International Journal of Natural and Social Sciences
ISSN: 2313-4461

Effects of land use on soil properties

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ARTICLE INFO

Article history

Accepted 20 January 2018
Online release 25 January 2018

Keyword

Soil texture
Soil pH
Organic matter
Total nitrogen
Available phosphorus
Exchangeable potassium
Soil colour

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ABSTRACT

An experiment was conducted with soils from five land use type namely: non cultivated soil, non treated (control), NPKSZn and NPKFYM treated rice growing soil and horticultural farm soil to observe the effect of land use on soil properties. Soil samples were collected from four depths vice: 0-10, 10-20, 20-30 and 30-60 cm of each land use. Soil pH, texture, organic matter, total nitrogen, available P, K and soil colour were determined. Particle-size distribution showed that most of the soils were medium textured with silt loam textural classes. Soil pH ranged between 6.22 – 6.64. pH of the surface soil was lower and increased with the increased of soil depth. Organic matter of all soils ranged from 0.21-1.70% where most of the soils were low to medium in level. There was a clear stratification of soil organic matter and it decreases with increased of depth. The highest soil organic matter was determine in NPKSZn fertilized cultivated soil followed by non cultivated soil NPKFYM applied soil, control plot of paddy soil and the lowest in horticultural farm soil. Total nitrogen followed the similar trend. Total nitrogen was varied from 0.020-0.109% where most of the soils were very low to medium in level. The available Phosphorus (P) was varied from 0.45-24.48 mg kg-1, where most of the soils were very low to optimum in level. The exchangeable potassium (K) was varied from 28.20-167.20 mg kg-1 where most of the soils were low to optimum in level. Cultivated rice growing surface soil had a lower K content than the sub-surface soil. The highest K content was observed in non cultivated soil. Wetland cultivation changes the soil color from dark grey to very dark gray. But dry land cropping turned the colour to reddish brown.

INTRODUCTION

Bangladesh is mainly an agro-based country. Economic development of the country mainly depends on agricultural development. The population of this country has been increasing rapidly over past few decades. To meet the increased food demand for the increasing population either to the land under cultivation or increase the crop yield per unit area should be increased. Since land area under cultivation cannot be increased, an increase in the crop yield per unit area through proper crop and soil management has no alternative (Ahmed, 2003).

For research planning and better crop production, the physical properties of soil have much uses in getting idea on drainage, irrigation, water holding capacity, aeration, root penetration, water and plant nutrient retention capacity etc. On the hand, basic data on chemical properties of soils are very much important. The chemical characteristics of soils represent the nature of genetic process which has undergone during its development and present nutrient status. So, for evaluating the present fertility status of soil, chemical analysis has got much importance.

Now a days, the farmers of the country are desperately trying to increase the yield by applying more and more inorganic fertilizer, pesticides and increasing cropping intensity. The application of excessive amount of a particular fertilizer may hinder the availability of other nutrients. Our farmers do not know about the inherent nutrient status of the soil and they use fertilizers indiscriminately out of their experience. In order to minimize these problems, it is very pertinent to evaluate the fertility status of our soils at the farmer's level (Bhuiya et al., 1974; Ahsan and Karim, 1988).

In the past, research on evaluation of physical and chemical characteristics of Bangladesh soils has

How to cite this article: Sarker KR, Mian MJA, Barman SC and Kader MA (2018). Effects of land use on soil properties. International Journal of Natural and Social Sciences, 5(1): 07-14.

been neglected. Recently different research organizations of Bangladesh namely, SRDI, BINA, BARI, BRRI, BAU and Dhaka university have taken extensive programmes to study, in detail the physical and chemical properties of many soil series for better land use classification, agricultural planning and management of soil. A judicial application of fertilizers directly depends on the inherent nutrient status of a soil. Thus, the status of physical and chemical properties plays a significant role in achieving higher crop yields. Most often crop yields are limited by physical, hydrophysical and chemical conditions of pH (Russel, 1975).

