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# Soil characterization and fertility assessment of *char* lands for increased cropping intensity and crop productivity

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## Abstract

A study was done for soil characterization and soil fertility assessment in *Char Latif* and *Char Monpura* of *Bhola* District to identify suitable crops for increasing cropping intensity and crop yields. The soils of *Char Latif* were almost silt loam to silty clay loam in texture. Soil pH values were slightly alkaline in reaction. The organic matter contents were low to medium (1.23-2.53%), the total N very low to low (0.08-0.22%), available P low to very low (4.67-14.1μg $g^{-1}$ soil), available S low to very high (4.02-156.8 μg $g^{-1}$ soil) and exchangeable K low to optimum (0.138-0.311%), exchangeable Ca and Na very high in *Char Latif* areas. At *Char Monpura* areas, the soils were silt loam to silty clay loam in texture. The soil pH was neutral to slightly alkaline in reaction. The organic matter contents of the soil were low to medium (0.21-2.60%) and the total N contents were very low to low (0.03-0.18%). Available P contents were very low (2.40-6.65 μg $g^{-1}$ soil). Available S contents were low to very high (4.02-156.8 μg $g^{-1}$ soil). Exchangeable K, Ca and Na contents were medium to optimum (0.20-0.48 me%), in desired level (4.54-9.07me%) and very high level (1.64-5.14me%), respectively. The soils of both *char* land areas were normally erosive having low fertility and low water holding capacity. Generally, farmers of char lands cultivated local varieties of crops. As a result, crop yields are low. High yielding profitable crops and crop cultivation measures could be recommended for both of the *Char Latif* and *Char Monpura* areas. The findings could help the government and the other organizations to take proper steps for improving livelihood of the char peoples by improved crop varieties and management practices. Hence, there is great opportunity to increase crop production through intensification of crop cultivation with the selection of appropriate crop varieties and soil management at char lands.

**Key words**: Soil characterization, soil fertility, char land, cropping intensity, crop productivity



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## Introduction

Bangladesh is the largest deltaic plain in the world. It is traversed by the *Ganges, Brahmaputra*, and the *Meghna* river system and their tributaries and distributaries. It is a developing country discharges with numerous problems like over population, poverty, lack of appropriate infrastructural and institutional facilities, etc. (Hossain and Ferdousi, 2004). The state of Bangladesh is the largest concentration of people in a highly disaster-prone environment, with significant risk of natural hazard (Benson and Clay, 2002; Rahman *et al.*, 2018; Afrin *et al.*, 2018). The erosion affected people migrate to cities and they live in the urban slum areas (CEGIS, 2009; Islam *et al.*, 2017) and also live on the permanent or semi-permanent sandbar (*char*).

The livelihood of char people is described by Schumuck-Widmann (2001) and Sarker *et al.* (2003). Population displacement due to flood and river erosion is considered as one of the main contributors to landlessness and about 10,000 hectares of land per year is eroded by river in Bangladesh (NWMP, 2001). Besides, unique natural setting of Bangladesh and the characteristics of tropical monsoon climate are greatly responsible for flood hazards in the country (Elahi, 2001). The whole of the riverine island is unstable and prone to annual flooding (Kabir, 2006). The char dwellers are some of the poorest and most vulnerable people particularly those who live on the chars although people living on the unprotected river banks experience similar difficulties. River bank erosion is a perennial problem causing loss of lands and livelihood along major rivers in Bangladesh (Roy *et al*., 2007; Islam *et al.*, 2017). Char land areas irrespective of their geographic attachment to the mainland and distance from the growth centers are particularly vulnerable to flood, drought and river erosion (ISPAN, 2003). Char people use their indigenous knowledge to adapt through this diverse situation. So it is important to improve and indicate the indigenous knowledge to adapt with the char land environment. Generally, farmers of char lands cultivate low yielding local varieties of crops. There is great scope to increase crop yields as well as enhance crop production with appropriate crop selection and management practices of crops and soils. Soil fertility assessment is necessary for sustainable crop production and it is also determine the types of crops to be grown in particular land. But information is very scanty about the land use pattern and soil fertility status of *Char Latif* and *Char Monpura* of *Bhola* District. Therefore, the objectives of this study were: to characterize and assess of soil fertility for introducing suitable cropping patterns and increased cropping intensity and crop yields in *Char Latif* and *Char Monpura* of *Bhola* District.

