NDICEA AS A USER FRIENDLY MODEL TOOL FOR CROP ROTATION PLANNING IN ORGANIC FARMING

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Key Words: mineralization, modelling, organic, precision farming, rotation, sustainable

Abstract

For organic farming systems, the challenge is to become more specific in practices to maintain high standards in sustainability. Soil processes need to be clearly understood if rotations and manure applications are to become more precise. Simulation models like the NDICEA model help in the design and maintenance of these farming systems. These models play a key-role in the design of organic precision farming.
The NDICEA model has been calibrated for a number of long-term crop rotation experiments. Recently, the model was validated using research data from more than 35 organic farms all over the country. The model is used to calculate soil-specific mineralization rates in precision applications. In a new easy-to-use application, it was developed to design crop rotations and evaluate performance of crop rotations. This application is used to evaluate the sustainability of farming systems.

Introduction

For organic farming systems, the challenge is to become more specific in manuring practices, taking into account the characteristics of crop residues, green manures, organic manures and composts as a source of nutrients and as a contributor to the formation of organic matter. Management of sustainable soil fertility is of paramount importance for organic farming systems. It is therefore essential in the design and maintenance of these systems that we gain the greatest possible insight into soil fertility at the process level. Simulation models like the NDICEA model, will help in the design and maintenance of these farming systems. Organic farms profit from developments of precision farming techniques (Koopmans and Zanen, 2005). Soil processes however, need to be clearly understood if rotations and manure applications are to become more precise and sustainable.

Methodology

The NDICEA model was designed to simulate processes of nitrogen mineralization and organic matter turnover in organic farming systems. The model has been calibrated for a number of long-term crop rotation experiments. The model was recently validated using research data from more than 35 organic farms across the country (Figure 1).
Nitrogen and organic matter dynamics at arable and vegetable farms throughout the Netherlands have been monitored for inorganic nitrogen levels. Laboratory incubations and extractions were used to characterize organic fertilizer decomposition rates of fertilisers used at the farms.

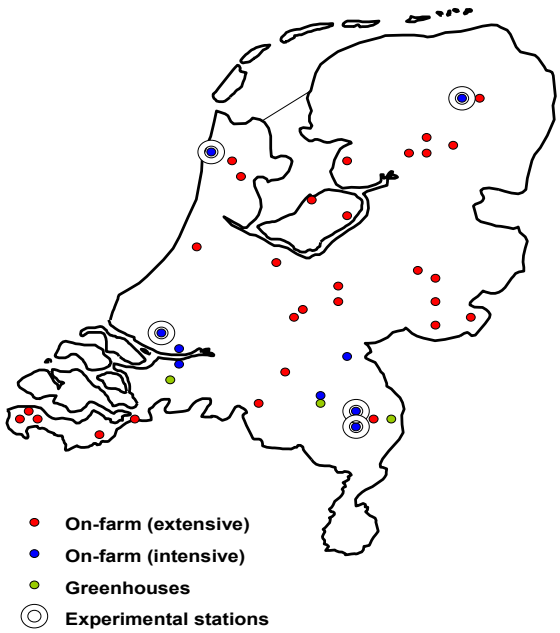


Figure 1. Sites with application of the NDICEA model in the Netherlands

To investigate nitrogen and organic matter turnover levels at these farm fields, results were combined using the dynamic simulation model NDICEA (Koopmans and Bokhorst, 2000; Van der Burgt et al., 2005). To design crop rotations and evaluate performance of crop rotations in the sustainability debate, a user-friendly model application was developed (Figure 2). This application uses standard environmental data for different regions of the country and standard nitrogen contents of the crops.

