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Impacts of Topsoil Removal due to Brick Manufacturing on Soil Properties of Agricultural Lands at Nagarpur Upazila of Tangail, Bangladesh

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Abstract— *The study was conducted to compare soil nutrients status between agricultural land and top soil removal land from surrounding area of brick field due to brick manufacturing at Nagarpur region, Tangail, Bangladesh, during the period of July to December 2018. Total 30 samples were collected from three different brickfields area namely S1, S2, S3. Among them 10 samples were collected from each site whereas 5 samples from productive agricultural land and 5 samples from removal land at a depth 0-15 cm. The overall study stated that the status of % organic matter (OM), total nitrogen (N), available phosphorus (P), exchangeable potassium (K), available sulfur (S), available zinc (Zn), available boron (B), magnesium (Mg) and calcium (Ca) were decreased in top soil removal land. The mean status of these nutrients were very low (0.92%), very low (0.053%), very low (3.34 µg g^{-1} soil), very low (0.09 meq100g^{-1} soil), optimum (22.8 µg g^{-1} soil), very high (3.80µg g^{-1} soil), low (0.28 µg g^{-1} soil), optimum (1.26 meq100g^{-1} soil) and very low (1.25 meq100g^{-1} soil) respectively in top soil removal land. On the other hand these were medium (2.49%), low (0.14%), very low (4.82 µg g^{-1} sol), low (0.16 meq100g^{-1} soil), high (35.07µg g^{-1} soil), very high (4.14 µg g^{-1} soil), medium (0.42 µg g-1 soil), very high (4.35 meq100g^{-1} soil) and high (6.36 meq100g^{-1} soil) respectively in adjacent agricultural land. The cropping patterns of the agricultural land were Mustard- Boro rice-Jute but Fellow-Fellow-Jute in top soil removal land. The economic analysis showed a gross of 1845.24 US$ net loss per hectare per annum of crops yield due to top soil removal for brick manufacturing in the brick field.*

***Keywords*— brickfield, soil nutrients, top soil, agricultural land.**

I. INTRODUCTION

Soil is a natural resource for which there is no substitute. It is a thin covering over the land consisting of a mixture of minerals, organic materials, living organisms, air and water that together support the growth of plant life (Huq and Shoaib, 2013). Topsoil, is one of the earth's most vital resources and the upper surface of the earth's crust. It is naturally deposited material that mixes rich humus with minerals and composted material (Tucker *et al*., 1995). But topsoil degradation is the most serious problems in the world today as a result of natural or anthropogenic factors, because of their adverse effects on agriculture and the life on earth (Eswaran *et al*., 1999; Khan *et al.*, 2007). Brick burning is one of the principal agents of topsoil degradation (Rahman and Khan, 2001). Brick kilns remove topsoil for brick making. The negative impact of topsoil removal results in reduction in agricultural output and increases cost of replacing the nutrients lost (Das, 2015). Brick are destroying large area of land every year especially in Bangladesh (Rahman and Khan, 2001). These affected areas are expanding rapidly due to the increase in brick production (IUSS, 2002). There are about 6,000 brick manufacturers in Bangladesh which produce about 18 billion pieces of brick a year (Rahman, 2012).

In the Nagarpur upazila, soil is mainly used for agricultural production. The soil quality is decreasing due to the negative effects of brickfields. The temperature surroundings the brickfield is very high, for this reason rust increases in paddy in the study area and agricultural production is decreasing year to year in this area. Top soils are used for making bricks and that causes loss of nutrients in the agricultural land and decreases soil fertility in the study area. According to these points of view, the study was conducted to fulfill the following objectives:

i) To compare the soil nutrients status between the top soil removal and productive agricultural land, and

ii) To estimate net economic loss of agriculture products due to top soil removal for brick manufacturing in the brick field.

II. MATERIALS AND METHODS

Study area

The study area is located in Nagarpur upazila under Tangail district, Bangladesh which is located between 23°58' to 24°10' N latitudes and 89°46' to 90°01' E longitudes. The total area of Nagarpur upazila is 266.77 sq. km. It is bounded by Tangail sadar and Delduar upazila on the north, Daulatpur (Manikganj) and Saturia upazila on the south, Mirzapur and Dhamrai upazila on the east, Chauhali and Shahjadpur upazila on the west.

