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Effect of different land uses on soil health in Ga3a micro-watershed of Solan district in Himachal Pradesh

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Abstract
The present study entitled "Effect of different land uses on soil health in Ga3a micro-watershed of Giri River in Solan district of Himachal Pradesh" was carried out with a view to ascertain the hydrophysico-chemical characteristics of soils under different land uses viz. forest, grasslands, agrisilviculture and vegetable land. Soil samples from two different depths of 0.0-0.15 and 0.15-0.30 m were collected from each land uses. Soil samples were evaluated with respect to their hydraulic, physical and chemical characteristics. The soils of Ga3a micro-watershed are coarse in texture with sand constituting the major fraction. Soils are characterized by high bulk density. These soils were poor in moisture retention and had low available water capacity. Among the land uses, forest and grasslands have better aggregate stability due to higher organic matter contents and presence of vegetative cover.

Keywords: Land uses; Soil health; Micro watershed

Introduction
Soil health deals with the integration and optimization of the physical, chemical and biological properties of the soil for improved productivity and environmental quality. Soil health includes dynamic characters of soil (Thakur *et al*. 2011) [5]. Characterization of soil health by farmers focuses on descriptive/qualitative properties of soil with a direct value judgment. Healthy soil is easy to work, friable, holds water and nutrients well and is free-draining. Healthy soil allows healthy root growth and good crop establishment. Crops grown on healthy soils have less diseased, water to infiltrate, store and moderate water creating steady base flows. Integrated nutrient management is the most common amendments applied to soil to improve soil quality and crop productivity. Nutrient management in a proper perspective not only sustains the productivity but also improves chemical, physical or biological properties of soil (Singh M. 2010) [1]. Understanding the effects of land use and land cover changes on soil properties have implications for devising land management strategies for sustainable use. Generally, a sound understanding of land use effects on soil properties provides an opportunity to evaluate sustainability of land use systems (Bewket and Stroosnijder, 2003) [2]. Therefore, the present study has been undertaken to generate information on soil physico-chemical properties of the soils. The objective of the present study was:
i) To study physico-chemical properties of soil under different landuse systems.

Materials and Methods
The study was undertaken in "Ga3a" micro-watershed located in Solan district of Himachal Pradesh and lies between $30^0$50'to$30^0$53'N latitudes and $77^0$08'to$77^0$15'E longitudes. The physiography is marked by undulating topography dotted by elevation and depressions. The climate of the study area sub-humid sub-temperate with mean annual temperature of 18ºC. The area receives an annual rainfall of 1150 mm, most of which is concentrated during the months of June to September (monsoon period). The winter showers during the months of January and February are very common.
The surface (0.0-0.15 m) and sub-surface soil samples (0.15-0.30 m) were collected from four different land uses viz. forest, grassland, agrisilviculture and cropland (vegetable). The study of hydrophysico-chemical characteristics of the soil was carried out under different land uses. Particle size analysis was done by International pipette method as described by Jackson (1973). Stability of the soil was assessed by determining the water stable aggregates (>0.25mm and <0.25mm) following the procedure given by Yoder, 1936. Bulk density and particle density was determined by core-tube method. Moisture retention at 10, 33, 50, 100, 300, 500, 1000 and 1500 atmospheric was determined by Richard pressure plate apparatus. The available water was determined from the soil moisture retention as follows:

Available water (AW) = Field Capacity (FC) – Permanent Wilting Point (PWP)

Water holding capacity of soil was determined by the Keen-Raczkowski Box Method (Keen & Raczkowski 1921) [3]. Hydrauclic conductivity of soil was determined by constant head method and calculated by Darcy's equation (Richard, 1954) [4].

Soil pH in 1:2 soil water mixture were determined as per Richards (1954) [4]. Organic carbon content (OC) was determined by Walkley and Black's rapid titration method (Piper 1950).

Results and Discussions

The textural classes were found to be gravely silty loam in forest, agrisilviculture and vegetable lands and gravely sandy loam in grasslands. Clay content was the highest in the agrisilviculture land use (22.86% and 24.20% in 0.0-0.15 and 0.15-0.30m respectively) followed by vegetable, forest and grass land use. The soils of forest recorded lowest percentage of total sand content (44.20% and 41.93% in 0.0-0.15 and 0.15-0.30m respectively). Furthermore, soils of forest land use had higher silt content (38.23% and 36.00%) than those of other land uses (Table 1).

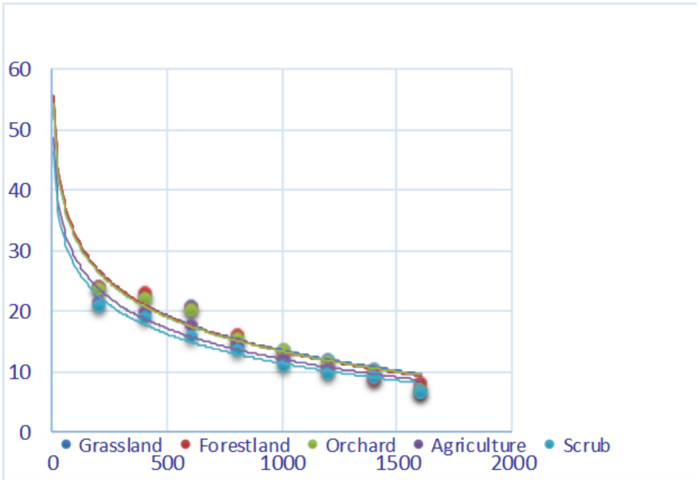
Table 1: Physico-chemical characteristics of surface and sub-surface soils

