

## THE STATE OF SOIL ORGANIC MATTER IN DIFFERENT PHYSICAL FRACTIONS DEPEND ON LAND USE TYPE

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### ABSTRACT

Known fact is that arable soils compared with correspondent native soils differ in the state of soil organic matter (SOM) and that agricultural practices halved content of soil organic carbon in last decades. Further, soil structure or aggregation mediates many biological and chemical processes in soil and influence on protecting of SOM. The objectives of this paper is to analyze how the different land use (forest, grassland and arable soil) effects on quality and quantity of SOM in different physical fraction. In particular, it is important to determine what pool (physically separated fraction) of SOM is most sensitive on cultivation and what pool is more resistant to mineralization.

The research is carried out on two soil type with different texture, Pseudogley and Terra rossa, in condition of different climate and soil management. Two groups of SOM analysis are singled out: 1) quantify SOC and N storage, and  $\delta^{13}\text{C}$  by horizons; and 2) quantify the SOC and N in the following physically separated fractions of SOM: a) coarse and fine particulated organic matter (POM) density  $<1.8 \text{ gcm}^{-3}$ ; b) occluded POM in stable microaggregates 53-250  $\mu\text{m}$ ; and c) SOM in small microaggregates  $<53 \mu\text{m}$ .

**Keywords:** *soil organic matter, physical fractions, type of land use*

### INTRODUCTION

Quantitative and qualitative inventory of soil organic carbon (SOC) is one of the main fields of research in soil science, spatially after increasing interest for biogeochemical cycles of carbon. The type of land use is an important factor controlling soil organic matter (SOM) storage since it affects the amount and quality of litter input, the litter decomposition rates and the processes of organic matter stabilization in soils (Six *et al.*, 2002a). When a forest soil is brought under cultivation, the SOC content start declining (in same time release of  $\text{CO}_2$  to the atmosphere), and the rate of declining depends upon climatic factors, soil type (structure and texture) and intensity of cultivation. Historically, agricultural ecosystems have lost more than 50 PgC (Lal *et al.*, 2004). Some of this carbon lost can be recovered through improved management, thereby

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withdrawing atmospheric CO<sub>2</sub>. Enhancing SOC content is important to improving soil quality, reducing risks of pollution and contamination of natural waters, and decreasing net gaseous emissions to the atmosphere. By J. Six *et al.*, (2002b), the relationship between soil physical characteristics and the ability of soils to stabilize SOM is a key element in understanding the sequestration of organic C in soils and to illuminate the effects of land use changes on soil organic matter storage. According to Six *et al.*, (2002b), Christensen (1996) and Stevenson (1994) describes three main mechanisms of stabilization SOM: i) chemical stabilization as the result of a chemical or physical chemical linkage between SOM and silt and clay, ii) physical protection where aggregates physically protected SOM forming a physical barrier between the microbe and organic substrates, and iii) biochemical stabilization that implies the existence of components in the organic substrate which are more resistant to decomposition. There is still considerable uncertainty about the effects of different land use and soil management on organic carbon storage in soil (B. John *et al.*, 2004).

Two approaches are used to determine the impact of land management on the storage of carbon: a) measuring the change in carbon content in soils under different management (Campbell *et al.*, 1995, 1996; according to D. Curtin *et al.*, 1998) and b) measuring the flux of CO<sub>2</sub> from the soil and in the soil (Rochette *et al.*, 1992; according to D. Curtin *et al.*, 1998).

The objectives of this paper is to analyse how the type of land use, in the condition of different texture and soil management, affects on quality and quantity of SOM in different physical fraction and to identify SOC pools that preferentially stabilize SOC in the long term.

## MATERIALS AND METHODS

The research was carried out on the two types of soils: i) Pseudogley (Albeluvisol stagnic) on diluvial clay from Sprečko polje in northern Bosnia, Tuzla vicinity, and ii) Terra rossa (Chromic Cambisol, Chr. Luvisol) from Dubrava plateau in Herzegovina, Mostar vicinity. Three soil profiles were opened per site, on arable land, grassland and forest. It was important that the land use types have a long constant history (at least several decades of permanent cropping or permanent grassland or permanent forest) and that within a site soil parent material and soil texture are identical. In Sprečko polje on Pseudogley the arable land is on a large farm which was a big Agricultural Complex in state-owned, with silage corn and oat in rotation, grassland represented 17 years abandoned arable soil and the forest was consisting of oak (*Quercus sp.*) In Dubrava plateau on Terra rossa, arable land is on a farm in private-owned, with cattle raising and agricultural production with 4-6 crops in rotation, and forest is degraded and consisting of oak (*Quercus pubescens*) and ash (*Fraxinus ornus*). On both plots on arable land was applied manure, and in Tuzla in arable land and grassland were calcification (liming) done.