Sample collection

A total of 30 samples were collected from three different brick field of three union (Shahabatpur-S1, Nagarpur-S2 and Bekra-S3) of Nagarpur upazila of Tangail. Ten (10) samples were collected from each union. Among them 5 samples were from productive agricultural land and 5 samples were from top soil removal land adjacent to brickfield. Soil samples A-1, A-2, A-3, A-4, A-5, A-6, A-7, A-8, A-9, A-10, A-11, A-12, A-13, A-14 and A-15 denoted the points of soil samples which were collected from agricultural land and R-1, R-2, R-3, R-4, R-5, R-6, R-7, R-8, R-9, R-10, R-11, R-12, R-13, R-14 and R-15 from top soil removal land surrounding brick fields, respectively. The samples were scraped from the top to bottom (0-15 cm) by auger in nine points of a land and made it a composite sample. About 1000 g of soils were collected for a representative sample. Then air dried for 7 days at room temperature. Visible roots and debris were removed. The larger and massive aggregates were broken by wooden hammer. Then screened to pass through a 2 mm stainless steel sieve and again screened to pass through a 0.5 mm sieve. The sieved samples were mixed thoroughly for making composite samples. Soil samples were preserved in polythene bags and labeled properly showing the location, sample number and date of collection.

Sample analysis

The pH was measured by Glass Electrode pH Meter with 1: 2.5 soil-water ratios (Jackson, 1962). The organic matter was determined by Walkley and Black's wet oxidation method (Huq and Alam, 2005).Total nitrogen was analyzed by micro Kjeldahl method (Bremner and Mulvaney, 1982). The available phosphorus was determined by the Olsen method (Satter *et al*., 1987). The available potassium was determined by ammonium acetate extraction method (Satter *et al.*, 1987).The available sulfur was analyzed by calcium chloride extraction method (Williums and Steinbergs, 1959). The available zinc was determined by DTPA (Diethylene-tri-amine penta acetic acid) method (Roberts *et al.*, 1971). The available boron was determined by azomethine-H method (Page *et al*., 1982). The calcium and magnesium were analyzed by EDTA (Ethylene-di-amine tetra acetic acid) titration method (Huq and Alam, 2005)**.** The status of the soil properties was interpreted according to Fertilizer Recommendation Guide 2018 (BARC, 2018). Mean, standard error and standard deviation were calculated by using Microsoft Excel programme.

III. RESULTS AND DISCUSSIONS

pH

The mean value of pH in agricultural land sample was slightly acidic (6.19) and in top soil removal land was slightly alkaline (7.54) (Fig. 1). The values in agricultural land samples were ranged from 5.65 to 7.07 (slightly acidic to neutral) and in top soil removal land samples were found 7.3 to 7.8 (neutral to slightly alkaline) (Table 1). Islam *et al.* (2015) reported that the pH values of the samples ranged from 6.52 to 7.23 in the burnt soils and from 5.62 to 6.15 in the unburnt soils. All kinds of crops are grown well in the pH range of 5.6-7.3 (neutral), because all types of essential nutrients are available in this range (BARC, 2018).

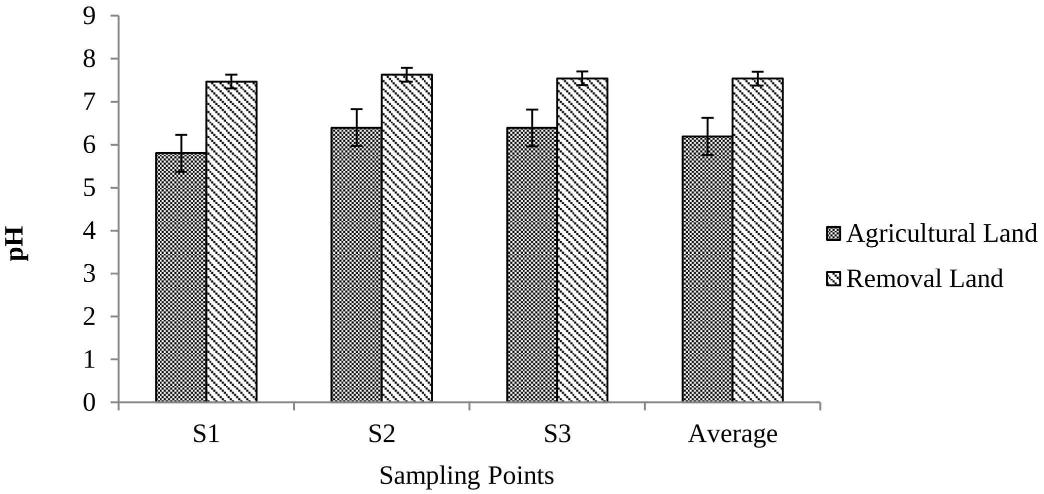

Figure 1 Comparison of pH between agricultural and top soil removal lands at different brick fields.

