Chairpersons: Claudia Wieners, Herman Russchenberg, Henk A. Dijkstra

17:00–17:06 | EGU22-11878 | On-site presentation

N2O-emission risk assessment tool for nitrogenous fertilizer applications

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STØTTET AF

Promilleafgiftsfonden for landbrug

Nitrous oxide (N_2O) emitted from agricultural soils makes up a significant part of the collective agricultural greenhouse gas (GHG) emissions. These emission are to a large extent caused directly or indirectly by the application of nitrogenous fertilizer and there is a strong demand for mitigation strategies.

Nitrous oxide is produced in the soil in a range of different processes but mainly in microbial nitrification and denitrification. A number of factors exert influence on these microbial processes in the soil, most notably the oxygen concentration, availability of ammonium and nitrate, available organic matter and diffusivity, and fairly advanced process-based simulation models are often used in attempts to simulate the amount of N_2O emitted. Here we propose using more a simplistic modelling approach to provide a novel risk assessment tool for nitrogenous fertilizer applications to be implemented in Danish farmers field management programmes.

At SEGES Innovation we have unique database access to field activity data from Danish farmers - e.g. crop sequence, fertilizer applications, residue handling, soil texture - covering more than 85 % of the Danish cultivated area. Based on these data and field specific climate data, a soil water balance model (Plauborg et al. 1995) and soil organic carbon model (Taghizadeh-Toosi et al. 2014) are running in daily timesteps for all fields in the database. These models provide, respectively, the daily level of WFPS in the soil and the organic matter turnover rate in the soil simulated during the weather forecast period of 10 days. Those two outputs are combined with a simulated soil temperature in a simplified version of the NGAS-model (Parton et al. 1996) to give a rough simulated N_2O-emission for any planned fertilizer application throughout the weather forecast period.

The risk assessment tool exhibits this daily simulated N_2O-emission as a risk evaluation of fertilizer application to the farmer in field management programmes, where future field activities are entered and logged. The objective is to lower the GHG emission by reducing the number of fertilizer applications right at peak N_2O-emission conditions, once the farmers are presented with this information.

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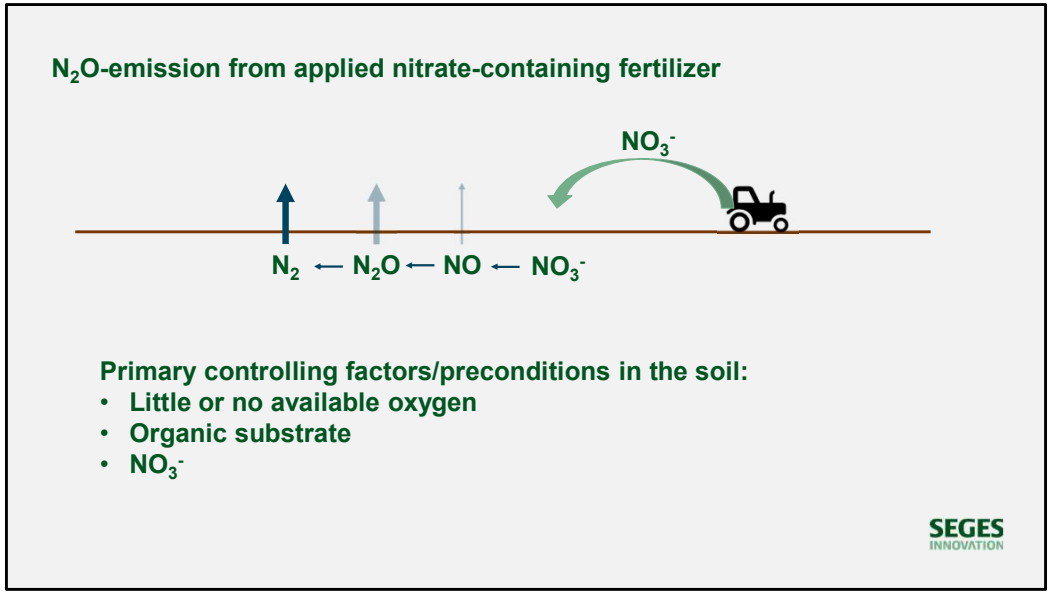
My name is Henrik Poulsen, I work at SEGES Innovation i Denmark, and I will present a quite simple risk assessment tool for N2O-emission that we have developed in collaboration with KU. I should start by stressing or admitting that the tool, in its first version, is only aimed at NO3 containing fertilizer, and not fertlizers containing reduced N-species such as in animal slurry or urea or ammonia fertilizers



When nitrate containing mineral fertilizer is applied to crops, it is at risk of being reduced to dinitrogen by microorganisms. As implied on the figure, NO and N2O may also be produced as byproducts of the denitrification proces. N2O being a very potent GHG is a major concern.

Modelling this processes and the relative distribution of products is really complex and most often approached with quite complex models.

