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Soil Organic Matter Status Changes with Cultivation of Overgrazed Pastures in Semi-dry West Central Iran

J. Fallahzade and M.A. Hajabbasi
Department of Soil Science, College of Agriculture, Isfahan University of Technology, Isfahan, Iran

Corresponding Author: Jaber Fallahzade, Department of Soil Science, College of Agriculture, Isfahan University of Technology, Isfahan, Iran Tel: +98 913 254 3570 Fax: +98 311 3913471

ABSTRACT

The native intensively grazed and degraded pastures in dry areas are initially low in soil organic matter content. Therefore, frequently cultivation and conversion of these lands to croplands might have a positive influence on soil properties including soil organic matter. This study was conducted to determine the impacts of cultivation of overgrazed pasture on selected soil organic matter components in Javanmardi Plain, west central Iran. Total Organic Carbon (TOC), Particulate Organic Carbon (POC) compounds, total nitrogen and carbohydrate fractions were measured. Two sites including a pasture overgrazed by sheep in adjacent with one pasture converted to wheat fields for more than 23 years were used. Soil samples were taken from 0-5 and 5-15 cm depths in each site. Land use change resulted in significant ($p<0.05$) increases in TOC, POC, total nitrogen and carbohydrates contents in both depths. In most cases, the amounts of TOC in macroaggregates (0.25-2 mm) were significantly higher than those of microaggregates (0.05-0.25 mm) and large portion of TOC was stored in the macroaggregates. Cultivation of overgrazed pasture considerably increased the percentage of POC/TOC, reflecting more plant residue inputs under plantation. Although, land use change considerably increased TOC and carbohydrate amounts of intact soil, in most cases positive impact of land use change on storage of TOC and carbohydrate in aggregates were not ($p>0.05$) significant.

Key words: Overgrazed pasture, cropland, cultivation, Total Organic Carbon (TOC), Particulate Organic Carbon (POC)

INTRODUCTION

Soil Organic Matter (SOM) is an important constituent of soil due to its capacity in affecting physical conditions of soil by enhancing aeration, aggregation and water retention, thereby making a suitable environment for plant growth (Senesi and Loffredo, 1999). Land use change is known to be an important factor controlling SOM storage since it affects the quantity and quality of litter input, the litter decomposition rates and the processes of SOM stabilization (Shepherd *et al*., 2001). Soil carbohydrates (Spaccini *et al*., 2001) and Particulate Organic Carbon (POC) (Chan, 2001) as SOM indicators are sensitive to changes in land use. Land use changes, especially cultivation of native lands in temperate and tropical areas have led to negative effects on SOM components. For instance, Spaccini *et al*. (2001) and Bongiovanni and Lobartini (2006) observed cultivation of undisturbed soils resulted in significant decreases in Soil Organic Carbon (SOC) and carbohydrate contents. The POC is preferentially lost when soils under pasture converted to cultivated fields

(Chan, 2001). In contrast, some research studies have shown that conversion from the pastures to cultivated soils may positively influence SOM. In the semi-arid region, positive influences of the conversion of overgrazed pastures to cropland on SOM were reported by Raiesi (2007). Cochran *et al.* (2007) also found that in semi-arid ecosystems conversion from the native land to cropland resulted in greater Total Organic Carbon (TOC) and total Nitrogen (N_t) contents in cropland.

Reduction in SOM due to removal of the plant biomass, accompanies soil quality degradation (Zech and Guggenberger, 1996). Mwendera and Saleem (1997) also reported that heavy to very heavy grazing pressure significantly reduced biomass contents and ground vegetative cover in the Ethiopian highlands.

In arid regions, low SOC is common attributes of soils (Hajabbasi and Hemmat, 2000) and pastures in these regions are characterized by low annual rainfall, overgrazing by animals and loss of mineral fertilizer application. Many of these pastures are poor in SOM, because the large quantities of the plant biomass are removed by grazing livestock (Raiesi and Asadi, 2006). Nonetheless, the impacts of cultivation of overgrazing pasture on soil carbohydrate fractions and POC components in the semi-arid regions of Iran are not understood. Thus, the present investigation aims at analyzing the effects of a change in land use from overgrazed pasture to wheat fields on some SOM properties, like TOC, N_t, carbohydrate fractions and POC components.

MATERIALS AND METHODS

Study area and soil sampling: The study area locates in Javanmardi plain at an elevation of around 1700 m above the sea level, nearly 35 km east of Lordegan (31°27'N, 51°02'E), South East Zagrous Mountain, Iran (Fig. 1) covering of about 408 km^2. This area has a natural semiarid rangeland ecosystem with a mean annual rainfall of 500 mm and mean annual temperature of 14.9°C. The area is typically overgrazed pasture and continuous overgrazing especially by sheep.

For the purposes of this study, two adjacent sites were chosen including: (1) an old (several decades) overgrazed pasture with no control on stock rate and grazing duration and frequency and (2) converted similar pasture to cropland (winter wheat) with almost 23 years old. Soils were

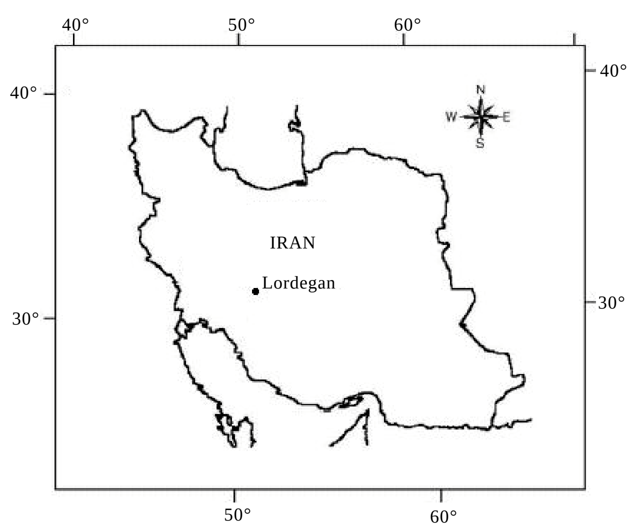

Fig. 1: Location of the study area in central Iran

Table 1: Total organic carbon, total nitrogen and carbohydrate concentrations (g kg^{-1} soil) and soil texture in overgrazed and cropland sites

Sampling depth and site	TOC	N_t	CH_{da}	CH_{hw}	Texture
	(g kg^{-1} soil)				
0-5 cm					
Overgrazed	6.73b	0.70b	0.25b	0.44b	Clay
Cropland	8.45a	1.18a	0.31a	0.55a	Clay
5-15 cm					
Overgrazed	6.12b	0.68b	0.24b	0.34b	Clay
Cropland	9.02a	1.27a	0.32a	0.54a	Clay

TOC: Total organic carbon, N_t: total nitrogen, CH_{da}: dilute acid-hydrolysable carbohydrate, CH_{hw}: hot water-hydrolysable carbohydrate. Means within a column followed by the same letter are not significantly different at $p<0.05$

sampled in October 2006. At time of soil sampling for the pasture site, plant coverage (dominantly grass species of *Astragalus* sp.) was poor. For the cropland, the crop residues (wheat straw) were not burned during land preparation, soil plough method was moldboard and disc plough and cropland was irrigated by flooding method. In the cropland, mineral N (as urea) and P (as di-ammonium phosphate) fertilizers are usually applied to improve soil productivity. Soil samples were taken after the crop harvest (October, 2006) from the 0-5 and 5-15 cm depths for both land use systems. Overall, 48 soil samples (i.e., 2 sites × 12 composite soil samples × 2 depths) were taken for physical and chemical analysis. After air-drying, soil samples were sieved through 4 mm sieve size for aggregate fractionation and separation of POC and the remaining soil was sieved through 2 mm sieve size for chemical analysis and particle size distribution. The TOC was determined using the wet oxidation method (Walkely and Black, 1934) and N_t was measured using the Kjeldahl method (Bremner and Mulvaney, 1982). Soil texture was determined by hydrometer method (Gee and Bauder, 1986). Soil texture in the study area is clayey (Table 1) and soils are Calcic Haploxeralfs.

Carbohydrates measurement: The carbohydrate fractions were extracted by two different methods. In one of the method a hot water-soluble carbohydrate (CH_{hw}) was used by which one g of soil was mixed with 10 mL of hot distilled water (85°C) and heated for 2.5 h. In the other method, a dilute acid-soluble carbohydrate (CH_{da}) was carried out with one g of soil or aggregate was mixed with 10 mL of 0.25 M H_2SO_4 and shaken in a plane rotary shaking machine for 16 h. Both types of soil suspension were centrifuged at 3,000 rpm for 30 min (Adesodun *et al*., 2001). Afterwards 2 mL of the supernatant solution was mixed with 0.05 mL of 80% phenol solution and 5 mL of concentrated (98%) sulphuric acid. The absorbency was read in a spectrophotometer at 490 nm. The calibration curve was obtained using glucose standard solution (Dubios *et al*., 1956).

Fractionation of water stable aggregates and POC separation: The size distribution of soil aggregates was measured by wet sieving through a series of sieves (2, 1, 0.5, 0.25 and 0.05 mm). A 50 g sample of air-dried soil (<4 mm) was spread on the top of 2 mm sieve submerged in a bucket of distilled water. Soils sieved by moving the sieve 3 cm vertically 50 times during a period of 2 min. Materials that passed through the sieve was poured on to the next finer sieve and the processes were repeated. The aggregates were dried in the oven at 50°C and weighed. The percentage ratio of the aggregates in each sieve represents the aggregates of size classes: 2-4, 1-2, 0.5-1, 0.25-0.5 and 0.05-0.25.

For the separation of Particulate Organic Matter (POM), aggregate fractions were combined into two groups: microaggregate (0.05-0.25 mm) and macroaggregate (0.25-2 mm). Ten grams of each aggregate fraction was dispersed in 30 mL sodium hexametaphosphate (5%) for 16 h on a reciprocating shaker at 120 strokes per minute. After dispersion, the suspensions were sieved through 0.05 mm sieve to separate sand particles + POM. The collected sand particles + POM were dried at 55°C to constant weight and then subjected to 450°C for 4 h to measure POM by Loss On Ignition (LOI) method (Cambardella *et al*., 2001) and POC estimated by multiplying the mass difference by 0.58. Thus, by this procedure the POC in microaggregate (POC_{mic}) and macroaggregate (POC_{mac}) were separately determined.

The TOC and CH_{da} concentration in the sand-free aggregates (sand-free $TOC_{fraction}$ and $CH_{da\text{-}fraction}$) were calculated as (Six *et al*., 1998):

$$\text{Sand-free (TOC or CH}_{da})_{fraction} = \frac{(\text{TOC or CH}_{da})_{fraction}}{1\text{-(sand proportion)}_{fraction}}$$

where, $TOC_{fraction}$ and $CH_{da\text{-}fraction}$ were the concentration of TOC and CH_{da} in the respective aggregate fraction, respectively. The sand $proportion_{fraction}$ was the relative proportion of sand particles in the aggregate fraction. The Mean Weight Diameter (MWD) of the soil aggregates was calculated through the following equation:

$$\text{MWD} = \sum_{i=1}^{n} X_i W_i$$

where X_i is the mean diameter of the ith sieve size and W_i the proportion of the total aggregates in the ith fraction.

Statistical analysis: The effect of cultivation of overgrazed pastures on soil and aggregate variables was determined by two-way Analysis of Variance (ANOVA). Means were compared by Duncan test at $p<0.05$. Statistical procedures were carried out using the software package SAS 9.1 for Windows.

RESULTS

Altering the overgrazed pasture to cropland changed the quantity and quality of organic matter in intact soil and aggregates. These changes will be discussed first for the intact soil and then for the aggregates.

The intact soil TOC, N_t and carbohydrates: Cultivation of overgrazing pastures considerably increased TOC content of soil. In 0-5 and 5-15 cm depths, the amount of TOC contents were increased from 6.73 and 6.12 g kg^{-1} in soil under overgrazing pasture, respectively to 8.45 and 9.02 g kg^{-1} in the cropland soil, reflecting 1.25 and 1.5 times greater as a result of cultivation, respectively (Table 1). Compared with the pasture soil, the amounts of N_t, CH_{da} and CH_{hw} were 69-87, 24-33 and 25-58% higher under wheat at depth 0-15 cm, respectively (Table 1).

Aggregate size distribution and stability: The results of cultivation effects on the aggregate size distribution and MWD size classes are reported in Table 2. At 0-5 cm depth, the proportion of

Table 2: The distribution and MWD of water-stable aggregates in overgrazed and cropland sites

	Distribution (%)				MWD (mm)			
	Overgrazed		Cropland		Overgrazed		Cropland	
Aggregate size (mm)	0-5 cm	5-15 cm	0-5 cm	5-15 cm	0-5 cm	5-15 cm	0-5 cm	5-15 cm
2-4	7.7a	1.4b	1.0b	1.3b	0.23a	0.04b	0.03b	0.04b
1-2	3.8b	11.7a	9.2a	10.7a	0.05b	0.17a	0.14a	0.16a
0.5-1	14.6b	24.0a	25.7a	22.7a	0.10b	0.18a	0.19a	0.17a
0.25-0.5	21.4a	25.2a	28.2a	22.4a	0.08a	0.09a	0.11a	0.08a
0.05-0.25	47.3a	33.1b	26.6b	34.3b	0.07a	0.05b	0.04b	0.05b
Total	94.8	95.4	90.7	91.4	0.54	0.53	0.51	0.50

MWD: Mean weight diameter. Means within a raw followed by the same letter are not significantly different at $p<0.05$

Table 3: The amount of TOC and CH_{da} (g kg^{-1} aggregate) of soil aggregate size classes in overgrazed and cropland sites

	Aggregate size classes							
	1-2 mm		0.5-1 mm		0.25-0.5 mm		0.05-0.25 mm	
Sampling depth and site	TOC	CH_{da}	TOC	CH_{da}	TOC	CH_{da}	TOC	CH_{da}
0-5 cm								
Overgrazed	8.65a	0.27a	8.65ab	0.24a	7.55a	0.20a	6.80ab	0.21ab
Cropland	9.02a	0.35a	9.00a	0.30a	7.70a	0.29a	8.60a	0.32a
5-15 cm								
Overgrazed	7.50a	0.25a	5.13b	0.24a	6.90a	0.21a	5.85b	0.19b
Cropland	9.00a	0.34a	8.90a	0.33a	8.90a	0.32a	9.00a	0.27ab

TOC: Total organic carbon, CH_{da}: dilute acid-hydrolysable carbohydrate. Means within a column followed by the same letter are not significantly different at $p<0.05$

2-4 and 0.05-0.25 mm size fractions were significantly ($p<0.05$) lower in the cropland than in the pasture soils. However, in this depth the proportion of 1-2 and 0.5-1 mm size fractions was significantly ($p<0.05$) lower in the pasture soils than in the cropland (Table 2). However, the aggregate stability (MWD) values for land uses were not statistically different and ranged from 0.53-0.54 mm in overgrazed pasture to 0.50-0.51 mm in cropland (Table 2).

TOC and CH_{da} of aggregates: The amounts of TOC and CH_{da} (g kg^{-1} aggregate) of the different aggregate size classes are shown in Table 3. The amounts of TOC and CH_{da} in 2-4 mm size class were not determined because in most cases the proportions of this size class were scant. Although, the amounts of TOC in the 0.5-1 mm and 0.05-0.25 mm size classes of the cropland soils (in 5-15 cm depth) were significantly higher than those in overgrazed pasture, in other cases differences were not ($p>0.05$) significant (Table 3). The distribution pattern of TOC and CH_{da} (g kg^{-1} soil) showed that the amounts of TOC in the 0.5-1 mm size class (in both depths) and CH_{da} in the 0.5-1 mm and 0.25-0.5 mm size classes (in 0-5 cm depth) of the cropland soils were significantly higher than those in overgrazed pastures (Table 4). However, in other aggregate size classes differences were not ($p>0.05$) significant (Table 4).

TOC in micro and macroaggregates: For the 0-5 cm depth, the amounts of TOC (g kg^{-1} soil) in the macroaggregates were significantly greater in the soil under cropland compared to overgrazing

Table 4: The amount of TOC and CH_{da} concentration (g kg^{-1} soil) of soil aggregate size classes in overgrazed and cropland sites

Sampling depth and site	Aggregate size classe 1-2 mm TOC	1-2 mm CH_{da}	0.5-1 mm TOC	0.5-1 mm CH_{da}	0.25-0.5 mm TOC	0.25-0.5 mm CH_{da}	0.05-0.25 mm TOC	0.05-0.25 mm CH_{da}
0-5 cm								
Overgrazed	0.32b	0.01b	1.21b	0.04b	1.55a	0.04b	3.38a	0.11a
Cropland	0.84ab	0.03ab	2.27a	0.08a	2.20a	0.09a	2.28a	0.08a
5-15 cm								
Overgrazed	0.92a	0.03ab	1.23b	0.06ab	1.70a	0.05ab	1.92a	0.06a
Cropland	0.97a	0.04a	1.97a	0.08a	1.95a	0.08ab	3.00a	0.10a

TOC: Total organic carbon, CH_{da}: dilute acid-hydrolysable carbohydrate. Means within a column followed by the same letter are not significantly different at $p<0.05$

Table 5: The amount of TOC in macro and microaggregate of soils in overgrazed and cropland sites

Land use and fraction	0-5 cm TOC (g kg^{-1} soil)	0-5 cm TOC (% in TOC of soil)	5-15 cm TOC (g kg^{-1} soil)	5-15 cm TOC (% in TOC of soil)
Overgrazed pasture				
Macroaggregate	3.08b	45.80ab	3.85ab	62.75a
Microaggregate	3.38b	50.20a	1.92c	31.21b
Cropland				
Macroaggregate	5.31a	62.84a	4.91a	54.40a
Microaggregate	2.28b	27.00b	3.00bc	33.15b

TOC: Total organic carbon. Means within a column followed by the same letter are not significantly different at $p<0.05$

pasture (Table 5). In 0-5 and 5-15 cm depths of pasture soils, the macroaggregate contains about 46 and 63% of SOC and the microaggregate contains 50 and 31% of SOC, respectively (Table 5). In 0-5 cm depth of cropland soils, the macroaggregates and microaggregates contain nearly 63% and 27% of SOC and in 5-15 cm depth, the macroaggregates and microaggregates contain 54% and 33% of SOC, respectively (Table 5).

POC_{mic} and POC_{mac}: Figure 2 shows the data on the amount of POC (g kg^{-1} soil) in the macro-and microaggregates. Land use change from pasture to cropland considerably increased the amount of POC_{mic} and POC_{mac} in both depths (Fig. 2a, b). The pasture soils contained POC_{mic} of 1.21 and 1.26 g kg^{-1} and POC_{mac} of 1.42 and 1.40 g kg^{-1} at 0-5 and 5-15 cm depths, respectively. The amount of POC_{mic} in the wheat fields was 1.80 and 2.23 g kg^{-1} and the amount of POC_{mac} was 2.15 and 2.43 g kg^{-1} at 0-5 and 5-15 cm depths, respectively (Fig. 2a ,b).

At 0-5 and 5-15 cm depths, the percentage of POC_{mic}/TOC increased from 17.8 and 21% in pasture soils to 21 and 25% in the cultivated soil, respectively (Fig. 3a). Similarly, land use changes caused a significant increase in the percentage of POC_{mac}/TOC. In overgrazed pasture, the percentage of POC_{mac}/TOC was 21 and 23% and these values for wheat fields were 25 and 28% at 0-5 and 5-15 cm depths, respectively (Fig. 3b). The POC (POC_{mic} +POC_{mac}) contained 39-44 and 47-52% of TOC in overgrazed pasture and cropland, respectively (Fig. 3a, b).

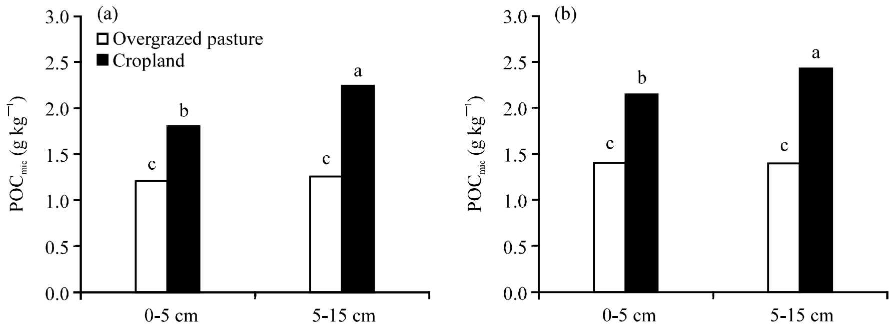

Fig. 2: The amount of soil (a) POC_{mic} and (b) POC_{mac} in overgrazed and cropland sites. POC_{mic}: Particulate organic carbon (POC) in microaggregate (0.05-0.25 mm); POC_{mac}: POC in macroaggregate (0.25-2 mm)

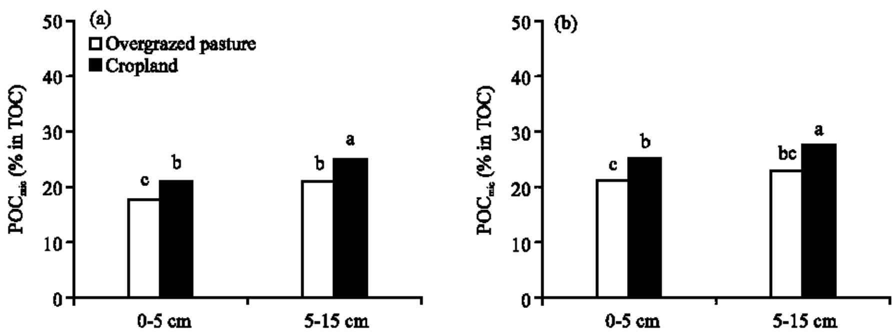

Fig. 3: The percentage of soil (a) POC_{mic}/TOC and (b) POC_{mac}/TOC in overgrazed and cropland sites. POC_{mic}: Particulate organic carbon (POC) in microaggregate (0.05-0.25 mm); POC_{mac}: POC in macroaggregate (0.25-2 mm); TOC: total organic carbon

DISCUSSION

Conversion of overgrazed pasture to wheat fields resulted in a greater SOM compounds. These results were in contrast with findings of Chan (2001), Spaccini *et al.* (2001) and Bongiovanni and Lobartini (2006) who showed that cultivation of the undisturbed soils resulted in a significant decrease in the amounts of SOM. The results of this study indicated that the impacts of overgrazing in reducing the quantity and quality of SOM are much more considerable than the impacts of soil ploughing. The lower amounts of SOM in overgrazed pasture may be attributed to reduced plant residual inputs to the soil because a great portion of plant biomass is normally grazed and removed by livestock (Raiesi and Asadi, 2006). Aweto and Adejumobi (1991) for the southern Guinea savanna zone of Nigeria and Nael *et al.* (2004) for the semiarid rangeland in central Iran found SOM contents to be lower in overgrazed than in ungrazed pastures and croplands. In overgrazed pasture, soil disturbance by trampling and consequent lack in physical preservation of the surface SOC may be responsible for reduction of TOC (Raiesi, 2007). High grazing intensity has been reported to decrease soil productivity (Dormaar and Willms, 1998) therefore cultivating and cropping of overgrazed soils in these areas generally results in higher TOC, N_t and CH_{da} contents (Table 1). Similarly, Raiesi (2007) in central Iran demonstrated that the land use changes from overgrazed pastures to cropland have resulted in positive influences on TOC and N_t contents. In the croplands, soil fertilization leading to increase SOM level (Alvarez, 2005; Raiesi, 2007). The intensification of farming systems enhances SOC levels mainly by increasing the amount of biomass produced and the amount of residues returned (Campbell and Zetner, 1993). The increase in soil carbohydrates concentration in cropland suggested that overgrazing may decrease carbohydrates concentration through a reduced input of fresh residues, while cultivation may increase crop residue and fresh organic matter inputs to the soil.

Mbah *et al.* (2007) reported that SOM is important in the soil aggregate stability. Although, cultivation of overgrazed pasture had a positive influence on SOM, the aggregate stability (MWD) values for land uses were not statistically different. Other workers reported that the stability of aggregates is low in cropland compared to grassland soils and decreases with SOM content of the soil (Six *et al.*, 1999; John *et al.*, 2005). Also, Zolfaghari and Hajabbasi (2008) and Emadi *et al.* (2008) observed a greater MWD in the pasture and forest soils compared to the cultivated soils. In cultivated sites, soil ploughing might influence the aggregates stability (Beare *et al.*, 1994).

Although, land use change significantly increased TOC and CH_{da} amounts of the intact soils, in most cases the distribution pattern of TOC and CH_{da} showed that the amounts of TOC and CH_{da} for the aggregate size classes were not statistically different among land use change (Table 3). These results are in disagreement with the observation of Bongiovanni and Lobartini (2006) who found that cultivation of undisturbed soils has decreased the SOM content in the aggregate fractions.

As with the findings of Cambardella and Elliott (1993) and John *et al.* (2005), the data indicated that in most cases, the TOC contents in the macroaggregates were higher than those in the microaggregate fractions and large portion of TOC was stored in the macroaggregates (Table 5). Studies by Mbagwu and Piccolo, (1990) also showed that carbon and nitrogen are preferentially concentrated in the macroaggregate fraction.

These results indicated that large fraction (80-90%) of SOC was stored in stable aggregates and the silt plus clay particles contained small fraction of SOC. This is in agreement with the finding reported by John *et al.* (2005).

Land use change from pasture to cropland considerably increased the amount of POC_{mic} and POC_{mac} in both depths. This could be attributed to different annual organic matter input in pasture and cropland. Grazing is regularly removing plant biomass and therefore removing carbon and plant residues from the grazed systems (Raiesi and Asadi, 2006). Soil fertilization with nitrogen fertilizer could increase the content of fresh plant residues returned to the soil (Raiesi, 2007). Consequently greater inputs of fresh plant residues in cropland could be accounted for the higher contents of POC in cropland relative to overgrazed pasture. Also Mendham *et al.* (2004) in soils of south-western Australia reported that the POM fraction carbon was higher in plantation soils than under pasture soils, reflecting the coarser nature of plant residue inputs under plantation.

