The NDICEA model as a learning tool: field experiences 2005.

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Abstract — **In organic agriculture, major part of the plant available nitrogen originates from mineralisation of organic matter. Self-reliance with respect to nitrogen implies limited nitrogen amounts and thus a need for efficient nitrogen management. The NDICEA model is developed to enable assessment of organic fertilization strategies, based on easily obtainable agronomic information. Examples are given on how this model is used in extension work in Holland in 2005.**

INTRODUCTION

Organic agriculture relies on mineralization of organic nitrogen from manure and residues. Operational management can hardly control mineralization. Tactical, i.e. within-season, decisions on timing and amount of organic nitrogen to apply are complex as a result of the prolonged release of inorganic nitrogen, which is influenced by uncontrollable factors such as rainfall and temperature. Also from a strategic viewpoint, nitrogen in organic farming systems is a point of concern. Oomen (1995) calculated that for Europe self-reliance in organic agriculture implies that less than 95 kg manure-N is available per hectare. Arable cropping systems have to be designed in such a way that this limited amount of manure suffices to attain acceptable production levels. Thus, from both a tactical and strategic viewpoint there is a need for farmers to adjust nitrogen demand and supply. Models based on a system representation of key processes of nitrogen dynamics and location-specific inputs enable assessment of the current cropping system, and allow evaluation of alternative systems, and may thus accelerate learning among farmers.

The model NDICEA was developed to enable assessment of organic fertilization strategies and of crop rotations using relatively easily obtainable information on initial states, parameters and driving variables. Parameter calibration is an inherent component of the modelling philosophy and is geared to establishing plot-specific factors (Van der Burgt et al, 2006). Evaluations of this model with data from experimental fields in The Netherlands and Germany have been published elsewhere (Koopmans and Bokhorst 2002; Van der Burgt 2004, Van der Burgt et al, 2006). Purpose of this paper is to present experiences in case of farmers' fields, where, contrary to experimental farms, only a few data of measured soil inorganic nitrogen are available to be used in the calibration of plot-specific factors.

Three outcomes of the farm modeling will be discussed.
If the calculated values of inorganic nitrogen fit well to measured values without calibration of the model parameters, farmers have reason to incorporate the results of NDICEA in their decision making process.
If calibration improves the fit between measured and calculated values, the model may function as a diagnostic tool by indicating that some processes are more important than expected initially.
If calibration fails to come to a sufficient fit, an hidden process may not be excluded and further investigation is required.

METHOD

In 2005 data from 30 farmers' fields were processed by using NDICEA5.2 (Van der Burgt et al, 2006, to be downloaded via www.ndicea.nl). Inorganic nitrogen content of top soil and sub soil (N kg ha^{-1}) was calculated based on measurement of nitrate-N in the extract of a 1 volume water plus 1 volume moist soil using Merckoquant strips and nitrachek 404. Performance of the model was evaluated by visual inspection of the coincidence of simulation results and observations. Visual inspection focused on closeness of observations to simulated dynamics and therefore on trends and representation of peaks and troughs. Finally, we calculated the percentage of absolute prediction errors, i.e. $|sim\text{-}obs|$, falling within a range of 20 kg ha^{-1} for inorganic nitrogen in the top soil. This statistic is based on a concept of 'sufficiently good' predictions for practical purposes, which are within the range, and predictions of insufficient accuracy outside the range. If that percentage is equal to 100% for a field, the model is considered to reconstruct the nitrogen flows sufficiently in that field. If that percentage is within the range of 66% - 100%, performance is considered moderate. If is lower than 66% performance is considered poor.

RESULTS AND DISCUSSION

In 60% of the fields performance of NDICEA was sufficient without further calibration (table 1). In these cases nitrogen dynamics are reconstructed well, and the simulation can be used for decision making. For instance: a farmer decided to apply 1000 kg vinasse at 1 February 2006 (Week 111) in field A to lift the availability of inorganic nitrogen in April to 40 kg N ha^{-1} ha in top soil to give the onions a good start (Fig. 1).

