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Physico-Chemical Properties of Soils with Special Reference to Organic Carbon Stock under Different Land Use Systems in Dimoria Tribal Belt of Assam

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Abstract: *Soil quality mainly depends on the response of soil to different land use systems and management practices, which may often modify the soil properties and hence soil productivity. The important soil quality indicators were investigated under different land use systems of Dimoria Tribal Belt of Assam. In total 7 stations were selected. One station each from bamboo grooves, teak plantation, rubber plantation, shifting cultivation, orange orchard, low land rice field and natural forest were selected. The findings of this study revealed that the soil texture varied in all the land use types. Soil moisture percentage ranged from 16.1% to 24.31% in different land use systems and it was found highest in bamboo plantation. The soil was strongly acidic to moderately acidic with p^H ranging from 5.2 to 6.26 in all the land use systems. The average OM content was highest in bamboo grooves and lowest in teak plantation. The available potassium and nitrate nitrogen was found higher in rice-cultivated land than in compared to other land use systems. While the natural forest had relatively higher amount of available phosphorus.*

Keywords: *Land use system, Physico-chemical properties, Soil organic carbon, Soil quality*.

I. Introduction

Soil, the uppermost layer of the earth's crust, is one of the most important natural resources that exist since it is the basic sustaining life on the planet. Soil may be defined as a thin layer of earth's crust, which serves as a natural medium for growth of plants. Soil differs from the parent material in the morphological, physical, chemical and biological properties. The components of soil are mineral matter, organic matter, water and air, the proportions of which vary and which together form a system for plant growth.

Soils are the fundamental resource supporting agriculture and forestry, as well as contributing to the aesthetics of a green planet. By supporting plant growth, soil becomes a major determinant of atmospheric composition and therefore earth's climate. World soils contain an important pool of active carbon that plays a major role in the global carbon cycle (Lal, 1995, Melillo et al., 1995). Soils store two or three times more carbon than that exists in the atmosphere as CO_2. (Davidson et al., 2000) and 2.5 to 3 times as much as that stored in plants (Post et al., 1990).

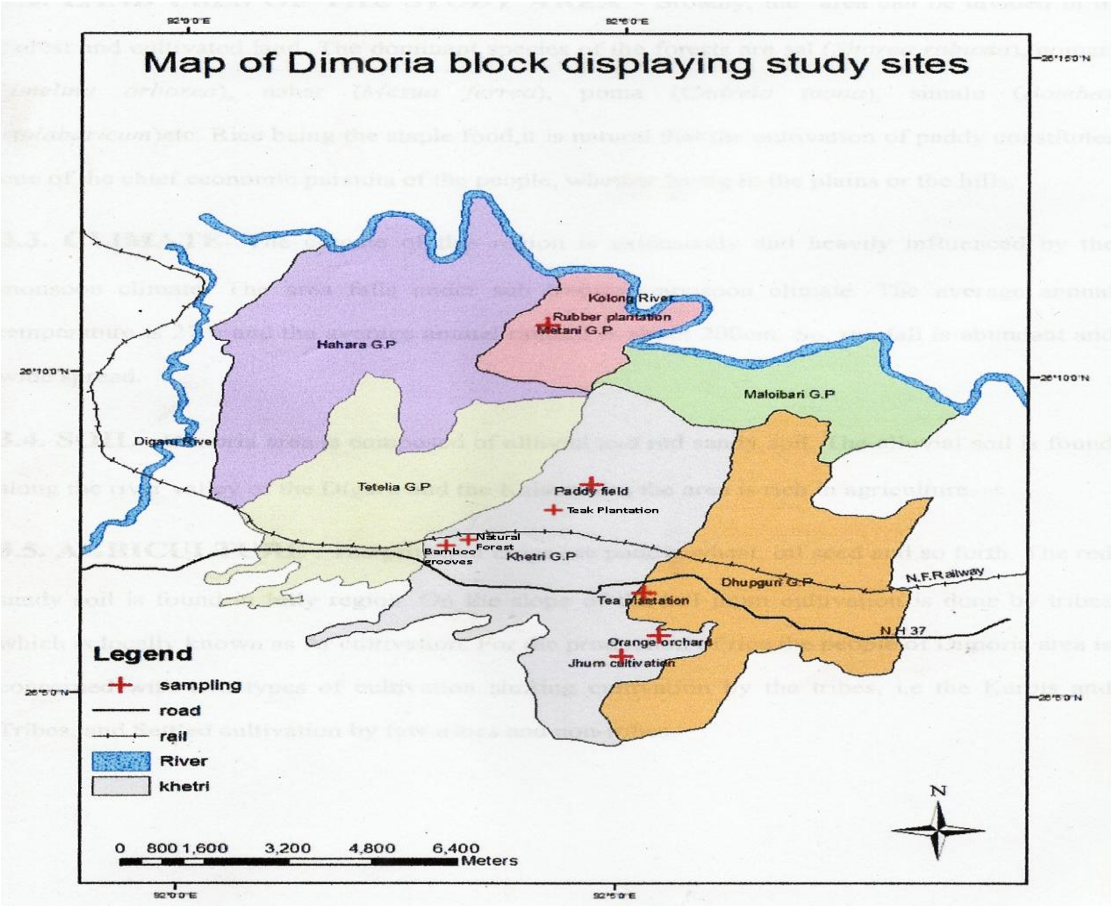
Soil is the single most important non-renewable resource for people's food and livelihood in the rural area. In a developing country like India where the majority of the population is still dependent on forest and agriculture, maintenance and improvement of soil quality is a prime concern. The plant growth is directly dependent on good soil functions. The soil resources of Asia particularly the south Asian countries will continue to deteriorate mainly due to increasing population. The study will provide information on the distribution and status of major nutrients, SOC and other soil properties.

The soil nutrients vary with respect to land use and management. The general factors affecting soil quality are elevation, aspect, land use and parent materials. The nutrient content of agricultural land may also vary significantly from that of forestland. Similarly, the nutrient content in a rubber garden may vary from that of orange garden. Farming systems have strong influence on soil properties, such as organic matter (OM), pH and major nutrients. Land use and soil management practices can significantly influence soil organic SOC dynamics and C flux from the soil (Paustian et al., 1995, Batjes, 1996, Post and Kwon, 2000, Tian et al. 1999, McGuire et al., 2001).

1.2 Study area

The Dimoria Tribal Development Block is situated in the South Eastern part of the Kamrup District of Assam and on the South bank of the river Brahmaputra. It is bounded by Meghalaya on the South, by Morigaon District on the North East, and by greater Guwahati City on the West upto Jorabat Amrigog. The climate of this region is extensively and heavily influenced by the monsoon climate. The area falls under sub tropical monsoon climate. The average annual temperature is 27^0c and the average annual rainfall is about 200cm. So, rainfall is abundant and widespread.

The people of this region practice different land use systems like Food agriculture, Bamboo plantation, Horticulture, Agro-forestry, Natural forest, Shifting cultivation, etc. Dimoria area is composed of alluvial and red sandy soil. The alluvial soil is found along the river valley of the Digaru and the Kalang. So, the area is rich in agriculture. The principal crops are paddy, wheat, oil seed and so forth. The red sandy soil is found in hilly region. On the slope of the hill jhum cultivation is done by tribes, which is locally known as Ar cultivation. Rice, being the staple food, it is natural that the cultivation of paddy constitute one of the chief economic pursuits of the people, whether living in the plains or hills.



1.3 Objectives of the study

The main aim of the research work is to find out the changes in soil physical and chemical properties under different land-use systems prevailing in the area. The changes will be deduced from direct comparison with relatively undisturbed soil within the same climatic regime.

The objectives are based on the following: -

- To identify the variation of different soil properties with respect to land use.
- To identify the soil quality indicator of different land use systems.
- To quantify carbon stock in different land uses in relation to other soil parameters.

