Journal of the Faculty of Environmental Science and Technology,
Okayama University
Vol.12, No.1, pp.83-89, March 2007

Effects of Brick Burning on Microbial Biomass and C/N Ratio in Selected Soil Profiles in the Eastern Region of Bangladesh

Md. H. R. KHAN*, Md. K. RAHMAN[1], A. J. M. A. ROUF[2], G. S. SATTAR[3], M. S. AKHTAR, Y. OKI and T. ADACHI

(Received November 30, 2006)

The pH values in the profiles of unburnt (agricultural land) soils were found to increase as a function of soil depth and burning (400 to 1000°C) of the soils increased average pH by 8%. The average sand content of the burnt (soil around brick kilns) soil profiles was increased by 245%, while 39 and 36% decreased the silt and clay contents. Soil organic carbon (Corg) in the unburnt soils (0-20 cm) at different agro-ecological zones in the eastern region of Bangladesh ranged from 0.8 and 1.4 %, whereas the content of microbial biomass carbon (Cmic) in the studied unburnt soils ranged between 5 and 7 % of the total Corg, suggesting that the microbial biomass releasing considerable amounts of carbon in soil while burning of the soils drastically reduced this contribution to about 1 %. The values of soil Cmic in the unburnt soils were approximately 2 to 6 times higher in the topsoils than the subsoils (20-60 cm). Variable rainfall, temperature and soil fertility had an overriding influence, which was reflected by the average minimum (276 μg g^{-1}) and maximum (439) amounts of soil Cmic in Moulvibazar and Cox' Bazar sites. The Cmic decreased upon soil burning by 92 % of its original average value (346 μg g^{-1}) in the soil profile of up to 100 cm. Burning of topsoils strikingly increased the Corg/Cmic ratio by about 6 to 9 times, while reduced the C/N ratio by about 1.5 to 2.5 times. The average loss of Corg, available and total N due to burning of the soils were 66, 72 and 44 % (increase over average content of unburnt soil: IOAC), respectively, which suggests that the burning of the soils offset the essential roles of soil microorganisms, reduced soil fertility and soil microbial contribution.

Key words: *brick burning, C/N ratio, microbial biomass carbon, soil organic carbon, ratio of microbial biomass to organic carbon.*

1 NTRODUCTION

Soil is one of the most fundamental resources we have. For some years, reports have told of its alarming degradation by several means. If the current rates of loss are continuing then the topsoil reserves would disappear in about 150 years (Pimentel, 1993). Brick kilns are not out of this threat. Millions of hectares of lands and tons of carbon, nitrogen, other elements and microbes are being losing every year through brick burning, which not only destroying the agriculturally most important topsoils and forest resources but also hindering microbially-mediated essential soil processes and inducing the global warming and greenhouse effects. Khan *et al.* (2005) reported that soil microbial population releases a considerable amount of essential nutrients for plant growth but burning of the soils drastically reduced these contributions. It is reported that about 1 billion tons of carbon per year is lost through forest burning (USEPA, 1988). A little or scanty information is available on the effects of brick kiln on soil degradation, environmental pollution and biodiversity.

Carbon and nitrogen dynamics rely heavily on a labile pool of soil organic matter, the so-called active fraction (Parton *et al.*, 1987). Soil microbial biomass is a significant part of the active fraction and is furthermore a sensitive indicator of changes in total organic matter caused by management practices (Powlson *et al.*, 1987). Soil organic carbon was also highly correlated with microbial biomass carbon. There was no such strong significant relationship between any of the other soil chemical and physical properties (Drury *et al.*, 1991). Microbial biomass, the living part of organic matter, represents only a small portion of soil organic matter (<5%) but, due to its dynamic nature, it acts as a major sink and source of labile nutrients (Paul and Voroney, 1984). Microbial biomass is responsible for organic matter transformations and nutrient cycling.