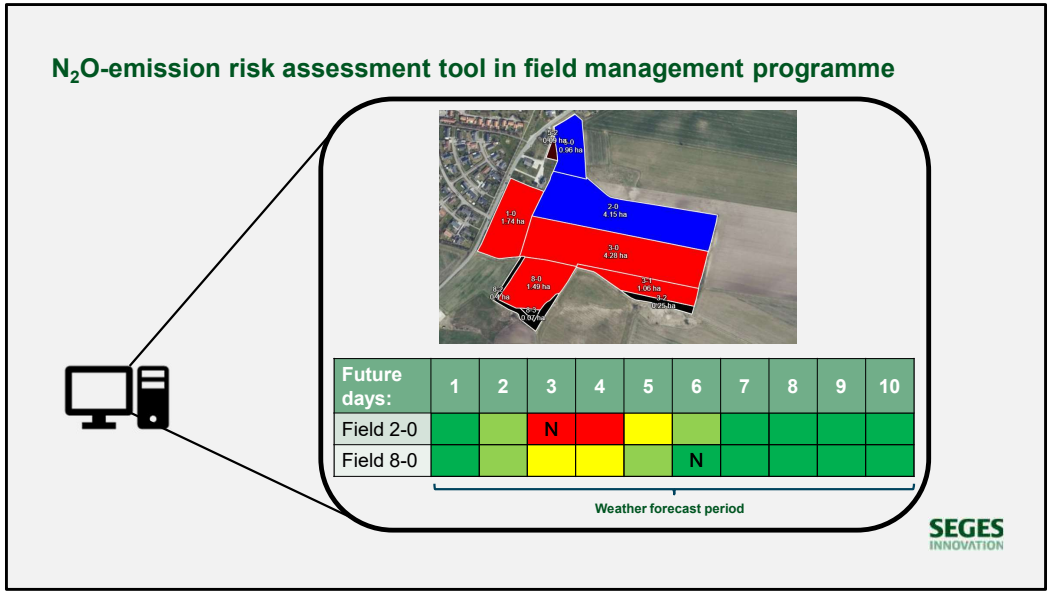
However there are a few primary controlling factors which is then also preconditons for denitrification to occur in the soil:

1. There needs to be only very little or no oxygen availabe and this is to a large extent determined by the proportion of soil pores filled with water, often referred to the as water filled pore space.

2. There needs to be oxidizable organic substrate available for the nitrate reducing microorganisms.

3. And finally and obviously there have to be nitrate present, which, when we as here talk about application of nitrate-containing fertilizer, is present in ample amounts.

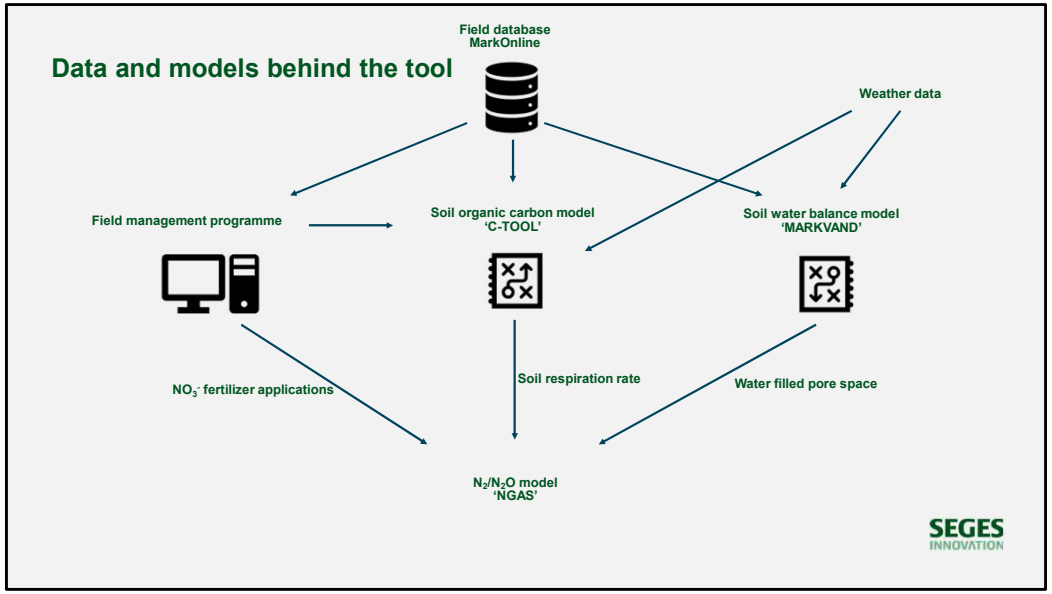
So it follows that avoiding to meet these conditions would reduce the nitrous oxide emissions related to application of nitrate contaning fertilizer.



An so to assist or help the farmer to avoid this we have developed a risk assessment tool, which will be implemented in a widely used field management programme in Denmark, called Cropmanager.

This is the everyday management programme, where the farmer has an overview of his fields and planned activities. Here have exemplified how the tool may be implemented in the programme. So here is an overview of the fields. And here in the table we can see that there is a planned fertilizer application in three days on field 2-0 and in six days time on field 8-0. If we the apply the N2O risk assessment tool - we see the assessment covers a weather forecast period of 10 days and that the farmer in this case might consider

It should be noted that the risk assessment relates isolated to the specific days and does not take into account that applied nitrate fertilizer maybe denitrified until taken up by the crop. And it is the up to farmer to take this into account using the tool.

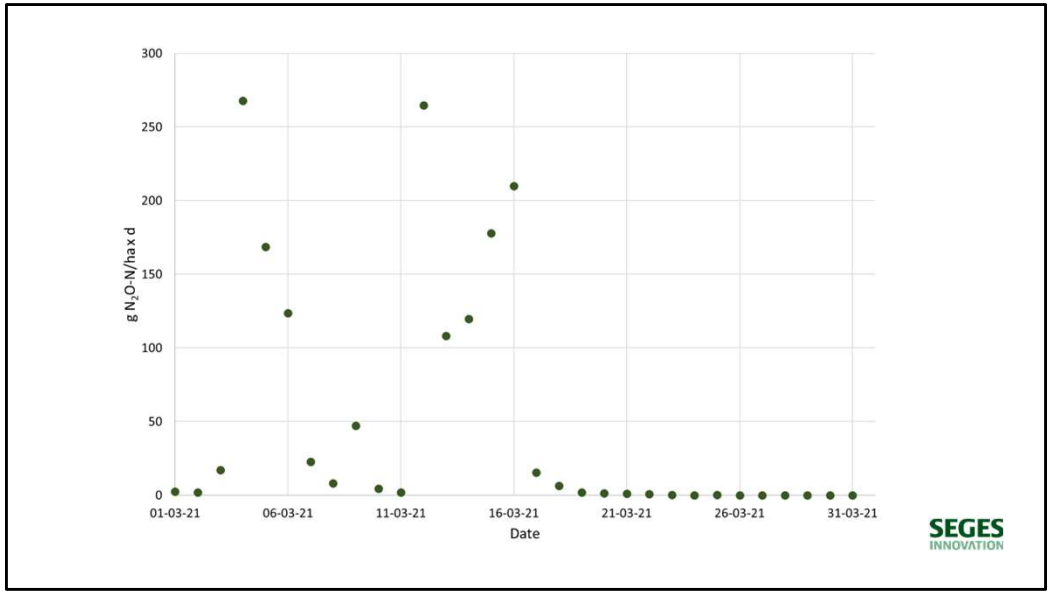


MO: Database operated by SEGES. Covers ~85 % of the danish agricultural area. Here we have information on crops, soil type/texture, location.

Cropmanager: Here the farmer plans and logs acitvities, dates og fertiliser application, is straw harvested or left for instance. These informations and data on soil texture feed into a soil organic carbon model running on all fields.

Like MARKVAND a danish water balance model runs on all fields based on inormation drawn from the MO database.

And naturally these models need to be fed wheater data - or here forecast weather data.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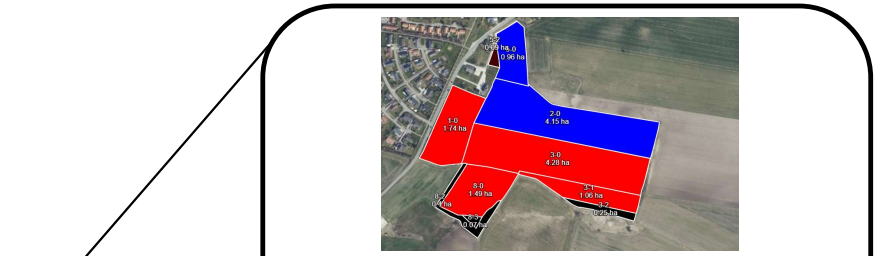
N_2O-emission risk assessment tool in field management programme



Future days:	1	2	3	4	5	6	7	8	9	10
Field 2-0			N							
Field 8-0						N				

Weather forecast period

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Referenced models

'NGAS'
Parton, W.J., Mosier, A.R., Ojima, D.S., Valentine, D.W., Schimel, D.S., Weier, K. and Kulmala, A.E. 1996. Generalized model for N2 and N2O production from nitrification and denitrification. Global Biogeochemical Cycles 10(3): 401-412.

MARKVAND
Plauborg, F. and Olesen, J.E. 1990. Development and validation of the model MARKVAND for irrigation scheduling in agriculture. Statens Planteavlsforsøg. Beretning nr. S2113.

C-TOOL
Taghizadeh-Toosi, A., Christensen, B.T., Hutchings, N.J., Vejlin, J., Kätterer, T., Glendining, M. and Olesen, J.E. 2014. C-TOOL: A simple model for simulating whole-profile carbon storage in temperate soils. Ecological Modeling 292: 11-25.

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