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# Soil degradation by grazing pig in Mediterranean environment

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**Abstract.** The breeding of pigs grazing can cause serious environmental problems for the particular feeding behaviour of these animals. The aim of this research was to study the soil damage caused by pigs grazing in a Mediterranean forest. Eight adult pigs were introduced in an enclosure of 1300 m<sup>2</sup> (with a density of about 200 m<sup>2</sup> per animal), partially wooded. Experimental observations were made about visual characterization of damage, physical and chemical characteristics of soil structure. The results showed an initial compaction of the enclosure perimeter with a progressive increase of the rooting action and excavation over the entire surface. Particularly, the excavation damages phytocoenosis because causes the destruction of turf and tree and shrub roots. Soil organic matter increases after a short grazing period (increase of C organic and N total), while it decrease at the end of the trial. Soil physical characteristics showed a worsening during grazing period, with a progressive loss of porosity and soil structure. All of these results showed that soil damages caused by pigs grazing are extremely serious with negative repercussion on the entire ecosystem.

**Keywords.** Pig – Soil – Environment – Organic matter.

## **La dégradation des sols par le pâturage de porcs dans l'environnement méditerranéen**

**Résumé.** L'élevage de porcs au pâturage peut entraîner de graves problèmes d'environnement dû au comportement alimentaire particulier de ces animaux. L'objectif de cette recherche était d'étudier la dégradation des sols causée par les porcs au pâturage dans une forêt méditerranéenne. Huit porcs adultes ont été introduits dans un enclos de 1300 m<sup>2</sup> (avec une densité d'environ 200 m<sup>2</sup> par animal), en partie boisé. Les observations expérimentales ont été faites sur la caractérisation visuelle des dégâts et sur les caractéristiques physiques et chimiques de la structure du sol. Les résultats ont montré un compactage initial du périmètre avec une augmentation progressive de l'action de fouissage et d'excavation sur toute la surface. En particulier, l'excavation endommage la phytocénose par la destruction du gazon et des racines des arbres et des arbustes. La matière organique du sol a augmenté après une courte période de pâturage (augmentation de C organique et N total), tandis qu'elle diminue à la fin du processus. Les caractéristiques physiques du sol ont montré une détérioration durant la période de pâturage, avec une perte progressive de la porosité et de la structure du sol. Tous ces résultats ont montré que les dommages du sol causés par des porcs au pâturage sont extrêmement graves, en raison des incidences négatives sur l'écosystème tout entier.

**Mots-clés.** Porc – Sol – Environnement – Matière organique.

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## **I – Introduction**

Due to some external agents of interference, the soil may undergo a degradation process which causes a regression from a high quality level to a low quality one; furthermore, in case of an extreme desertification it may cause the total loss of the soil's biological potential and its resilience. Among the possible causes of this desertification process, the most important one is the high animal pressure. In fact, the animals impact on the soil degradation both in a direct way and in an indirect one. The pigs grazing may cause a reduction of the vegetation which protects the soil from an erosion process and it may guarantee a good level of organic matter. A further

effect of pigs grazing is the soil compaction caused by pigs trampling. Both those reasons may lead to a reduction of the soil's vitality and fertility also showed through chemical and physical structural parameters. Among livestock animals, pigs cause the most relevant environmental problems for their specific behavioural characteristics.

The two main damaging effects on the soil are the rooting and the soil compaction. The rooting is based on pigs excavation activity to find tubers, roots, and terricolous fauna. Furthermore, it may reduce the surface layers of soil of about 20-30 cm causing a high reduction of the vegetable biomass (so, the involved areas look like a milled soil), (Barrett, 1982; Singer *et al.*, 1984). The soil compaction is due to pigs habit to pass through selected paths; in this way, it stops the vegetation growing and the soil becomes asphyxial.

The aim of this research was to check the time evolution of the soil's quality and turf exposed to pigs overgrazing in a specific forest area.

## II – Materials and methods

The research took place in a farm, (Pisa, Italy) located in woodland typical of the Mediterranean coast. For the trial was fenced a flat pasture area of about 1300 m<sup>2</sup> with a high density of animals (160 m<sup>2</sup> per animal). The area was representative of the forest, and was never used before as grazing land. Eight "Large White" pigs were entered in this area, according to a continuous grazing technique, and fed with organic diet. Environmental monitoring was carried out for a period of 100 days long. Four sampling were carried out after 0 (T0), 15 (T1), 45 (T2) and 100 (T3) days, to evaluate quantitative and analytical soil's damage.

The observations (expressed as percentage of disturbed area) were made to determine soil's direct damage (trampling and rooting activity); moreover, the over 5 cm depth wallows were measured, to evaluate the surfaces and volumes of removed soil. On the samples analysis focused on chemical and physical-structural parameters were carried out. Three samples per plots of 1m<sup>2</sup>, were collected for each type of damage and each time of sampling, according the follow scheme: a) control (undisturbed soil) at T0; b) two types of soil damage: rooting activity and trampling activity at T1, T2, T3.