The Cmic and the Cmic/Corg ratio are useful measures to monitor soil organic matter and both provide a more sensitive index than Corg measured alone (Sparling,

Department of Environmental Management Engineering, Faculty of Environmental Science and Technology, Okayama University, Japan. [1]*Department of Soil, Water and Environment, Faculty of Biological Sciences, University of Dhaka, Bangladesh.* [2]*Ministry of Science and Information & Communication Technology, Bangladesh.* [3]*Department of Geology and Mining, University of Rajshahi, Bangladesh.* * *Corresponding author.*

1992). The sensitivity of soil Corg and Cmic measurements, and the Cmic/Corg ratio, to reflect climate, vegetation, cropping and management history was investigated using a range of topsoils in the eastern regions of Bangladesh. Accordingly, the aim of the present research was to assess the impacts of brick burning on the degradation of agricultural soils and possible hazards to environment through the quantification and comparison with the size and distribution of microbial biomass and essential nutrients in the profiles of burnt and unburnt soils.

2 MATERIALS AND METHODS

Five agro-ecological zones in the eastern regions of Bangladesh, including Cox' Bazar, Comilla, Moulvibazar, Dhaka and Mymensingh districts were studied for the assessment of the impact of brick kilns on microbial biomass and C/N ratio in selected soil profiles in the eastern region of Bangladesh. The sites were selected based on the climatic conditions, soil type and fertility status, geographic position and land use (Table 1). Five man-made profiles of each burnt soil obtained by staking the soils in open air at the boundary or periphery of brick kilns were studied. They consisted of remnants in the brickfields and had been subjected to heating at 400 to 1000°C temperatures. The unburnt soils profiles consisted mostly soils in agricultural lands from where the topsoils (1 to 2 m depth) had been removed, depending on soil quality, for brick production. The studies were carried out during the dry seasons of 1998 to 1999. Pits approximately 1.5 m deep were dug for each burnt and unburnt natural soil at a distance of about 0.5 km from the brick kilns where the topsoils had usually been collected. From the agronomic point of view, the topsoils to a depth of 100 cm are very important in terms of nutrient dynamics and degradation of soil fertility. Accordingly, the soils in each profile were sampled and analyzed at intervals of 10 cm to a depth of 100 cm. The representative data obtained from the soils at selected depths and the weight of the topsoils (1 m extending over an area of 5,000 ha, topsoil sampling areas) were considered for the determinations of nutrients. The bulk samples obtained from each section were stored in the field under moist conditions by putting the soil samples into polyethylene bags in an airtight box immediately prior to laboratory analysis. The sub-samples were air-dried and gently crushed to pass through 1 and 2 mm mesh sieves, as required. After treatment with 300 g kg^{-1} H_2O_2, particle size distribution was determined by the pipette method (Day, 1965). Textural classes were determined using a triangular co-ordinate diagram. The pH of the soil samples was determined in the laboratory (dry soil and distilled water ratio of 1 : 2.5) and measured by using a Corning glass electrode pH meter (Jackson, 1973).

2.1 Determination of soil and microbial biomass carbon

Organic carbon content of the soil samples was determined volumetrically by the wet oxidation method with a 1N $K_2Cr_2O_7$ solution and concentrated H_2SO_4 mixture, followed by rapid titration with a 1N $FeSO_4$ solution, as recommended by Nelson and Sommers (1982). Microbial biomass carbon was analyzed following fumigation through alcohol free chloroform and extraction by 0.5 M potassium sulfate as described by Vance *et al.* (1987). Microbial biomass carbon was estimated by the subtraction of carbon in unfumigated soils from the carbon in fumigated soils.

2.2 Determination of nitrogen

Available nitrogen was extracted with a 2M KCl solution and the amount was determined according to the Micro-Kjeldahl distillation method (Jackson, 1973). Total N content in soil was determined by the Micro Kjeldahl method following H_2SO_4 acid digestion and alkali distillation (Jackson, 1973). Correlations between the selected parameters, level of significance and standard deviation were determined using statistical packages in Office 2003 Program.

3 RESULTS AND DISCUSSION

3.1 Sites and soil conditions

The total land area of Bangladesh has been divided into 30 agro-ecological zones (AEZ), which provides extended national, district and thana digitized databases related to soil/land types, climatic conditions, hydrology, crops, land use and crop suitability as well as computerized procedures for land productivity assessment and mapping, demographic and socio-economic information. Detailed information about the individual AEZs can be obtained from the web site: www.fao.org. The present study sites in the five agro-ecological zones exhibited average rainfall values ranging from 1500 to more than 5000 mm and temperatures ranging from less than 15°C to more than 40°C, and differed in the soil types, soil fertility and land use conditions (Table 1). Among the sites, drier conditions prevailed at Keraniganj in Dhaka while moister conditions prevailed at Ramu in Cox' Bazar. Eight general soil types (Hussain, 1992: based on FAO/UNESCO Legend) predominated in the selected five AEZs (BARC, 1997). The fertility of the soils in the different AEZs ranged from medium to low based on the soil fertility classification (BARC, 1997). The soils at Devidar in Comilla were relatively more fertile, followed by the soils at Srimangal in Moulvibazar and the soils with the lowest fertility were identified at Keraniganj in Dhaka (Table 1).

3.2 Distribution of soil properties

The pH values in the burnt and unburnt soil profiles ranged from 6.8 to 7.5 (burnt) and 4.3 to 5.8 (unburnt) for Cox' Bazar, 4.9 to 8.1 and 6.3 to 6.5 for Comilla, 3.8 to 6.2 and 4.1 to 4.6 for Moulvibazar, 4.9 to 6.2 and 5.1 to 6.6 for Dhaka and 5.1 to 6.5 and 4.2 to 6.5 for Mymensingh (Table 2). The pH values in the profiles of the unburnt soils increased with increasing depth, except for the soil profile in Cox' Bazar, where the pH values of the sub-soils decreased at depths from 60 cm (Table 2).

Table 1 Description of study sites in the eastern region of Bangladesh

Sampling sites	No. and name of AEZ$^{\#}$	Rainfall (mm)	Air temperature (average °C)	Main soil types*	Soil fertility	Land use (main crops)
1. G. M. K. Bricks, Uttarfaricul, Ramu, Cox' Bazar	**29.** Northern and Eastern Hills	Mean annual: 4000 to more than 5000	More than 20°C from October, never 40°C, moist and thermal zones	Brown Hill soils (yellow brown to deep brown)	Low OM^{*1} content, WHC^{*2}; low fertility; strongly acidic	Shifting (Jhum) cultivation, paddy, sesame, pulse, maize, cassava, gourds, vegetables, etc.
2. Russel Brick Field, Baroir, Devidar, Comilla.	**16.** Middle Meghna River Floodplain	Less than 2000 to 2300	More than 15°C for 50-70 days and less than ½ days with maximum of 40°C	Non-calcareous Dark Grey Floodplain soils	Medium fertility with low N and OM^{*1} contents.	Deepwater aman or mixed aus, mustard, groundnut, chilli, sweet potato, wheat, jute, etc.
3. Tista Brick Field, Fullchari, Srimangal, Moulvibazar.	**22.** Northern and Eastern Piedmont Plains	2000 to 5000	More than 20°C from October and exceeding 40°C for ½ days during summer	Grey Piedmont and Grey Flood-plain soils	Low to medium fertility, acidic in reaction	Broadcast or transplanted aus followed by boro, deepwater aman, tea, etc.
4. S. B. M. Bricks, Ayllapara, Keraniganj, Dhaka.	**8.** Young Bramaputra and Jamuna Floodplain	1500 to 2500	More than 20°C from November and exceeding 40°C for about ½ - 5 days	Grey Floodplain and Non-calcareous Alluvium soils	Deficient in N, P, S, but adequate K and Zn contents	Boro, aman, wheat, barley, maize, mustard, groundnut, kaon, pulses, chilli, sweet potato, jute, etc.
5. Wadud Brick Field, Chaparbari, Bhaluka, Mymensingh.	**9.** Old Bramaputra Floodplain	2000 to 4000	More than 20°C from November and seldom exceeding 40°C during summer	Grey and Dark Grey Floodplain soils	Low fertility but medium P content and CEC	Boro - aman, aus or jute, groundnut, sugarcane, wheat, potato, tobacco, lentil, mustard, khesari, etc.

Sources: Fertilizer Recommendation Guide (BARC, 1997), *Hussain (1992; based on FAO/UNESCO legend), $^{\#}$AEZ = Agro-ecological zone, OM^{*1} = Organic matter, and WHC^{*2} = Water-holding capacity.

The pH values of the burnt soils also increased toward the deeper layers of soils, except for the soil profile in Moulvibazar, where the trend of pH distribution was opposite (Table 2). The profile of the unburnt soil up to 1 m depth in Moulvibazar was strongly acidic with an average pH value of 4.3, followed by pH 5.0 in Cox' Bazar and 5.8 in Mymensingh (Table 3). Soil burning was found to increase the average pH values of soils, except for the soils at the Dhaka site and the increment was striking for the soils of Cox' Bazar, which might be due to the high EC value of the soils (Table 3). In the present study, the increment in pH was 8% (IOAC = increase over average content of unburnt soil), while in other studies (Khan *et al.*, 2004) in the surface soils (15 cm) in the separate AEZs of the soils, the pH and sand content were increased by 15 and 245% (IOAC), while the silt and clay contents decreased by 42 and 36%, respectively (Table 3), which may lead to the reduction of the strength and quality of bricks.

3.3 Losses of nutrients

The contents of organic matter, available and total N were higher in the unburnt soils of Cox' Bazar, followed by the soils of Mymensingh. The average loss of these components due to burning of the agricultural topsoils amounted to 66% (IOAC) for soil organic carbon, 72 and 44% for available and total N, respectively (Table 3). Khan *et al.* (2004) reported in their other studies that the losses of the total N, P, K and S in the surface (15 cm depth) soils amounted to 66, 59, 91 and 58%, respectively. It is well known that soil organic matter is a reservoir for plant nutrients, enhances the water-holding capacity, protects the soil structure against compaction and erosion, and thus determines soil productivity. All agriculture to some extent depends on the content of soil organic matter as well as those the above soil nutrients. Maintenance of organic matter is critical for preventing land degradation (Martius *et al.*, 2001). The distribution of organic carbon, total and available N in the unburnt soil profiles showed significant ($p \leq 0.05$) negative relationships with the corresponding depths of soils (data not shown). The trend of the relationships of these components was very similar to that in the burnt soils but not significant. Soil organic carbon content showed a significant positive relationship with the contents of the nutrients in the unburnt soils, while these relationships were not significant for the burnt soils. The available N content displayed a significant positive relationship with the nutrient contents in both the burnt and unburnt soils. The trends of the relationships among the components studied in both the burnt and unburnt soils were very similar with a few exceptions. These relationships revealed that the burning of topsoils seriously degraded the soil fertility, productivity and sustainability level of the environments. This large loss of nutrients associated with the burning of topsoils, reduced crop production and also led to pollution of the environment and atmosphere. The losses by burning of 66 % of organic carbon and 44 % of total N throughout the 1 m deep profile (Table 3) over an area of 5000 ha, led to a large depletion of nutrients from the soils and also adversely affected the environment, along with contribution to changes in the global climate.

3.4 Distribution of soil microbial biomass and impacts of soil burning

The content of microbial biomass carbon (Cmic) in the unburnt surface soils (0-10 cm) and subsurface soils (10-60 cm) ranged from 542 to 802 and 95 to 640 $\mu g\ g^{-1}$ (Table 2). The minimum amounts of 16 to 63 $\mu g\ g^{-1}$ of Cmic were obtained from the depth of 100 cm in all the unburnt soils. The amounts of microbial biomass carbon following the clear-felling are characterized by the small values found in the burnt soils (17 to 47 $\mu g\ g^{-1}$ in all the profiles), while at the same time relatively optimum values or at least an unaffected biomass were obtained from the 0 to 20 cm soil layer (Table 2). Values of soil Cmic in the unburnt soils ranged from approximately 2 to 6 times higher in the surface soil than the subsurface soils (Table 2). This indicates the importance of this surface soil layer for microbially mediated processes such as nutrient cycling and decomposition. Loss of this surface soil through human or natural disturbance like brick burning is detrimental to the functioning of this ecosystem.

