.41-0.74	0.48-0.80
Mean	6.22	6.36	0.56	0.62
SD	0.45	0.46	0.12	0.13

Note : EC- Electrical conductivity

0.48 to 0.80 dS m^{-1} at subsurface depths. EC values were slightly higher in subsurface soils across all systems. Coffee land use had the highest EC (0.74 and 0.80 dS m^{-1}), followed by ginger, potato, maize, fallow and forest with forest having the lowest EC (0.41 and 0.50 dS m^{-1}). The lower EC in forest soils is likely due to the loss of base cations through water percolation, downward movement of basic cations which is attributed to its low bulk density and high porosity.

Higher EC in coffee plantations may result from continuous fertilizer application, which increases salt content. This is consistent with findings by Nagaraj *et al*. (2002) in Karnataka's coffee-growing soils. EC values were generally higher at subsurface depths, possibly due to salt movement from surface to subsurface layers and the lowest mean EC was recorded in surface soils (0-15 cm) across all land use systems. This variation is likely due to soluble salts, leaching and rainfall intensity, agreeing with previous research by Nagaraj *et al*. (2002) and Ananthkumar (2011).

Soil Organic Carbon (g kg^{-1})

The soil organic carbon content differed with land use systems and depth (Table 4) was in the range of (1.60-14.04 g kg^{-1}) and (1.04-8.94 g kg^{-1}) at surface and subsurface depth. Among different land use systems, the highest mean SOC content (14.04 and 8.94 g kg^{-1}) at surface and subsurface depth was recorded in forest land use system followed by coffee land use system (7.56 and 5.84 g kg^{-1}), ginger land use system (6.41 and 4.36 g kg^{-1}), potato land use system (4.86 and 3.28 g kg^{-1}), maize land use system (3.55 and 2.07 g kg^{-1}) and the lowest mean value SOC content (1.60 and 1.04 g kg^{-1}) at surface and subsurface was recorded in fallow land use system which is attributed to lack of organic matter inputs, existing organic matter in the soil continues to decompose and mineralize, this process releases carbon dioxide into the atmosphere, leading to a gradual decline in SOC over time.

Higher soil organic carbon (SOC) content in forest and coffee land use systems is attributed to the significant litter biomass addition and reduced oxidation due to less soil disturbance. Similar findings were reported by Nagaraja (1997). In agricultural systems, SOC variation is influenced by factors such as litter input, farmyard manure application, root growth, surface cover, soil erosion, tillage practices, and intensive cultivation. SOC accumulation is a balance between residue input and decomposition rates, affected by soil temperature and moisture.

TABLE 4

Soil organic carbon and nitrogen status as influenced by different land use systems at surface (0-15 cm) and subsurface (15-30 cm) depths

Land use systems	SOC (g kg^{-1})		Available N (kg ha^{-1})	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Natural Forest	14.04	8.94	328.83	315.62
Coffee	7.56	5.84	386.64	359.22
Fallow	1.60	1.04	121.18	86.07
Ginger	6.41	4.36	288.50	254.53
Potato	4.86	3.28	243.92	220.60
Maize	3.55	2.07	203.63	193.28
Range	1.60-14.04	1.04-8.94	121.18-386.64	86.07-359.22
Mean	6.34	4.26	262.12	238.22
SD	4.32	2.85	94.09	96.31

Note : SOC-Soil organic carbon

Available Nitrogen (kg ha^{-1})

The available nitrogen content differed with land use systems and depth (Table 4) was in the range of (121.18-386.64 kg ha^{-1}) and (86.07-359.22 kg ha^{-1}) at surface and subsurface depth. Among the land use systems, the highest mean value of available nitrogen content (386.64 and 359.22 kg ha^{-1}) at surface and subsurface depth was recorded in coffee land use system followed by forest land use system (328.83 and 315.62 kg ha^{-1}), ginger land use system (288.50 and 254.53 kg ha^{-1}), potato land use system (243.92 and 22.60 kg ha^{-1}), maize land use system (203.63 and 193.28 kg ha^{-1}) and the lowest mean value of available nitrogen (121.18 and 86.07 kg ha^{-1}) was recorded in fallow land use system.

Soil organic matter (SOM) is essential for nitrogen (N) storage and supply with about 95 per cent of soil N associated with SOM. Higher available N in man-made systems, such as coffee plantations, results from high N fertilizer use and substantial farm yard manure (FYM). In forest systems, higher available N is due to the quality and quantity of litter and mineralization rates. Shivakumar *et al*. (2020) reported that natural systems like evergreen and semi-evergreen forests have higher available N compared to forest plantations like teak and acacia, attributed to the diverse vegetation in natural systems. In agricultural systems, lower available N is due to reduced litter inputs and soil organic carbon loss from cultivation. Livestock grazing and soil exposure can increase runoff, removing residues and depleting N. Also found higher total N in forest lands compared to adjacent grazing and cultivated lands. Surface soils typically have higher available N (424.41 kg ha m^{-1}) compared to subsurface soils (275.97 kg ha m^{-1}), due to greater organic matter accumulation and decomposition at the surface (Chemada *et al.,* 2017). These findings align with (Govind and Krishna murthy, 2022) who observed higher available N in surface soils across various land use systems.

