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# Effect of depth-wise distribution of physico-chemical properties of different land-use systems of District Baramulla of Kashmir

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**Abstract**
To study the effect of land-use systems on the physicochemical properties of soils from different land-use systems, *viz*., forestry, horticulture, Agri-horti and agriculture, in the district of Baramulla, J & K. 105 surface and sub-surface samples were collected from five different locations and were studied for physico-chemical properties like pH, EC, OC, $CaCO_3$, CEC, bulk density, particle density, porosity, and moisture content. All the soil samples in the studied land-use system were medium to moderately fine in texture and slightly acidic to slightly alkaline in nature, but normal in electrical conductivity. Bulk density and particle density were low in forest soils and high in cultivated lands, and organic carbon was slightly low to high in the soils under investigation. pH, electrical conductivity, organic carbon, and cation exchange capacity showed a definite pattern with depth, whereas calcium carbonate showed an irregular trend with depth.

**Keywords:** Physico-chemical properties, forestry, horticulture, Agri-horti, agriculture

## Introduction

Land use is characterised by the arrangements, activities, and inputs that people undertake on a certain land cover type to produce change or maintain it (Abad *et al.*, 2014) [1]. Dynamic soil nature describes the condition of a specific soil due to land use and management practices. Soil quality is primarily determined by the Soil's responsiveness to various land-use systems and management practices, as these can cause changes in land productivity (Islam and Wali 2000) [6]. Changes in land use and management practises often modify most soil morphological, physical, chemical, and biological properties to the extent reflected in agricultural productivity. The effect of land-use systems on soil properties provides an opportunity to evaluate the sustainability of the land-use systems and soil degradation concerning land use. Land use patterns also play a vital role in governing the nutrient dynamics and fertility of the soil (Venkatesh *et al.*, 2003) [14]. Soils under a particular land-use system may have different physicochemical properties, which may modify fertility status and nutrient availability. The physical properties of soil mainly depend upon the amount, shape, size, pore space, organic matter, and mineral composition of the soil. The soils of the district are mostly colluvial, lacustrine, and alluvial in nature. Physiographic ally, they have been classified as low, mid, and high altitude soils and are located at an altitude of 1500 to 1700 m, 1701 to 1800 m, and 1801 to 2000 m above mean sea level, respectively. These soils vary greatly in morphology, physicochemical properties, nutrient status, and ultimately productivity. Irrespective of land capability and suitability, these soils are put to different land-use systems in the district, which has resulted in chemical degradation. Continuous cultivation of high-yielding varieties, use of inorganic fertilizers, and limited use of organic materials has further aggravated the chemical degradation. The study of the up-to-date status of soil properties is an important tool to enhance production on a sustainable basis.

## Materials and Methods

### Description of study area

The site is located between 330 and 44 North latitudes and 750 to 96 East longitude, which is 60 km away from Srinagar. Four land use sites were selected for this study area, and these were forestry, horticulture, Agri-Horti, and agriculture.

### Land use selection and soil sampling
Soil samples were collected from four land uses (forestry, horticulture, Agri-Horti, and agriculture) following standard protocols. Representative sampling sites were selected randomly from each land use. The composite soil samples were collected from two depths (0–30 and 30–60 cm) and one depth (0–30 cm). Agriculture, land use system

**Land use selection and soil sampling:** The samples were processed and analysed for soil properties, namely pH, electrical conductivity in a 1:2.5 soil-water suspension as described by Jackson (1973) [7], organic carbon of the soil sample was estimated by Walkley and Black (1934) [16] as described by Jackson (1973) [7], calcium carbonate by the rapid titration method as described by Piper (1966) [12], and cation exchange capacity was determined by Schollenberger's method of leaching the soil with neutral normal ammonium acetate and determination of ammonical nitrogen (Jackson, 1973) [7]. Clay sand and silt contents were determined by the Bouyoucous hydrometer method as per the procedure outlined by Piper (1966) [12].

## Results and Discussion
### Soil physico-chemical characteristics of soils
**Soil Texture:** Based on the sand, silt, and clay content, the studied soils varied in texture from medium (loam, silt loam) to moderately fine texture (sandy clay loam, silty clay loam, clay loam). This variation in texture could be attributed to the alluvial nature of these soils (table 1). Similar results were reported by Maqbool *et al. in* 2017 [10]. The average mean value of sand content was 36.65 per cent in the studied land-use systems. The contents did not depict any trend in depth. The forest land-use system had the highest mean value of sand (53.13 percent). This can be attributed to the removal of a finer fraction of soil by rainfall and accelerated erosion at high altitudes. In the studied land-use system, the average mean value of silt content was 43.18 percent. The silt content exhibited an irregular trend with depth. This could be attributed to variation in the weathering of parent material or in situ formation (Satish Kumar and Naidu 2012) [13]. In the forest, horticulture, agri-Horti, and agriculture land-use systems, the average mean value of clay was 27.305 percent. Similar results were reported by Kaur and Bhat in 2017. In general, forest land-use systems had the lowest clay content (22.27 percent), with significant variation with soils of land-use systems. This could be attributed to the removal of clay particles by erosion at high altitudes and slopes with less penetration of water. Mahapatra *et al.* (2000) [9]

