A NEW TECHNOLOGY TO RESTORE SOIL FERTILITY: THE RECONSTITUTION

Manfredi P.[1], Cassinari C.[2], Trevisan M.[2]

[1]m.c.m. Ecosistemi srl, località Faggiola, 29027 Gariga Podenzano, Italy

[2]Istituto di Chimica Agraria e Ambientale, Università Cattolica del Sacro Cuore, Piacenza, via Emilia Parmense 84, 29122 Piacenza, Italy

NEW LIFE
www.lifeplusecosistemi.eu
LIFE10 ENV/IT/000400 NEW LIFE
total budget 4.025.473.00 euro
EU contribution 1.929.837.00 euro

Soil erosion, compactation, sealing, loss or change in the aggregates structure, reducing of water retention capacity, of heat capacity and of organic matter cause environmental effects such as the decrease of physical and chemical fertility, and the reduction of biodiversity.

The objective of this study was to describe the reconstitution, a new technology to restore the soil fertility of a degraded soil.

New Life project is supported to develop and apply the reconstitution technology to restore a closed-landfill of 20 hectares near Piacenza. The experimental phase of the project is to compare the physico-chemical and microbiological characters of different natural degraded soils and reconstituted soils in experimental plots.

THE RECONSTITUTION TECHNOLOGY

The reconstituted soils are produced by a technology based on degraded and desertified soils treatment for the restoration of their fertility.

This treatment is designed and developed from the research laboratory mcm Ecosistemi and two patents cover it. It applies to **degraded soil mechanical and chemical treatments**: an initial **mixing with waste sludge**, followed by a **disgregation**, an **organic matter stabilization** treatment and a final **mechanical reconstitution**.

In the first phase of the reconstitution the degraded soil is mixed with one of the follow paper industry sludge:

a) Sludge from mechanical separation of waste fibers and depuration of production water.
b) Sludge from primary and secondary treatment of settling, clarification and purification of wastewater; it contains calcium carbonate.
c) Sludge from suspended solids thickening in wastewater, resulting from the cleaning of the dough and the suspended biomass depuration.
d) Sludge from sedimentation and oxidation of de-inking recycling paper wastewater.

EXPERIMENTAL PLOTS

24 experimental plots (3 m x 5 m) are located in a farm in Gossolengo, Piacenza. They are different on the basis of the soil and / or type of sludge used.

1-2-3-4-5-6-7-8-9 R plots: the reconstitution was performed using the same sludge and different soils; **the effect of the reconstitution on different soils is tested**.

10 (1-2-3-4-5) R plots: the reconstitution was performed using the same soil and different sludge; **the effects of different sludge are tested**.

The same number is for the same soil (native and reconstituted soil); N: natural soil plots, R: reconstituted soil plots.

N	1	2	3	4	5	6	7	8	9	10	10	10	10	10
R	1	2	3	4	5	6	7	8	9	10 1	10 2	10 3	10 4	10 5

SOIL SAMPLING AND ANALYSIS

Every six months, plots are sampled for chemical and physical analysis. Each sample - collected at 20 cm depth - is made up of 3 sub-samples.

- **Chemical and physical analyses** were carried out based on the Methods of Soil Chemical and Physical Analysis (Official Gazette of the Italian Republic).
- To test the effect of the reconstitution on different types of soils **t-test for paired samples** is performed on the average of the physical-chemical data of plots 1-2-3-4-5-6-7-8-9 N / R.
- To test the effects of different sludge the Analysis of Variance (**ANOVA**) and the Least Significant Difference (**LSD**) are performed on the chemical data of three samplings of plots 10 N / 10 R 1-2-3-4-5.

The software IBM SPSS version 21 is used.

RESULTS

CHANGES IN PHYSICAL PROPERTIES OF SOIL

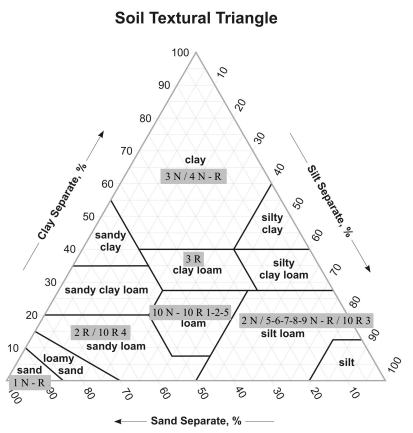
The reconstitution has little effects on texture class of soil (Figure 1).