## Materials and Methods

*Char Latif* of *Borhan uddin* Upazila under the District of *Bhola* is an isolated *char* land in the *Tetulia* river in the North-West part of Borhan uddin Upazila. This char is surrounded by *Bauphal* Upazila of *Patuakhali* District on the South and West, *Bhola* Sadar on the North and *Borhanuddin* Upazila sadar area on the East. It is located in between 22°23´ and 22°29´ North latitudes and in between 90°36´ and 90°38´ East longitudes. The total area of this *char* is 2,274 hectare. *Char Monpura*, a separate island of *Shahbazpur* river is situated at the east of *Bhola* District. It is bounded by *Tazumuddin* Upazila on the North, *Hatiya* Upazila of *Noakhali* on the East, Bay of Bengal on the South, *Lalmohan* and *Charfasson* Upazila on the West. It is located in between 21° 50´ and 22° 24´ North latitudes and in between 90° 52´ and 91° 02´ East longitudes. Based on the objectives, brief information such as present crops and cropping patterns, irrigation and fertilizer management, crop yields, etc. have been collected from the study areas. Soil survey and crops across seasons have been done. The soil samples were collected from eight depths ($D_1$-$D_8$) from ten spots at *Char Latif* where *at Char Monpura*, soil was collected from 21 depths ($D_1$-$D_{21}$) from eight spots which have been described in the Table 1 and the Table 2, respectively. About 1 kg of soil from each depth was brought to the laboratory for physio-chemical analyses. The soils were dried at room temperature and processed and passed through 10 mm sieve and stored for analysis. The soil samples were analyzed following standard methods for determination of texture, soil pH, electrical conductivity (EC), organic carbon (OC), total nitrogen (TN), exchangeable Ca, K and Na.

***Textural class*:** Particle size analysis was carried out by hydrometer method (Black, 1965) and finally textural class was determined by fitting the %sand, % for silt and % clay to the Marshall's Triangular Coordinates following USDA system.

***Soil pH and EC*:** Soil pH and EC were measured by a glass electrode pH and EC meter using soil: water suspension of 1:2.5 (10 g soil and 25 ml distilled water) as described by Jackson (1967).

***Organic matter*:** Organic carbon was determined by wet oxidation method as described by Black (1965).

**Table 1.** Soil sampling from different depths at *Char Latif***.**

| Sl. No. | GPS reading | No. of depth | Depth (cm) |
|---|---|---|---|
| Spot1 | N: 22°31.288, E: 090°37.212 | $D_1$ | 0-13 |
| | | $D_2$ | 13+ |
| Spot 2 | N: 22°31.218, E: 090°37.312 | $D_3$ | 0-11 |
| | | $D_4$ | 11+ |
| Spot 3 | N: 22°30.987, E: 090°37.371 | $D_5$ | 0-10 |
| | | $D_6$ | 10+ |
| Spot 4 | N: 22°30.904, E: 090°37.583 | | 0-10 |
| | | | 10+ |
| Spot 5 | N: 22°31.745, E: 090°37.00 | | 0-10 |
| | | | 10+ |
| Spot 6 | N: 22°32.005, E: 090°36.803 | | 0-11 |
| | | | 11+ |
| Spot 7 | N: 22°32.229, E: 090°36.750 | $D_7$ | 0-12 |
| | | $D_8$ | 12+ |
| Spot 8 | N: 22°32.361, E: 090°36.665 | | 0-12 |
| | | | 12+ |
| Spot 9 | N: 22°32.588, E: 090°36.653 | | 0-11 |
| | | | 11+ |
| Spot 10 | N: 22°32.588, E: 090°36.653 | | 0-11 |
| | | | 11+ |