Landuses	Soil depth (m)	Mechanical composition (%)			Textural class	Bulk density (g cm^{-3})	Particle density (g cm^{-3})	pH (1:2)	OC (%)
		Sand	Silt	Clay					
Forest	0.0-0.15	44.20	38.23	17.56	gsil	1.32	2.36	6.17	2.00
	0.15-0.30	41.93	36.00	22.07		1.27	2.42	6.24	1.70
Grassland	0.0-0.15	77.40	9.80	12.13	gls	1.27	2.33	6.60	2.03
	0.15-0.30	71.50	16.13	12.36		1.30	2.40	6.65	1.73
Agrisilviculture	0.0-0.15	49.75	29.57	22.86	gsil	1.37	2.51	6.67	1.53
	0.15-0.30	44.28	31.15	24.20		1.45	2.56	6.71	1.03
Vegetable	0.0-0.15	51.40	25.73	20.67	gsil	1.53	2.62	6.72	0.80
	0.15-0.30	48.58	32.07	19.35		1.56	2.67	6.79	0.66

Soils under vegetable land use showed highest value bulk density (1.53 and 1.56 g cm^{-3}) and particle density (2.62 and 2.67 g cm^{-3}) in surface and sub-surface soils respectively, which can be accounted for by the coarser texture and low organic matter content of the soils.. Bulk density and particle density increased with profile depth. However, lowest bulk density i.e. 1.27 and 1.30 g cm^{-3} in surface and sub-surface respectively and particle density i.e. 2.33 and 2.40 g cm^{-3}in surface and sub-surface respectively was recorded lowest in grassland.

The water retention characteristics of the soils were observed to be highest in forest land use system and lowest under vegetable land use system in both surface and sub-surface layer (Fig 1). This may be ascribed to better soil physical conditions and presence of higher organic matter content in the forest land use system. Available water was highest under forest i.e. 17.78 and 15.03 % in surface and sub-surface layers respectively (Table 2). However, lowest available water was observed under grassland which may be due to coarse texture of the soil. The average values of saturated hydraulic conductivity in surface layer were 1.88, 2.05, 1.46 and 1.68 in forest, grassland, agrisilviculture and vegetable land use respectively (Table 4). Highest value was observed under grassland and lowest under agrisilviculture land use. Same trend was observed in sub-surface layer. The average values of water holding capacity in surface layer i.e. 41.58, 28.15, 41.83 and 38.73 percent in forest, grassland, agrisilviculture and vegetable land use respectively, (Table 2) showed that water holding capacity was highest in case of soils under agrisilviculture land use system. Whereas, in sub-surface layer the water holding capacity was highest under forest land use system (41.53%) which may be ascribed to higher organic matter and clay fractions. However, lowest average values were recorded under grassland in both surface and sub-surface layer.

Soil pH reveals that the soils of the area were acidic to neutral in reaction (6.17-6.79) and the highest pH was recorded in vegetable land with average values of 6.72 and 6.79 in 0.0-0.15 and 0.15-0.30 m soil depths, respectively. Lowest values of pH were recorded under forest (Table 1). A definite decreasing trend of OC was found with the increase in the soil depth under all land uses. Highest organic carbon content was found in forest soils, which may due to the higher tree density resulting in higher litter addition.



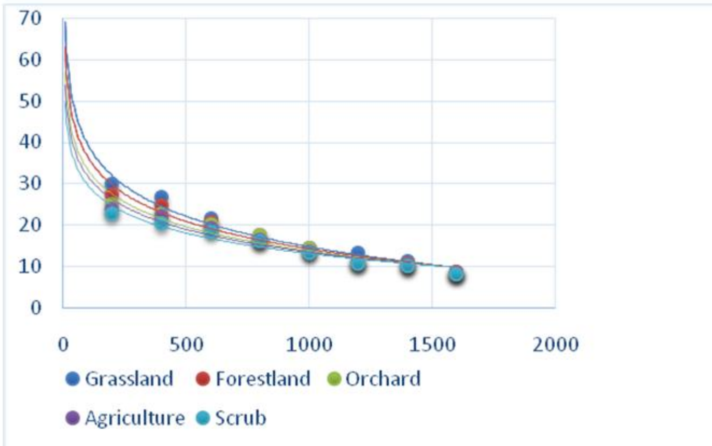


Fig 1: Moisture retention under different land uses in surface and sub-surface layer

Table 2: Hydraulic properties of soils under different land uses

Landuses	MWHC (%)		K_s x 10^{-5} (ms^{-1})		AW (w/w, %)	
	Soil depth (m)					
	0.0-0.15	0.15-0.30	0.0-0.15	0.15-0.30	0.0-0.15	0.15-0.30
Forest	41.58	41.53	1.88	1.50	17.78	15.03
Grassland	28.15	29.82	2.05	1.94	12.53	12.27
Agrisilviculture	41.83	40.53	1.46	0.95	16.09	14.79
Vegetable	38.73	37.38	1.68	1.37	12.56	13.61

Conclusion

The soils of Ga3a micro-watershed in district Solan of Himachal Pradesh are coarse in texture with sand constituting the major fraction. Soils are characterized by high bulk density. Among the land uses, forest and grasslands have better aggregate stability due to higher organic matter contents and presence of vegetative cover. The various land uses has direct impact on soil organic carbon MWHC and available water.

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