Table 1 Comparison of soil fertility status in productive agricultural and top soil removal lands

Soil nutrients	Site	Agricultural land Average*	Range	Removal land Average*	Range
pH	S1	5.8	5.65-7.07	7.46	7.3-7.8
	S2	6.39		7.63	
	S3	6.39		7.54	
	Mean ± SD	6.19±0.43		7.54±0.16	
	Status	Slightly acidic	Slightly acidic –Neutral	Slightly alkaline	Neutral – Slightly alkaline
%Organic Matter (OM)	S1	2.39	1.65-3.3	0.98	0.4-2.44
	S2	2.54		0.82	
	S3	2.56		0.97	
	Mean ± SD	2.49±0.40		0.92±0.42	
	Status	Medium	Low – Medium	Very low	Very low - Medium
%Total Nitrogen (N)	S1	0.14		0.056	
	S2	0.14	0.08-0.18	0.046	0.03-0.12
	S3	0.15		0.058	
	Mean ± SD	0.14±0.02		0.053±0.025	
	Status	Low	Very low – Low	Very low	Very low - Low
Available Phosphorous (P) (µg g^{-1} soil)	S1	3.50		3.89	
	S2	4.14	1.4-8.7	3.49	1.2-5.96
	S3	6.81		2.63	
	Mean ± SD	4.82±2.30		3.34±1.36	
	Status	Low	Very low - Low	Very Low	Very low - Low
Exchangeable	S1	0.15		0.08	
	S2	0.16	0.11-0.23	0.09	0.03-0.19

Potassium (K) ($meq 100g^{-1}$ soil)	S3	0.17		0.10	
	Mean ± SD	0.16±0.03		0.09±0.04	
	Status	Low	Low – Medium	Very low	Very low - Medium
Available Sulfur (S) ($\mu g\ g^{-1}$ soil)	S1	40.8		24.16	
	S2	31.71	23.37-47.95	21.62	15.2-37.43
	S3	32.69		22.61	
	Mean ± SD	35.07±6.85		22.8±7.25	
	Status	High	Optimum – Very high	Optimum	Medium - High
Available Zinc (Zn) ($\mu g\ g^{-1}$ soil)	S1	4.46		4.06	
	S2	4.1	3.3-5.9	3.92	2.9-5.1
	S3	3.86		3.44	
	Mean ± SD	4.14±0.74		3.80±0.64	
	Status	Very high	Very high	Very high	Very high
Available Boron (B) ($\mu g\ g^{-1}$ soil)	S1	0.42		0.23	
	S2	0.40	0.33-0.51	0.29	0.18-0.43
	S3	0.43		0.32	
	Mean ± SD	0.42±0.05		0.28±0.07	
	Status	Medium	Medium – Optimum	Low	Low - Medium
Calcium (Ca) ($meq 100g^{-1}$ soil)	S1	6.4		1.46	
	S2	6.4	5-7.5	1.14	0.6-2
	S3	6.3		1.15	
	Mean ± SD	6.36±0.93		1.25±0.44	
	Status	High	Optimum – high	Very low	Very low - Low
Magnesium (Mg) ($meq 100g^{-1}$ soil)	S1	4.36		1.42	
	S2	4.03	3.3-5.5	1.35	0.5-2.5
	S3	4.66		1.02	
	Mean ± SD	4.35±0.78		1.26±0.57	
	Status	Very high	Very high	Optimum	Low – Very high

Note: * = Average of five samples, SD = Standard Deviation.

Organic Matter (OM)

The mean organic matter (OM) status of agricultural land was medium (2.49%) but in top soil removal land it was very low (0.92%) (Fig. 2). The organic matter (OM) contents of agricultural land samples were ranged from 1.65 to 3.3% (low to medium) and of removal land samples were ranged from 0.4 to 1.99% (very low to medium) (Table 1). SRDI (2018) reported that the OM values of Nagorpur agricultural soils ranged from 2.20 to 2.70%, respectively. Above 3.4% (high) OM content is the suitable for the most of the agricultural crop production (BARC, 2018).

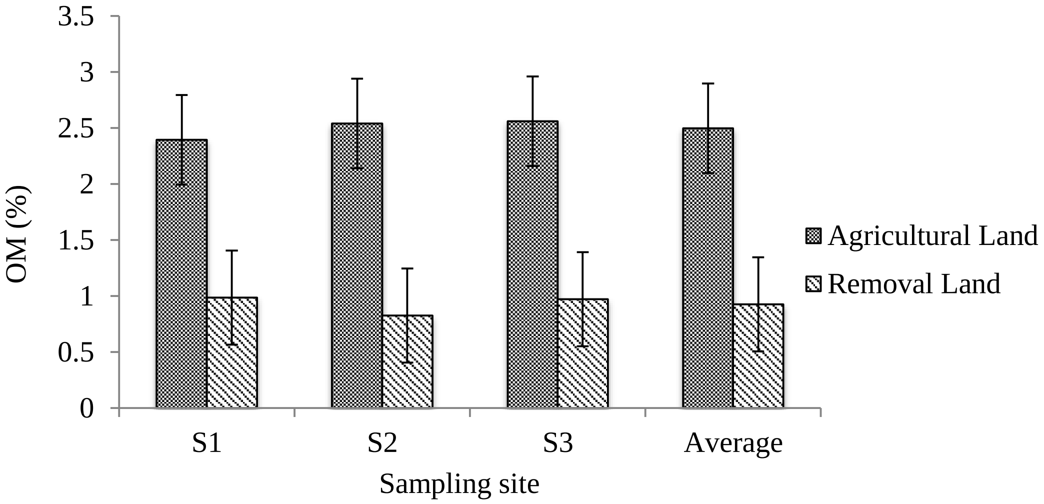

Figure 2 Comparison of organic matter (OM) contents between agricultural and removal lands at different brick fields.

Total Nitrogen (N)

The mean total nitrogen (N) status of agricultural land was low (0.14%) but in top soil removal land it was very low (0.053%) (Fig. 3). The total nitrogen (N) contents of agricultural lands were ranged from 0.08 to 0.18% (very low to low) and of removal lands were ranged from 0.03 to 0.12% (very low to low) (Table 1). Optimum (>0.27%) N status is the suitable for all kinds of crop production (BARC, 2018). Hossain *et al.* (2003) observed that the total N content decreased with increasing the depth of soils. In the Old Brahmaputra Floodplain soil, the nitrogen was varied from 0.038 to 0.100% and in Madhupur tract from 0.010 to 0.082% under different cropping patterns and tillage.

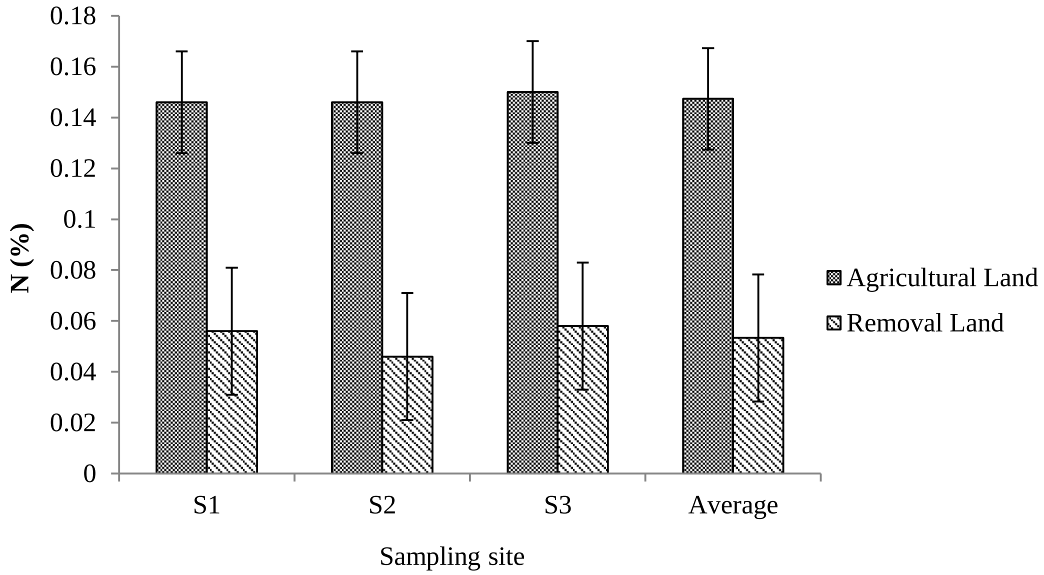

Figure 3 Comparison of total nitrogen (N) contents between agricultural and top soil removal lands at different brick fields

Available Phosphorous (P)

The mean available phosphorous (P) status of agricultural land was low (4.827 µg g^{-1} soil) but in top soil removal land it was very low (3.34 7 µg g^{-1} soil) (Fig. 4). The available phosphorous (P) contents of agricultural lands were ranged from 1.4 to 8.7 µg g^{-1} soil (very low to low) and of top soil removal lands were ranged from 1.2 to5.96 µg g^{-1} soil (very low to low) (Table 1). Prabpai *et al.*

(2007) found that available phosphorus, plant macronutrient constituent, in landfill soil was at a high to very high level; 21-26 mg kg^{-1}. BARC (2018) reported that the optimum (>11.26 µg g^{-1} soil) status of available P value is suitable for all kinds of crop production.