The land use practices carried out for growing wet and dry land crops remarkably influence the properties of soil. However, research works on the effect of land management on soil physical, chemical and biological properties are very scanty. Therefore the present research was carried out to determine the effects of land use on soil properties.

MATERIALS AND METHODS

The experiment was carried out at the Department of soil science, Bangladesh Agricultural University, Mymensingh, in order to examine the effects of land use on physical and chemical properties of soils. The materials used and procedures followed for these studies were as follows.

Table 1
Location, land use, land type and textural classes of soils of BAU farm.

Location	Land use	Land type	Textural class
Non-treated rice soil	R-F-R	Low land	Silt loam
NPKSZn treated rice growing plot	R-F-R	Low land	Silt loam
NPKFYM treated rice plot	R-F-R	Low land	Silt loam
Non-cultivated soil	F	Medium high land	Silt loam
Horticultural farm soil	HC	High land	Silt loam

R= Rice, F=Fallow, HC= Horticultural crops

Silt loam soils of Brahmaputra alluvium were collected from five different land use area of Bangladesh Agricultural University (BAU) farm. The area were non-treated (control), NPKSNZn and NPKFYM treated rice soil of long term experiment, Non-cultivated area and Horticultural farm. The depths were 0-10, 10-20, 20-30 and 30-60cm. The sample of each depth was the composite of five random spots of each area.

Soil pH was determined by glass electrode pH meter as described by Jackson (1962). Wet oxidation method as outlined by Nelson et al. (1982) was followed for determination of soil organic carbon. Total N content of soil was determined by micro-Kjeldahl digestion method (Bremner and Mulvaney). Available phosphorus was extracted from the soil by using 0.5M $NaHCO_3$ solution and the phosphorus in the extract was determined calorimetrically by developing blue color with $SnCl_2$ (Olsen *et al.* 1954). Exchangeable K concentration in the 1 M ammonium acetate extract was directly determined by atomic absorption spectrophotometer (Peterson, 2002). Soil colour was determined by using Mumsell's colour chart.

RESULTS AND DISCUSSION

Soil texture

Results obtained on sand, silt and clay content of soils from different locations are presented in Tables 1a, 1b and 1c. The highest sand, silt and clay content in soils were, 35%, 69% and 35.40% irrespective of depths and locations where the lowest contents of these particales were 9.00%, 19.40% and 15.40%, respectively irrespective of depths.

In non cultivated soil the sand, silt and clay content were 13-21%, 61.6-69.6% and clay 15.4-17.4% irrespective depths, long term cultivation of wet land rice remarkably decreased the silt with increase of clay in all treatments. The sand content remained almost same although some minor changes were noted. In horticultural farm soils the sand content was much higher but silt content was lower in upper two depths when compared with non cultivated soils. The content of silt was relatively low in lower depth while the clay content was higher in all soils.

Table 1a
Effect of land use on soil texture in different depth.

Depth (cm)	Soil texture					
	Control			NPKS Zn		
	Sand	Silt	Clay	Sand	Silt	Clay
0-10	12.60	60.00	27.40	15.00	59.60	25.40
10-20	15.00	55.60	29.40	15.00	59.60	25.40
20-30	15.00	54.60	30.40	5.00	59.60	35.40
30-60	9.00	55.60	35.40	11.00	54.00	35.00

Table 1b
Effect of land use on soil texture in different depth.

Depth (cm)	Soil texture					
	NPKFYM			Non Cultivated Area		
	Sand	Silt	Clay	Sand	Silt	Clay
0-10	19.00	60.60	20.40	15.00	69.60	15.40
10-20	20.00	54.60	25.40	13.00	69.60	17.40
20-30	20.00	55.60	25.40	21.00	61.60	17.40
30-60	15.00	59.60	25.40	15.00	67.60	17.40

Table 1c
Effect of land use on soil texture in different depth.

Depth (cm)	Soil texture		
	Horticultural farm		
	Sand	Silt	Clay
0-10	33.00	51.60	15.40
10-20	35.00	49.60	15.40
20-30	15.60	64.00	20.40
30-60	15.00	59.60	25.40

Soil pH

Results obtained on pH values of soils from different locations are presented in Table 2. The highest pH value was 6.64 and the lowest pH value was 6.22 irrespective of depths and locations.