In Tuzla (Pseudogley), the climate is temperate continental. Average precipitation is 923 mm yearly, and average yearly temperature 10.2°C. Mostar vicinity (Terra rossa) have a Mediterranean climate. Average precipitation is 1,459 mm yearly, and average yearly temperature 15°C. Despite high precipitations mediterranean climate have arid characteristic rather than humid, because season (periodical) precipitations. Very important role on soil process have strong and dry wind “bura” which draying soil surface and take away small particles fine soil (wind erosion).

A soil profile samples has taken from the horizons (4 horizons per profile). Disturbed soil samples, which represents the horizons (3 replicates per horizon) have sieved <2 mm (remove all stones and all plant residues >2 mm), and then the sample has split in two parts: i) milled subsample, are used for analyses of total SOC and N in CN elementary analyzer; and ii) 2 mm sieved sample are used for analyses of pH, CEC (repeated washing of the sample with NH<sub>4</sub>Cl, pH at the start of washing is 4.6), and finally for physical fractionation and quantification of C and N<sub>f</sub> in different soil physical fractions (density fractions and particle size fractions). Undisturbed samples in Kopezky rings V=100 cm<sup>3</sup>, (3 replicates per horizon) are used to determine soil bulk density necessary to determine SOC stocks. At the forest plots the organic layer has to be sampled (n=3, and 25x25 cm plots) to determine SOC and N stocks of the forest floor.

The research strategy adopted was to compare, in the same soil unit, plots with different land use (arable soil with conventional tillage, and native soils under grassland and forest) and to evaluate the long term impact of cultivation on SOM stocks in the soils. Three group objectives are singled out:

- quantification of total SOC and N and the analysis C/N and  $\delta^{13}\text{C}$  per horizons until 10 and 30 cm depth, as an indicator of the impact anthropogenisation;
- The main work on Institute of Soil Science and Forest Nutrition in Goettingen was the physical fractionation of the soil organic matter pools by modified method Six *et al.* (2002b) (density fractions and particle size fractions) in 2 mm sieved samples taken from 10 cm topsoil. That means to quantify the SOC and N in the following five physically separated fractions of SOM:
- three size fraction of light particulated organic matter (POM) density <1.8 gcm<sup>-3</sup>: free light fractions, coarse >250  $\mu\text{m}$  (cPOM) and fine 53-250  $\mu\text{m}$  (fPOM) which are unprotected from decomposition, and occluded/intra POM which is physically protected in stable microaggregates 53-250  $\mu\text{m}$  (iPOM). Fractionation of particulated organic matter (POM) were done on the basis floating in sodium polytungstate (SPT) specific gravity of 1.8 gcm<sup>-3</sup>,

- two fraction heavy SOM chemically protected by associated with silt and clay in small microaggregates ( $<53 \mu\text{m}$ ) density  $>1.8 \text{ g cm}^{-3}$ : SOM associated with free silt and clays (f silt+clay) separated after breaking macroaggregates, and occluded (intra) SOM associated with silt and clays physically protected in small microaggregates  $<53 \mu\text{m}$  (and silt+clay), separated after breaking microaggregates;
- discussion of affects soil texture and soil management on the storage soil organic carbon.

