C-SIMULATOR

DEVELOPMENT OF AN ADVISORY SYSTEM FOR FIELD SPECIFIC ORGANIC MATTER MANAGEMENT ON ARABLE SOILS IN FLANDERS

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Introduction

Soil organic matter (SOM) is an important parameter of the quality of arable land and at the global scale agricultural soils are considered to be a major sink of carbon dioxide.
Results of thousands of soil analyses carried out annually by the Soil Service of Belgium have shown that carbon stocks in Flemish agricultural land have dwindled in the past decades, and this in spite of the increased use of animal manure from intensive livestock holdings.

At present, due attention to the soil organic matter content is already among the agro-ecological conditions to be fulfilled by the Flemish farmers in the framework of the Mid Term Review. Future European legislation could impose even more stringent and compelling measures to be taken by farmers with respect to the build-up and/or conservation of the organic matter stocks in agricultural land.

Objectives and principles of the system

At the request of the Flemish government, a consortium consisting of the Soil Service of Belgium and the University of Ghent is currently developing C-simulator, a simple but efficient interactive Access based tool to assist farmers with the assessment and improvement of their agricultural practices with respect to carbon stock management on arable land. By simply providing input on the current carbon status of a particular field, the crop rotation and the (organic) fertiliser plan, the model will calculate the expected evolution of the soil organic matter over a thirty year period. The user can thus observe whether the agricultural practices foreseen will contribute to maintaining or building up the soil organic matter stock or rather lead to declining rates.

By consulting comparative lists of the characteristics of different crops and organic manures provided with the programme, the farmer can adjust the strategy, if and when necessary, for more efficient organic matter management.

Methods

The core of the programme is the Roth C model that was developed at the agricultural research centre of Rothamsted (UK) by D.S. Jenkinson and others in the 1980's making use of the results of several long term experimental fields at the station. For the purpose of the assignment, this model was withheld among other potential candidates for several reasons, the main ones being the fact that it was developed in comparable agro-ecological conditions as those encountered in Flanders, as well as its open and transparent structure facilitating its adaptation to the specific conditions and practices of the Flemish agriculture.

The Roth C model is based on the interaction between 5 conceptual SOM fractions, 4 whereof are considered to be active: DPM (decomposable plant material), RPM (resistant plant material), BIO (living organisms) and HUM (stable humus fraction). The 5th fraction, IOM or inert organic matter does not play a significant role within the time lapse considered (30 years). Each active fraction is converted into BIO, HUM or CO_2 at specific rates. Fresh organic matter brought in either as plant residues or organic manure are considered to consist entirely of DPM and RPM at specific ratios. External parameters influencing the transformation processes are temperature, soil moisture, land cover and CEC. Specific data on the characteristics of plant residues of most common arable crops and organic fertilisers used in Flanders were obtained through extensive literature study.
Based on a series of test runs four initial Roth C pool distributions were developed for relevant soil/rotation combinations for Belgium: 1° arable rotation with low OM input history; 2° fodder crop rotation; 3° all cropland with high OM input history; 4° recently cultivated grasslands. Next, a linear regression between the commonly used 'humification coefficient' and the DPM/RPM ratio of manures and plant residues was used to estimate these DPM/RPM ratios.

C-Simulator was developed in MS Access but does not require any knowledge of this programme. It is easily installed as a stand alone application on any PC running under MS Windows and its use is largely self explaining. Required input is subdivided in user information, field characteristics and rotation data. There is virtually no limit to the number of fields and rotations that can be stored. Data on fields and rotations can be retrieved at any time and can be combined arbitrarily to simulate the expected C-evolution.

Apart from field name, field number and surface area, the user will provide data on initial C-level of the ploughing layer (preferably based on a soil analysis), soil type, ploughing depth and fertiliser history. The latter is important in order to define the initial repartition of the soil organic matter over the 4 fractions.

Crop rotations can take 1, 2, 3 or 4 years. Data to be provided are crop type (including green manures), period of planting and harvesting or incorporation for up to 3 crops per year, period, type and quantity of manure application (up to 2 applications per year). For specific crops, the user has to indicate whether or not plant residues are left on the field (f.i. straw or beet leaves).

The user can now calculate the expected 30 years evolution of the organic soil matter for any selected combination of field and crop rotation by simply pushing a button. The result is displayed as a graph indicating the changing SOM level as well as the soil specific reference zone for SOM content and the minimum level as required by the Flemish MTR conditions. For each year of the rotation, the programme will as well indicate the levels of N and P_2O_5 provided as organic manure in order to check if the rates applied are complying with the applicable rules on fertiliser use.

References

[1] Soil Service of Belgium, Tri-annual overviews of the chemical fertility status of the agricultural soil of Belgium editions 1988, 1992, 1996, 2000 and 2004 (in Dutch)
[2] Jenkinson D.S., Hart P.B.S., Rayner J.H and Parry L.C., (1987). Modelling the turnover of organic matter in long-term experiments at Rothamsted. *Intecol Bulletin* 15, 1-8.

C-SIMULATOR
development of an advisory system for field specific organic matter management on arable soils in Flanders (Belgium)

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Introduction

Soil organic matter (SOM) is an important parameter of the quality of arable land and a major sink of carbon dioxide.
Carbon stocks in Belgian agricultural land have dwindled in the past decades. Soil organic matter content is one of the agro-ecological conditions to be fulfilled by the farmers in the framework of the Mid Term Review.