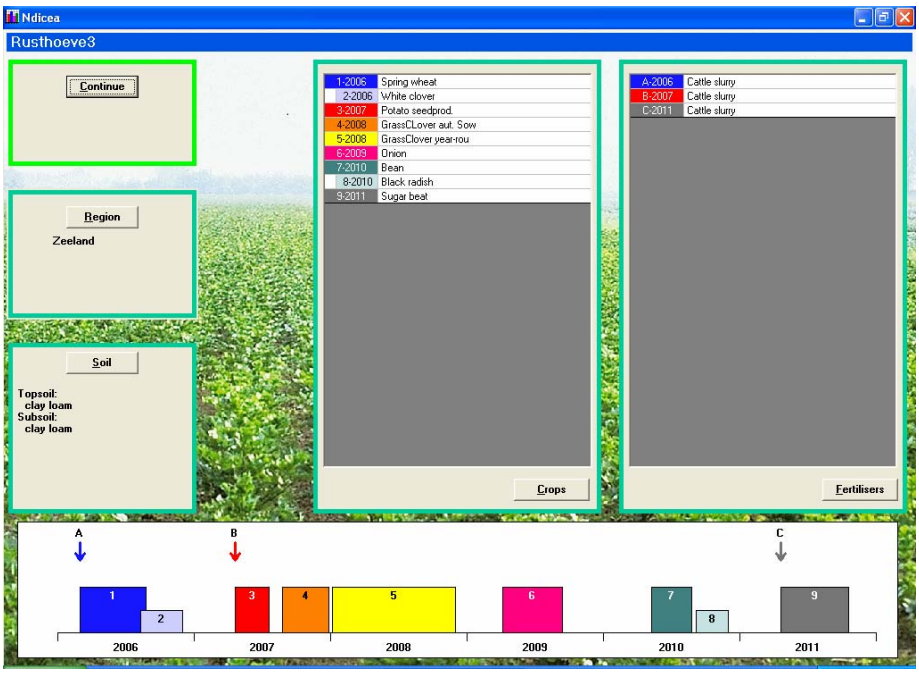
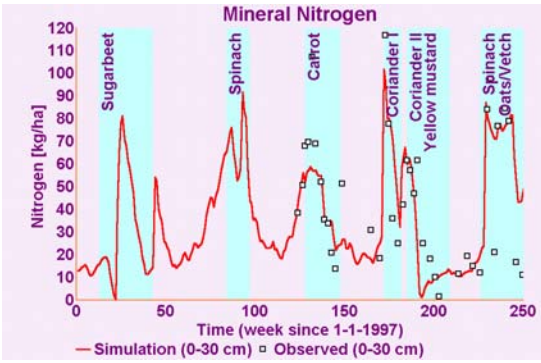


Figure 2. Example of the farmer's version of the NDICEA model for modelling complete crop cycles but no single field evaluations



	Soil layer 0-30 cm	
	Non calibrated	Calibrated
Number of observations	777	777
Mean of observations	39,1	39,2
Average error	-0,5	-0,8
Root mean square error	41,7	30,3
Normalised root mean square error	1,1	0,8
Modelling efficiency	0,1	0,5
r2	0,2	0,5

Figure 3. Example of visual and statistical model performance evaluation (after Koopmans and Heeres, 2002)

Results and Discussion

Model performance was evaluated visually as well as by statistical measures (Figure 3). The model was able to describe the nitrogen dynamics in the soil of fields who had been in organic rotations for several years and on several soil types (Koopmans and Bokhorst, 2002; Koopmans and Heeres, 2002). Using the model as a tool, we first identified soil-specific mineralization rates (Figure 4). Second, the use of a simple simulation model helped to determine the relative importance of each process in the system (Figure 5). Third, the model was used to evaluate alternative management strategies with respect to their impact on the nitrogen availability for the crop, the level of organic matter in the soil, and the nitrogen leaching potential. With the model, organic production has the potential to be attuned to each specific farm, site and soil. The model is used in developing precision farming techniques in organic farming.

Comparison of the NDICEA model with other models (Koopmans and Heeres, 2002) shows that the NDICEA model describes nitrogen mineralization in the soil and organic matter turnover in such a way that it is a good-performing tool for applied research in organic and sustainable farming.