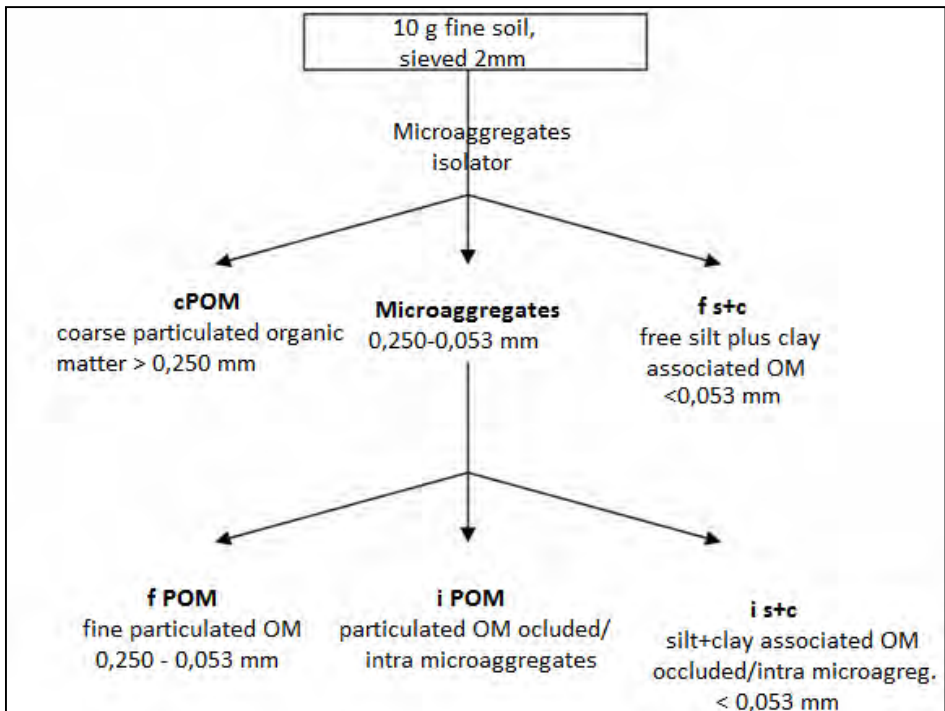


Figure 1. Scheme of fractionation

## RESULTS

Table 1. Physical and chemical properties 2 mm sieved samples: Texture, Bulk density (BD), pH (1M KCl), Cation exchange capacity (CEC), Base saturation (BS): Ca<sup>2+</sup>, Mg<sup>2+</sup>, Na<sup>+</sup> and K<sup>+</sup> in CEC, Soil organic carbon (SOC), Nitrogen (N), C/N ratio and δ<sup>13</sup>C under different type of the land use

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Site/ land use	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	BD gcm <sup>-3</sup>	pH (KCl)	CEC cmol.kg <sup>-1</sup>	BS %	C %	N %	SOC kgm <sup>-2</sup>	C/N	δ <sup>13</sup> C (‰ <sub>PDB</sub> )
<b>Pseudogley/Albeluvisol (stagnic)</b>													
<b>Arable land</b>	0-12	25.6	45.2	29.2	1.47	3.7	6.5	61.7	1.24	0.12	2.18	10.1	-25.01
	12-30	25.6	44.5	29.9	1.45	3.7	6.5	60.8	1.16	0.12	3.03	9.8	-24.82
	30-52	24.8	47.5	27.7	1.54	3.6	6.6	59.6	0.99	0.10	3.35	9.6	-24.93
	52-99	41.6	35.9	22.5	1.57	3.3	15.6	70.3	0.27	0.05	2.03	5.7	-25.40*
<b>Grassland</b>	0-15	20.8	29.7	49.5	1.46	3.9	6.7	74.5	2.12	0.20	4.72	10.8	-26.10
	15-30	21.2	30.1	48.7	1.30	3.9	6.1	71.6	1.76	0.16	3.42	11.1	-26.19
	30-50	24.8	28.4	46.8	1.51	3.5	6.3	45.7	0.79	0.08	2.38	9.7	-26.25
	50-99	40.4	18.8	40.8	1.47	3.2	13.8	53.0	0.35	0.05	2.57	6.7	-25.68*
<b>Forest</b>	OL								17.7	1.11	2.20	16.0	-27.90
	0-15	20.4	45.5	34.1	1.19	3.5	6.1	14.7	2.49	0.21	4.42	11.7	-27.39
	15-30	18.8	44.1	37.1	1.24	3.5	4.9	24.3	0.98	0.09	1.80	10.7	-27.18
	30-50	24.4	43.1	32.5	1.58	3.3	8.9	54.4	0.29	0.05	0.90	5.5	-25.95*
	50-99	39.2	33.2	27.6	1.53	3.3	16.1	74.3	0.25	0.05	1.88	4.7	-25.46