The pH values of three rice growing soils varied from 6.37-6.52, 6.22-6.43 and 6.42-6.64 in control, NPKSZn and NPKFYM treated soils respectively. The lowest values were in the surface soils which increased with increasing depths. Between the three rice growing soils the pH of NPKSZn treated soil was the lowest (6.22-6.43) followed by control (6.37-6.52) and the NPKFYM treated soil (6.42-6.64).

An increase in pH of soils with increasing depths was also noted in non-cultivated area and horticultural farm. Soils of surface two depths of horticultural farm were more acidic (pH 6.24-6.36) than the soils from non-cultivated area. But a reverse solution was observed in soils of lower depths.

Table 2
Effect of land use on soil pH in different depth.

Depth (cm)	Soil pH				
	Control	NPKS Zn	NPKFYM	Non Cultivate Area	Horticulture
0-10	6.37 b	6.22 b	6.42 c	6.34 b	6.24 b
10-20	6.49 a	6.43 a	6.42 c	6.43 b	6.36 b
20-30	6.52 a	6.43 a	6.56 b	6.57 a	6.64 a
30-60	6.52 a	6.40 a	6.64 a	6.47 ab	6.64 a
$LSD_{0.05}$	0.103	0.145	0.059	0.133	0.231
SE (±)	0.036	0.050	0.054	0.048	0.101
Level of significance	*	*	**	*	**
CV (%)	0.81	1.23	0.54	1.13	1.91

** = Significant at 1% level of probability; * = Significant at 5% level of probability

Organic matter

Results obtained on organic matter of soils from different locations are presented in Figure 1. The highest organic matter was 1.70% and the lowest organic matter was 0.21%, irrespective of depth and locations.

In control plot of paddy soil organic matter ranged from 0.36%-1.33% irrespective of depths. The highest organic matter was 1.33% at 0-10 cm depth. It decreased significantly at 10-20 cm over the 0-10 cm. The status further decreased significantly at 20-30 cm and remained statistically same up to 60 cm although t he lowest value was found at 30-60 cm.

In NPKSZn treated rice plot, organic matter content were 1.70%, 1.05%, 0.47% and 0.42% at 0-10 cm, 10-20 cm, 20-30 cm and 30-60 cm depth respectively. The organic matter of surface two depths of NPKFYM treated soils were more closed to NPKSZn treated soils, But the status of lower two depths was closed to control.

In NPKFYM treated rice growing plot, value of organic matter 1.60%, 1.16%, 0.40% and 0.32% at 0-10 cm, 10-20 cm, 20-30 cm and 30-60 cm depth respectively. The value of organic matter of 0-10 cm depth was higher than control but lower than NPKSZn plot. But in other depths its content was lower than control. The difference between 0-10 and 10-20 cm and again between 10-20 cm and 20-30 cm was significant. The decrease was more prominent below 20 cm than other depths.

In non cultivated area, percentages of organic matter were 1.50%, 1.20%, 0.57% and 0.30% at 0-10 cm, 10-20 cm, 20-30 cm and 30-60 cm depths respectively. The status decreased significantly with increasing depths.

In Horticultural farm, percentages of organic matter varied from 0.21%-0.79% showing decreasing trend with increasing depths. This content of soil organic matter was lower than all other soils under this study.

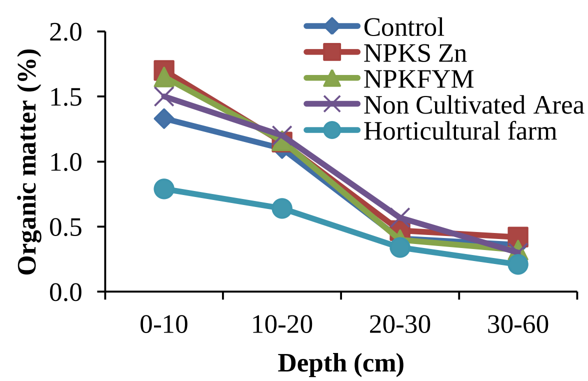

Figure 1
Effect of land use on soil organic matter in different depth.