II. Methodology

2.1 Selection of sampling station

For the purpose of this study samples were collected from different land uses of the area. In total 7 stations were selected. One station each from bamboo plantation, teak plantation, rubber plantation, shifting cultivation, orange orchard, low land rice field and natural forest were selected. Three soil samples at 0-15 cm depth were collected randomly from each station.

2.2 Sampling procedure

In order to collect soil samples (0-15 cm depth) grasses, mosses, litter and other plant residues were removed from soil surface. Collection of soil samples was done by using an auger. In each case, a triangular block was cut with the help of the auger. Soils were collected in plastic bags, which were sealed, and labeled properly. Three soil samples from a rooting depth of 15 cm were collected randomly from each station of natural forest, bamboo, teak and rubber plantations. One sample each was also taken from 0 to 15 cm layer for bulk density determination.

Soil samples were brought to the laboratory for analysis. Before analysis, the samples were spread out thinly on a piece of hard paper for drying in air in a shade. The big lumps were broken down, and plant roots, pebbles and other undesirable matter were removed. After the soil become completely dry, it was sieved through a 2mm sieve. The samples were preserved in clean sealed polythene bags for analysis.

2.3 Soil quality parameters and methodology for their study

A large number of parameters are generally used to characterize the soil quality criteria. The most important consideration should be those properties of soil, which influence the movement and retention of water that contribute to store and supply of nutrients. In this study some selected physical and chemical parameters were determined.

2.3.1. Physical parameters

- Temperature
- Texture
- Bulk density
- Moisture content

2.3.2. Chemical parameters

- P^H
- Organic matter
- Nitrate
- Phosphorus
- Potassium

The different parameters that were used to assess soil quality of different land uses are shown in Table 1.

Table 1: Soil Properties Under Study With Their Methods Of Measurement

Soil properties	Methods
Bulk density	Core sampling method (Blake and Hartge, 1986)
Texture	Feel method
Temperature	Soil thermometer
Moisture content	Moisture meter
Ph	pH meter.
Organic matter	Titrimetric method (Walkley and Black, 1934). % Soil organic matter =% organic carbon x 1.724 (Allison, L.E., 1965)
Nitrate nitrogen	Spectrophotometric method
Available phosphorus	Spectrophotometric method
Available potassium	Flame photometer method (1986)

III. Results And Discussion

3.1 Results of soil physico-chemical parameters analysed

The soil quality has been discussed with respect to some representative physico chemical parameters. The results have been discussed on the basis of existing literature.

Table 2: Mean ± SE of selected soil (0-15 cm) physical properties in the land use systems

Properties	Land use systems						
	Rubber Plantation	Orange Orchard	Teak Plantation	Rice field	Shifting Cultivation	Bamboo	Natural Forest
	Mean S.E	Mean S.E	Mean S.E	Mean S.E	Mean S.E	Mean S.E	Mean S.E
Temperature	24.67 ± 0.33	22 ± 0.33	29.67 ± 0.33	28 ± 0.33	22 ± 0.33	22.33 ± 0.33	21.67 ± 0.33
Moisture (%)	20.68 ± 11.95	19.7 ± 8.85	16.1 ± 3.90	17 ± 4.90	19.4 ± 7.95	24.31 ± 10.73	22.2 ± 8.34
Bulk density (g/cm^3)	1.32 ± 0.004	1.17 ± 0.004	1.41 ± 0.002	1.34 ±0.002	1.22 ± 0.004	1.07 ± 0.003	1.33 ± 0.003
Texture	Silt Loam	Silt loam	Loamy Sand	Clay loam	Silty Clay Loam	Silty Clay Loam	Silt Loam

Table 3: Mean ± SE of selected soil (0-15 cm) chemical properties in the land use systems.