### Bulk density
The bulk density of soils varied from 1.13 to 1.48 g $cm^{-3}$ under different land-use systems, with the highest mean value of 1.36 g $cm^{-3}$ and the lowest 1.24 g $cm^{-3}$ in forest soils, followed by soils of Agri-Horti 1.36 g $cm^{-3}$ and horticulture 1.35 g $cm^{-3}$ (Table 1). Maximum bulk density in an arable land use system could be due to continuous tillage and low organic matter, which consequently led to more compaction of soil, resulting in high bulk density. The minimum (1.24 g $cm^{-3}$) bulk density of forest soils could be due to fewer biotic interferences, which lead to less compactness of soils, resulting in low values of bulk density. These results are in accordance with the findings of Dadhwal *et al. (*2011) [4] and less disturbance of the sub-surface in compacted soils (Sonaimuthu *et al.* 2018) [14].

**Table 1:** Effect of different land use system on soil texture and physical properties of soil

| LUS | | Bulk Density (g $cm^{-3}$) | Particle Density (g $cm^{-3}$) | Porosity (%) | Moisture Content (%) | Sand (%) | Silt (%) | Clay (%) |
|---|---|---|---|---|---|---|---|---|
| Forestry | Range | 6.50-7.50 | 0.08-0.18 | 0.52-1.75 | 0.07-0.28 | 20.21-62.32 | 19.10-63.17 | 8.10-38.00 |
| | Mean | 7.09 | 0.12 | 1.07 | 0.14 | 53.13 | 54.36 | 22.27 |
| Horticulture | Range | 6.26-7.44 | 0.18-0.27 | 0.42-1.24 | 0.00-0.20 | 17.11-49.86 | 22.31-59.51 | 19.20-35.40 |
| | Mean | 7.10 | 0.23 | 0.75 | 0.13 | 32.28 | 41.14 | 26.92 |
| Agri-Horti | Range | 6.56-7.29 | 0.10-0.24 | 0.45-1.53 | 0.07-0.23 | 17.25-60.18 | 18.00-68.50 | 12.14-37.10 |
| | Mean | 7.09 | 0.17 | 0.83 | 0.15 | 27.78 | 44.60 | 27.14 |
| Agriculture | Range | 6.92-7.28 | 0.11-0.27 | 0.67-1.20 | 0.10-0.20 | 18.23-57.41 | 18.00-46.00 | 22.11-38.42 |
| | Mean | 7.17 | 0.18 | 0.93 | 0.15 | 33.41 | 32.64 | 32.89 |

### Particle density
The overall particle density ranged from 2.27 to 2.66 g $cm^{-3}$ (Table 1) in the studied land-use system. In general high values of particle, densities were recorded in cultivated lands which could be ascribed to the removal of finer particles by percolating water thereby increasing the proportion of coarse particles in soil and reduction of organic matter by continuous cultivation that leads to an increase in particle density (Gupta *et al.*, (2010) [5] and Maqbool *et al* (2017) [10]. The increase in particle density with depth could be due to a decrease in organic carbon.

### Porosity
The data presented in table 1 revealed that the values of porosity ranged from 36.18 to 51.65 percent in the different land-use systems. The highest mean (49.86 percent) porosity was recorded in forest soils and the lowest 45.43 percent in agriculture land-use systems. This might be due to high organic matter in forest lands and high compaction in cultivated lands. These results are in conformity with the findings of sonaimuthu *et al* 2018 [14].

### Moisture content
The data presented in table 1 indicated that the overall moisture content of the studied land-use systems varied from 20.15 to 65.09 percent with the highest mean value of 47.97 percent found in agriculture land-use systems which showed significant variation with other land-use systems. The high moisture content in agricultural lands can be attributed due to high clay content and organic carbon with high microporosity which leads to high retention of water as compared to other land-use systems (sonaimuthu *et al* 2018) [14].