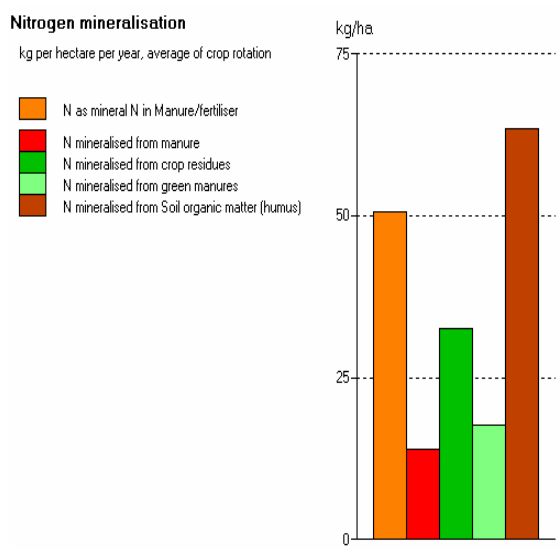


Figure 4. Example of the NDICEA model indicating nitrogen mineralization from different sources

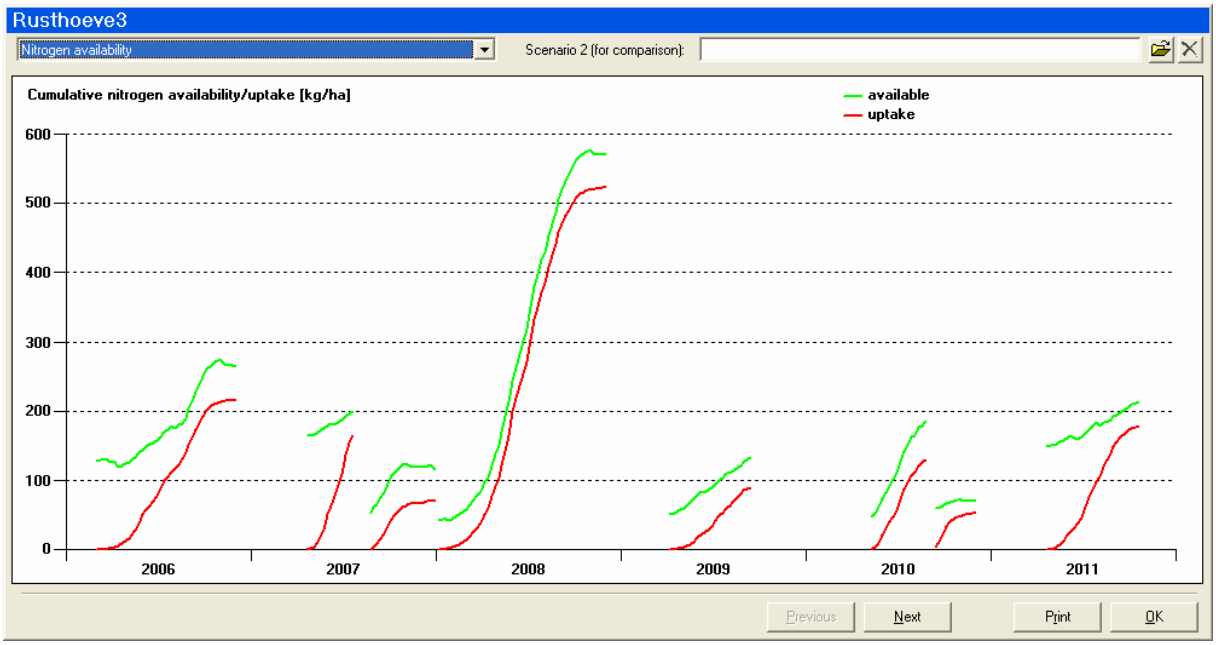


Figure 5. Example of model output from the NDICEA model indicating nitrogen availability in the soil and nitrogen uptake by the crops for several years of rotation

Conclusions

Nitrogen mineralization potentials from soils, manures and plant residues are required management information for farmers who want to optimize their nutrient management and want to close nutrient cycles at their farm. The NDICEA model has a performance that is necessary to develop precision farming techniques for organic farming. The model is a useful tool in evaluating the sustainability of farming systems and the development of indicators like soil fertility levels and leaching losses of nitrogen from farms.

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