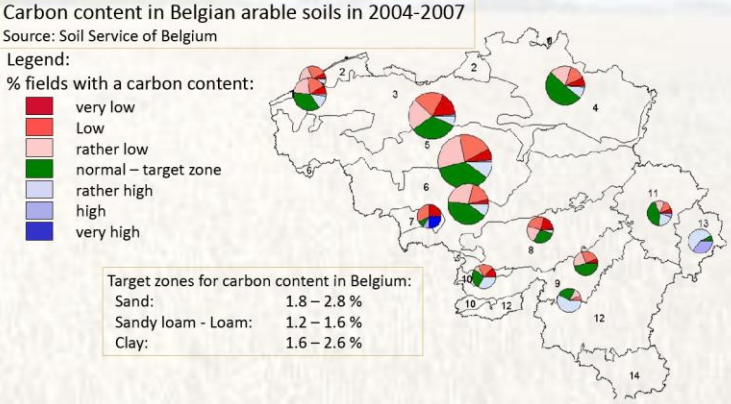
Objective of the system

Development of a simple but efficient interactive tool to assist farmers with the assessment and improvement of their agricultural practices with respect to carbon stock management on arable land.

Simulation model

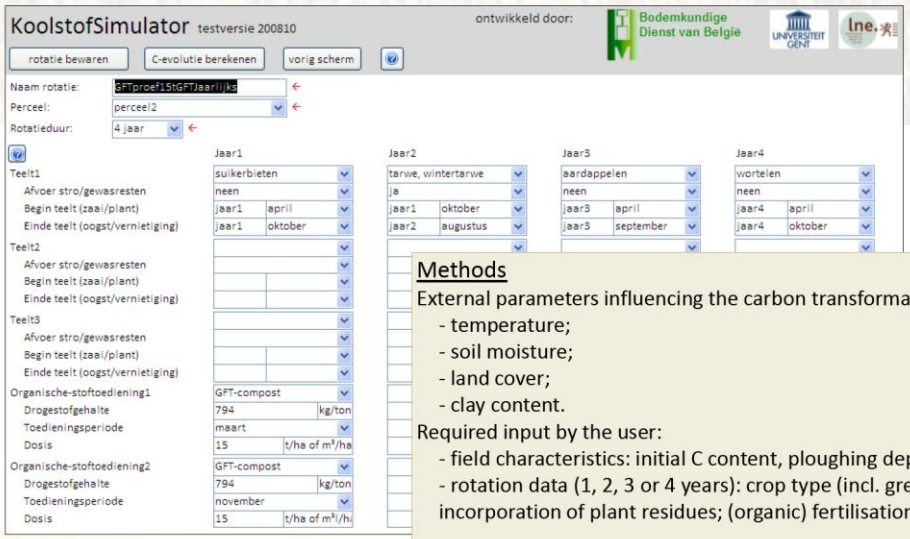
The simulation model used in the program is based on the Roth C model (developed by D.S.Jenkinson et al. at the agricultural research centre of Rothamsted).

Carbon content in Belgian arable soils in 2004-2007
Source: Soil Service of Belgium



Target zones for carbon content in Belgium:

Sand:	1.8 – 2.8 %
Sandy loam - Loam:	1.2 – 1.6 %
Clay:	1.6 – 2.6 %



By simply providing input on
- the current carbon status of a particular field,
- the crop rotation and
- the (organic) fertiliser plan,

the model will calculate the expected evolution of the soil organic matter over a thirty year period.
The user can thus observe whether the agricultural practices foreseen will contribute to maintaining or building up the soil organic matter stock or rather lead to declining rates.

Methods

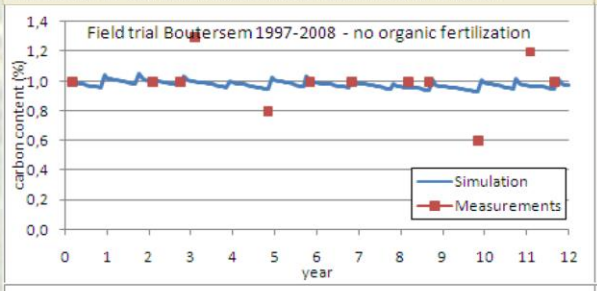
External parameters influencing the carbon transformation processes:
- temperature;
- soil moisture;
- land cover;
- clay content.

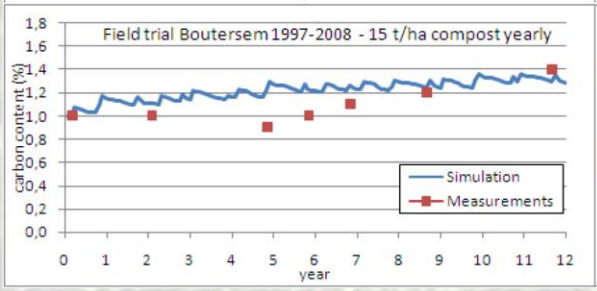
Required input by the user:
- field characteristics: initial C content, ploughing depth, soil type, fertiliser history;
- rotation data (1, 2, 3 or 4 years): crop type (incl. green manures), period of planting, harvesting/incorporation, incorporation of plant residues; (organic) fertilisation: period, type and quantity of application.

→Long term (30 years) estimation of the evolution of the soil organic matter.

By consulting comparative lists of the characteristics of different crops and organic manures provided with the program, the farmer can adjust his strategy, if necessary, for more efficient organic matter management.

Validation of the simulation model with field trial data:





Output of the C-simulator program: