STRUCTURE AND ORGANIC MATTER UNDER DIFFERENT SOIL MANAGEMENT CONDITIONS IN THE CENTER OF ARGENTINA

Estela Bricchi. National University of Río Cuarto. Argentina

In Central Argentina, Córdoba Province, as in different parts of the world, the equilibrium state of soil under natural condition has been modified by both: The replacement of natural vegetation and also by tillage. These two disturbing factors have led a long the time to a new soil state whose main characteristic is an important decreasement of chemical, physical and biological soil functions. The degree of these changes is directly related to soil resistance according to soil genesis

The soil organic matter and the structure of the superficial profile of soil are suitable indicators mainly for physical functions. As it has been demonstrate in temperate areas the changes on soil uses have meant looses of organic carbon. These changes have happened very fast at the beginning (10 to 20 first years). Then, they have happened at a lower rate. Finally, at about 50 to 70 years, soils reach a new equilibrium state where the organic carbon quantities are lower and the quality differs from de original organic matter. This loose means a lower plasma quantity among skeleton particles, and therefore, disturbance of soil structure due to the mineralization of those compounds which are more easily degraded and are responsible of soil structure. This phenomenon is common in very fine sandy loam texture.

The great subdivision of land took place in 1920, at that time, the agricultural activity began with winter crops (wheat, oats and rye). Then, these crops were substituted by summer crops (Corn, peanut, sunflower and soybean). There has been an intense mechanization by means of heavy equipments from 1960 to 1990. We consider this period of time to be the cause of the most important deterioration of physical conditions of soil profile, resulting in an important loose of organic matter, the break of superficial aggregates that later on will form a seal under heavy rainfalls. On the other hand, the broken subsuperficial aggregates, can be turned into compact horizons. All these processes also affect the infiltration, distribution and storage of water. Beside favoring erosion.

It became necessary, then, to look for a combination of technologies leading to an energy input throughout conservation tillage systems, soil covering and agro-chemicals which tend to improve soil quality in order to obtain a sustainable production.

One of the researching works has as a main objective to conduct a temporal analysis about the influence of some technological factors on two quality indicators: organic matter and superficial structure of a Typical Hapludoll showing a very fine sandy loam texture. We have worked in a region located at 32º 57´South latitude and 64º 50´ West longitude. The mean annual temperatures range from 8-23º C and the mean annual rainfall value is up to 850 mm. 80% of rainfalls take place during spring and summer. The natural vegetation belongs to an open forest, presenting caducou leaves trees, with inner grasslands. The relief is normally weavy, showing slopes of 3 to 4% gradient. The original material is a loessic sediment.

That the trial was conducted on a production system. It began in August 1994. The production sequence that the production system followed was corn-corn-sunflower- corn-sunflower, they were planted according to the following factors: a) Two different topographic positions: medium high slope (**I**) and medium low slope (**II**). b) Under three different tillage systems: Conventional with moldboard plow (**CT**), minimum with chisel (**MT**) and non-tillage (**NT**). c) The after harvest the stubble were grassed by cattle (**G**) on the other hand, in 50 % of the plot no grassing was allowed during the trial years (**NG**) d) Two different fertilizer doses were studied: zero fertilization (**NF**) and fertilization of crops at the beginning of planting every years. (**F**).

The trial was conducted by using a simple at-random design with two repetitions for each treatment. The soil superficial part was determined in 2000: A) organic matter content (**CO**)
B) Distribution of sizes of aggregates which are water stable.
The quantity of superficial residues was estimated every year after grassing for each treatment. Results were statistically processed by using the General Lineal model and Kruskal-Walis´ non-parametric test, for a significance level of 95% with the SPSS software. The studied variables were also evaluated on a site showing a minimum disturbance level a relict area , which has natural vegetation, presents a relief condition similar to the trial sites and it shows a low use of soil (**MD**, **MDI** and **MDII**).
The following results were obtained:

1.- Soil organic carbon content

Table 1
Organic carbon content (gr. kg^{-1}) for studied factors

Factor	Level	OC (gr.kg.$^{-1}$)
Position	I	8,72 a
	II	10,17 b
Grassing	NG	10,06 a
	G	8,83 b
Tillage	NT	9,76 a
	MT	9,76 a
	CT	8,6 b
Fertilization	F	9,36 a
	NF	9,47 a

Different letter mean significant differences at the 5% level

Table 1 shows the significant differences between positions (about 14 %). On the other hand, the **OC** is significantly higher when stubble are left on surface. The conservation tillages (**MT** and **NT**) show similar values of **OC** and they are significantly higher to **CT.** It should noticed that the **OC** for conservation tillages is 11 % higher and it has been observed for 5 years of trial. This might indicate that has been initiated an improvement function. The fertilization did not bring about any differences on **OC** content of soil.