Table 1. NDICEA performance on 30 fields.

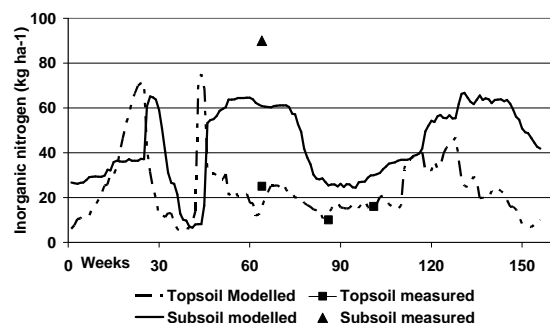|	Without calibration	With calibration
Sufficient	60%	27%
Moderate	25%	10%
Poor	15%	3%

Fig. 1. Course of inorganic nitrogen in field A.
X-axis: time in weeks.
0 = 1 January 2004, 156 = 31 December 2006

Out of the 40% fields with moderate and poor modelling results, 27% could substantially be improved by calibration (table 1). In this calibration procedure, default values of eleven soil parameters are varied within a preset margin. Some processes like denitrification or preferential water flow appeared to have more effect than initially expected, thus based on the default values for the parameters which describe these processes. As a result of the simulation, extra attention will be given in field B to find out whether and why denitrification plays such an important role. It was decided to apply 3000 kg vinasse per hectare on field B in February 2006 to compensate probable losses by denitrification and to make sure that availability of nitrogen will not limit the yield of grass seed (Fig. 2). If substantial denitrification indeed occurs, a more organic solution of this problem has to be found in the long term.
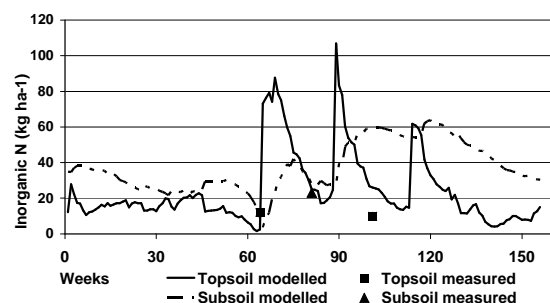

Fig. 2. Course of inorganic nitrogen in field B.
X-axis: time in weeks.
0 = 1 January 2004, 156 = 31 December 2006

In fields where peat layers are found in the subsoil, calibration did not result in a much better performance of NDICEA. In field C some extra nitrogen seemed to be released (Fig. 3) from peat and in another field inorganic nitrogen seemed to be immobilised or denitrified in the peaty sub soil (not shown). With this outcome of the simulation, simple experiments can be done to check the presence of these processes. Only after this check, modelling results with NDICEA can play a role in farm management.
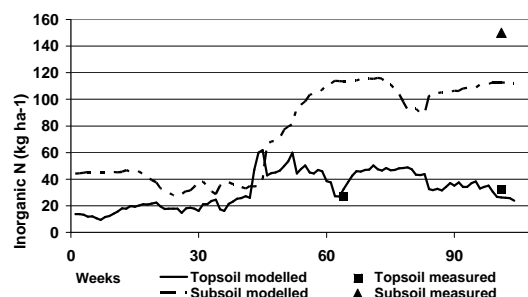

Fig. 3: Course of inorganic nitrogen in field C.
X-axis: time in weeks.
0 = 1 January 2004, 104 = 31 December 2005

CONCLUSIONS

On most farmers' fields the course of inorganic nitrogen was reconstructed sufficiently well without calibration, so by using default soil parameters. Here, farmers have reason to take the results of NDICEA into account in the process of decision-making, and they indeed did so (Fig.1). In some cases calibration improved the results (Fig. 2). This made clear that some processes may play a more important role then initially expected. In other cases processes , that are not described by NDICEA, may play a role. Such presumptions have to be verified by small tests or experiments before nitrogen management can be based on results of NDICEA.

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