Total nitrogen (N)

The total nitrogen content showed wide variations between depths and locations ranging from 0.020-0.109%. Non cultivated soil contained the highest amount of total N in all depths (0.031%-0.109%) compared to other soils. The N status of NPKSZn treated rice soils was next to non cultivated soils.

This was followed by NPKFYM treated soils and the control soils. Horticultural farm soils in general contained the lowest amount of total N. Total N of soils of all location decreased with increasing depths. The difference in N content between surface (0-10 cm) and sub-surface (10-20 cm) was more prominent in rice growing soils but in other two soils. The difference between 10-20 cm and 20-30 cm was more prominent (Figure 2).

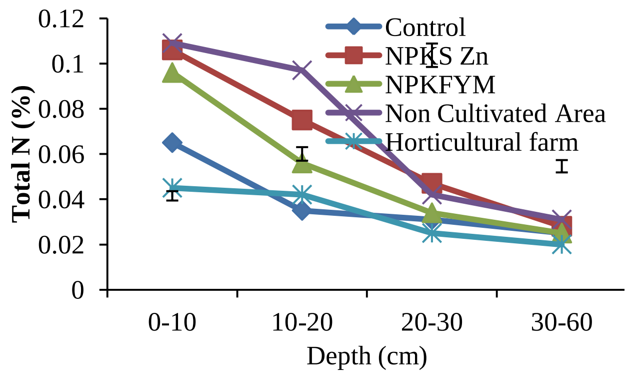

Figure 2
Effect of land use on soil total nitrogen N (%) in different depth.

Available phosphorus (P)

The phosphorus (P) content of soil showed significant variation between the depths as well as locations.

In three rice growing soils the status of available phosphorus varied from 0.55-3.25 mg kg^{-1} irrespective of depths. The content phosphorus was higher in surface soils of phosphorus treated plot but in control plot the subsurface soil content was higher than the surface soil. However, the concentration of available phosphorus gradually decreased with increasing depths.

In non cultivate area, value of available phosphorus was 24.12, mg kg^{-1} in surface (0-10 cm) soil. It drastically decreased to 1.90 mg kg^{-1} in 10-20 cm depth (Figure 3). The concentration gradually decreased with increasing depth. Unlike other soils the status of available phosphorus gradually increased with depth up to 30 cm in horticultural farm soil. In general the concentrations of horticultural farm soils were higher than other soils.

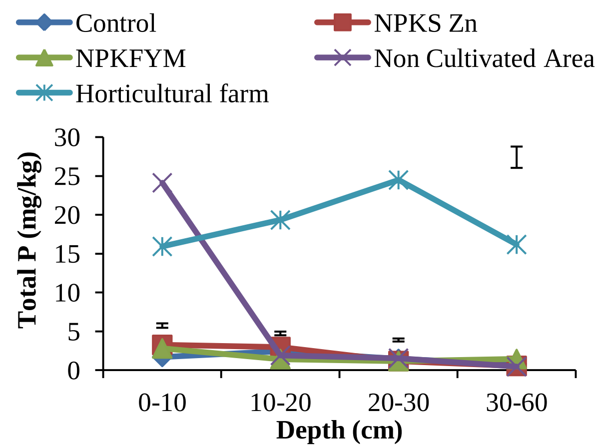

Figure 3
Effect of land use on available phosphorus P (mg/kg) in different depth.

Exchangeable potassium (K)

Exchangeable K content of rice soils was low (34.24-58.42 mg kg^{-1}) with relatively higher value in soils of K treated plot followed by non treated plot (Figure 4). The highest and the lowest K content were found in non-cultivated and horticultural farm soils. The status of K showed an increasing trend with depth in rice soils but decreasing trend in non-cultivated soils. It remained almost stable in horticultural farm soils.