The underlying principle was used to oxidize the organic matter with an excess of 1N $K_2Cr_2O_7$ in presence of conc. $H_2SO_4$ and conc. $H_3PO_4$ and to titrate the excess $K_2Cr_2O_7$ solution with 1N $FeSO_4$.To obtain the organic matter content the amounts of organic carbon were multiplied by Van Bemmelen factor 1.73. The results were expressed in percentage (Page et al., 1989).

***Total nitrogen*:** Total N content was determined following micro-Kjeldahl method as described by Jackson (1967). Soil sample was digested with $H_2O_2$, conc. $H_2SO_4$ and catalyst mixture ($K_2SO_4$:$CuSO_4$.5$H_20$:Se in the ratio of 100:10:1). After completion of digestion, made the volume to 100ml. Distillation was performed with adding of 40% NaOH into the digest. The distillate was received in 2% boric acid ($H_3BO_3$) solution and 4 drops of mixed indicator of bromocresol green and methyl red solution. Finally the distillate was titrated with standard $H_2SO_4$ (0.01N) until the color changed from green to pink. The amount of N was calculated using the following formula:

%N = (T-B) ×N×l.4S,

Where,

T = Sample titration value (ml) of standard $H_2SO_4$
B = Blank titration value (ml) of standard $H_2SO_4$
N = Strength of $H_2SO_4$
S = Sample weight in gram

***Available phosphorus*:** Available phosphorus was extracted from the soil samples by shaking with 0.5 M

$NaHCO_3$ solutions at pH 8.5 following the method of Olsen and Sommers (1982). The extracted phosphorus was determined by developing blue color by $SnCl_2$ reduction of phosphomolydate complex and measuring the intensity of color calorimetrically at 660 nm wave length and the readings were calibrated to the standard P curve.

**Table 2.** Soil sampling from different depths at *CharMonpura.*

| Sl. No. | GPS | No. of depth | Depth (cm) |
|---|---|---|---|
| Spot 1 | N: 22°07.591′ E: 090°56.317′ | $D_1$ | 0-10 |
| | | $D_2$ | 10-72 |
| | | $D_3$ | 72+ |
| Spot 2 | N: 22°07.592′ E: 090°56.280′ | $D_4$ | 0-07 |
| | | $D_5$ | 7-70 |
| | | $D_6$ | 70+ |
| Spot 3 | N: 22°11.344′ E: 090°56.193′ | | 0-10 |
| | | $D_8$ | 10-45 |
| | | $D_9$ | 45+ |
| Spot 4 | N: 22°12.580′ E: 090°56.778′ | $D_{10}$ | 0-09 |
| | | $D_{11}$ | 9-60 |
| | | $D_{12}$ | 60+ |
| Spot 5 | N: 22°13.949′ E: 090°57.418′ | $D_{13}$ | 0-8 |
| | | $D_{14}$ | 8-70 |
| | | $D_{15}$ | 70+ |
| Spot 6 | N: 22°16.681′ E: 090°58.705′ | | 0-09 |
| | | $D_{16}$ | 9-42 |
| | | $D_{17}$ | 42+ |
| Spot 7 | N: 22°18.222′ E: 090°59.144′ | | 0-8 |
| | | $D_{18}$ | 8-55 |
| | | $D_{19}$ | 55+ |
| Spot 8 | N: 22°18.795′ E: 090°58.810′ | $D_{20}$ | 0-09 |
| | | $D_{21}$ | 9-45 |
| | | | 45+ |

***Exchangeable Ca, K and Na*****:** Exchangeable Ca, K and Na was extracted from the soil samples with 1N $NH_4OAC$ (pH 7) and cations were determined from the extract by flame photometer (Black, 1965) and calibrated with a standard curve.