	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>13</b>	<b>14</b>
<b>Terra rossa /Chromic Cambisol</b>														
<b>Arable land</b>	0-13	27.6	32.7	39.7	1.36	4.2	10.1	95.7	1.51	0.15	2.66	10.2	-25.42	
	13-23	28.0	31.7	40.3	1.25	4.3	9.8	97.1	1.47	0.14	1.84	10.4	-25.33	
	23-47	43.2	34.6	22.2	1.52	4.7	10.4	98.9	1.21	0.12	4.41	9.8	-23.62	
	47-78	39.6	33.4	27.0	1.54	4.7	12.8	99.5	1.25	0.12	5.99	10.5	-24.11	
<b>Grassland</b>	0-10	31.6	37.4	31.0	1.31	4.7	12.0	98.3	2.05	0.18	2.69	11.6	-23.74	
	10-20	39.2	27.3	33.5	1.46	4.5	10.4	97.6	1.26	0.12	1.84	10.7	-22.95	
	20-40	46.0	22.4	31.6	1.52	4.4	12.0	97.4	0.82	0.09	2.50	9.3	-22.64	
	40-78	56.4	20.0	23.6	1.49	4.6	17.8	99.3	0.63	0.09	3.55	7.3	-22.42	
<b>Forest</b>	O <sub>L</sub>								19.1	0.92	0.32	20.8	-26.68	
	0-11	33.2	44.4	22.4	1.27	4.6	12.9	96.6	2.63	0.22	3.67	11.7	-26.21	
	11-23	37.6	38.0	24.4	1.38	4.2	10.0	88.4	1.65	0.15	2.75	10.7	-24.70	
	23-38	44.0	26.5	29.5	1.43	4.1	9.9	88.4	0.98	0.10	2.10	9.6	-23.36	
	38-78	43.6	29.5	26.9	1.48	4.1	10.5	89.8	0.63	0.07	3.70	8.3	-23.30	

\* signal less than 300 mV results with uncertain results

Pseudogley has a loam soil texture and Terra rossa clayey-loam texture (US Soil Taxonomy). According by Schefer-Schachtschabel (pH in 1M KCl) Pseudogley has a very strong acidity pH and Terra rossa strong acidity. Furthermore, a rate of decomposition SOM increase throughout the soil profile. Data shows that upper layers of Terra rossa contains the higher values of CEC (10-13 cmol<sub>c</sub> kg<sup>-1</sup>) as well as to impermeable clayey horizon in Pseudogley. In Terra rossa total percent base saturation are in range 88.4-99.3%. Lowest values of CEC are recorded in topsoil in pseudogley in forest where recorded total percent base saturation less then is 50%. In arable land and grassland on Pseudogley where liming is made, records show higher values of total percent base saturation (60-70%) than in forest.

Depend of the type of land use examined soils has been tested by the analysis of the complete C storage in kg m<sup>-2</sup> within 10 cm and 30 cm of depth.

Table 2. SOC storage within 10 and 30 cm

Depth (cm)	SOC storage (kg m <sup>-2</sup> )					
	Pseudogley			Terra rossa		
	Arable	Grassland	Forest	Arable	Grassland	Forest
<b>within 10 m</b>	1.82	3.15	2.95	2.04	2.70	3.34
<b>within 30 cm</b>	5.21	8.14	8.42	5.78	5.78	7.71

The SOC stock to 10 cm depth in Pseudogley in mineral soil is greater in grassland than in the forest, which is in accordance with the suggestions of Collins *et al.*, 2000, and Kononova, 1996 (according to J.Six *et al.*, 2002b) that grassland have a highest potential for storage SOC due to their higher base saturation, as is the case in this soil.

SOC storage in kg m<sup>-2</sup> within 30 cm of depth is a good indicator of the impact cultivation on the SOC content. The average difference in SOC storage within 30 cm between forest and agricultural soils is 2.58 kg m<sup>-2</sup> for both soils. Pseudogley makes the biggest proportion, with 3.21 kg m<sup>-2</sup> more SOC in forest than in arable soil.

This analysis showed too, that natural soils on Pseudogley (grassland which is converted arable land and forest) have a higher content of organic carbon than natural soils of the Terra Rossa. Probably the most effective way of restoring the stock of carbon in cultivated soils is the restoration and maintenance of perennial vegetation (Bruce *et al.*, 1998). However, in Terra rossa on the cultivable land were found higher content SOC than in arable land on Pseudogley and the same storage of SOC as well as on the nearby grassland. The level of carbon in natural soils reflects the balance of the input C and loss of C under natural conditions, but in any case does not represent the upper limit of the carbon content of the soil (J. Six *et al.*, 2002a).

