

An internet-based tool for use in assessing the likely effect of intensification on losses of nitrogen to the environment

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Introduction

As agricultural commodity prices continue to fall in real terms, farmers are obliged to choose between increasing profits, accepting a fall in their standard of living relative to the rest of society, or seeking partial or complete alternatives to farming as a source of income. Parallel with this economic trend is the desire amongst farming families to follow the social trend in the rest of society towards shorter working hours. This generates a secondary economic pressure to develop enterprises with sufficient revenue-generating capacity to employ relief labour. As agricultural land prices generally remain high in Europe, there is an incentive to intensify production as far as possible on the existing land available to the farm. Operating in the reverse direction is the pressure from an increasingly urban population for reductions in the environmental impact of farming. This pressure has become tangible in the form of regulations such as the EU Nitrates and Habitat directives, the Convention on Long-range Transboundary Pollution and the Kyoto Agreement. Agricultural losses of nitrate, ammonia and nitrous oxide are therefore under scrutiny by national and international environmental authorities.

These conflicting pressures emerge at farm level, partly through increasing restrictions on farm management, particularly when farmers wish to intensify their operations. The environmental authorities must then assess the likely effect of the change in operation and weigh the economic benefits against the environmental impact. This is particularly difficult on farms with ruminant livestock, because losses from animal housing, manure storage facilities and fields are intricately interlinked. A satisfactory resolution of the potential conflict between economic and environmental pressures is more likely if farmers, farm advisors and environmental authorities have access to tools that enable them to reach a consensus on how the farm is likely to be structured and managed in the future, and to provide an objective assessment of the environmental losses that will result.

Methods

The FARM-N internet tool was developed to help fulfil this need. The internet, as opposed to CD-ROM, was chosen because it offered the possibility of linking in the future to databases of climate and soil, and in order to ease updating. The farmer must describe both the current and proposed farm structures and management in terms of the number and type of livestock to be kept, the animal housing and manure storage facilities to be used, the land that will be available to the farm and details of field management. The latter include the crop rotation and type of manure spreading equipment to be used. For ruminant livestock farms, the production of milk and livestock has to be consistent with the animal feeding practice, the choice and productivity of the crops chosen, the sale of crop products and the amount of additional animal feed imported. To assist in this process, the tool contains two models. The first is based on a series of decision rules and enable an agronomically sensible crop rotation(s) to be constructed, based on an input combination of crop type and area planted (Detlefsen, 2004). It then determines the applications of manure and mineral fertiliser that should be applied to each crop, dependent on the amount and quality of manure that is available. The amount and quality of manure is, at this stage, assumed to be equal to the standard values in the Danish nutrient management regulations (Poulsen *et al.*, 2001). The second model predicts N excretion from livestock, N losses from animal housing, manure storage and fields and crop responses to N inputs. This model is also based on the methods used in Poulsen *et al.*, 2001. In situations where livestock are partly fed on home-grown products, there is a closed cycle between crop production and protein content, N excretion by the livestock, N losses in animal housing, storage and after manure spreading and the N available to the crop. This means that these models have to be used iteratively until a consistent N flow is achieved.

The tool calculates a farm N balance and uses relatively simple models to partition this balance between ammonia emissions from animal housing, manure storage and field application (Hutchings *et al.*, 2001), nitrous oxide and dinitrogen losses (Vinther and Hansen, 2004), nitrate leaching (Simmelsgaard *et al.*, 2000) and changes in the soil N (Petersen *et al.*, 2002). The results are presented in the form of a simple table. The tool can store a number of future farm structure and management scenarios, enabling the farmer and environmental case officer to explore different structural and management options.

Discussion

Discussions with target users indicate that they are satisfied with the technical aspects of the tool but disagree amongst themselves concerning the role of soil C and N in the future scenarios. Under Danish conditions, both the models and monitoring (Heidmann *et al.*, 2001) suggest that there is an accumulation of C and N in the soil of grassland farms. This is thought to be because most Danish farms were mixed livestock/arable until 30-40 years ago and the soils are still adjusting to the higher inputs and larger contribution of grassland to the crop rotation. The soil organic model, which is the only dynamic model used here, suggests that this accumulation could continue for decades, slowly decreasing as the soil reaches a new steady state with management. The disagreements relate to whether this accumulated C and N should be considered semi-permanent storage or a large source of N that could be lost to the environment, should management practices change.

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