For the trial analyzed the following analytical parameters have been:

Bulk Density assessed according Blake and Hartge (1986) method; porosity evaluated using the bulk density according the following formula:  $P=1-(BD/PD)/100$ , where BD= Bulk Density and PD= Real Density (=2.65 g/cm<sup>3</sup> for a medium texture soil). Cracking, analyzed according Petruzzelli and Guidi (1975) method. Total Organic Carbon (TOC), evaluated by an elemental analyzer RC-412 MULTIPHASE CARBON, and Total Nitrogen (TN) assessed by an elemental analyzer FP-528 PROTEIN/NITROGEN DETERMINATOR.

All results are the means of determination made on three replicates. To evaluate the effect of damage, the chemical and physical parameters were analyzed by ANOVA one way, within each treatment (rooting and trampling activity). The significant level reported ( $P < 0.05$ ) are based on the Pearson coefficients.

## III – Results and discussion

The qualitative assessment of environmental damage, directly observed on the soil can be summarized in Table 1.

At T1, the presence of a trampled area along the fence and a rooting activity which interested one third of the surface was detected. Moreover, a sporadic wallowing activity was revealed.

At T2, trampling activity spread not only in the peripheral zone but also in the inner pasture area. Much of the surface was rooting and contemporary the excavated area percentage increased.

At T3 is not possible to distinguish the two different types of effects because the surface is totally degraded by rooting activity, so the last sampling was done only on the soil rooting. The wallows were widespread.

**Table 1. Soil damage**

	T0 (0 days)	T1 (15 days)	T2 (45 days)	T3 (100 days)
Trampling activity (%)	0	10	25	0
Rooting activity (%)	0	30	65	100
Undisturbed (%)	0	60	15	0
Wallowing activity (m <sup>2</sup> ) <sup>†</sup>	0	5.8	12.85	18.12
Wallowing activity (m <sup>2</sup> ) <sup>††</sup>	0	0.5	1.32	1.69
Wallows (n)	0	5	12	18

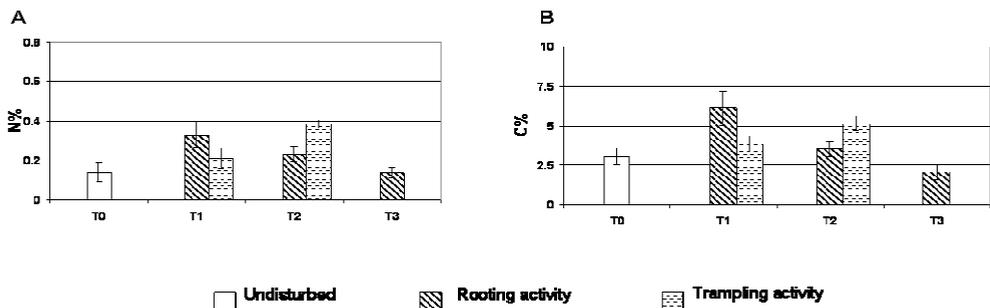
<sup>†</sup>Area estimated as ellipse.

<sup>††</sup>Volume estimated as semi ellipsoid:  $(4/3 * a * b * c * 3.14) / 2$

The organic matter content, expressed as Total Organic Carbon (TOC%) and Total Nitrogen (TN,%) (Fig.1 A, B), decreases during the trial in soils subjected to rooting activity, while increases in trampled soils. These parameters change significantly over time, this is a negative indicator for the estimation of soil fertility.

In the case of high animal density, rooting causes the complete removal of biomass in the soil (roots, leaves, small branches, etc.), which is partly eaten by animals and does not restore the soil organic matter sink. Furthermore, excessive compaction reduces roots and plants growth, preventing the restoration of soil organic matter content.

Along the trial, in trampled soils, the increase of both parameters could be due to continuous grazing that led to an accumulation of manure and alter the true values of TOC and TN in the soil. Moreover, the decomposition of crop residues typical of the forest, may have contributed to increase both parameters.



**Fig. 1. A) Total Nitrogen (TN, %)**

**B) Total Organic Carbon (TOC, %).**

The bulk density parameter (Fig. 2, B) is inversely related to soil porosity (Fig. 2, A), which expresses the volume of voids of the soil as the percentage of the total volume. This physical property directly affects the dynamics of the gaseous and liquid phase in soil and, indirectly, the chemical fertility. Moreover, it shows a close correlation with the structure and tillage. The activity of overgrazing by pigs caused a worsening of soil porosity (increase in bulk density), but

the intensity of this disturbance is greater in the trampled soil, due to excessive trampling by animals ( $P > 0.05$ ). This effect in rooting soil is less evident.