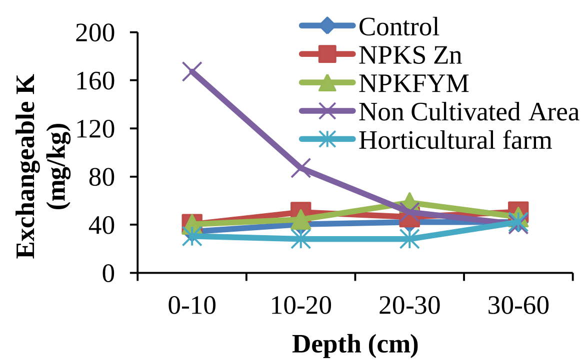

Figure 4
Effect of land use on exchangeable potassium K (mg/kg) in different depth

Soil colour

Results obtained on soil colour from different locations are presented in Tables 3a, 3b, 3c, 3d and

3e. In control plot of paddy soil, the soil colour was very dark grayish brown at 0-10 cm depth and dark gray at 10-20 cm and 20-30 cm depth but dark brown at 30-60 cm depth.

In NPKS Zn treated rice growing plot, the colour of surface soil was very dark grey. At 10-20 cm and 20-30 cm depth the colour of soil very dark grayish brown. But below 30 cm the soil colour of NPKS Zn treated rice growing plot was dark brown.

In NPKFYM treated paddy soil, the colour of soil was dark grayish brown at 0-10 cm depth. The colour of soil was very dark grayish brown at 10-20 cm depth. At 20-30 cm depth soil colour was very dark gray and below 30 cm the soil colour was gray.

Table 3a
Effect of land use on soil color in different depth.

Depth (cm)	Control	Soil colour
0-10	10 YR 3/2 moist	very dark grayish brown
10-20	10 YR 4/1 moist	dark gray
20-30	10 YR 4/1 moist	dark gray
30-60	10 YR 4/3 moist	dark brown

Table 3b
Effect of land use on soil color in different depth

Depth (cm)	NPKS Zn	Soil colour
0-10	10 YR 3/1 moist	very dark grey
10-20	10 YR 3/2 moist	very dark grayish brown
20-30	10 YR 3/2 moist	very dark grayish brown
30-60	10 YR 3/3 moist	dark brown

In non cultivated area, the colour of surface soil was dark gray. At 10-20 cm depth the colour of soil was brown. At 20-30 cm depth soil colour was pinkish gray and below 30 cm the soil colour was brown.

In Horticultural farm, the colour of surface soil was light reddish brown. At 10-20 cm, 20-30 cm and 30-60 cm depths the soil colour was reddish brown.

Table 3c
Effect of land use on soil color in different depth.

Depth (cm)	NPK FYM	Soil colour
0-10	10 YR 4/2 moist	dark grayish brown
10-20	10 YR 3/2 moist	very dark grayish brown
20-30	10 YR 3/1 moist	very dark gray
30-60	10 YR 5/1 moist	gray

Table 3d
Effect of land use on soil color in different depth

Depth (cm)	Non cultivated area	Soil colour
0-10	7.5 YR 4/0 moist	dark grey
10-20	7.5 YR 5/4 moist	brown
20-30	7.5 YR 6/2 moist	pinkish grey
30-60	7.5 YR 5/2 moist	brown

Table 3e
Effect of land use on soil color in different depth

Depth (cm)	Horticultural farm	Soil colour
0-10	5 YR 6/3 moist	light reddish brown
10-20	5 YR 4/3 moist	reddish brown
20-30	5 YR 4/4 moist	reddish brown
30-60	5 YR 4/4 moist	reddish brown

It appears from the results that the soils from rice growing area contained higher amount of clay than non cultivated and Horticultural farm soil. The silt content of non cultivated soils was the highest whereas its sand and clay content was relatively low. In general, the soils of Brahmaputra alluvium are silt loam in texture containing the highest amount of silt as evident from the results of soils of non-cultivated area. Cultivation of soils for wetland and dry land crops brought change in the content of individual particles from original status.