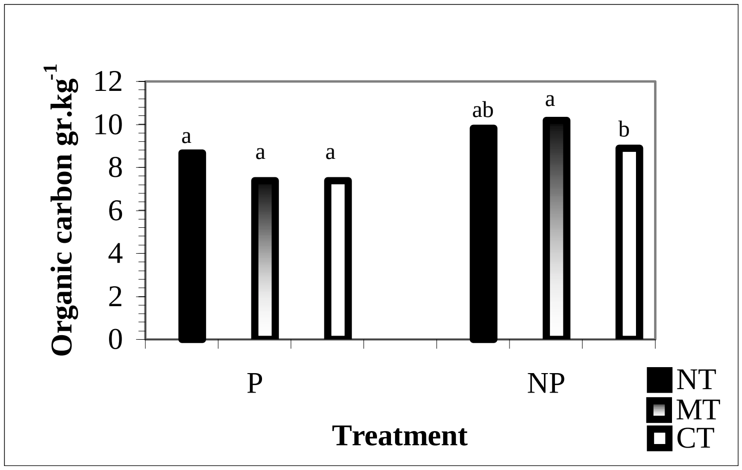

Fig. 1.- Effect of tillage system and stubble quantity on the organic carbon at topographic positions: medium high slope (I).

Different letter mean significant differences at the 5% level

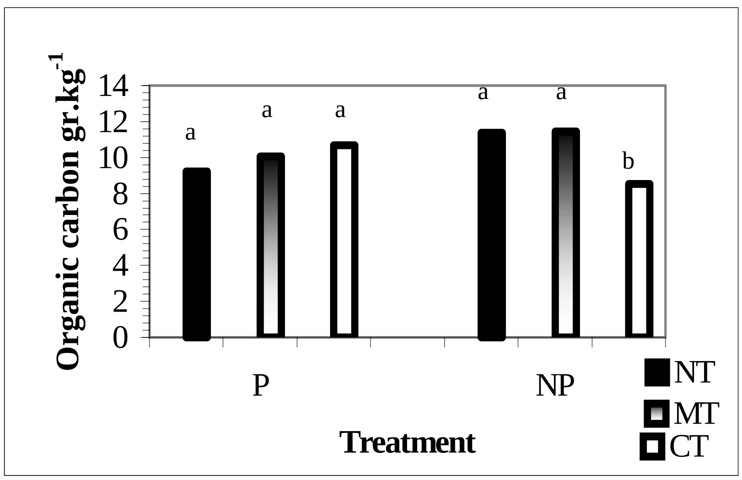

Fig. 2.- **Effect of tillage system and stubble quantity on the organic carbon at topographic positions: medium low slope (II)**

Different letter mean significant differences at the 5% level

Both figures (1 and 2) show no significant differences among tillage systems in the two studied positions under cattle grassing. On the other hand, minimum tillage differs from **CT** tillage in position **I** without grassing, while in position **II** the **CT** system differs from the other two systems.

Table 2

Differences in Organic Carbon (%) among treatments and MD situation.

Treatments	OC (gr./kg.$^{-1}$)	Differences (%)
I	8,72	-77,98
II	10,17	-78,19
NG	10,06	-76,66
G	8,83	-79,52
NT	9,76	-77,36
MT	9,76	-77,36
CT	8,60	-80,05
F	9,36	-78,29
NF	9,47	-78,03
MD I	39,60	
MD II	46.63	

Table 2 shows a higher loose of **OC** in **CT** under grassing. The values obtained for conservation tillage are a little lower for **NG**.

2.- Aggregate Stability

Table 3

Distribution of sizes of aggregates which are water stable (%) in treatments and MD.