The cultivation of overgrazing pasture considerably increased the percentage of POC/TOC (Fig. 3). This was presumably mainly due to the quantity and quality of the litter inputs (recent inputs of less decomposed fresh organic residues from roots of the previous crop), because POM is the first product of SOM stock in the decomposition process of plant residues and also consists of relatively young plant debris primarily from plant roots (Gale and Cambardella, 2000). Since, POM mainly consists of young and labile SOM (Gale and Cambardella, 2000) the SOM in cropland presumably is younger than that in overgrazed pasture. The primary effect of grazing on rangeland would be a significant reduction in the input amounts of fresh plant residues largely due to remove by grazing animals (Baron *et al.*, 2002). Cultivation of overgrazed pastures resulted in a greater microbial activity (soil carbon mineralization and basal respiration) due to greater inputs of labile carbon from plant residue and root exudates (Raiesi, 2007). Cultivation in the mentioned situation increases crop residue and fresh organic matter inputs to the soil. Since, soil quality depends in part upon the amount of SOM (Zech and Guggenberger, 1996) the results of this study further showed that cultivation of overgrazed pasture that are very poor in SOM could improve soil quality.

REFERENCES

Adesodun, J.K., J.S.C. Mbagwu and N. Oti, 2001. Structural stability and carbohydrate contents of an ultisol under different management systems. Soil Tillage Res., 60: 135-142.

Alvarez, R., 2005. A review of nitrogen fertilizer and conservation tillage. Effects on soil organic staorage. Soil Use Manage., 21: 38-52.

Aweto, A.O. and D.O. Adejumobi, 1991. Impact of grazing on soil in the southern guinea savanna zone of Nigeria. Environmentalist, 11: 27-32.

Baron, V.S., E. Mapfumo, A.C. Dick, M.A. Naeth, E.K. Okine and D.S. Chanasyk, 2002. Grazing intensity impacts on pasture carbon and nitrogen flow. J. Range Manage., 55: 535-541.

Beare, M.H., M.L. Cabrera, P.F. Hendrix and D.C. Coleman, 1994. Aggregate protected and unprotected organic matter pools in conventional and no-tillage soils. Soil Sci. Soc. Am. J., 58: 787-795.

Bongiovanni, M.D. and J.C. Lobartini, 2006. Particulate organic matter, carbohydrate, humic acid contents in soil macro and microaggregates as affected by cultivation. Geoderma, 136: 660-665.

Bremner, J.M. and C.S. Mulvaney, 1982. Total Nitrogen. In: Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties, Page, A.L. (Ed.). American Society of Agronomy, Madison, Wisconsin, pp: 595–624.

Cambardella, C.A. and E.T. Elliot, 1993. Carbon and nitrogen distribution in aggregates from cultivated and native grassland soils. Soil Sci. Soc. Am. J., 57: 1071-1076.

Cambardella, C.A., A.M. Gajda, J.W. Doran, B.J. Wienhold and T.A. Kettler, 2001. Estimation of Particulate and Total Organic Matter by Weight Loss-on-ignition. In: Assessment Methods for Soil Carbon, Lal, R., R.M.J. Kimble, R.J. Follett and B.A. Stewart (Eds.). Lewis Publishers, CRC Press, Boca Raton, Fl., pp: 349-359.

Campbell, C.A. and R.P. Zetner, 1993. Soil organic matter as influenced by crop rotations and fertilization. Soil Sci. Soc. Am. J., 57: 1034-1040.

Chan, K.Y., 2001. Soil particulate organic carbon under different land use and management. Soil Use Manage., 17: 217-221.

Cochran, R.L., H.P. Collins, A. Kennedy and D.F. Bezdicek, 2007. Soil carbon pools and fluxes after land conversion in a semiarid shrub-steppe ecosystem. Biol. Fertil. Soils, 43: 479-489.

Dormaar, J.F. and W.D. Willms, 1998. Effect of forty-four years of grazing on fescue grassland soils. J. Range Manage., 51: 122-126.

Dubios, M., K.A. Gilles, J.K. Hamilton, P.P.A. Reters and F. Smith, 1956. Colorimetric method of determination of sugars and related substances. Anal. Chem., 28: 350-356.