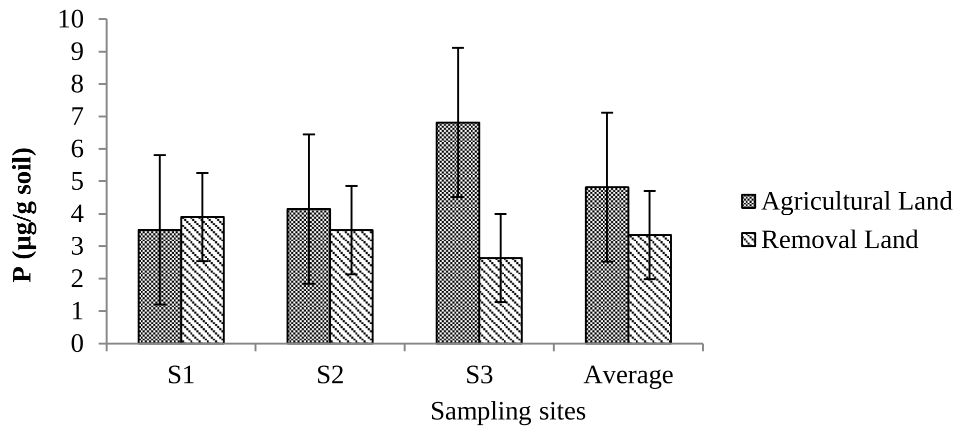

Figure 4 Comparison of phosphorous (P) concentrations between agricultural and removal lands at different sampling sites

Exchangeable Potassium (K)

The mean exchangeable potassium (K) status of agricultural land was low (0.16 meq100g^{-1} soil) but it was very low (0.09 meq100g^{-1} soil) in top soil removal soil (Fig. 5).The potassium (K) contents of agricultural lands were ranged from 0.11 to 0.23 meq100g^{-1} (low to medium) and of top soil removal lands were ranged from 0.03 to 0.19 meq100g^{-1} soil (very low to medium) (Table 1). Singh *et al.* (2000) reported that the exchangeable K of old alluvial soils of some basin was 0.04 to 0.87 meq100g^{-1} soil. Optimum (>0.27 meq100g^{-1} soil) status of exchangeable K is the suitable for all kinds of agricultural crops production (BARC, 2018).

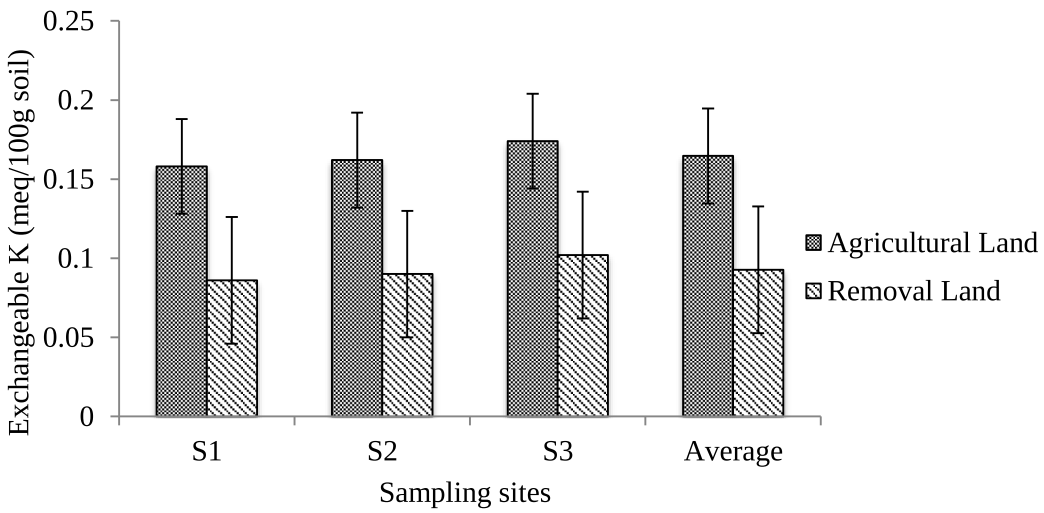

Figure 5 Comparison of potassium (K) concentrations between agricultural and removal lands at different sampling sites

Available Sulfur (S)

The mean available sulfur (S) status of agricultural land was high (35.07 µg g^{-1} soil) but it was optimum (22.8 µg g^{-1} soil) in top soil removal land (Fig. 6). The available S contents of agricultural lands were ranged from 23.37 to 47.95µg g-1 soil and of top soil removal lands were ranged from 15.2 to 37.43 µg g-^{1} soil (Table 1). Optimum (>22.5 µg g-1 soil) status of S is suitable for all kinds of agricultural crops production (BARC, 2018).