The ratios of Corg/Cmic in the unburnt surface (0-10 cm) and subsurface (10-60 cm) soils ranged between 17.5 to 19.7 and 15.3 to 68.4 (Table 2). The ratios were very high (57-200) in the soils at depth of 90 to100 cm and also in all the profile of 0 to 100 cm of burnt soils (63-182). The maximum amount of Cmic in Corg was estimated in the profile at Cox' Bazar followed by Comilla and Mymemsingh soils, while the soil profile at Dhaka contained the lowest amount of Cmic (Table 2). Burning of top soils strikingly increased the Corg/Cmic ratio by about 6 to 9 times, while reduced the C/N ratio by about 1.5 to 2.5 times (Table 2). The usefulness of the Cmic/Corg ratio as a monitoring index has not been widely reported. However, the Cmic/Corg ratio has been found useful (Hart et al., 1989) as an index of changes in soil organic matter resulting from land management changes. Higher organic matter contents high levels of organic carbon; such factors may affect the reported consistency of the Cmic/Corg ratio. Soil Cmic values for these the studied soils are comparable to other terrestrials. The soil underneath soil crust had the lowest biomass C. The topsoils of up to 20 cm was found to contribute 5 to 7 % of Cmic to the total Corg in soils, which suggests that microbial population in soil is not only mediated the different processes in soils but also releasing a considerable amounts of carbon. Burning of the soils drastically reduced this contribution to about 1% (Table 2). The values of soil Cmic reported here are important because the literature is almost nil regarding to the evaluation of impacts of brick kiln on soil microbial biomass in the tropical and sub-tropical ecosystems. Even the estimates of soil microbial biomass from agricultural, forest or grassland soils are also very scanty.

Factors other than soil characteristics have prominent

Table 2 Some selected properties and microbial biomass carbon (Cmic) in burnt (soil around brick kiln) and unburnt soils (agricultural land) sampled from soil profiles (1 m depth) in the eastern region of Bangladesh