Emadi, M., M. Baghernejad and M. Emadi, 2008. Effect of shifting cultivation on distribution of nutrient elements and carbohydrates within water-stable aggregates in Northern Iran. Pak. J. Biol. Sci., 11: 195-201.

Gale, W.J. and C.A. Cambardella, 2000. Carbon dynamics of surface residue- and root-derived organic matter under simulated no-till. Soil Sci. Soc. Am. J., 64: 190-195.

Gee, G.W. and J.W. Bauder, 1986. Particle Size Analysis. In: Methods of Soil Analysis, Part 1, Physical and Mineralogical Methods, Klute, A. (Ed.). American Society of Agronomy, Madison, WI., pp: 383-411.

Hajabbasi, M.A. and A. Hemmat, 2000. Tillage impacts on aggregate stability and crop productivity in a clay-loam soil in central Iran. Soil Till. Res., 56: 205-212.

John, B., T. Yamashita, B. Ludwig and H. Flessa, 2005. Storage of organic carbon in aggregate and density fractions of silty soils under different types of land use. Geoderma, 128: 63-79.

Mbagwu, J.S.C. and A. Piccolo, 1990. Carbon, nitrogen and phosphorus concentration in aggregates of organic waste-amended soils. Biol. Wastes, 31: 97-111.

Mbah, C.N., M.A.N. Anikwe, E.U. Onweremadu and J.S.C. Mbagwu, 2007. Soil organic matter and carbohydrate contents of a dystric leptosol under organic waste management and their role in structural stability of soil aggregates. Int. J. Soil Sci., 2: 268-277.

Mendham, D.S., E.C. Heagney, M. Corbeels, A.M. O'Connell, T.S. Grove and R.E. McMurtrie, 2004. Soil particulate organic matter effects on nitrogen availability after afforestation with Eucalyptus globules. Soil Biol. Biochem., 36: 1067-1074.

Mwendera, E.J. and M.A.M. Saleem, 1997. Infiltration rates, surface runoff and soil loss as influenced by grazing pressure in the Ethiopian highlands. Soil Use Manage., 13: 29-35.

Nael, M., H. Khademi and M.A. Hajabbasi, 2004. Response of soil quality indicators and their spatial variability to land degradation in central Iran. Appl. Soil Ecol., 27: 221-232.

Raiesi, F. and E. Asadi, 2006. Soil microbial activity and litter turnover in native grazed and ungrazed rangelands in a semi-arid ecosystem. Biol. Fertil. Soils, 43: 76-82.

Raiesi, F., 2007. The conversion of overgrazed pastures to almond orchards and alfalfa cropping systems may favor microbial indicators of soil quality in central Iran. Agric. Ecosyst. Environ., 121: 309-318.

Senesi, N. and E. Loffredo, 1999. The Chemistry of Soil Organic Matter. In: Soil Physical Chemistry, Spark, D.L. (Ed.). CRC Press, Boca Raton, FL., pp: 239–370.

Shepherd, T.G., S. Saggar, R.H. Newman, C.W. Ross and J.L. Dando, 2001. Tillage-induced changes to soil structure and organic carbon fractions in New Zealand soils. Aust. J. Soil Res., 39: 465-489.

Six, J., E.T. Elliot, K. Paustian and J.W. Doran, 1998. Aggregation and soil organic matter accumulation in cultivated and native grassland soils. Soil Sci. Soc. Am. J., 62: 1367-1377.

Six, J., E.T. Elliott and K. Paustian, 1999. Aggregate and soil organic matter dynamics under conventional and no-tillage systems. Soil Sci. Soc. Am. J., 63: 1350-1358.

Spaccini, R., A. Zena, C.A. Igwe, J.S.C. Mbagwu and A. Piccolo, 2001. Carbohydrates in water-stable aggregates and particle size fractions of forested and cultivated soils in two contrasting tropical ecosystems. Biogeochemistry, 53: 1-22.

Walkely, A. and I.A. Black, 1934. An examination of Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Sci., 37: 29-38.

Zech, W. and G. Guggenberger, 1996. Organic Matter Dynamics in Forest Soils of Temperate and Tropical Ecosystems. In: Humic Substances in Terrestrial Ecosystems, Piccolo, A. (Ed.). Elsevier, Amsterdam, Netherlands, pp: 101–170.

Zolfaghari, A.A. and M.A. Hajabbasi, 2008. Effect of different land use treatments on soil structural quality and relations with fractal dimensions. Int. J. Soil Sci., 3: 101-108.