## Results

***Char Latif*****:** *Char Latif* is almost flat which is formed by the *Meghna* Floodplains. The nature of land topography is medium high. Most of the area is short temporarily flooded by tidal water during the moon soon. There are innumerable small canals which have fresh water flow throughout the year. The physio-chemical properties of the soils of *Char Latif* are presented in the Table 3 and the Table 4. From the Table 3, the soils of *Char Latif* were loamy in texture except a single sampling spot where the soil was silty loam in texture. Soil pH values were slightly alkaline in reaction. The organic matter contents were low to medium (1.23-2.53%). From Table 4, the total nitrogen contents were very low to low (0.08-0.22%), available phosphorus low to very low (4.67-14.1ppm), and available sulphur low to very high (4.02-156.8ppm). Exchangeable potassium contents were low to optimum (0.14-0.31%). Exchangeable calcium and exchangeable sodium contents were very high in *Char Latif* areas. The soil properties were more or less similar within the sampled layers of soils although the little variations were observed among the layers.

**Table 3.** Texture, pH, electrical conductivity (EC) and organic matter (OM) contentsin the soils of *Char Latif.*

| Sl. No. | GPS reading | Depth (cm) | Textural class | pH | EC ($dSm^{-1}$) | OM (%) |
|---|---|---|---|---|---|---|
| Spot1 | N: 22°31.288 | 0-13 | Loam | 8.0 | 0.22 | 1.89 |
| | E: 090°37.212 | 13+ | Loam | 7.9 | 0.17 | 1.26 |
| Spot 2 | N: 22°31.218 | 0-11 | Loam | 7.8 | 0.31 | 1.82 |
| | E: 090°37.312 | 11+ | Loam | 8.0 | 0.18 | 1.68 |
| Spot 3 | N: 22°30.987 | 0-10 | Loam | 7.7 | 0.43 | 1.33 |
| | E: 090°37.371 | 10+ | Loam | 7.8 | 0.17 | 1.96 |
| Spot 4 | N: 22°30.904 | 0-10 | Loam | 7.7 | 0.20 | 2.25 |
| | E: 090°37.583 | 10+ | Loam | 7.8 | 0.20 | 1.33 |
| Spot 5 | N: 22°31.745 | 0-10 | Loam | 7.5 | 0.50 | 2.11 |
| | E: 090°37.00 | 10+ | Loam | 7.6 | 0.25 | 1.47 |
| Spot 6 | N: 22°32.005 | 0-11 | Loam | 7.5 | 0.25 | 2.53 |
| | E: 090°36.803 | 11+ | Loam | 7.7 | 0.16 | 1.68 |
| Spot 7 | N: 22°32.229 | 0-12 | Loam | 7.4 | 0.40 | 1.52 |
| | E: 090°36.750 | 12+ | Loam | 7.5 | 0.18 | 1.33 |
| Spot 8 | N: 22°32.361 | 0-12 | Loam | 7.4 | 0.33 | 2.04 |
| | E: 090°36.665 | 12+ | Silt Loam | 7.6 | 0.15 | 1.40 |
| Spot 9 | N: 22°32.588 | 0-11 | Loam | 7.4 | 0.25 | 1.82 |
| | E: 090°36.653 | 11+ | Loam | 7.5 | 0.22 | 1.23 |
| Spot 10 | N: 22°32.588 | 0-11 | Silt Loam | 7.5 | 0.30 | 2.18 |
| | E: 090°36.653 | 11+ | Loam | 7.5 | 0.16 | 1.82 |