Location	Depth (cm)	pH	Tex-ture	Avail-N (mg/L)	Total N (%)	#Corg (%)	C/N ratio	*Cmic μg/g	Corg/Cmic	Cmic in Corg (%)
Burnt soils										
1. Cox' Bazar	10	6.8	SCL	9	0.03	0.26	8.7	27	96.3	1.0
	20	7.0	L	11	0.03	0.25	8.3	31	80.6	1.2
	30	7.3	L	10	0.02	0.21	10.5	29	72.4	1.4
	60	7.5	CL	8	0.03	0.22	7.3	26	84.6	1.2
	100	6.9	SiCL	6	0.02	0.31	15.5	17	182.4	0.5
2. Comilla	10	5.0	SL	8	0.03	0.32	10.7	21	152.4	0.7
	20	6.2	SCL	6	0.03	0.37	12.3	34	108.8	0.9
	30	7.3	SCL	6	0.02	0.30	15.0	32	93.8	1.1
	60	8.1	SL	4	0.03	0.26	8.7	31	83.9	1.2
	100	4.9	SCL	4	0.02	0.29	14.5	30	96.7	1.0
3. Moulvibazar	10	6.2	SCL	9	0.03	0.24	8.0	19	126.3	0.8
	20	5.9	SL	8	0.04	0.28	7.0	23	121.7	0.8
	30	4.9	SCL	5	0.03	0.22	7.3	29	75.9	1.3
	60	4.3	SCL	6	0.04	0.27	6.8	27	100.0	1.0
	100	3.8	CL	4	0.03	0.21	7.0	20	105.0	1.0
4. Dhaka	10	5.4	SCL	7	0.02	0.19	9.5	22	86.4	1.2
	20	5.8	CL	5	0.03	0.22	7.3	27	81.5	1.2
	30	6.2	SiCL	6	0.04	0.22	5.5	31	71.0	1.4
	60	5.5	CL	7	0.04	0.21	5.3	33	63.6	1.6
	100	4.9	CL	5	0.03	0.21	7.0	23	91.3	1.1
5. Mymensingh	10	5.1	L	12	0.03	0.28	9.3	33	84.8	1.2
	20	5.2	SCL	13	0.04	0.32	8.0	41	78.0	1.3
	30	5.9	SCL	11	0.05	0.32	6.4	47	68.1	1.5
	60	6.3	CL	13	0.03	0.36	12.0	34	105.9	0.9
	100	6.5	C	9	0.02	0.34	17.0	37	91.9	1.1
Unburnt soils										
1. Cox' Bazar	10	4.8	SiCL	49	0.11	1.40	12.7	802	17.5	5.7
	20	4.9	SiC	41	0.08	0.98	12.3	640	15.3	6.5
	30	5.8	SiC	33	0.05	0.95	19.0	414	22.9	4.4
	60	5	SiCL	20	0.03	0.80	26.7	320	25.0	4.0
	100	4.3	SiC	15	0.01	0.33	33.0	18	183.3	0.5
2. Comilla	10	6.3	SiCL	44	0.09	1.22	13.6	678	18.0	5.6
	20	6.4	SiCL	34	0.07	0.92	13.1	581	15.8	6.3
	30	6.4	SiCL	21	0.05	0.78	15.6	403	19.4	5.2
	60	6.5	SiL	12	0.04	0.67	16.8	101	66.3	1.5
	100	6.3	SiCL	13	0.02	0.40	20.0	27	148.1	0.7
3. Moulvibazar	10	4.1	SCL	40	0.07	1.08	15.4	584	18.5	5.4
	20	4.1	C	31	0.05	0.86	17.2	456	18.9	5.3
	30	4.4	C	19	0.04	0.55	13.8	227	24.2	4.1
	60	4.5	C	13	0.03	0.65	21.7	95	68.4	1.5
	100	4.6	SCL	15	0.01	0.32	32.0	16	200.0	0.5
4. Dhaka	10	5.1	SiC	39	0.08	1.07	13.4	542	19.7	5.1
	20	6.1	C	33	0.06	0.82	13.7	382	21.5	4.7
	30	6.3	C	24	0.05	0.70	14.0	271	25.8	3.9
	60	6.3	SiCL	13	0.04	0.61	15.3	181	33.7	3.0
	100	6.6	SiCL	9	0.02	0.42	21.0	25	168.0	0.6
5. Mymensingh	10	4.2	SiCL	51	0.10	1.32	13.2	719	18.4	5.4
	20	5.6	SiCL	44	0.08	0.98	12.3	607	16.1	6.2
	30	6.2	SiCL	32	0.07	0.80	11.4	301	26.6	3.8
	60	6.3	SiCL	23	0.06	0.72	12.0	192	37.5	2.7
	100	6.5	SiL	17	0.04	0.35	8.8	63	55.6	1.8

#Corg = Organic carbon; *Cmic = Microbial biomass carbon. **Texture: C = Clay, L = Loam, SiC = Silty Clay, SiL = Silt Loam, SCL =Sandy Clay Loam, SiCL = Silty Clay Loam, SL = Sandy Loam, CL = Clay Loam

Table 3 Average values of selected properties of the burnt (soil around brick kiln) and unburnt (agricultural land) soils sampled from soil profiles (I m depth) in the eastern region of Bangladesh

Study Site	pH	Particle size (%)			#Corg (%)	*Cmic (μg/g)	Available N (mg/kg)	Total N (%)
		Sand	Silt	Clay				
Burnt soils								
Cox' Bazar	7.1	40	34	26	0.25	26	8.80	0.03
Comilla	6.3	62	18	20	0.31	30	5.60	0.03
Moulvibazar	5.0	62	13	25	0.24	24	6.40	0.03
Dhaka	5.6	40	39	21	0.21	27	6.00	0.03
Mymensingh	5.8	35	35	30	0.32	38	11.60	0.03
Mean	**6.0**	**48**	**28**	**24**	**0.27**	**29**	**7.68**	**0.03**
SD	**0.8**	**13**	**11**	**4**	**0.05**	**6**	**2.52**	**0.004**
Unburnt soils								
Cox' Bazar	5.0	8	51	41	0.89	439	31.60	0.06
Comilla	6.4	10	57	33	0.80	358	24.80	0.05
Moulvibazar	4.3	29	17	54	0.69	276	23.60	0.04
Dhaka	6.1	11	46	43	0.72	280	23.60	0.05
Mymensingh	5.8	11	54	35	0.83	376	33.40	0.07
Mean	**5.5**	**14**	**45**	**41**	**0.79**	**346**	**27.40**	**0.05**
SD	**0.8**	**9**	**16**	**8**	**0.08**	**69**	**4.72**	**0.01**
****IOAC (%)**	**8**	**245**	**-39**	**-36**	**-66**	**-92**	**-72**	**-44**

