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Comparative study of soil physico-chemical properties under forest and agricultural lands of West Bengal

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Abstract
In order to generate data and compare the differences in soil properties under varying land use the present investigation was taken into consideration. The main objective of this study was to determine some chemical and physical properties of soil under forest and agricultural lands of West Bengal. Rasomati forest (26°27’N, 88°20'E) of Pundibari range of Cooch Behar forest division was selected as the study area. It is a tropical moist-deciduous forest, situated in the Terai region of the southern foothill of eastern Himalaya .The soil samples were collected from Rasomoti and Sonapur forest range along with from the agricultural fields of the neighbouring areas. Soil basic parameters like pH, effective cation exchange capacity and texture were measured. Soil samples were collected from surface (0-20 cm) .The amount of leaf and litter fall per unit area per month was measured as these are the key input source of C in forest soils. Basic soil physico-chemical properties like pH, soil texture and CEC were analysed using standard procedure. The data usually shows that after long term continuous cultivation of the natural forest soils resulted in change in soils both in physical and chemical characteristics. However, results processed so far indicate acidic type of soil irrespective of landuse with silty loam texture (surface soil) and the dominance of exchangeable Ca and Mg with little of exchangeable Al.

Keywords: Forest lands, agricultural land, physico-chemical properties

1. Introduction
Forests ecosystems spreading about 4,0333 million hectare globally (FAO, 2010) [12]. This ecosystem is considered as a major sink of terrestrial C stock (Richter *et al*., 1995) [13]. Due to growing demands of timber and other forest products, the natural forests are being converted to pure plantation resulting lower infiltration rate, lower particulate organic C (POC), light fraction organic C (LFOC) and microbial biomass C (MBC) (Yang *et al*., 2009) [14]. Thus, understanding the mechanisms in forest soils is important to identify and enhance natural sinks for C sequestration, to mitigate the Global climate change (Lal, 2005) [15]. The researchers also reported that the transformation of natural forest to other forms of land use promotes soil erosion, loss of soil quality and modification of soil structure (Lichon, 1993; Chen *et al*., 2001) [3, 4]. The land use also affect microbial dynamics. The conversion of forest land into other land use system decreases the amount of soil nutrient. The low values of CEC in proportion to their organic matter may be due to dominance of illite and kaolinite clay. The C loss is lower with increase in the clay content. Individual tree species influence the C and N dynamics (Finzi *et al*., 1998) [8]. Soil is a complex system wherein chemical, physical and biochemical factors are held in dynamic equilibrium. Land use changes such as forest clearing, cultivation and pasture introduction are responsible for changes in soil chemical, physical and biological properties (Houghton *et al*., 1999) [5], but the sign and magnitude of these changes vary according to land cover and land management (Baskin, Binkley, 1998) [6]. The wide range of land use and soil/ vegetation management options (Lal, 1997) [16] such as integrated nutrient management, mulch farming, conservation tillage and diverse crop rotations based on legumes and cover crops in the rotation cycle helps in the enhancement of the SOC density, and aggregation improvement (Lal, 2004) [17]. The effects of land use change on C storage are of increasing concern in context of converting forest ecosystem to agricultural land in terms of greenhouse gas emission mitigation (Yang *et al*., 2009) [14].
The future objective is to understand the changing regional heterogeneities, and to quantify linkages between land-use and land-cover changes, climate change, and other human and environmental components. Therefore, land-use and land-cover changes have been focal point of scientific researches since long time (Matson *et al*., 1997) [1]. The study of land use changes from the past to the present will contribute greatly to the planning work to be done concerning

the future (Kizilkaya and Dengiz, 2010) [9]. It will also help in making the environment more sustainable to live in (Gulgun *et al*., 2009) [7].

2. Materials and Methods

2.1. Study area

This study was conducted in northern part of Cooch Behar District of West Bengal, India. Following the set of objective of the present study, forest (natural as well as plantation) and agricultural land use were considered for soil sampling. Rasomati forest (tropical moist semi-evergreen forest), located at 26°27' N latitude and 88°19'E longitude with an elevation of 66 m above mean sea level, was selected for collection of forest soil samples. This area comes under Pundibari forest range of Cooch Behar forest division, at the foothills of sub-Himalayan mountain belts. The agricultural lands were selected from the nearby villages. The average minimum and maximum temperature of this area varied from 23 °C during winter (January) to 33 °C during summer (July) (data of nearest station as obtained from ClimWat). On an average, the annual rainfall varies from 2000 mm to 3500 mm, bulk of which is being received during pre-monsoon and monsoon period i.e. May to September. This area belongs to warm and humid climate except a short spell of winter extending from December to February.

2.2. Soil Sampling

Soil sampling was done in the month of March, 2018 (pre-monsoon) from the forest and cultivated lands. 14 soil samples were collected from these forests while 13 were collected from arable lands. Composite sampling (5 samples for a soil samples) were done. To exactly determine the sampling locations, hand-held GPS receiver (Garmin, Olathe, KS, USA) was used.

2.3. Soil analysis

This air dried soil was then passed through 5 mm sieve (used for aggregate analysis) and 2 mm sieve (used for physico-chemical analysis).

2.3.1. Determination of basic soil properties

2.3.1.1 Soil pH

The pH of the samples was determined using a pH meter (Utech instrument pH 600) with glass electrode. The pH meter was first adjusted to temperature and then calibrated using three buffers of 4.0 ± 0.05, 7.0 ± 0.05 and 9.2 ± 0.05 pH. The pH was determined in 1:2.5::soil:water suspension. After 5 min of continuous stirring with a glass rod, the pH of the suspension was determined.

2.3.1.2 Soil effective cation exchange capacity (ECEC)

Soil Ca, Mg, Na, K, and Al were estimated individually and their summation was expressed as soil ECEC. The 1st four elements were extracted using 1.0 *N* ammonium acetate (NH4OAc) at pH 7.0 (Mandal *et al*., 2007) [10]. Each of the elements were estimated using Flame photometer. For Al, soil was extracted using KCl. The filtered aliquot of each of the samples were titrated using NaOH.

2.3.1.3 Soil particle size distributions

Particle size distributions of the soils were determined following the International pipette method (Gee and Or, 2002) [11]. From the percent contents of sand, silt and clay, the textural class of the soil was determined with help of triangular textural diagram.

3. Result and Discussion

Study of soil basic physico-chemical properties indicated presence of acidic soils in this area, irrespective of land use. Fig 1. indicated less soil pH in agricultural lands ($\bar{x}$ 5.04) in comparison to forest lands ($\bar{x}$ 6.34). This is a bit surprising as arable soils receives annual/ bi-annual liming. Possibly basic nature of the leaves of the semi evergreen forest trees and continuous addition of organic matter in soil from the leaf-litter deposits was responsible for this.

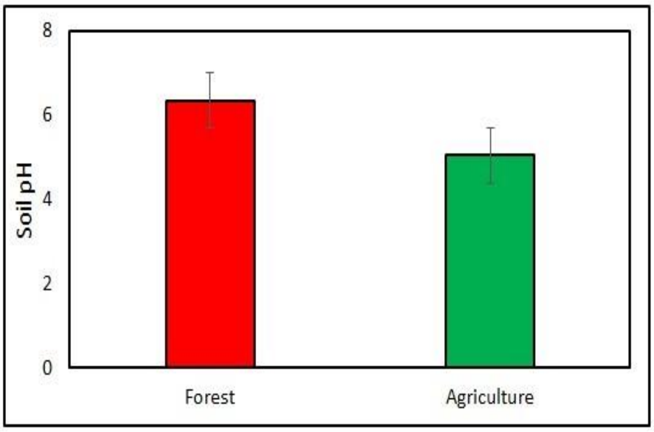

Fig 1: Soil pH under different land use

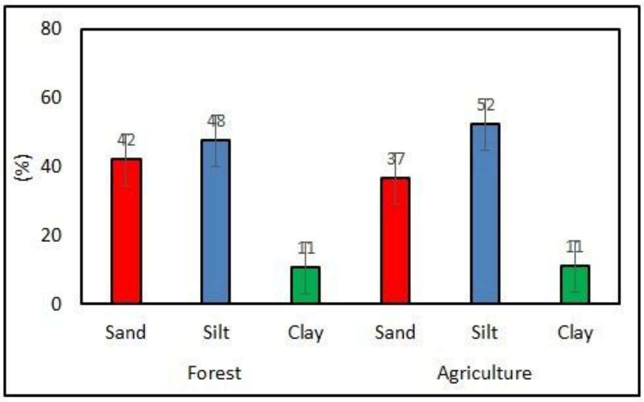

Fig 2: Soil texture under different land use

The soils were sandy loam, silty loam or loamy in texture (Fig 2). The average clay content of the soil was 10%. Clay percentage in soil is important as it controls soil C fixation and residence time. The silt percentage was highest in the soils texture, mainly clay % determines the cation exchange capacity (CEC). As this soils were acidic irrespective of land use, this study measured soil effective CEC (ECEC), i.e. the summation of exchangeable K, Na, Ca, Mg and Al.

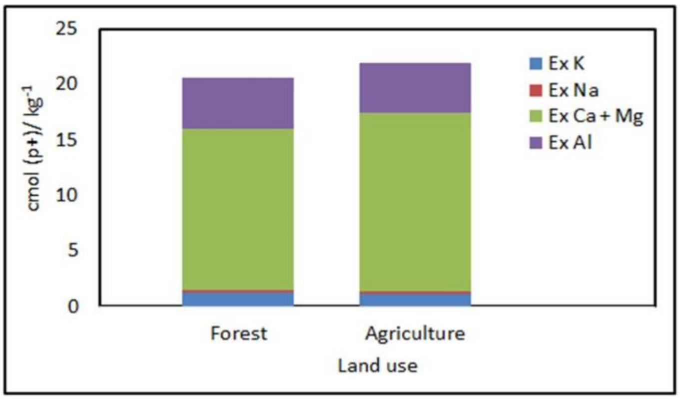

Fig 3: Effective cation exchange capacity of the soils (ECEC)

4. Conclusion

The soil pH was found higher in forest soil as compared to the agricultural land. The clay % was more or less similar under both the land use, silt % found higher under agricultural land and the fine sand % is higher in forest land compared to agricultural land. Results also indicated the dominance of Ca and Mg along with K in exchangeable complex. There was also noticeable amount of exchangeable Al present in the soil. The ECEC was found higher in agricultural soil which may be due to less organic matter found in this type of land use in comparison to forest cover.

The main constraints of these soils were low pH, which is responsible for low availability of nutrients for which liming is much more needed. The acidity of these areas is also due to leaching of bases due to high amount of rainfall. The low pH and light textured soil also limit the crop production but these are suitable for tea cultivation.

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