**Table 4.** Total nitrogen (TN) available P, available S and exchangeable K, Ca and Na contents in the soils of *Char Latif.*

| Sl. No. | Depth (cm) | TN (%) | P (μg $g^{-1}$) | S (μg $g^{-1}$) | K (me%) | Ca (me%) | Na (me%) |
|---|---|---|---|---|---|---|---|
| Spot 1 | 0-13 | 0.14 | 14.1 | 42.2 | 0.24 | 10.2 | 0.64 |
| | 13+ | 0.09 | 13.4 | 12.1 | 0.15 | 13.8 | 0.59 |
| Spot 2 | 0-11 | 0.14 | 8.91 | 84.5 | 0.20 | 13.8 | 0.73 |
| | 11+ | 0.08 | 8.06 | 10.1 | 0.14 | 16.3 | 0.74 |
| Spot 3 | 0-10 | 0.10 | 8.06 | 156.8 | 0.25 | 15.2 | 0.69 |
| | 10+ | 0.16 | 6.93 | 12.1 | 0.24 | 19.7 | 0.76 |
| Spot 4 | 0-10 | 0.12 | 10.0 | 22.1 | 0.17 | 9.22 | 0.57 |
| | 10+ | 0.09 | 4.67 | 4.02 | 0.14 | 9.90 | 0.69 |
| Spot 5 | 0-10 | 0.22 | 8.06 | 154.8 | 0.31 | 16.0 | 0.88 |
| | 10+ | 0.10 | 7.64 | 78.4 | 0.25 | 11.7 | 0.66 |
| Spot 6 | 0-11 | 0.16 | 5.09 | 100.5 | 0.31 | 11.5 | 0.63 |
| | 11+ | 0.13 | 4.81 | 6.03 | 0.18 | 14.6 | 0.62 |
| Spot 7 | 0-12 | 0.18 | 6.08 | 155.1 | 0.20 | 10.7 | 0.62 |
| | 12+ | 0.10 | 4.81 | 22.1 | 0.16 | 11.0 | 0.69 |
| Spot 8 | 0-12 | 0.14 | 6.65 | 100.5 | 0.24 | 11.4 | 0.64 |
| | 12+ | 0.17 | 6.65 | 8.04 | 0.18 | 13.8 | 0.62 |
| Spot 9 | 0-11 | 0.17 | 5.23 | 84.5 | 0.29 | 15.9 | 0.66 |
| | 11+ | 0.15 | 4.67 | 62.3 | 0.21 | 12.6 | 0.59 |
| Spot | 0-11 | 0.22 | 6.08 | 100.5 | 0.30 | 10.7 | 0.55 |
| 10 | 11+ | 0.13 | 5.37 | 20.1 | 0.19 | 10.8 | 0.61 |
| Critical level | | 0.12 | 7 | 10 | 0.12 | 2 | - |

***Char Monpura*: *Char Manpura*** is almost flat, which is formed by the *Meghna* Floodplain. Major part of this area is short temporary flooded in rainy season and some area is medium to deeply flooded locally. All the sediments of the plains transported from the river *Meghna* and its channels. The waters of the river channels are saline in dry season. Soil salinity is a major problem in this area. Yield of crops is low due to improper crop and fertilizer management. Farmers cultivated low yielding local varieties (such as *aman* rice, mungbean, grass pea, groundnut, sweet potato, chilli, garlic and different kinds of vegetables). The physio-chemical characteristics of the soils of *Char Manpura* have been presented in Table 5 and Table 6.