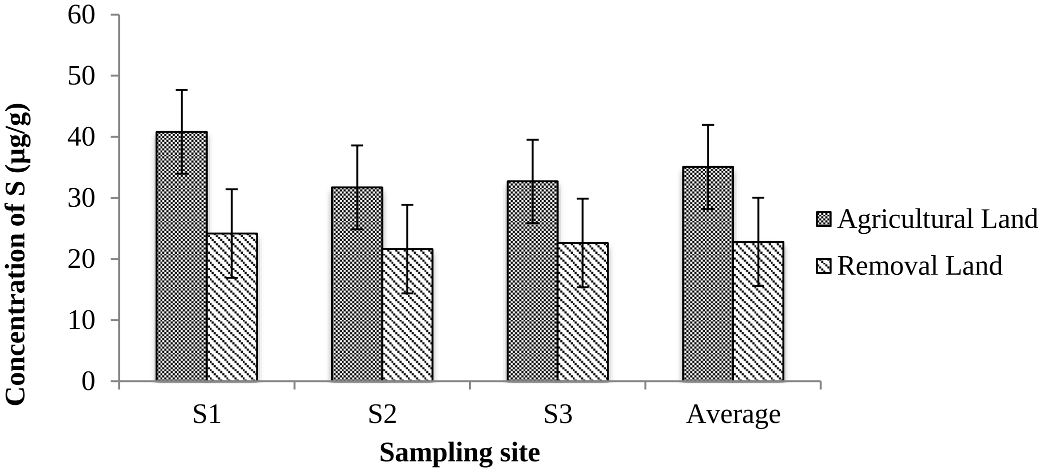

Figure 6 Comparison of sulfur (S) concentrations between agricultural and top soil removal lands at different sampling sites

Available Zinc (Zn)

The mean available zinc (Zn) status of agricultural land and top soil removal land were very high (4.14 and 3.80 µg g^{-1} soil respectively) (Fig. 7). The available Zn contents of agricultural lands were ranged from 3.3 to 5.9 µg g^{-1} (very high) and of top soil removal land samples were ranged from 2.9 to 5.1 µg $g-^{1}$ (very high) also (Table 1). Islam *et al.* (2015) found total Zn content ranged from 2.030 to 2.089 ppm in the burnt and from 2.112 to 2.991 ppm in the unburnt soil. Optimum (>0.1.35 µg g^{-1} soil) status of Zn is suitable for all kinds of agricultural crops production (BARC,2018).

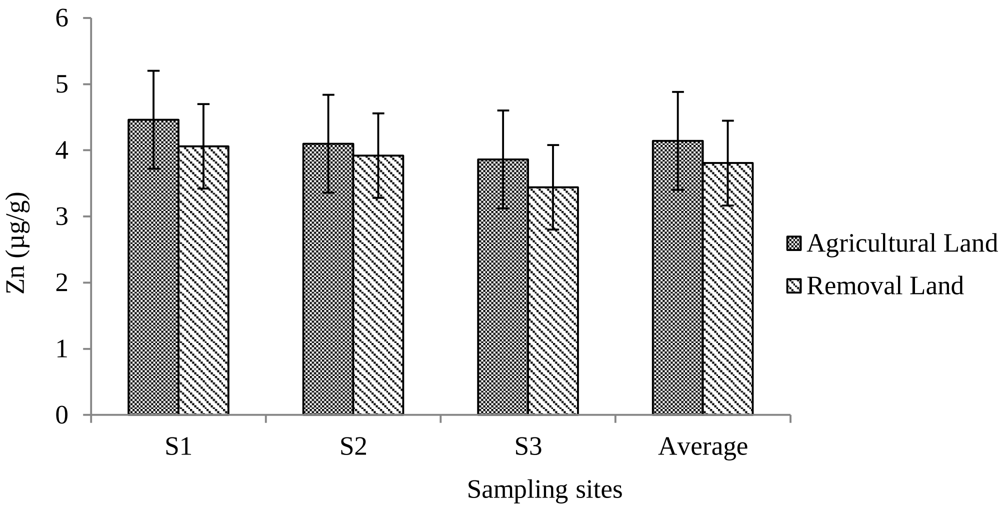

Figure 7 Comparison of zinc (Zn) concentrations between agricultural and removal lands at different sampling sites

Available Boron (B)

The mean available boron (B) status of agricultural land was medium (0.42 µg g^{-1} soil) but it was low (0.28 µg g^{-1} soil) in top soil removal land (Fig. 8). The available B contents of agricultural lands were ranged from 0.33 to 0.51 µg g^{-1} soil (medium to optimum) and of top soil removal lands were ranged from 0.18 to 0.43 µg g^{-1} soil (low to medium) (Table 1). Optimum (>0.45 µg g^{-1} soil) status of B is suitable for all kinds of agricultural crops production (BARC, 2018).