Properties	Land use systems						
	Rubber Plantation	Orange Orchard	Teak Plantation	Rice field	Shifting Cultivation	Bamboo	Natural Forest
	Mean S.E	Mean S.E	Mean S.E	Mean S.E	Mean S.E	Mean S.E	Mean S.E
pH	5.2 ±0.79	5.9 ± 0.36	5.47 ±0.36	6.26 ± 0.32	6.08 ± 0.47	5.4 ±0.27	5.13 ±0.22
Organic Matter (%)	3.15 ±0.05	3.62 ± 0.14	2.65 ±0.12	2.81 ± 0.25	3.31 ± 0.31	3.80 ±0.05	3.04 ±0.04
NO3 N (mg/Kg)	1.97 ±0.32	3.6 ± 0.22	1.6 ±0.04	4.6 ± 0.25	4.15 ± 0.32	2.83 ±0.33	1.9 ±0.00
AP (Kg/ha)	7.92 ±0.64	12.8 ± 5.25	11.84 ±4.32	14.5 ± 3.32	13.4 ± 1.68	10.06 ±1.49	15.82 ±18.29
AK (Kg/ha)	26.73 ±52.75	71 ± 27.33	26.01 ±11.7	82.5 ± 19.7	75.1 ± 31.75	34.80 ±9.33	43.29 ±9.33

The soil temperature was found highest in teak plantation (29.67^{0}C) followed by bamboo grooves (29.33^{0}C), whereas the soil temperature of natural forest was 21.67^{0}C .It may be due to presence of thick plant cover on the land during the sampling time. The average moisture content of soils ranged from 16.1% to 24.31% for different land use systems. The highest percentage of moisture was noted in bamboo plantation. Soil in teak plantation had relatively less moisture content. The average bulk density of soil ranged from 1.07 to 1.41 for different land use systems. Teak plantation had higher amount of bulk density while bamboo grooves had lower amount of bulk density. Soil in the bamboo plantation and shifting cultivation was fine textured, clay or silty clay soil. In teak plantation, coarse or sandy textured soil was found. While the texture of rubber plantation was sandy loam. In natural forest, rubber and orange orchard, texture of soil was silt loam, sandy loam or loam. The average value of p^H ranged from 5.13 to 6.26 for different land use types. The pH of soil samples were found acidic in almost all the samples. The average amount of organic matter ranged from 2.65% to 3.80% for all the land use systems. In bamboo grooves, the organic matter amount was found highest. Lowest amount of OM was found in teak plantation. The average amount of nitrate nitrogen was found to be between 1.6 to 4.6 ppm in different land use types. Rice field had relatively higher values of nitrate nitrogen. It may be attributed due to addition of synthetic nitrogen as fertilizers. Teak plantation had relatively lower value of nitrate nitrogen. The average amount of phosphorus in soil ranged from 7.92 to 15.82 kg/ha for different land use types. In comparison with natural forest, all the land uses had relatively lower value of phosphorus. The average amount of available potassium among different land use system ranged from 26.01 ppm to 82.5 kg/ha. Higher amount of available potassium was found in rice field. While, teak had lower amount of available potassium.

IV. Conclusion

Depending on soil conditions like nutrient availability, pH, aeration, temperature, moisture etc. the soil quality varies. Rice is generally cultivated in basic or low acidic pH soils and rice straws are left in the field, hence due to decomposition and recycling of straw organic phosphates, the rice field was rich with available phosphorus. The amount of nitrate nitrogen, P and K in the rice field may be due to the use of NPK fertilizers in the field. Moreover easy and rapid grazing of cattle in the field enhances the nitrate content of the soil.

Most of the soil samples revealed organic matter above 3%, which were moderate according to ICAR rating, 1997. The organic matter was found highest in bamboo grooves followed by orange orchard and natural forest. The teak plantation was poor in this respect. The reason may be that the soil is sandy and low under vegetation. Whereas, the others experience regular falling down of leaves which may increase the soil organic carbon and thus the total organic matter.

The temperature of teak and rice field was found comparatively high. It may be due to absence of plant cover. As it was very much exposed to the sun the soil temperature of the rice field was found higher and the moisture content of the soil was found low as in compared to the other sites.

The bulk density depends on factors such as compaction, consolidation of the soil but it is negatively correlated to the organic content.

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