**Table 5.** Texture, pH, electrical conductivity (EC) and organic matter (OM) contents in the soils of *Char Monpura.*

| Sl. No. | GPS | Depth (cm) | Textural class | pH | EC($dSm^{-1}$) | OM (%) |
|---|---|---|---|---|---|---|
| Spot 1 | N: 22°07.591´ E: | 0-10 | Silt Loam | 7.0 | 1.20 | 2.04 |
| | 090°56.317´ | 10-72 | Silty Clay Loam | 7.6 | 0.61 | 1.05 |
| | | 72+ | Silty Clay Loam | 8.0 | 0.96 | 0.56 |
| Spot 2 | N: 22°07.592´ E: | 0-7 | Silt Loam | 6.2 | 2.32 | 2.11 |
| | 090°56.280´ | 7-70 | Silty Clay Loam | 7.4 | 0.57 | 0.70 |
| | | 70+ | Silty Clay Loam | 8.0 | 0.83 | 0.49 |
| Spot 3 | N: 22°11.344´ E: | 0-10 | Silt Loam | 6.3 | 2.99 | 2.04 |
| | 090°56.193´ | 10-45 | Silt Loam | 7.3 | 0.91 | 0.84 |
| | | 45+ | Silt Loam | 7.5 | 0.95 | 0.77 |
| Spot 4 | N: 22°12.580´ E: | 0-09 | Silt Loam | 6.3 | 2.46 | 2.11 |
| | 090°56.778´ | 9-60 | Silty Clay Loam | 7.4 | 0.84 | 0.63 |
| | | 60+ | Silt Loam | 7.5 | 0.49 | 0.91 |
| Spot 5 | N: 22°13.949´ E: | 0-8 | Silt Loam | 6.9 | 4.13 | 2.53 |
| | 090°57.418´ | 8-70 | Silty Clay Loam | 7.7 | 1.34 | 0.42 |
| | | 70+ | Silty Clay Loam | 7.8 | 1.77 | 0.77 |
| Spot 6 | N: 22°16.681´ E: | 0-9 | Silt Loam | 6.3 | 3.46 | 0.98 |
| | 090°58.705´ | 9-42 | Silty Clay Loam | 7.5 | 1.01 | 0.21 |
| | | 42+ | Silty Clay Loam | 7.8 | 1.06 | 0.49 |
| Spot 7 | N: 22°18.222´ E: | 0-8 | Silt Loam | 6.8 | 1.99 | 2.18 |
| | 090°59.144´ | 8-55 | Silty Clay Loam | 8.2 | 0.45 | 0.49 |
| | | 55+ | Silty Clay Loam | 8.4 | 0.62 | 0.63 |
| Spot 8 | N: 22°18.795´ E: | 0-9 | Silt Loam | 7.0 | 0.62 | 2.60 |
| | 090°58.810´ | 9-45 | Silty Clay Loam | 7.9 | 0.08 | 0.70 |
| | | 45+ | Silty Clay Loam | 8.0 | 0.21 | 0.70 |

**Table 6.** Total nitrogen (TN) available P, available S and exchangeable K, Ca and Na contentsin the soils of *Char Monpura.*

