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Diagnostic Study of Surface Soil: A Case Study of Selected Mouzas of Dhupguri Block, Jalpaiguri, West Bengal

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Abstract

Dhupguri Block is located over the extensive piedmonts of the Doors of North Bengal where the economy principally bases on agriculture and as such it is necessary and important to evaluate the status of surface soil from the perspectives of geography as well as the status of fertility. The entire block in general contains an admixture of sandy loam and silty loam type of soils. The present study is based on field observations on the pedogenic factors in general and a number of properties like nature of profile, NPK status, soil pH, organic carbon in particular.

Introduction

Soil is simply defined as an accumulation of natural particles on the terrestrial surface of the earth consisting of both the biotic and abiotic substances. It plays a vital role in plant growth. Dhupguri block is located in the middle part of Jalpaiguri district extending from its northern to southern boundary. The district basically has a monsoon climate. Apparently, the lack of irrigation facilities have resulted in the agricultural backwardness in terms of appliances and chemical fertilizers. The support of modern technology has to be implemented on a priority basis to initiate development in the agrarian sector and also in the socio-economic sphere. The present work is an attempt to analyse the surface soil status of the study area.

In arable soils, operations like ploughing, harrowing, etc. bring about changes in the upper few centimeters of the soil (Daji, 1998). Actually it is this layer which gets maximum alterations through all kinds of known procedures of farming. It is demarcated by the maximum plough line and is known as top soil or surface soil layer. It is followed and surrounded by the sub soils. The surface soil is about 22 cm thick and usually forms a part of horizon A (Daji and Kadam, 1998).

Methodology

Related methodological approaches are divided into two heads as furnished below —

1. Laboratory Assessments(secondary sources):

a. The pH of the soil samples has been found by Kuhn's colorimetric method.
b. Organic carbon and organic matter has been determined by Walkley and Black's method.
c. Munshell Colour Chart has been used to identify colours of the soil samples.

2. Data Presentations:

Maps have been prepared under GIS platforms to present the spatial variations of the soil properties.

Study Area

Dhupguri is situated at an altitude of almost 76 m from m.s.l. (mean sea level). The northern part of the block is comparatively higher in altitude than the southern part and the former is mostly covered with tea gardens and forests. Maximum concentration of settlements has

developed at the junctions of roads in the block headquarter. The southern part cointains extensive alluvial plains used for cultivation (Fig. 2.a).

Climate

The study area receives about 300 - 320 cm of rain annually, 90% of which falls between April and September, and remaining 10% occurs between October and March (Table - 1). July is the wettest month and and January is the driest month. Pre-monsoon showers starts from February and gradually go on increasing till the end of March and is followed by the onset of monsoon heavy showers (MHS). Seasonal and spatial variations of rainfall influences soil character in a big way by shaping up run-off, leaching, sub-surface flow and plant associations. Humidity is maximum (90 - 95%) during rainy season with an average of 75 - 80% and rarely falls below 50%.Mean monthly maximum temperature is highest in May, August and September and minimum in January. Mean monthly minimum temperature is highest in July and August and minimum in January. Thus monthly range of temperature is highest in January - February while the annual range is of the order of about 9°C (Table - 1).

Drainage

The study area is drained by a large number of rivers namely, Jaldhaka, Gilandi, Kumlai, Balasai, Dudua and so on. Most of these get bankfull discharge during rains and wetted perimeter increases with the onset of heavy monsoon showers and often cause local floods.

Soil Properties

(a) Texture

The textural composition of soil in Dhupguri block has been determined in the laboratory test reports using 22 samples collected from various locations from a depth of about 20 cm, i.e., plough line (Table- 2a and 2b). Such diagnostic surface horizons are called epipedon or the upper part of the soil which are usually darkened by organic matter (Brady, 2001). The result shows that loam, sandy loam and silty loam predominate in the study area (Block Agricultural Development Office, 2012).