It is interesting to compare the results from Pseudogley in Tuzla with the research John *et al.* (2004) at Stagnic luvisol (silty loam) in Rotthalmuenster (mean annual rainfall of 886 mm and a temperature of 8.7°C, spruce forests)

Table 3. SOC storage (kg m<sup>-2</sup>) whit in 30 cm in Tuzla and Rotthalmuenster

	Arable land	Grassland	Forest (mineral soil +O)
<b>Stagnic Albeluvisol/Psudogley, Tuzla</b>	5,211	8,142	6,220 + 2,200
<b>Stagnic luvisol, Rotthalmuenster</b>	5,269	6,006	4,886 + 4,108

Results of SOC stocks in the arable land for both sites are equal, while in the natural soil under meadow in Tuzla have accumulated more organic carbon than in Rotthalmuenster. Furthemor, in the mineral soil in oak forest in Tuzla were found larger stocks SOC, while in Rotthalmuenster the O horizon in spruce forest have a larger SOC stocks.

Table 4. Physical fraction: concentration soorganic carbon (C) and nitrogen (N), ratio C/N, storage of C in fractions gC<sub>fr</sub>m<sup>-2</sup>, yield C<sub>fr</sub>(gm<sup>-2</sup>) in total SOC (gm<sup>-2</sup> within 10 cm depth), storage of C in fractions in gC<sub>fr</sub>kg<sup>-1</sup>soil

1	2	3	4	5	6	7	8
Site/land use	Physical fraction	C <sub>fr</sub> %	N <sub>fr</sub> %	C <sub>fr</sub> /N <sub>fr</sub>	gC <sub>fr</sub> m <sup>-2</sup>	Yield (%) C <sub>fr</sub> in C <sub>t</sub>	C <sub>fr</sub> gC <sub>fr</sub> kg <sup>-1</sup>
<b>Pseudogley/Stagnic Albeluvisol</b>							
<b>Arable land</b>	c POM	32.45	1.52	21.41	80	4.39	0.55
	f POM	26.15	1.50	17.42	58	3.18	0.39
	i POM	19.8	1.31	15.17	59	3.24	0.40
	i silt + clay	1.28	0.15	8.59	477	26.19	3.25
	f silt + clay	1.02	0.12	8.72	944	51.89	6.45
<b>Grassland</b>	c POM	30.39	1.81	17.01	183	5.82	1.25
	f POM	27.47	1.85	14.87	126	4.00	0.87
	i POM	25.12	1.79	14.12	195	6.19	1.34
	i silt + clay	2.79	0.28	9.84	695	22.05	4.74
	f silt + clay	1.54	0.17	9.25	1.587	50.39	10.87
<b>Forest</b>	c POM	34.18	1.24	27.55	157	5.32	1.32
	f POM	27.64	1.42	19.27	53	1.81	0.45
	i POM	23.43	1.46	16.1	119	4.03	1.01
	i silt + clay	3.05	0.31	9.9	767	25.99	6.53
	f silt + clay	2.07	0.21	10.04	1.555	52.71	13.04



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	1	2	3	4	5	6	7	8
<b>Terra rossa/Chromic Cambisol</b>								
Arable land	c POM	27.81	1.60	17.43	103	5.05	0.76	
	f POM	27.02	1.47	18.35	88	4.30	0.65	
	i POM	30.55	1.78	17.1	120	5.89	0.89	
	i silt + clay	1.49	0.15	8.24	661	32.40	5.11	
	f silt + clay	1.43	0.16	9.14	973	47.71	7.19	
Grassland	c POM	27.61	1.10	25.32	148	5.49	1.12	
	f POM	19.02	0.99	19.16	99	3.67	0.75	
	i POM	30.85	1.45	21.31	109	4.02	0.83	
	i silt + clay	2.11	0.23	9.14	1.146	42.43	8.70	
	s silt + clay	1.86	0.20	9.48	1.127	41.74	8.53	
Forest	c POM	31.56	1.42	22.23	192	5.74	1.51	
	f POM	25.15	1.43	18.56	75	2.24	0.60	
	i POM	29.05	1.52	19.12	218	6.53	1.73	
	i silt + clay	2.65	0.28	9.45	1.076	32.22	8.50	
	f silt + clay	2.1	0.21	9.95	1.635	48.94	12.75	