| Sl. No. | Depth (cm) | TN (%) | Avail. P ($\mu g\ g^{-1}$) | Avail. S ($\mu g\ g^{-1}$) | Exch. K (me%) | Exch. Ca (me%) | Exch. Na (me%) |
|---|---|---|---|---|---|---|---|
| Spot 1 | 0-10 | 0.18 | 5.51 | 313.7 | 0.31 | 6.05 | 3.76 |
| | 10-72 | 0.06 | 3.25 | 88.5 | 0.30 | 6.20 | 2.91 |
| | 72+ | 0.05 | 4.10 | 48.3 | 0.33 | 7.64 | 2.88 |
| Spot 2 | 0-7 | 0.09 | 5.37 | 321.7 | 0.36 | 6.12 | 3.73 |
| | 7-70 | 0.06 | 3.96 | 44.2 | 0.27 | 6.28 | 2.43 |
| | 70+ | 0.03 | 3.54 | 112.6 | 0.28 | 5.67 | 2.37 |
| Spot 3 | 0-10 | 0.11 | 6.50 | 261.4 | 0.42 | 5.59 | 4.27 |
| | 10-45 | 0.06 | 6.22 | 20.1 | 0.31 | 4.76 | 3.02 |
| | 45+ | 0.07 | 5.37 | 36.2 | 0.24 | 4.54 | 3.84 |
| Spot 4 | 0-09 | 0.12 | 6.65 | 321.7 | 0.37 | 5.37 | 4.32 |
| | 9-60 | 0.07 | 6.22 | 76.4 | 0.23 | 5.44 | 2.71 |
| | 60+ | 0.11 | 3.11 | 80.4 | 0.21 | 5.14 | 2.77 |
| Spot 5 | 0-8 | 0.10 | 5.09 | 370.0 | 0.48 | 9.07 | 7.97 |
| | 8-70 | 0.03 | 4.81 | 140.8 | 0.33 | 6.43 | 3.28 |
| | 70+ | 0.05 | 4.67 | 156.8 | 0.36 | 6.88 | 4.27 |
| Spot 6 | 0-9 | 0.13 | 5.23 | 345.8 | 0.35 | 9.07 | 5.14 |
| | 9-42 | 0.07 | 4.81 | 88.5 | 0.26 | 5.37 | 2.35 |
| | 42+ | 0.09 | 4.24 | 84.5 | 0.26 | 4.91 | 2.71 |
| Spot 7 | 0-8 | 0.08 | 5.09 | 305.6 | 0.38 | 9.07 | 3.02 |
| | 8-55 | 0.07 | 2.97 | 28.2 | 0.26 | 6.12 | 2.35 |
| | 55+ | 0.04 | 4.81 | 68.4 | 0.20 | 5.29 | 3.08 |
| Spot 8 | 0-9 | 0.17 | 4.52 | 72.4 | 0.30 | 6.43 | 1.84 |
| | 9-45 | 0.08 | 2.40 | 16.1 | 0.22 | 6.58 | 1.64 |
| | 45+ | 0.04 | 3.54 | 16.1 | 0.22 | 6.35 | 1.67 |
| Critical level | | 0.12 | 7 | 10 | 0.12 | 2 | - |

From Table 5, the soils were silt loam to silty clay loam in texture. The soil pH values were neutral to slightly alkaline in reaction. The soil of a single sampling site showed slightly saline (4.13 dsm$^{-1}$) in nature. The organic matter contents of the soil were low to medium (0.21-2.60%). From Table 6, the total nitrogen contents were very low to low (0.03-0.18%). Available P contents were very low (2.40-6.65 µg g$^{-1}$). Available S contents were ranged from low to very high (4.02-156.8 µg g$^{-1}$). Exchangeable K, Ca and Na contents in soils were medium to optimum (0.20-0.48 me%), in desired level (4.54-9.07me%) and very high (1.64-5.14me%), respectively.

## Discussion

The physio-chemical properties of the soil of *Char Latif* and *Char Monpura* are described in Table 3 to Table 6. From Table 2 and Table 4, the texture of soil was silt loam to silty clay loam. The soils like silt loam and silty clay loam have higher agricultural values and being less susceptible to become loose and open. Soil pH is slightly alkaline. Soil pH increased with the increase of soil depth with few exceptions. It might be happened due to removal of basic soil materials like $CaCO_3$ and $MgCO_3$ from upper soil layer with simultaneous accumulation in lower layer through leaching. This result was in agreement with the findings of Prodhan (2010). Tamhane *et al.* (1970) reported that pH from 6.5 to 7.5 was the most suitable for crop production in which most soil nutrients were available to plants. From agricultural points of view it was observed that the soils were suitable for crop cultivation. The organic matter content was low to medium (1.23-2.53%). The data showed that the organic matter (OM) content in soil was different in various layers of soils. The upper layers of soils generally contained higher OM than the lower depths. The OM content showed a fall with the depth which might be perhaps due to the differential decomposition rates of plants and animal residues in the successive layers. This variation also might be possible for addition of OM in the surface layer. Mondal (1998) and Fakir (1998) observed similar results. From Table 5 and Table 6, the total nitrogen contents were very low to low. The results were very close to the findings of SRDI (1996). According to Portach and Islam (1984), hundred percent soils of Bangladesh contained N in below critical level. Bhuiyan (1988) reported that the total N contents of different soil series of Bangladesh ranged from 0.05 to 0.22%. It is apparent from the results that the nitrogen content decreased with the soil depth i.e. it was higher at surface soil than sub-surface soil. Hossain *et al* (2003) also supported it. Total N contents in these soils might be related to accelerated decomposition of organic matter in the tropical climate, less addition of organic matter, the quality and quantity of these elements in flooding water and variation in soil characteristics. Chowdhury (1992) also supported it. The results showed that available P contents were very low to low. The low available P contents might be due to the low level of organic matter in the soils (Table 3 and Table 4). Telati *et al* (1975) stated that available phosphorus content was varied at different spots and depths. Portch and Islam (1984) reported that 41% of soils of Bangladesh contained phosphorus below critical level and 35% below optimum level. Bhuiyan (1988) observed that the available P of different soil series of Bangladesh ranged from 2.2 to 140µg g$^{-1}$ with a mean value of 21.2 µg g$^{-1}$. The addition of P fertilizer may benefit the production in the areas where soil contained low level of phosphorus.