Factor	Level	Stable Aggregates in water (%)			
		Diameters			
		0,1-0,5 mm	0,5-1 mm.	1-2 mm	2-4 mm
Position	I	17,85 a	7,72 a	10,56 a	19,85 a
	II	16,87 a	8,08 a	11,89 a	20,78 a
Grassing	NG	16,92 a	7,78 a	11,39 a	23,92 a
	G	17,79 a	8,01 a	11,06 a	16,71 a
Tillage	NT	11,64 a	4,90 a	12,6 a	33,06 a
	MT	18,25 b	8,03 b	10,20 a	15,69 b
	CT	22,19 b	10,69 c	10,87 a	12,20 b
Fertilization	F	17,46 a	7,83 a	12,09 a	21,74 a
	NF	17,26 a	7,96 a	10,37 a	18,89 a
Situation Min. Dist.	MD	5,19 c	1,91 c	15,09 c	52,50 c

Different letter mean significant differences at the 5% level

Table 3 shows a significant different **MD** for all treatments no matter sizes. On the other hand, in **MD** the highest percentage belong to the thicker aggregates while the treatments present a bi modal distribution (very thick and very fine). The only significant differences that can be observed are produced by tillage except for 1-2 mm. diameter. **NT** produces the highest percentage in higher sizes. Fine aggregates show a lower percentage, obtaining the same results for 0.5–1 mm. where tillage systems are differents.

3.- Organic matter and structure relation

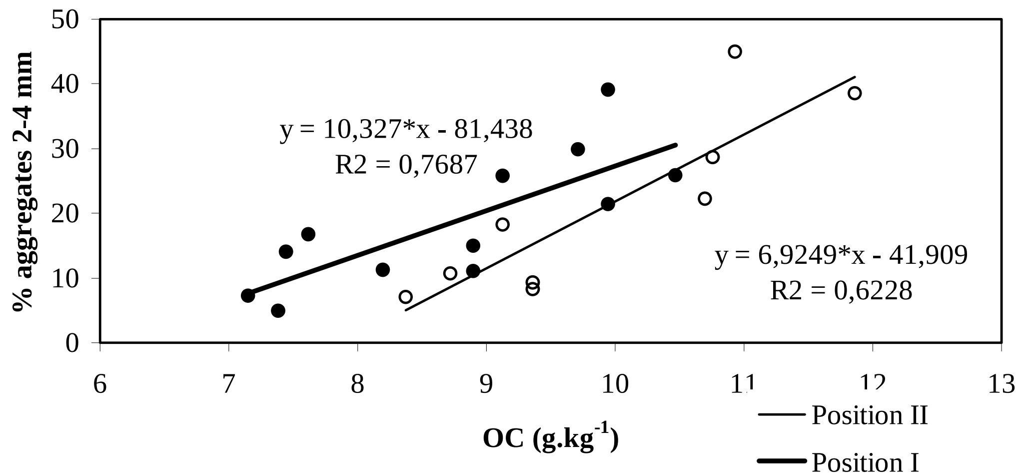

Fig. 3.- Relation between OC and % of 2-4 mm de aggregates, for the two studied topographic positions

The increasement of organic matter content presents a lineal relation regarding the macroaggregate proportion for both relief positions. However the impact is higher in position **II**.

Conclusions

The remotion of natural vegetation and tillage systems have caused the following effects on the first centimeters of soils: Losses of organic matter in a 77 to 80 % during a period of time of about 80 years. Changes in the water stable aggregates distribution. These changes brought about a loose of 77 % on thick aggregates, and gain of 55 % on fine aggregates.

Our results would indicate that the disturbance level was higher to the natural resistance of soil.

The organic carbon content in the first centimeters of soil is increased when all crop stubble are left over and conservationist tillage is applied. Conservationist tillages are more efficient in the lower position of relief. Those results mean the beginning of a change on organic matter tendency that would possibly tend to new equilibrium state.

On the other hand the percentage of water stable aggregates would also be increased as consequence of a higher organic carbon content.

Commentary

There are other variables being analyzed in this production system along the time: Organic matter fraction. Compactibility. Pore distribution according to size and characteristic wetness curve. Simulation on non saturated hydrologic conductivity, and calculations of the continuity index by pore classes. We hope to be able to state change rates through the evolution of the studied indicators. These change rates will help us to obtain a monitoring of soil quality along the time.