Agricultural practices are very much dependent upon mechanical properties of soil that influences the permeability and porosity. Sandy soil is more porous, sily soils contain more nutrients while clay soils are impermeable that hinders soil drainage and aeration. Mechanical analysis shows that —

a) Soil is more porous in Chamurchi and Patkidaha than in Riabari and Jalapara as the content of coarse sand is comparatively higher.

b)With more than 30% silt content, soils of Jalapara, Sakojhora and Riabari stand tall in productivity of crops.

c) The mouzas of Riabari and Sakojhora have clay soils with lower potentials of crop yield (Table-3).

(B) pH

Most of the soils in the study area of Dhupguri Block have been found ranging between 5-6 value of *pH* i.e. moderately acidic.7.0 is considered as neutral (Hussain M, 1999). In the northern part of the block the mouzas like Chmurchi, Jalapara, Riabari are having 6-7 *pH* alue i.e. slightly acidic in nature. Mouza Sakojhora is having 7.6 value of *pH*, i.e. alkaline in nature. Thus the overall range of *pH* of these samples is within 4.2 to 7.6.

The highly acidic soil has been found in the areas like Madhya Khuttimari, Red Bank, Binnaguri Tea Garden area, Maynatali, and Dakshin Jhar Altagram which are showing the *pH* value of 4.2 - 4.6. Though maximum samples are having the *pH* value ranging from 5.0 to 6.0 (fig.4), an overall assessment generalizes that the northern part of Dhupguri block shows comparatively lower *pH* value than that of southern part, enriching the soil for Tea Cultivation. On the basis of the general textural properties (mechanical) mainly three soil categories are available in Dhupguri: (a) shallow to moderate coarse loam, (b) deep to very deep clay loam, and (c) deep to very deep clay resulted from past flood submergences.

Fig. 4 shows the mouzawise distribution of *pH*. Agricultural practices are very much dependent upon mechanical properties of soil i.e. mechanical composition of soil, simply meaning that the percentage of sand, silt and clay, as the magnitude of permeability and porosity of pine sand particle bearing soil is much higher than fine and non coarse sand bearing soil. At the same time silt bearing soils contribute to the good nutrient quality of the soil and clay content signifies good water holding capacity of soil, Sample study shows that —

a) With more sand content, soils of Chamurchi and Patkidaha are more porous that those of Riabari and Jalapara.

b) With 30% silt content, general productivity of crops in Jalapara, Sakojhora and Riabari stand quite tall.

c) With 10 - 20% clay content, soils of Riabari and Sakojhora are more sticky having greater moisture / water storage (Table-3).

The pH - organic matter relationship is positive but not significant as the value of R^2 is only 0.028 (fig.5).

(c) Organic Matter

The decomposition of dead animals and plants results in the accumulation of organic matter in the soil. The micro organisms are involved in the decay of the organic matter and the soil mixed up with these organic compounds is commonly known as 'Humus' (Jenny, 1941). This plays an important role in the storage of soil nutrients for plants. Table -2 shows that the average percentage of organic matter content in the surface soil of the study area is moderate, which varies from 0.37% to 3.57%. Basically it varies depending on the density of vegetation. Due to medium density of vegetation, soils have moderate organic matter content.

It is highest in Binnaguri with 3.57% organic matter and 2.55% organic carbon and very low (0.37%) in Purba Duramari (fig. 3).

(d) Organic Carbon

It results from the decomposition of organic matter by microorganism. Organic matter serves as a moisture reservoir in sandy soils where water enters easily but leaves just as easily (Joffe, 1953). It is one of the macro elements highly required for plant nutrition. Almost 50% of any organic matter is its carbon content. The surface soil of Dhupguri block has organic carbon content ranging roughly from 0.03% to 2.55%. Generally, the tea gardes and some lowland areas have high carbon content.