Concentration of  $C_{fr}$ , in both soils, is higher in light fractions - particulated organic matter compared with heavy fractions - OM associated with silt and clay. The concentrations of  $C_{fr}$  in Pseudogley come in following order  $cPOM > fPOM > iPOM > i s+c > f s+c$ . These results for Pseudogley can be considered the opposite of the conclusions Golchin *et al.* (1994) who report that occluded within the micro aggregate light fraction (iPOM) had a higher concentration of C and N than the free light fraction (cPOM and fPOM), what in generally confirmed results from Terra rossa.

$C_{fr}/N_{fr}$  ratio also show higher values in light fractions POM (less decomposed SOM) than in mineral associated OM which was actually a biochemical processed organic material, what is in accordance with studies John *et al.* (2004). The fraction particulated organic matter having a high C/N ratio and low potential net mineralization of nitrogen ( $N_{min}$ ) (Catroux and Schnitzer, 1987; Chichester, 1969; Ford and Greenland, 1964; Sollins *et al.*, 1984; Tiessen and Stewart, 1983; and Turchenek Oades, 1979 - according to J.Six *et al.*, 2002).

The major part of the SOC in both soils was associated with the mineral fractions  $fs+c$  and  $is+c$ , in Pseudogley 76% and in Terra rossa 81%.

In Pseudogley, absolute differences in SOC storage between forest and arable land is the most evident in fractions  $fs+c$  (difference  $611 \text{ gC}_{fr} \text{ m}^{-2}$ ) and  $is+c$  (difference  $415 \text{ gC}_{fr} \text{ m}^{-2}$ ). Relative difference between arable and native soils is most the evident in the iPOM

fraction where values of  $C_{fr}$  storage in arable soil ( $59 \text{ gC}_{fr} \text{ m}^{-2}$ ) is more than three times lesser than in grassland ( $195 \text{ gC}_{fr} \text{ m}^{-2}$ ) and in fraction cPOM where is content of SOC in arable land halved. Six *et al.* 2002a in a study conducted at the Wildlife area in Ohio - USA, on the silty clay soil were found more than three times higher the amount of C in iPOM fraction in the forest ecosystem with walnut and oak than in agriculture. Many studies have found that the light fractions of particulate organic matter, particularly cPOM ( $> 250$  microns), are relatively easily and widely decompose under cultivation indicating their relatively unprotected (biochemical and physical) status (Cambardela and Elliott, 1992; Six *et al.*, 1999; Solomon *al.*, 2000, according to Six *et al.*, 2000).

In Terra rossa, SOC storage in all separated fractions has highest values in forest compared to arable land and grassland. Exceptions are s+c fraction where values  $C_{fr}$  storage for forest and grassland are balanced, and fine POM fraction, which in all ecosystems have a similar values  $C_{fr}$  storage.

Table 5. The degree of stability of microaggregates (the percent of carbon from fraction intra microaggregates silt plus clay (i s+c) in total chemically protected SOC associated with total silt and clay (f s+c plus i s+c)

	Pseudogley			Terra rossa		
	arable land	grassland	forest	arable land	grassland	forest
<b><math>C_{fr}</math>- free silt+clay (<math>\text{g m}^{-2}</math>)</b>	944	1587	1555	973	1127	1635
<b><math>C_{fr}</math>- intra microaggregates silt+clay (<math>\text{g m}^{-2}</math>)</b>	477	695	767	661	1146	1076
<b>% C from stable microaggregates</b>	34	30	33	40	50	40

The share of carbon from fraction intra micro aggregate silt plus clay (i s+c) in the total chemically protected SOC associated with silt and clay (C from f s+c plus i s+c) represents the degree of stability of microaggregates. Data show higher percent stable microaggregates in Terra rossa than in Pseudogley. Kemper Koch (1966) note that the stability of the aggregates increases to the maximum level with increase of clay content and the content of Fe-oxide (according to Six *et al.*, 2002a).

## CONCLUSIONS

In both types of soil, significantly lower storage of SOC within 30 cm on arable soils compared to forests (as well as to meadow in Pseudogley) was recorded. The forest proved to be the most favorable for the accumulation of SOC in the form of organic matter both on the surface (O horizon) and in mineral soil.