Available-phosphorus (kg ha^{-1})

The available phosphorus content differed with land use systems and depth (Table 5) was in the range of (26.42 and 79.77 kg ha^{-1}) and (18.13-66.98 kg ha^{-1}) at surface and subsurface depth. Among the land use systems, the highest mean value of available

TABLE 5

Available phosphorus and available potassium status as influenced by different land use systems at surface (0-15 cm) and subsurface (15-30 cm) depths

Land use systems	Available P_2O_5 (kg ha^{-1})		Available K_2O (kg ha^{-1})	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Natural Forest	62.80	55.94	316.62	292.74
Coffee	79.77	66.98	398.78	364.52
Fallow	26.42	18.13	103.66	71.04
Ginger	54.52	47.47	306.49	266.77
Potato	46.19	39.73	214.65	179.29
Maize	40.10	33.90	180.25	151.10
Range	26.42-79.77	18.13-66.98	103.66-398.78	71.04-364.52
Mean	51.63	43.69	221.74	220.91
SD	18.56	17.16	142.85	106.73

phosphorus content (79.77 and 66.98 kg ha^{-1}) at surface and subsurface depth was recorded in coffee land use system followed by forest land use system (62.80 and 55.94 kg ha^{-1}), Ginger land use system (54.52 and 47.74 kg ha^{-1}), potato land uses system (46.19 and 39.73 kg ha^{-1}), Maize land use system (40.10 and 33.90 kg ha^{-1}) and lowest mean value of available phosphorus (26.42 and 18.13 kg ha^{-1}) was recorded in fallow land use system.

Available P_2O_5 is notably higher in surface soils than in subsurface soils, primarily due to the higher organic matter content at the surface, which enhances phosphorus availability through the release of organic phosphorus. Chemada *et al.* (2017) observed similar trends in forest lands. Lower mobility of P in soil decrease in available phosphorus with soil depth is attributed to higher clay content and reduced organic matter at greater depths. Variations in P_2O_5 content across land use systems are influenced by litter turnover, organic matter and phosphate fertilizer application. Organic compounds increase phosphorus availability by forming organophosphate complexes, replacing anions at adsorption sites, coating Fe/Al oxides with humus and reducing phosphorus fixation. Additionally, organic matter decomposition releases acids that enhance calcium phosphate solubility. Shivakumar *et al.* (2020), found the highest available P in coffee soils (29.31 kg ha m^{-1}), followed by evergreen forests (28.37 kg ha m^{-1}), semi-evergreen forests (27.26 kg ha m^{-1}) and other systems.

Available Potassium (kg ha^{-1})

The available Potassium content differed with land use systems and depth (Table 5) was in the range of (103.66-398.78 kg ha^{-1}) and (71.07-364.52 kg ha^{-1}) at surface and subsurface depth. Among the land use systems, the highest mean value of available potassium content (398.78 and 364.52 kg ha^{-1}) at surface and subsurface depth was recorded in coffee land use system followed by forest land use system (316.62 and 292.74 kg ha^{-1}), Ginger land use system (306.49 and 266.77 kg ha^{-1}), potato land use system (214.65 and 179.29 kg ha^{-1}), maize land use system (180.25 and 151.10 kg ha^{-1}) and lowest mean value of available potassium (103.66 and 71.04 kg ha^{-1}) was recorded in fallow land use system.

Available potassium (K_2O) was highest in coffee land use systems, followed by forest systems, compared to other land uses might be due to crop removal. This is due to the high doses of potassic fertilizers applied over the years and increased litter turnover and decomposition. Studies by Anilkumar (2002) and Ananthkumar (2011) also reported high potassium levels in horticulture systems due to excessive potassium fertilization. Forest systems have lower available K_2O compared to coffee plantations, likely due to the absence of potassic fertilizers, crop removal and slower mineralization. Additionally, the lower potassium content in forest litter and potential leaching of surface-applied K_2O may contribute to reduced K_2O status in forest soils, exacerbated by acidic soil pH conditions (Rudramurthy *et al*., 2007).

Soil characteristics vary significantly across land use systems. Forest and coffee plantations typically show lower bulk density, higher porosity and better moisture holding capacity due to higher organic matter and reduced disturbance. These systems also exhibit higher available nitrogen and phosphorus, though coffee plantations have higher potassium due to intensive fertilization. Agricultural systems in contrast, often have higher bulk density, lower nutrient availability and reduced moisture retention. Soil pH, electrical conductivity and nutrient levels are influenced by factors such as organic inputs, fertilization and soil depth. Overall, natural and managed forest systems generally support better soil health compared to agricultural systems.