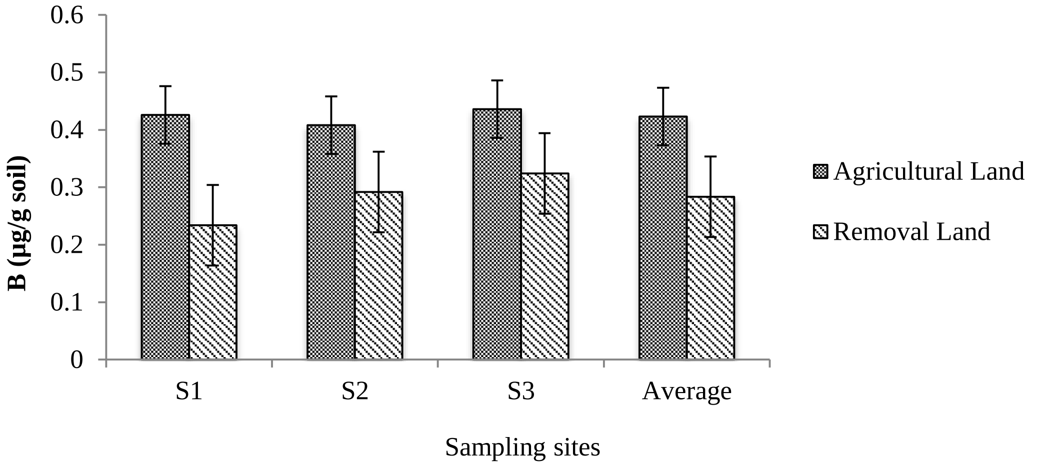

Figure 8 Comparison of boron (B) concentrations between agricultural and removal lands at different sampling sites

Calcium (Ca)

The mean calcium (Ca) status of agricultural land was high (6.36 meq100g^{-1} soil) but very low (1.25 meq100g^{-1} soil) in top soil removal land (Fig. 9). The Ca contents of agricultural lands were ranged from 5 to 7.5 meq100g^{-1} soil (optimum to high) and in top soil removal land it was ranged from 0.6 to 2 meq100g^{-1} soil (very low to low) (Table 1). Optimum (>4.5 meq100g^{-1} soil) status of Ca is the suitable for all kinds of agricultural crops production (BARC, 2018).

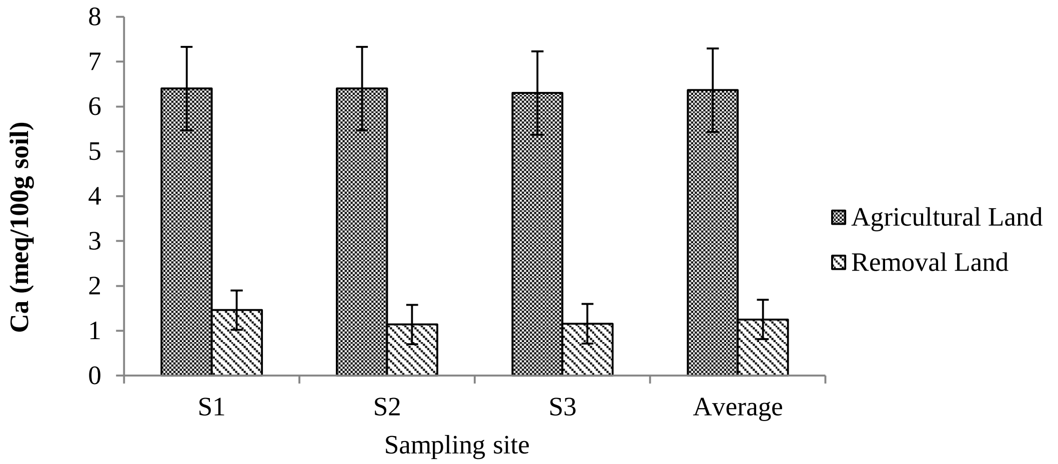

Figure 9 Comparison of calcium (Ca) concentrations between agricultural and removal lands at different sampling sites

Magnesium (Mg)

The mean magnesium (Mg) status of agricultural land was very high (4.35 meq100g^{-1} soil) but it was optimum (1.26 35 meq100g^{-1}soil) in top soil removal land (Fig. 10).The Mg contents of agricultural lands were ranged from 3.3 to 5.535 meq100g^{-1} soil and of top soil removal lands were ranged from 0.5 to 2.35 meq100g^{-1} soil (Table 1). Optimum (>1.125 meq100g^{-1} soil) status is suitable for all kinds of agricultural crops production (BARC, 2018).