The reconstitution makes a lowering of bulk and particle density and an increase in porosity.

Table 1. Physical analysis, mean of three samplings.

	Bulk Density	Particle Density	Porosity
	kgm^{-3}	kgm^{-3}	%
1 N	1484	2689	45
1 R	707	2039	65
2 N	1257	2341	47
2 R	688	2066	67
3 N	1270	2232	44
3 R	818	1737	53
4 N	1378	2077	34
4 R	637	1906	67
5 N	1041	2143	51
5 R	551	1894	71
6 N	1491	2196	32
6 R	705	2043	65
7 N	1319	2288	42
7 R	403	1982	80
8 N	1209	2296	47
8 R	644	2063	69
9 N	1349	2272	41
9 R	903	1988	55
10 N	1233	2290	45
10 R 1	767	2259	67
10 R 2	781	1946	60
10 R 3	768	2346	68
10 R 4	734	2018	64
10 R 5	569	2057	73

Figure 1. Soil plots positions in soil textural triangle.



STATISTICAL RESULTS

The t-test for paired samples confirmed that the reconstitution has effect on bulk and particle density, porosity, pH, organic carbon and total nitrogen content, p-value ≤ 0.01, while on C/N ratio p-value ≤ 0.05. The ANOVA shows significant difference, p-value ≤ 0.01, for all parameters investigated; the LSD test shows which sludge influences what parameters (Table 2).

CHANGES IN CHEMICAL PROPERTIES OF SOILS

The reconstitution makes a lowering of pH, an increase of organic carbon content, total nitrogen content and C/N ratio.

Table 2. Chemical analysis, mean of three samplings.
LSD test on chemical analysis of plots 10 N / R 1-2-3-4-5. [A,B,C,D] Different letters indicate statistically significant difference (ANOVA and LSD test p value ≤ 0.01).

	pH	Organic Carbon	Total Nitrogen	C/N
		%	%	
1 N	8.28	0.09	0.03	3.00
1 R	7.86	6.28	0.28	22.43
2 N	8.26	0.15	0.05	3.00
2 R	7.87	8.16	0.20	40.80
3 N	7.68	0.32	0.07	4.57
3 R	7.74	7.40	0.21	35.24
4 N	8.15	0.23	0.06	3.83
4 R	7.81	7.91	0.30	26.37
5 N	8.05	3.07	0.33	9.30
5 R	7.80	7.51	0.68	11.04
6 N	8.32	1.83	0.23	7.96
6 R	7.85	9.35	0.68	13.75
7 N	8.14	1.90	0.22	8.64
7 R	7.76	8.53	0.71	12.01
8 N	8.04	2.78	0.27	10.30
8 R	7.80	5.07	0.48	10.56
9 N	8.04	2.87	0.35	8.20
9 R	7.87	6.49	0.61	10.64
10 N	8.26 [A]	0.83 [D]	0.13 [C]	6.34 [D]
10 R 1	7.23 [C]	4.07 [C]	0.44 [A]	9.32 [D]
10 R 2	7.75 [B]	6.17 [B]	0.30 [AB]	21.89 [BCD]
10 R 3	7.80 [AB]	4.85 [C]	0.24 [BC]	21.29 [CD]
10 R 4	7.89 [AB]	11.23 [A]	0.21 [BC]	58.60 [A]
10 R 5	7.97 [AB]	12.34 [A]	0.27 [BC]	46.51 [ABC]

CONCLUSIONS

The decreases in reconstituted soil bulk and particle density may be due to the increase of organic carbon content and to the better particles aggregation resulting from mechanical actions by reconstitution. The high total nitrogen content in reconstituted soil seems to be due to its immobilization and seems to increased nitrogen-fixing activity. The high reconstituted soil organic matter is due to the targeted sludge chosen, to the stabilization and to the induced polycondensation operated by the technology. This high content would not be obtained through a simple mixing or distribution of soil amendments. The reconstituted soil C/N ratio indicates a stable equilibrium between mineralization and humification, allowing the preservation of organic carbon stable forms. The low reconstituted soil pH brings to an increase in nutrients availability. **The reconstitution technology produces a new soil with good physical and chemical characters.**

AIIA 2015 International Mid-Term Conference, Italian Society of Agricultural Engineering,
Naples, June 22-23, 2015