From Table 3 and Table 6, the available S contents in the soils of the studied area were contained low to high level. Portch and Islam (1984) reported that 68% soils of Bangladesh contained sulphur in below critical level and 14% soils below in optimum level. Bhuiyan (1988) stated that the mean value of available S of different soil series of Bangladesh was 16.80 µg g$^{-1}$. Hossain *et al*. (2003) reported that the available S varied from 4.0 to 20 µg g$^{-1}$ soil in the *Old Brahmaputra* Floodplain soils. The addition of sulphur fertilizer may beneficial for the cultivation of crops in these areas.

Exchangeable K was ranged from low to optimum (Table 4 and Table 6). Exchangeable K content is related to clay content of soil. Relationship of Exchangeable K and clay content of soil is proportional. Continuous cropping without K application was found to decrease the content of K appreciably and increase the influence of potassium progressively (Ghosh and Biswas, 1978). The magnitude of the exchangeable K values greatly differed from place to place within a short distance as soil pattern was usually a complex mosaic characteristics of delta region (Karim and Rahman, 1980). So potassium fertilizer should be added in the high deficient areas.

Exchangeable Ca contents were higher in *Char Latif* areas where at *Char Monpura* areas exchangeable Na contents were higher (Table 4 and Table 6). The amount of exchangeable Ca content in different depth did not vary widely with the soil depth. The results were very close to the findings of SRDI (2009). The results indicated that the studied areas contained higher amount of exchangeable Ca and Na as these soils were alkaline in reaction. In general, the alkaline and saline soils show higher exchangeable Na over other soils. Akter (2009) reported that Na content varied from 0.44 to 7.83me% and the highest status was found 7.83me% in alkaline soil and the lowest 0.44me% in acidic soil. The soil may be highly productive through proper soil management and agricultural practices.

## Conclusion

At both of the char land areas, improved crop varieties of T.aman (HYV & local), Deep water rice, Boro (HYV & local), T.aus (Local), Mustard, Mungbean, Groundnut, Soybean, Potato, Jute, Maize, Chilli, Cauliflower, Cabbage, Onion, Garlic, Tomato, Water melon, Cucumber, Melon, etc. could be grown. Farmers could be benefited by the cultivation of modern crop varieties through improved management of soils such as application of balanced inorganic and organic (e.g. vermicompost, green manures, farmyard manures etc.) fertilizers, proper irrigation and tillage practices at these areas. Bio-fertilizer should be used for cultivation of legume (pulse and oilseed) crops. Cultivation of salt tolerant crop varieties should be expanded with fresh water irrigation adoption. Comprehensive agricultural development programs should be taken by different GO/NGO and other organizations at these areas. The findings could help the government and the other organizations to take proper steps for improving livelihood of the char peoples by improved crop varieties and management practices. Hence, there is great opportunity to increase crop production through intensification of crop cultivation with the selection of appropriate crop varieties and soil management at *char* lands.

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