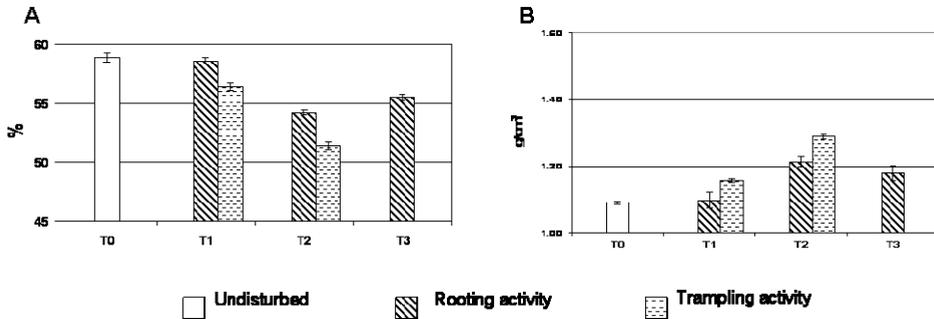


Fig. 2. A) Porosity (%)

B) Bulk Density.

In rooting soil there is an increase of total cracking (Fig. 3, C) in relation to undisturbed soil, a value that decrease from T1 to T3 ( $P < 0.05$ ).

In particular this increase at T1 is characterized by a small number of cracks with a diameter greater than 500  $\mu\text{m}$  (Fig. 3, B) [a dimension class of cracks representing the micro-habitat for soil microorganisms and, thus, the seat of microbiological and biochemical processes (Guidi *et al.*, 1978)], but a high content of cracks with a diameter less than 500  $\mu\text{m}$  (Fig. 3, A) which correspond to micro-porosity, can be regarded as a reservoir to hold water for plants and microorganisms (Pagliai *et al.*, 1980).

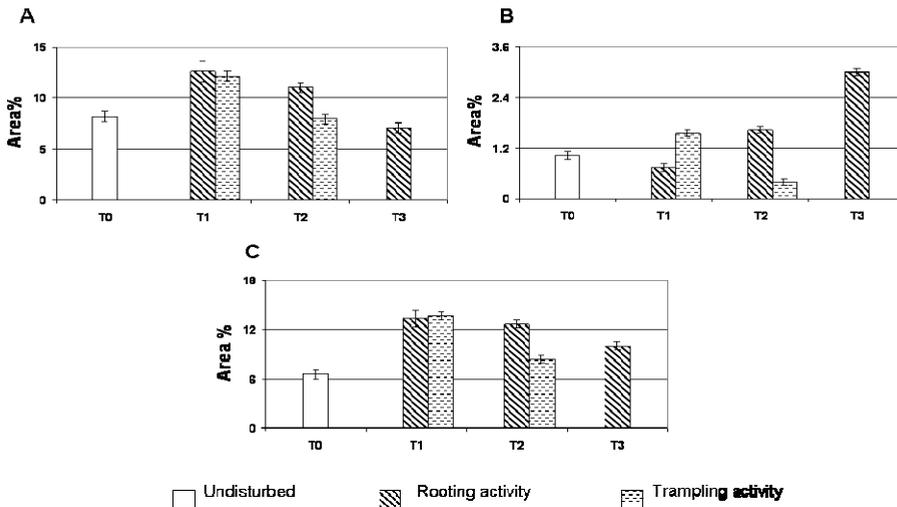


Fig. 3. A) Cracks <500  $\mu\text{m}$ .

B) Cracks >500  $\mu\text{m}$ .

C) Total cracks.

A mild rooting activity resulted in a beneficial effect on the microporosity of the soil but it causes adverse effects on the class cracks that are the habitat of soil microorganisms leading to a constraint normal course of microbial activity (Masciandaro *et al.*, 1997).

At the second sampling according with an evident rooting activity, the trend is changed. The cracks >500 µm are more than those <500 µm. This is a positive phenomena as far as a chemical field is concerned, but negative in relation to the soil structure. In trampled soil at T1 both the total cracks and the two ranges of cracks increase, according with the decrease of porosity, while at T2 both the total cracks and the two ranges of cracks decrease. This indicates that poaching has caused the soil compaction.

## IV – Conclusions

The problem of damage to the soil by pigs is a significant environmental issue. Macroscopic aspects and also less visible factors directly affect the quality of soil grazed by pigs and indirectly the functionality of the entire ecosystem. Even in a limited period the animals degrade the soil's quality. The results, in fact, show as the soil's damage (soil removal caused by rooting and trampling) is closely related to the analytical small scale parameters on the physical and chemical characteristics of soil (cracks, bulk density, organic matter) .

After just over a month the soil is severely compromised in its main structural features. The high compaction by animals creates an asphyxial condition and compromises the soil fertility. The results show that a slight grazing by pigs and the moderate stirring of the surface layers of soil don't give problems on the soil. Therefore, we must be careful in pig density and animal farming system used that must be rational and proportionate to the type of environment and food availability in grazing area. Should be absolutely avoided continuous grazing, adopting a grazing round to make shifts on the pasture and to protect the soil characteristics.

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