Mostly part of SOM in both soils is chemically protected by associated with silt and clay fractions. These values are for Pseudogley with loam texture 76% and in Terra rossa with clayey loam texture 81%. The degree of stability of microaggregates (the share C from intra silt + clay) is also higher on Terra rossa. It can connect with the present of Fe-oxides in the Terra rossa, which are connected with a positive impact on the stability of microaggregates (Kemper and Koch, 1966, according to Six *et al.*, 2002). Furthermore, on acid topsoil of Pseudogley were recorded low value CEC what can be connected with leaching bases, and it is well known a positive effect of  $\text{Ca}^{2+}$  (dominant in cation composition of CEC Terra rossa) on the aggregation.

In Pseudogley, lower storage of C in arable soils related to natural ecosystems is evident in each separated fractions, spatially in iPOM and cPOM. Compared with Pseudogley in Terra rossa different in SOC stocks between natural ecosystem and arable land in POM fractions is not so pronounced what indicated a good management with arable soils.

The example of managing agricultural soils on smaller farms (in private property) with cattle raising and agricultural production (Terra rossa) compared to large farms which was a big Agricultural Complex in state-owned (Pseudogley), has shown that the way of managed with agricultural soil can significantly influence the trend of organic matter storage both in positive way (by decreasing cultivation, increasing the use of organic fertilizers, using different cultures in crop rotation; arable land on Terra rossa example) and in negative way (by intensive cultivation, fixed crop rotations, poor managing of manure; arable soil on Pseudogley example). In Pseudogley, by converting a bounded arable soil into a meadow, in the period of 17 years SOC storage within 30 cm became equal to the storage SOC in forest, while, compared to 50 m distant arable soil, 2.93kg  $\text{m}^{-2}$  more SOC was accumulated in meadow. This is a good example that managing soil can increase storing C in soil, in other words, it shows what kind of positive effects can be produced by using mixture of clover-grass in crop rotation.

#### LITERATURE:

- Bruce J. P., Frome M., Hartes E., Janzen H., Lal R., Paustian K., 1998, Carbon Sequestration in Soils - Workshop, Soil and Water Conservation Society, Calgary-Alberta, 1988, 6-7.
- Curtin D., Selles F., Wang H., Campbell C. A., Biederbeck V. O., 1998, CO<sub>2</sub> Emissions and Transformations of Soil Carbon and Nitrogen during Wheat Straw Decomposition, *Soil.Sci.Am.J.* 62:1035-1041 (1998).
- Golchin A., J. A. Baldock, P. Clarke, T. Higashi and J. M. Oades, 1997, The effects of vegetation and burning on the chemical composition of soil organic matter of a volcanic ash soil as shown by <sup>13</sup>C NMR spectroscopy. II. Density fractions, Received 2 July 1996; accepted 28 November 1996.; Available online 5 June 1998, science@direct.

- John B. M., 2003. Carbon turnover in aggregated soils determined by natural  $^{13}\text{C}$  abundance, doktorska disertacija na Georg-August-Universität u Göttingenu, 4-18.
- John B., Yamashita T., Ludwig B., Flessa H., Storage of organic carbon in aggregate und density fractions of silty soils under different types and land use, available online at "<http://www.sciencedirect.com>" 2004, 1-2, 4.
- Lal R., Griffin M., Apt J., Lave L., Morgan M.G., 2004, Managing Soil Carbon, VOL 304, SCIENCE, [www.sciencemag.org](http://www.sciencemag.org)
- Scheffer, F., Schachtschabel, P., 2002. Lehrbuch der Bodenkunde. 15th edition. Spektrum Akademischer Verlag, Heidelberg. 593 pp.
- Six J., Callewaert P., Lenders S., De Gryze S., Morris S.J., Gregorich E. G., Paul E.A, I Paustian K., 2002a. Division S-7 – Forest and range soils; Measuring and Understanding Carbon Storage in Afforested Soils by physical Fractionation, Published in Soil Sci. Soc. Am J. 66:1981-1987 (2002a).
- Six J., Conant R. T., Paul E. A. I Paustian K., 2002b, Stabilization mechanisms of soil organic matter: Implications for C-saturation of soils, Kluwer Academic Publishers, Plant and Soil 241: 155-176.