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ESTIMATION OF THE SOIL CARBON SEQUESTRATION IN A FOUR YEAR ROTATION MANAGED WITH CONVENTIONAL AND CONSERVATIVE METHODS

Lorenzo D'Avino[1], Giovanni L'Abate[1](*), Francesca Chiarini[2] , Federico Correale[2], Francesco Morari[3]

[1] Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria
Centro di ricerca per l'agrobiologia e la pedologia (CREA-ABP), Firenze
[2] Veneto Agricoltura, Azienda Regionale per i settori agricolo, forestale e agroalimentare, Legnaro (PD)
[3] Università degli studi di Padova, Dipartimento Agronomia Animali Alimenti Risorse Naturali e Ambiente (DAFNAE)

Abstract
In three Veneto Agriculture experimental farms a three-year monitoring has been conducted. It involved the collection of a data set with 564 georeferenced sampling points with both soil and crop residues samples (epigeal and ipogeal) related to 32 plots extended about 1.5 hectares each. The conservative rotation included the use of cover-crops. In addition to residual biomass and the mean annual air temperature of the station, soil organic carbon, bulk density, coarse materials, clay content and total carbonates were considered. Those data allowed for developing of a mineralization index (MI) characterizing different soils. Data and rotations allowed for the defining different scenarios and the estimation the soil organic carbon after 20 years. The model provides for average MI soils a loss of SOM in conventional soils. The use of digestate determines credits for two farms. The contribution of organic fertilizers, increasing the mineralization, is particularly suitable in soils with low MI. This tool could enable quantifying C credits that could be paid to farmers. Estimations could provide guidance to the objective of the yearly increase of the C 4 ‰, proposed by the Climate Change Paris Conference of 2015.

Keywords: carbon sequestration scenarios, culture system, carbon dynamics, farming system, agroforestry

Extended Abstract
Soil organic carbon (SOC) sequestration estimation is decisive in a Life Cycle Assessment to provide the agricultural phase. However, the limited availability of data often does not allow the application of simulation models of the SOC dynamics in daily or monthly steps.

The aim of this work was to implement a physically based, simplified computational model, which provides guidance on how to increase the sequestration of SOC in the agricultural top-soil horizon (0-30 cm). Taking into account both site-specific characters an the culture system, established knowledge and analytical monitoring data have been implemented. The Hénin-Dupuis model (Tirado et al, 2013; Castoldi & Bechini, 2006; Mary & Guerif, 1994) has provided the conceptual basis, by annual application of the constants (k1 and k2) estimations in a complex cultural system.

In three Veneto Agriculture experimental farms a three-year monitoring has been conducted. It involved the collection of a data set with 564 georeferenced sampling points with both soil and crop residues samples (epigeal and ipogeal) related to 32 plots extended about 1.5 hectares each.
The conservative four-year rotation (no till) included the use of cover-crops (in green), in particular: 1st year Zea mays L. cv korimbos; 2nd year Hordeum vulgare L. + Vicia sativa L. - Glycine max (L.) Merr cv Demetra; 3rd year Triticum aestivum L. cv aubusson - Sorghum bicolor; 4th year Brassica napus L. cv excalibur - Sorghum bicolor; 5th year H. vulgare + V. sativa - Z. mays (repeated 4 times from 2nd year up). In addition to residual biomass and the mean annual air temperature of the station, soil organic carbon, bulk density, coarse materials, clay content and total carbonates were considered. Processing these data and

rotations allowed for the creation of different scenarios for each plot and the estimation the soil organic carbon after 20 years.

To evaluate the amount of organic carbon of each soil that is potentially mineralized each year per unit volume was estimated, for each analyzed soil, the mineralization index (MI) at time t0 calculated and soils with greater and lesser MI identified.

Three scenarios with annual pace have been compared: Conventional intensive management; Full replacement of mineral nitrogen with digestate from energy crops and industrial products; No tillage with cover crops. Digestate from energy crops and industrial products has defined by Bezzi & Regazzoni, 2014, has an efficiency of 45% (DM 25/02/16), biological stability similar to compost (Tambone et al, 2010), and increased mineralization; In no tillage cover crops are dried and / or shredded and mineralization results reduced.

Estimates of SOMBIL model were compared with the measured SOC values in 2012, 2013 and 2014, and with those obtained from the IPCC model (2006), which estimates the increase in SOC with decades step. The model estimates the carbon dynamic, however, the time interval of three years is excessively reduced and the values of SOC results extremely variable. Due also to the variation of soil bulk density, the estimates of the soil carbon stock after 4 years is far more accurate. An exception is the Vallevecchia farm (particularly in no till plots) where the clay fraction also contains carbonate rocks (dolomite and calcite, Piccoli et al, 2016). The protection of the mineralization induced by carbonates seems overestimated by the model, suggesting a possible adjustment in the case of carbonate rocks in clay fraction.

Estimated values were validated with the observed values after three years of experimentation, resulting compatible with the variability of data and allowing for model calibration. Burial of all crop residues would allow a substantial maintenance of carbon stocks, even in conventional farming scenarios, except for soils characterized by a high rate of mineralization, in which, according to the model, there would be depletion. Conservative scenarios instead show a general increase in organic SOC after 20 years.
This tool could enable quantifying SOC credits that could be paid to farmers. Already implemented, site-specific assessments on conservative agricultural practices are: compost or digestate intake, and agroforestry practices. Finally the thus obtained estimations could provide guidance to the objective of the yearly increase of the SOC 4 ‰, proposed by the Climate Change Paris Conference of 2015.

