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Large uncertainty in soil carbon modelling related to carbon input calculation method

Sonja G. Keel (1), Jens Leifeld (1), Arezoo Taghizadeh-Toosi (2), and Jørgen E. Oleson (2)

(1) Agroscope, Institute for Sustainability Sciences, Climate and Air Pollution, Switzerland (sonja.keel@agroscope.admin.ch), (2) Aarhus University, Department of Agroecology, Denmark

A model-based inventory for carbon (C) sinks and sources in agricultural soils is being established for Switzerland. As part of this project, five frequently used allometric equations that estimate soil C inputs based on measured yields are compared. To evaluate the different methods, we calculate soil C inputs for a long-term field trial in Switzerland. This DOK experiment (bio-Dynamic, bio-Organic, and conventional (German: Konventionell)) compares five different management systems, that are applied to identical crop rotations.
Average calculated soil C inputs vary largely between allometric equations and range from 1.6 t C ha-1 yr-1 to 2.6 t C ha-1 yr-1. Among the most important crops in Switzerland, the uncertainty is largest for barley (difference between highest and lowest estimate: 3.0 t C ha-1 yr-1). For the unfertilized control treatment, the estimated soil C inputs vary less between allometric equations than for the treatment that received mineral fertilizer and farmyard manure. Most likely, this is due to the higher yields in the latter treatment, i.e. the difference between methods might be amplified because yields differ more.
To evaluate the influence of these allometric equations on soil C dynamics we simulate the DOK trial for the years 1977-2004 using the model C-TOOL (Taghizadeh-Toosi et al. 2014) and the five different soil C input calculation methods. Across all treatments, C-TOOL simulates a decrease in soil C in line with the experimental data. This decline, however, varies between allometric equations (-2.4 t C ha-1 to -6.3 t C ha-1 for the years 1977-2004) and has the same order of magnitude as the difference between treatments.
In summary, the method to estimate soil C inputs is identified as a significant source of uncertainty in soil C modelling. Choosing an appropriate allometric equation to derive the input data is thus a critical step when setting up a model-based national soil C inventory.

References

Taghizadeh-Toosi A et al. (2014) C-TOOL: A simple model for simulating whole-profile carbon storage in temperate agricultural soils. Ecological Modelling 292:11-25