References

ABAD, J. R. S., KHOSRAVI, H. AND ALAMDARLOU, E. H., 2014, Assessment the effects of land use changes on soil physicochemical properties in Jafarabad of Golestan province, Iran Bull. *Environ. Pharmacol. Life Sci.*, **3** (3) : 296 - 300.

ANANTHKUMAR, M. A., 2011, Soil properties and dynamics of major nutrients in soils as influenced by shade trees, rainfall pattern and nutrient management in coffee growing areas of Karnataka. *Mysore J. Agric. Sci*., **45** (3) : 45 - 58.

Anil Kumar, K. S., 2002, Characterization, classification and suitability evaluation of coffee growing soils of Karnataka. *Ph. D. Thesis*, Univ. Agric. Sci., Bangalore.

Bhavya, V. P., Kumar, A. S., Alur, A., Shivanna, M. and Shivakumar, K. M., 2017, Changes in soil physical properties as a result of different land use systems with depth. *Int. J. Curr. Microbiol. Appl. Sci.*, **7** (1) : 323 - 327.

Bizuhoraho, T., Kayiranga, A., Manirakiza, N. and Mourad, K. A., 2018, The effect of land use systems on soil properties; A case study from Rwanda.

Chemada, M., Kibret, K. and Fite, T., 2017, Influence of different land use types and soil depths on selected soil properties related to soil fertility in Warandhab Area, Horo Guduru Wallaga Zone, Oromiya, Ethiopia. *Int. J. Environ. Sci. Nat. Resour.,* **4** (2) : 555 - 634.

Denis, M. K. A. and Patil, P. L., 2015, Mapping of biophysical constraints of soils in semi-arid Northern Transition Zone of India by GIS techniques. *American-Eurasian J. Agric. Environ. Sci.*, **15** (1) : 53 - 62.

Gajri, P. R. and Majumdar, S. P., 2002, Tillage. In: Fundamentals of soil science, *Indian Soc. Soil Sci.,* pp. : 125 - 132.

Govind, K. and Krishnamurthy, R., 2022, Impact of different land-use systems on selected soil physicochemical properties in Biligirirangana Hills, Chamarajanagara district. *Mysore J. Agric. Sci.,* **56** (2) : 135 - 143.

Hong, S., Piao, S., Chen, A., Liu, Y., Liu, L., Peng, S., Sardans, J., Sun, Y., Penuelas, J. and Zeng, H., 2018, Afforestation neutralizes soil pH. *Nat. Commun.*, **9** (1) : 1 - 7.

Jackson, M. L., 1973, Soil chemical analysis. Prentice Hall of India (Pvt.) Ltd., New Delhi.

Joshi, S. R., Sharma, G. D. and Mishra, R. R., 2004, Microbial enzyme activities related to litter decomposition near a highway in a subtropical forest of Northeast India. *Soil Bio. Biochem.*, **25** : 1763 - 1770.

Nagaraj, J. S., Aseef, K. M., D'souza, M. V. and Jayarama, J., 2002, Soil nutrient status of Chikkamagaluru district in Karnataka cropped to Arabica coffee and their relationship with coffee yield. *Proc. 15th Plantation Crops Symposium PLACROSYM*, **15** : 282 - 286.

Nagaraja, M. S., 1997, Biomass turnover, nutrient status and biological processes in different land use systems. *Ph. D Thesis,* Univ. Agric. Sci., Bangalore.

Paul, E. A., Paustian, K., Elliott, E. T. and Cole, C. V., 1997, Soil organic matter in temperate agro-ecosystems: Long-term experiment in North America. CRC, Boca Raton.

Piper, C. S., 1966, Soil and plant analysis. Hans Publishers, Bombay.

Pradeep and R. Krishnamurthy, 2023, Impact of different land - use systems on soil physico-chemical properties. *Mysore J. Agric. Sci*., **57** (1) : 229-244.

Pulakeshi, H. B. P., Patil, P. L. and Dasog, G. S., 2014, Characterization and classification of soil resources derived from chlorite schist in northern transition zone of Karnataka. *Karnataka J. Agric. Sci.,* **27** (1) : 14 - 21.

Rudramurthy, H. V., Puttaiah, E. T. and Vageesh, T. S., 2007, Chemical properties of soils under different land use systems in Shivmoga district of Karnataka. *J. Indian Soc. Soil Sci.,* **55** (3) : 259 - 264.

Shivakumar, K. M., Prakash, S. S., Nagaraja, M. S., Kumar, C. V. and Prabhudev, D., 2020, Effect of different land use systems on major nutrient status in soils of western ghat - Chikkamagaluru, Karnataka, India. *Int. J. Curr. Microbiol. Appl. Sci.*, **9** (11): 3502 - 351.