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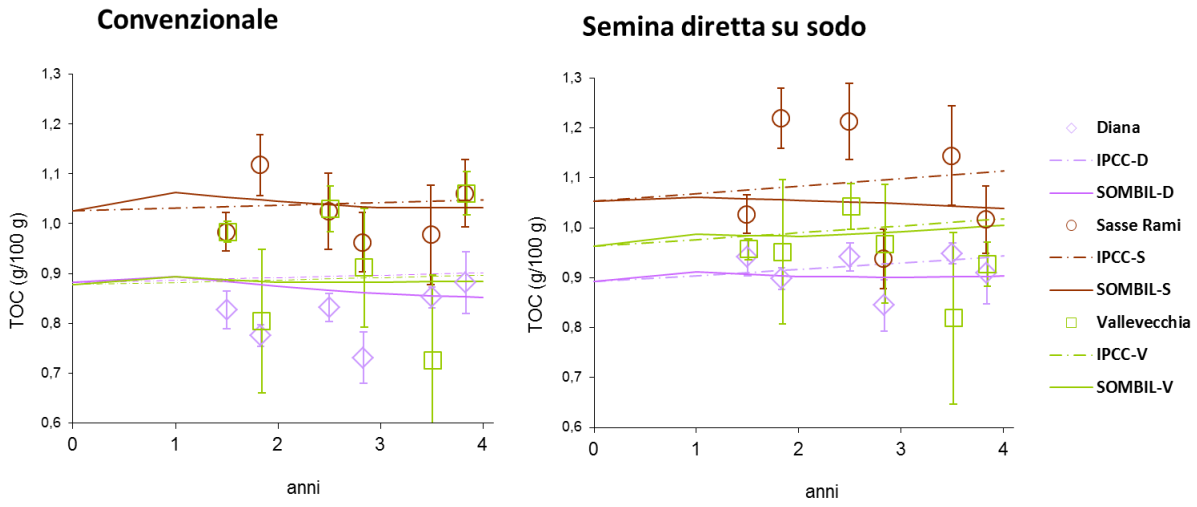

Fig. 1: Comparing the carbon stock predicted by the model and observed (bars: standard and dashed error, standard deviation)

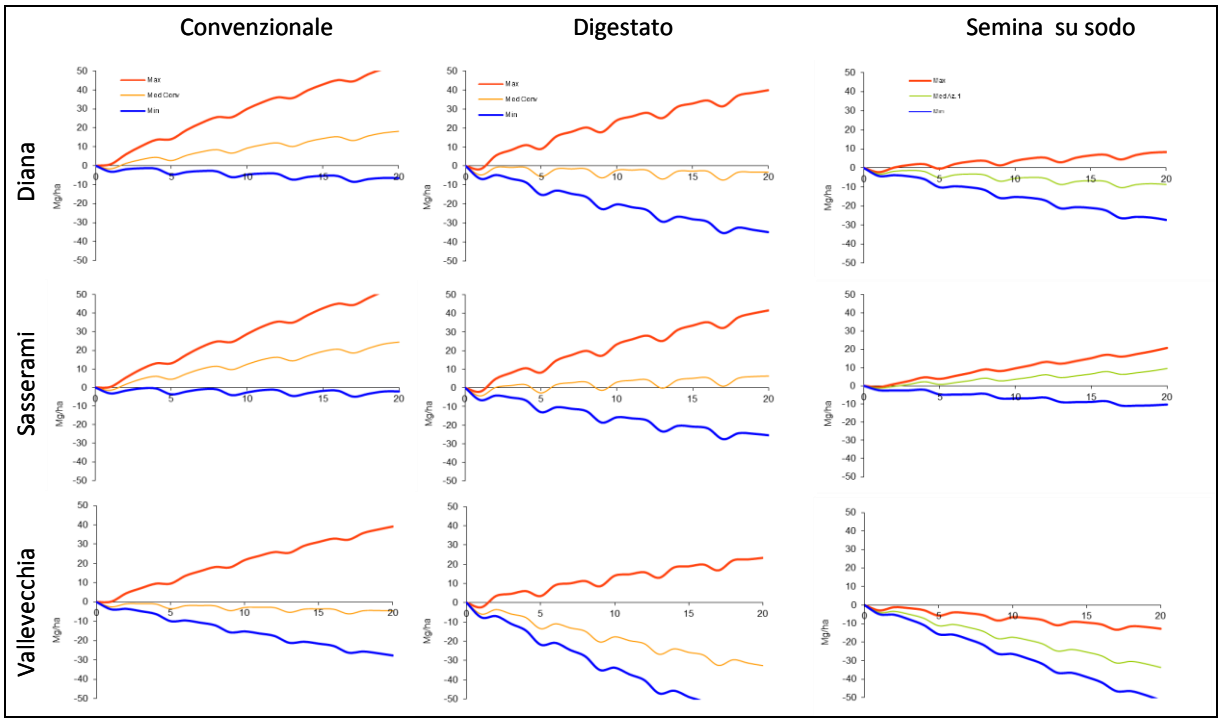

Fig. 2: Estimate of the SOC sequestration (<0) or the emissive character (> 0) of soils with mineralization potential maximum, medium and minimum in the different scenarios