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Dynamic modelling and humus balances as tools for estimating and upscaling soil carbon stock changes in temperate cropland

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Humus balances are simple mathematical tools used by farmers for assessing the overall performance of their management in terms of soil organic matter changes. They are based on humus reproduction factors which themselves mainly depend on crop rotation, residue management, and amount and type of organic fertilization. Dynamic models, on the other hand, are typically complex and need more detailed input data and are designed to calculate the time course of soil carbon content. In both cases, thorough validation is needed to utilize their potential for estimating carbon stock changes. We compared the results of three humus balance methods SALCA-SQ (Neyroud 1997), VDLUFA method (VDLUFA 2004), Humod (Brock et al. 2008) and the RothC model with measured soil carbon stocks in a long-term experiment in Switzerland for the period 1977-2005 (Fliessbach et al 2007). The field trial comprises various minerally and organically fertilized treatments, the latter differing in the amount and composition of organics applied. All methods were able to distinguish systematic management effects on soil organic carbon (SOC). However, only those SOC trajectories calculated with the dynamic model RothC matched measured stocks quantitatively. For both, humus balances and dynamic modelling the result strongly depended on parameterization of organic fertilizers, i.e. its stability and organic matter content. Therefore, incomplete information on the amount and composition of organic fertilizer and lack of knowledge about its potential for humus reproduction is regarded an uncertainty in both dynamic modelling and humus balance calculation, and seems to be a major drawback for the reliable application of these approaches at the regional scale. Our results stress the need for more detailed and harmonized data bases of organic fertilizer composition and application rates.

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