#Corg = Organic carbon; *Cmic = Microbial biomass carbon; **IOAC = Increase over average content of unburnt soil.

influence on soil microbial populations as evinced from the present studies (Tables 1 and 3). The variable rainfall and temperature might have overriding influences as reflected by the average minimum (276 μg g^{-1}) and maximum (439 μg g^{-1}) amounts of soil Cmic in Moulvibazar and Cox' Bazar areas (Table 3). Singh *et al.* (1989) shown that the size of the soil microbial biomass was strongly affected by tropical rainfalls. A few assessments on soil microbial biomass have been made in tropical soils and the role of soil microbes as a source-sink pool for plant nutrients in tropical regions is poorly understood (Wardle, 1992). Drying and remoistening of soils strongly influences microbial biomass and activity (Kieft *et al.*, 1987). The Cmic was found to decrease with increased clay and sand contents (Table 3), which suggest that the light (sandy) or heavy (clay rich) soils may have negative effects on microbial population. It was also reported that the turnover of C in the microbial biomass is faster in coarse textured soils than in fine-textured soils (Ladd *et al.*, 1992).

4 CONCLUSION

The content of carbon in soil microbial biomass was several fold higher in the unburnt (agricultural land) soil profiles than those of the burnt (soil around brick kilns) profiles, regardless of regions, climate and plant types or vegetations. The amount of microbial biomass carbon was lower in the higher clay and sandy soils, suggesting that the heavy and light textured soils may have negative effects on soil microbial population. The topsoils of up to 20 cm was found to contribute 5 to 7 % of microbial biomass carbon to the total soil organic carbon in soils, which suggests that microbial population in soil is not only mediated the different processes in soils but also releasing a considerable amounts of carbon. Burning of the soils drastically reduced this contribution to about 1%. The burning of enormous C and N not only degrade the soils but also led to a threat for atmospheric pollution and climate change. The loss of the topsoil through brick burning is a great loss for the society and habitat, and would be detrimental not only to microbially-mediated cycling of nutrients but also for the functioning of relevant ecosystem, environment and atmosphere.

ACKNOWLEDGEMENTS: Ministry of Science and Information & Communication Technology, Government of Bangladesh funded the research. The authors are grateful to the Alexander von Humboldt Foundation in Germany for their instrumental support. They are also grateful to the project staffs and technicians of the Department of Soil, Water and Environment, University of Dhaka, Bangladesh for their generous support to complete this research work.

REFERENCES

Bangladesh Agriculture Research Council (BARC), (1997): Fertilizer Recommendation Guide. Publ. BARC, Farm gate, Tejgaon, Dhaka, Bangladesh. pp 196.

Day, P.R. (1965): Particle fractionation and particle size analysis. *In* Methods of Soil Analysis. Part 2 (Ed.) C. A. Black, Agron. Series 9. p. 545-566. Am. Soc. Agron., Publ. Madison, WI, USA.

Drury, C.F., McKenney, D.J. and Findlay, W.I. (1991): Relationships between denitrification, microbial biomass and indigenous soil properties. Soil Biol. Biochem. 23, 751-755.

Hart, P.B.S., August, J.A. and West, W.A. (1989):. Long-term consequences of topsoil mining of selected biological and physical characteristics of two New Zealand loessial soils under grazed pasture. Land Degrad. Rehab. 1, 77-88.