(e) Color

It is an important and useful characteristic to know the soil attitude in relation to its nutrient value. It helps to estimate qualitatively and quantitatively the organic matter content, wetness of soil and soil mineral status plus inheritance from its parent material can even be verified. The Munsell colour system has been considered for the present study (Table - 4). The system has three components: hue (a specific color), value (lightness and darkness), and chroma (color intensity) that are arranged in books of color chips. Soil is held next to the chips to find a visual match and then assigned the corresponding Munsell notation. For example, a brown soil is noted as: hue value/chroma (10YR 5/3). In A-horizon, intensely darker shades are observed with higher content of organic matter than lighter shades. Soil colour is also related to drainage.

Light and dark gray soils are found in Sakojhora village due to higher organic matter. In areas of high rainfall colour is somewhat brownish, indicating poor drainage and steady washouts. Most of Dhupguri comprises light gray and light brown soils, e.g., Chamurchi, Jalapara, Madhya Salbari and Bhotpara. Dull colour, usually grey, is a sign of drainage problems for a major period of the year. Light olive gray colour is found only in Patkidaha that has loose sand - silt combination. Light gray to brown soils are found in Gayerkata and Binnaguri villages. Thus, light gray soils are more common as the proportion of litter compost is low to moderate.

(f) CEC

It means the ability of bases in the soil to absorb dissolved substances from solution (Brady, 2001). Simply it is the exchange of cations or bases between soil and salt contents (Dey, 2002). When soil is allowed to react with the naturally induced overland flow in solution of the KCL, portion of K is absorbed by the soil and an equivalent amount of Calcium (Ca) is displaced into solution, as follows:

$$Ca\ Soil + 2Kcl = K_2\ Soil + CaCl_2$$

The accumulation of calcium oxide on the surface soil has been shown (Table - 3) for some selected villages. It varies from 1.4% (Madhya Salbari) to 20.8% (Patkidaha). The CaO content of the block remains below 6.0% in most of the mouzas. It is unexpectedly high in Patkidaha (20.8%).

Soil Fertility Status

Nitrogen (N_2)

Nitrogen is essential for plant growth after only carbon, hydrogen, and oxygen and is the most demanded one by the plants. Its deficiency can be identified through bad health of the older leaves that become pale green or yellow. In such situation, crop growth becomes slow and yields are reduced. It is found to be 0.085% in Jalapara and 0.039% in Patkidaha. Hence, the overall soil quality is poor (Table - 3).

Phosphorus (P_2O_5) It is the prime source of phosphorus essential for plant growth and nutrition. It determines more energy storage and strength building capacity of bones stored in good quality grains. It is found to be highest in Jalapara (0.17%) and lowest in Patkidaha (0.079%) (Table - 3).

Potassium (K_2O) It plays the role of an important fertilizer element of the surface soil, which is essential for proper plant growth (Table - 3).Though the amount of K_2O varies at places within the study area, it is found to be in the range of highest (0.88%) at Chamurchi and lowest (0.29%) in Riabari.

Concluding Remarks

The study area is basically a forested tract inhabited by people dependant on forest. Currently, it has grown as a center for trade and commerce, although the dominant occupation still is agriculture which is definitely a function of the quality of soil in terms of its fertility status. It is found that the soils are dominantly alkaline although in some areas it is moderate to slightly acidic in reaction. In general, it is poor in nitrogen with low to medium organic matter and phosphorous, and medium to high potash content. The poor soils are often treated with chemical fertilizers by the farmers for better harvest and eventually it results in soil degradation. This is evident from the field observations and measurements before and after the application of chemical fertilizer.

Acknowledgement

Authors are thankful to all the respondents mainly farmers who generously shared their life-long experiences and also indebted to their parents and teachers for support and encouragement.