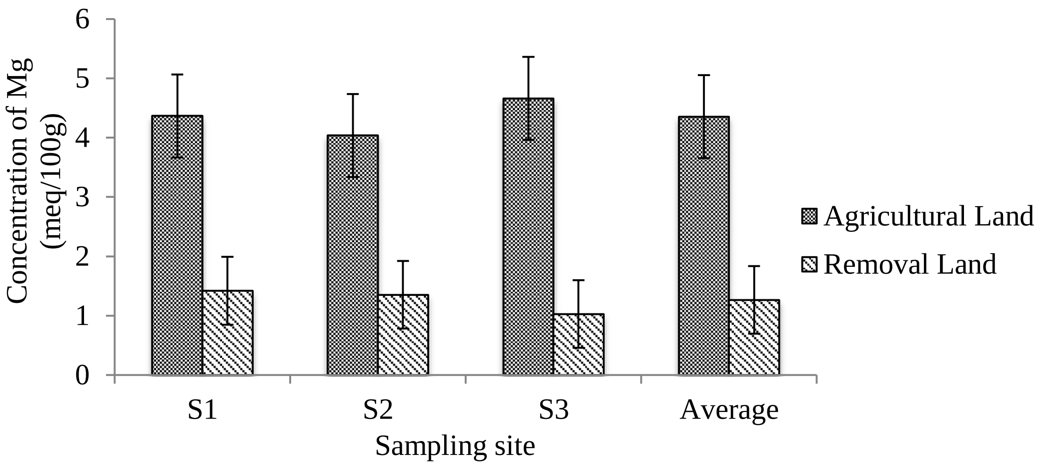

Figure 10 Comparison of magnesium (Mg) concentrations between agricultural and removal lands at different sampling sites.

Economic analysis:

Table 2 Land use pattern of the study area.

Site	Category of land	Cropping pattern
Site - 1	Productive agricultural land	Boro-Jute-Mustard
	Top soil Removal land	Fallow-Jute-Fallow
Site - 2	Productive agricultural land	Boro-Jute-Mustard
	Top soil Removal land	Fallow-Jute-Fallow
Site - 3	Productive agricultural land	Boro-Jute-Mustard
	Top soil Removal land	Fallow-Jute-Fallow

The result of the Table 2 showed that cropping pattern was been changed due to removal of top soil from the productive agricultural land. Three crops were been cultivated in agricultural land but only one crop was been cultivated from top soil removal land. This might be due to changing of land type. Due to top soil removal, medium high land was been converted to medium low land. Nutrient mining was also a factor of decreasing crops.

Table 3 Analysis of economic loss due to removal of top soil in the brick field from the productive agricultural land

Category of land	Name of the crops	Yield (ton/ha)	Market price (US$./kg)	Amount (US$)	Total(US$)
Productive agricultural land	Jute	3	0.36	1071.43	2738.10
	Mustard	1	0.60	595.24	
	Boro rice	6	0.18	1071.43	
Top soil removal land	Jute	2.5	0.36	892.86	892.86
Net Economic loss due to removal of top soil					1845.24

Table 3 showed that total income was been come 2738.10 US$ per year per hectare from productive agricultural land. On the other hand, only 892.86 US$ per year per hectare was been come from top soil removal land. That means, net economic lose found from the top soil removal land was 1845.24 US$ per year per hectare.

Result showed a remarkable variation of economic earning of crop production between productive agricultural land

and top soil removal land. The main reason of the economic loss might be changing of cropping pattern and mining of nutrients from the soil due to removal of top soil from productive agricultural land for the brick manufacturing at the study area.

IV. CONCLUSION

From the study, it was clearly identified that the mean value of pH, was lower in productive agricultural land than in top soil removal land. The mean value of organic matter (OM), nitrogen (N), phosphorus (P), potassium (K), sulfur (S), zinc (Zn), boron (B) magnesium (Mg)and calcium (Ca) were decreased at all sites of top soil removal land and lower than productive agricultural land. Finally, Nutrient status, crop yield and economic benefit were been declined tremendously as a consequence of top soil removal due to brick manufacturing. Therefore, based on the findings of the study it was recommended that proper initiatives should be taken by the Government to apply the rules and regulations to protect the productive agricultural land from nutrient mining, brickfield management and it should be ensured that farmers (land owners) should not sold their top soil from the productive agricultural land. It was also recommended that brick fields should be built far from the agricultural land.

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