Hussain, M.S. (1992): Soil classification with special reference to the soils of Bangladesh. Publ. Univ. of Dhaka, Dhaka, Bangladesh. pp 433.

Jackson, M.L. (1973): Soil Chemical Analysis. p. 41-330. Prentice Hall of India Pvt. Ltd., New Delhi.

Khan, H.R., Rahman, M.K., Rouf, A.J.M.A. and Satter, G.S. (2005): Consequences of microbial biomass and organic carbon in burnt and unburnt soil properties in different agro-ecological zones in the western part of Bangladesh. Bangladesh J. Soil Sci. 27-29: 51-60.

Khan, H.R., Rahman, M.K., Rouf, A.J.M.A. and Satter, G.S. (2004): Land evaluation and effects of brick burning on soil degradation at all upazilas in Rajshahi division. Dhaka Univ. J. Biol. Sci. 13 (1): 49-60.

Khan H. R. (2000): Problems, Prospects and Future Directions on Acid Sulfate Soils. *In* Proc. Inter. Conf. on the Remediation and Management of Degraded Lands. pp. 66-67. Ed. A. Brion and R.W. Bell. (Nov. 30 to Dec. 2, 2000, Perth, WA). Publ. by Promaco Convention Pvt Ltd., WA.

Kieft, T.L., Soroker, E. and Firestone, M.K. (1987): Microbial biomass response to a rapid increase in water potential when dry soil is wetted. Soil Biol. Biochem. 19, 119-126.

Ladd, J.N., Jocteur-Monrozier, J. and Amato, M. (1992): Carbon turnover and nitrogen transformations in an Alfisol and a Vertisol amended with [U-^{14}C] glucose and [^{15}N] ammonium sulfate. Soil Biol. Biochem. 24, 359-371.

Martius, C., Tiessen, H. and Vlek, van P. L. G. (eds.), (2001): Managing organic matter in tropical soils: scope and limitations. Nutrient Cycling in Agroecosystems, 61, 1-2.

Nelson, D.W. and Sommers, L.E. (1982): Total carbon, organic carbon and organic matter. *In* Methods of Soil Analysis. Part 2 (2nd ed.), Ed. A. L. Page, Agron. Series 9, p. 539-579. Am. Soc. Agron., Publ. Madison, WI, USA.

Parton, W.J., Schimel, D.S., Cole, C.V. and Ojima, D.S. (1987): Analysis of factors controlling soil organic matter levels in Great Plains grasslands. Soil Sci. Soc. Am. J. 51. 1173-1179.

Paul, E. A. and Voroney, R.P. (1984): Field interpretation of microbial biomass activity measurements. *In* Current Perspectives in Microbial Ecology, Eds. M.J. Klug and C.A. Reddy. pp. 509-514. Am. Soc. Microbiol.: Washington, D.C.

Powlson, D.S., Brookes, P.C., Christensen, B.T. (1987): Measurement of soil microbial biomass provides an early indication of changes in total soil organic matter due to straw incorporation. Soil Biol. Biochem. 19, 159-164.

Pimentel, D. (ed.), (1993): World Soil Erosion and Conservation. P. 1-5.

Singh, J.S., Raghubanshi, A.S., Singh, R.S. and Srivastava, S.C. (1989): Microbial biomass acts as a source of plant nutrients in dry tropical forest and savanna. Nature, London, 338, 499-500.

Sparling, G.P. (1992). Ratios of microbial biomass carbon to soil organic carbon as a sensitive indicator of changes in soil organic matter. Aust. J. Soil. Res., 30, 195-207.

United State's Environmental Protection Agency (USEPA), (1988): Meeting Summary. Stabilization Rep. Workshop on Agriculture and Climate Change. pp. 33-39. 29 February-March'88. Office of the Policy analysis, USEPA, Washington, D.C.

Vance, E.D., Brookes, P.C. and Jenkinson, D.S. (1987): An extraction method for measuring soil microbial biomass carbon. Soil Biology and Biochemistry, 19, 703-707.

Wardle, D.A. (1992): A comparative assessment of factors which influence microbial biomass carbon and nitrogen levels in soil. Biological Reviews, 67, 321-358.