It seems that physical weathering due to long cultivation decreased the sand and silt but increased the clay content. The increase in clay content in the lower depths of cultivated soil is the effect of deposition of colloidal particles from surface layers with percolation water.

The pH of soil of different locations did not show remarkable variation between the land uses. However, the relatively low pH of surface soils might be due to the effects of oxidation of ammonium to nitrate as well as ferrous ion to ferric hydroxide. In addition to this, the decreases in base content in soil due to uptake by the crops as well as leaching with percolation water also contributed to the lower pH of surface soil. The results are in agreement with the findings of Abedin *et al.* (1991 and 2000), who also found lower pH in surface soil and sever loss of Ca, Mg, K and through percolation water from surface to sub-surface soil.

The organic matter content of surface soils of paddy fields was higher than other two soils except control plot. Whose content was relatively low compare to non cultivated area. Ponnam perume (1972) reported that in rice growing soils the organic matter content increases slightly due to soil reduction. The obtained highest status of organic matter in surface soils of rice field might be possible for rice cultivation under anaerobic condition. In the 10-20 cm depth, the organic matter content of soils of rice field was significantly lower than the surface soil as well as non cultivated soils. The significant decrease in organic matter in sub surface soil was probably due to the presence of well known plough pan. In rice field, this pan restricted the penetration of rice roots as a consequence of which the organic matter content decreased. On the other hand, the non cultivated area probably plough pan was not formed as a result of which the roots of natural vegetations penetrated up to deapper depths hence increased the organic matter content over the rice growing soils. In soils of Horticultural farm the organic matter content was extremely low compared to rice growing soils as well as non cultivated soils. It seems that in Horticultural farm under aerated conditions of soils the rate of decomposition of organic matter was higher. As a consequence of which the status of organic matter could not increase remarkably.

The total nitrogen content of soils of different land uses and depths followed the similar trend of organic matter content of soil showing a good relation between them.

The available phosphorus content in rice growing soil varied from 0.55 to 3.25 mg/kg. According to BARC (2012) the status of available phosphorus was very low. Working on fractionation of phosphorus with soils of this rice field Hossain (2015) also found very low content of available phosphorus.

A rice crop yielding 6-7 ton require 15-20 kg phosphorus for normal growth and yields. On the other hand an amount of 20 kg phosphorus per hectare is applied in this field for growing rice. A major portion is taken up by the crop. In addition to this, a considerable amount of added phosphorus is adsorbed by the soil materials. Moreover a negligible amount is lost through leaching. As a result of this very negligible amount of added phosphorus is remain in available form. The above reason might be for getting the very low content of available phosphorus in rice soils. Phosphorus fertilization maintained relatively higher concentration in surface soils treated with P fertilization. But in control plot the lower concentration in surface soils was due to uptake by the crops. The available phosphorus status of non cultivated area was high in surface soils. But in Horticultural farm it was optimum (BARC, 2012). In non cultivated soil, the concentration suddenly decreased to very low status while in a Horticultural farm the concentration increased with depth.

Rice soils of both fertilized and non fertilized plots showed lower potassium (K) content in surface soils than lower depths. Higher uptake of K by the growing rice plots from the surface soil was probably main reasons for lower concentration at surface soils. In non cultivated soil, the exchangeable potassium at 0-10 cm and 10-20 cm layer was higher than all other soils because of non removal of potassium from the area. The lowest amount of potassium was found in Horticultural farm soils for its coarser texture than other soils.

Because of leaching loss of potassium was higher in addition to crop uptake. As a consequence the concentration decreased.

CONCLUSION

Wetland rice cultivation increase clay content, soil organic matter content and total nitrogen content. Dry land cultivation decrease clay content soil organic matter content and total nitrogen content. Phosphorus content was decreased in rice soil whereas it increases in Horticultural farm soil. Wet and dry land cropping severely decrease the potassium content of soil. Wetland cultivation reduced the soil and thereby changes the soil colour from dark grey to very dark gray. However, dry land cropping oxidized the soil and thereby turned the colour to reddish brown.

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