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Table -1: Variations in Rainfall and Temperature

Month	Temperature (in Degree C)		Rainfall (mm)
	Maximum	Minimum	
January	21	9	8
February	26	14	61
March	28	17	103
April	30	21	202
May	33	23	260
June	32	25	630
July	32	26	1234
August	33	26	432
September	33	25	550
October	31	23	314
November	29	18	24
December	27	14	24

Source: District Statistical Handbook, Jalpaiguri, 2004

Table - 2: Spatial Variation of pH, Organic Matter and Organic Carbon in the Study Area (May, 2012)

Village	JL No.	Sample No.	Depth (cm)	pH	Organic Matter (%)	Organic Carbon (%)
Chamurchi	4	1	0-20.0	6.1	1.40	0.85
Jalapara	7	2	0-30.0	6.0	1.10	0.56
Riabari	30	3	0-22.0	6.1	1.11	0.64
Madhya Salbari	36	4	0-20.0	6.0	2.20	1.10
Sakojhora	21	5	0-25.0	7.6	1.80	0.74
Patkidaha	80	6	0-20.0	5.9	0.98	0.30
Bhotpara	84	7	0-30.0	5.0	2.80	1.25
MadhyaKhuttimari	46	8	0-20.0	4.6	1.11	0.64
Purba Duramari	37	9	0-20.0	6.0	0.37	0.21
Red Bank	2	10	0-20.0	4.2	1.51	0.88
Binnaguri	19	11	0-17.5	6.0	3.57	2.55
Gayerkata	26	12	0-20.0	5.6	2.38	1.38
Bhatiapara	41	13	0-20.0	6.5	1.41	0.82
South Moraghat Forest	28	14	0-28.0	5.9	2.28	1.33
Jurapani	107	15	0-20.0	5.9	1.88	1.09
Dakshin Gossairhat	97	16	0-28.0	4.6	0.71	0.41
Maynatali	77	17	0-20.0	5.9	2.08	1.21
Dakshin JharAltagram	66	18	0-22.0	4.6	1.01	0.59
Kazipara	101	19	0-20.0	4.6	1.95	1.13
Dakshin Khayerbari	83	20	0-20.0	6.0	2.02	1.17
Khalaigram	85	21	0-20.0	6.0	3.13	1.81
JharMagurmari	63	22	0-35.0	5.9	2.61	1.57

Source: Laboratory Testing from Tea Science Department, University of North Bengal, 2012 (Ref: T. Sc/L-2/12-13 dtd.30/5/2012;Lab:68-69, Test: 01; Samples 01-14); Samples 15-22: Soil Test, Pedological Laboratory, Deptt. of Geography and Applied Geography, NBU, 2005.

Table - 3: Spatial Variation of pH, Organic Matter and Organic Carbon in the Study Area (May, 2013)

Village	JL No.	Sample No.	Depth (cm)	pH	Organic Matter (%)	Organic Carbon (%)
Banarhat	-	1	0-20.0	4.58	2.20	1.28
Sakojhora	-	5	0-20.0	5.19	2.63	1.53
Madhya Salbari	36	7	0-20.0	5.09	2.55	1.48
Sakojhora	21	6	0-25.0	4.08	1.38	0.88
Patkidaha	80	8	0-20.0	4.92	2.39	1.39
Red Bank	2	10	0-20.0	5.00	2.41	1.40
Binnaguri	19	4	0-17.5	4.88	2.55	2.55
Gayerkata	26	2	0-20.0	4.81	2.25	1.31
South Moraghat Forest	28	3	0-28.0	5.01	2.39	1.39
JharMagurmari	63	9	0-35.0	5.41	2.51	1.46

Source: Laboratory Testing from Tea Science Department,

Table - 4: Surface Soil Test Report on important Soil Constituting Contents (May, 2012)