### Soil pH and EC
Some of the important Physico-chemical properties of soil soils are presented in Table 2. The soils of district Baramulla of studied land-use systems were slightly acidic to slightly alkaline ranging from 6.25 to 7.50. The lowest mean pH 7.03

recorded in forest soils could be due to a high amount of organic matter, leaching of basis due to higher precipitation at a higher elevation. These results are in agreement with the findings of Najar *et al*. 2014. The pH exhibited an increasing trend with the increase in depth irrespective of the land-use system. This could be due to the continuous removal of bases from surface to sub-surface soils with percolating water (Padhan *et al*. 2016) [11]. The data presented in table 1 revealed that the mean value of electrical conductivity in the studied soils were 0.12, 0.23, 0.17, and 0.18 d sm-1 in forest land-use system, horticulture land-use system, Agri-Horti land-use system, and agricultural land use system respectively. The lowest mean value of 0.12 d sm-1 was noticed in forest soils which showed significant variation with electrical conductivity and another land-use system. The significantly low 0.12 d sm-1 electrical conductivity of forest soils could be attributed due to high rainfall in forest areas resulting in the leaching of salts and then the translocation out of solum. The highest electrical conductivity of the cultivated lands can be due to the addition of salts through fertilizers. The increase in electrical conductivity with depth could be due to the leaching of soluble salts from surface to sub-surface soils. These observations are supported by Kaur and Bhat (2017) [8] and Maqbool *et al* (2017) [10].

**Table 2:** Effect of different land use system on Chemical properties of soils under different land use systems

| LUS | | pH (1:2.5) | EC ($dSm^{-1}$) | OC (%) | $CaCO_3$ (%) | CEC Cmol($p^+Kg^1$) |
|---|---|---|---|---|---|---|
| Forestry | Range | 6.50-7.50 | 0.08-0.18 | 0.52-1.75 | 0.07-0.28 | 9.40-19.40 |
| | Mean | 7.09 | 0.12 | 1.07 | 0.14 | 14.87 |
| Horticulture | Range | 6.26-7.44 | 0.18-0.27 | 0.42-1.24 | 0.00-0.20 | 13.40-17.30 |
| | Mean | 7.10 | 0.23 | 0.75 | 0.13 | 16.13 |
| Agri-Horti | Range | 6.56-7.29 | 0.10-0.24 | 0.45-1.53 | 0.07-0.23 | 13.10-19.30 |
| | Mean | 7.09 | 0.17 | 0.83 | 0.15 | 16.33 |
| Agriculture | Range | 6.92-7.28 | 0.11-0.27 | 0.67-1.20 | 0.10-0.20 | 14.20-19.12 |
| | Mean | 7.17 | 0.18 | 0.93 | 0.15 | 17.28 |

**Soil organic carbon**

The mean value recorded at 1.07, 0.75, 0.82, and 0.93 percent in a forest, horticulture, Agri-Horti, and agricultural land use system respectively (Table 2). The lowest mean value (0.75, 0.82, and 0.93 percent) of organic carbon was recorded in uncultivated soils and the highest (1.07 percent) in forest soils. This is because continuous cultivation increases the aeration of soil which enhances the decomposition of organic matter, leading to low organic content in cultivated soils. The decrease in organic carbon with depth was observed in all land-use systems. The high organic carbon at the surface could be ascribed due to the accumulation and decomposition of leaves, litter on the surface. The soils in general were medium to high in organic matter. The organic carbon showed significant difference with land use system with the highest value of 1.07 percent observed in forest soils that could be ascribed to the slower rate of decomposition of organic matter owing to lower temperatures at high altitudes which leads to accumulation of organic matter. Chauhan *et al*.2011 [3], Celik 2005 [2].

**Calcium carbonate**

The calcium carbonate content of different land-use systems is presented in table 2 indicated that mean values of calcium carbonate of the forest, horticulture, Agri-Horti, and agricultural land use system were 0.14, 0.13, 0.15, and 0.15 percent respectively. Contents did not exhibit any significant variation with each other in different land-use systems. The contents exhibited an irregular trend with depth. These results are in agreement with the findings of Bhat 2009.

**Cation exchange capacity**

The overall cation exchange capacity c mol (p+) $kg^{-1}$ ranged from 9.40 to 19.40 c mol (p+) $kg^{-1}$) table 2. The highest mean value 19.40 c mol (p+) $kg^{-1}$ was recorded in the agricultural land use system and lowest in forestry 14.87 c mol (p+) $kg^{-1}$ (Table 1). This may be attributed due to high clay content and medium to high content of organic carbon. The significant variation of cation exchange capacity of forest soils with cultivated soils could be attributed due to variation in the organic carbon content of these soils (Mahapara *et al*. 2000) [9].

**Conclusion**

The study was conducted to evaluate the effect of different land-use systems *viz*. forestry, horticulture, Agri-Horti, and agriculture on soil Physico-chemical properties. The soil quality parameters decreased with depth which could be due to a decrease in organic carbon content with depth, calcium carbonate showed an irregular trend with depth.

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