Village	Chamurchi	Riabari	Jalapara	Madhya Salbari	Sakojhora	Patkidaha
JL No.	4	30	7	36	21	80
Depth (cm)	0-35.56	0-30.48	0-38.1	0-35.56	0-30.48	0-50.8
Coarse Sand (%)	47.92	0.72	1.63	11.22	0.51	24.14
Pine Sand (%)	32.80	46.77	21.40	50.27	30.66	57.20
Silt (%)	9.20	38.90	57.30	20.75	43.25	10.25
Clay (%)	8.83	18.95	15.3	15.90	17.75	7.60
Air-Dry Moisture (%)	1.26	0.84	4.19	1.86	7.83	0.84
Nitrogen; N_2 (%)	0.077	0.085	0.043	0.0116	0.070	0.039
Exchange Base (CaO) (%)	1.8	3.6	4.4	1.4	5.8	20.8
Hcl in Sol. P_2O_5 (ppm)	0.09	0.14	0.17	0.058	0.115	0.079
Hcl in Sol. K_2O (ppm)	0.88	0.29	0.55	0.52	0.39	0.75

Note: *Laboratory Testing from Tea Science Department, University of North Bengal, 2012 (Ref: T. Sc/L-2/12-13 dtd.30/05/2012; Lab:68-69, Test:02)*

Table - 5: Surface Soil Test Report on important Soil Constituting Contents (May, 2013)

Village	Madhya Salbari	Sakojhora	Patkidaha
JL No.	36	21	80
Depth (cm)	0-35.56	0-30.48	0-50.80
Coarse Sand (%)	30.00	80	30.00
Pine Sand (%)	-	-	--
Silt (%)	50.00	10.00	40.00
Clay (%)	20.00	10.00	30.00
Air-Dry Moisture (%)	1.65	6.75	0.79
Nitrogen; N_2 (%)	0.13	0.08	0.12
Exchange Base (CaO) (%)	-	-	-
Hcl in Sol.P_2O_5 (ppm)	18.5	5.0	20.0
Hcl in Sol.K_2O (ppm)	91.5	48.5	91.5

Source: Laboratory Testing from Tea Science Department, University of North Bengal, 2013 (Ref: T. Sc/L-2/12-13/490 dtd.31/05/2013 and 28/05/2013; Lab:1438-1447,NBU)

Table - 6: Soil Colour Identification (Selected Mouzas)

Samples from Mouza	Depth (cm)	Soil Color	Colour Identity
Sakojhora	0-25	2.5Y7/2	Light Gray
Patkidaha	0-25	5Y6/3	Pale Olive
Khuttimari	0-20	2.5Y6/2	Pale Red
Binnaguri	0-26	10YR5/3	Brown
Gayerkata	0-20	10YR7/2	Light Gray

Source: Pedological Laboratory, Department of Geography and Applied Geography, University of North Bengal
(Note: The Hue (like-2.5YR) notation of a color indicates its relation to Red, Yellow, Green, Blue and Purple; the value notation indicates its lightness and the Chroma (like-6/2) notation indicates its strength (or departure from a neutral of the same lightness)

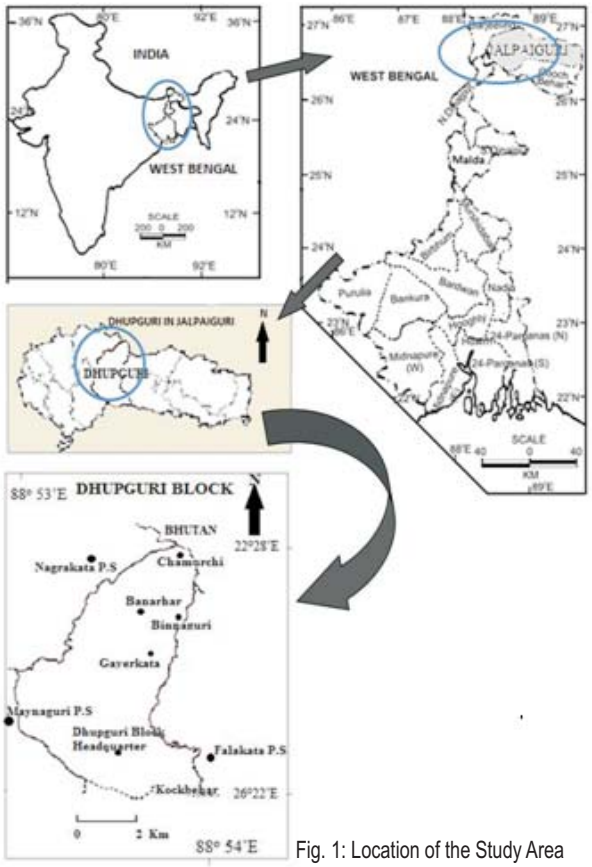

Fig. 1: Location of the Study Area

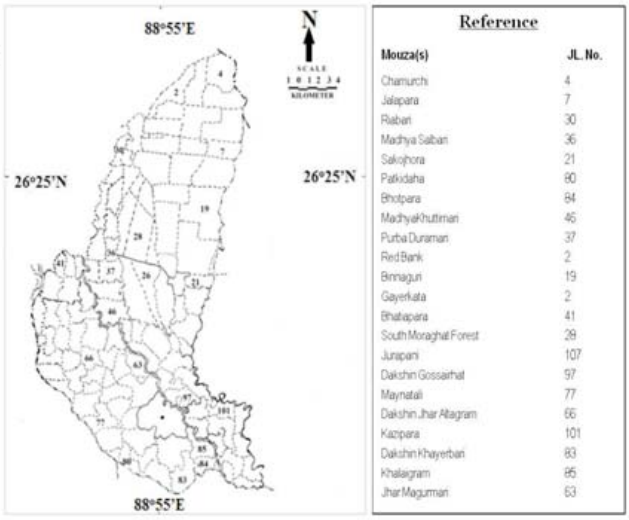

Fig. 2: Location of the Selected Mouzas

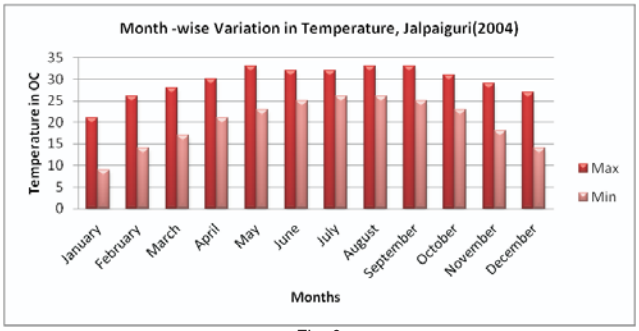

Fig. 3

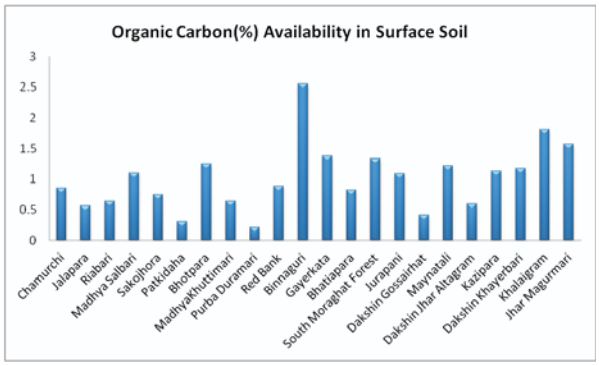

Fig. 4

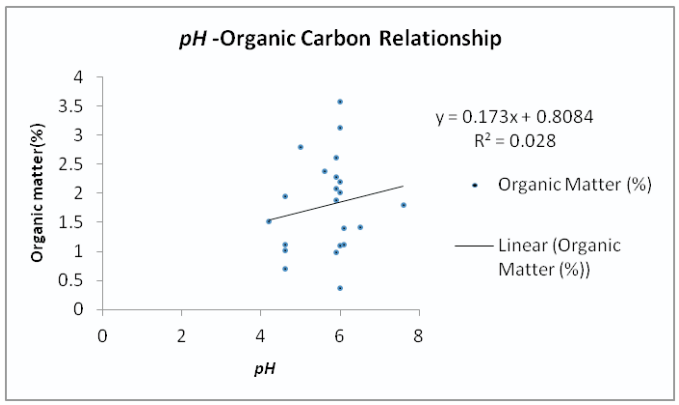

Fig. 5

Fig. 6: Spatial Variation of pH, May 2012

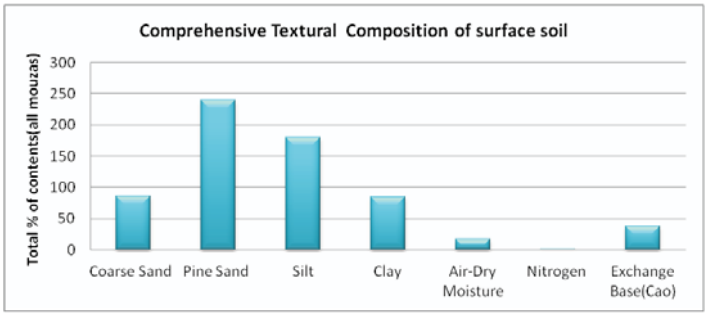

Fig. 7

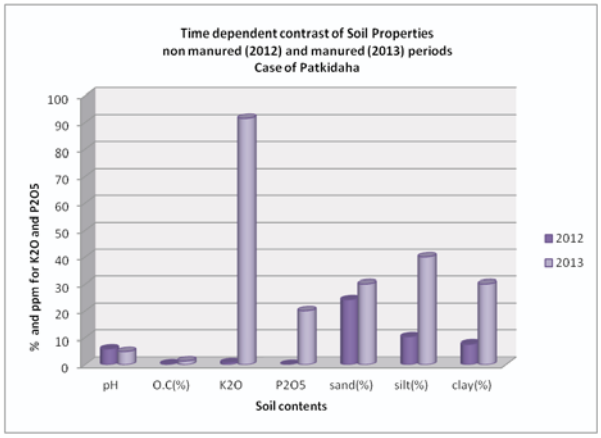

Fig. 8

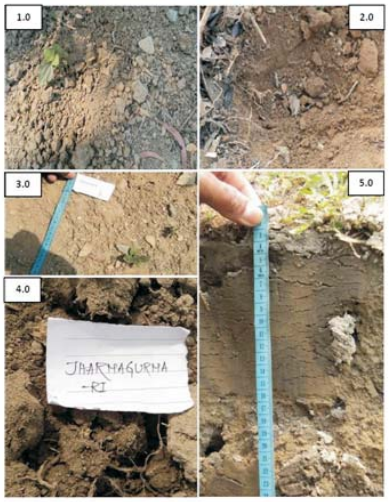

Fig. 9: 1= Sample Collection from A_0 Layer at Moraghat, 2 = Exposed Profile at Binnaguri, 3= Porous Soil at Gayerkata, 4= Soil lumps at Jharmagurmar, 5 = Saturated Hygroscopic Clay-Silt Loam at Patkidaha

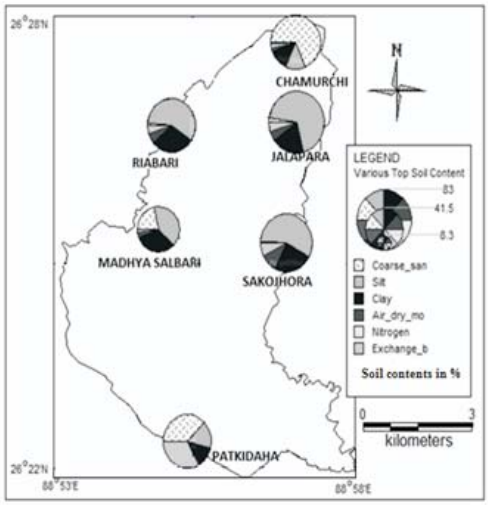

Fig. 10: Spatial Variation of Soil Constituents

Fig. 11: Soils of Tea Gardens

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