Evaluating the economic and environmental sustainability of integrated farming systems

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Introduction Economic and environmental sustainability has become a major concern for forage-based animal production in Europe, North America and other parts of the world. Development of more sustainable farming systems requires an assimilation of experimental and modelling research. Field research is critical for supporting the development and evaluation of models, and modelling is needed to integrate farm components for predicting the long-term effects and interactions resulting from farm management changes. Experimentally supported simulation provides a tool for evaluating and comparing farming strategies and predicting their effect on the watershed, region and beyond.

Materials and methods Field experiments on sandy soils in northern Germany have determined nitrogen fluxes in grass and maize silage production systems (Wachendorf *et al*., 2004). Grass production included defoliation strategies of all silage harvests, silage harvest followed by grazing later in the season and all grazed. Nitrate leaching and denitrification losses of nitrogen were monitored on plots receiving various applications of fertilizer and manure. These production systems were simulated using a whole farm model (Rotz & Coiner 2004), and simulated nitrogen fluxes were verified by field data. The model is now being used as a research and teaching tool to evaluate cropping, feeding and manure management strategies in integrated crop and animal farming systems and to predict their environmental impacts.

Results To illustrate an application of the model, all grass and grass and maize silage systems were simulated for a typical dairy farm in northern Germany with and without the use of rotational grazing. Farm net return or profit increased with the use of maize silage or grazing (Figure 1). Nitrogen losses increased with the use of grazing but decreased with the use of maize silage. An appropriate combination of grass, maize silage and grazing was used to maximize farm profit while maintaining nitrogen losses. These results are not directly transferable to other sites such as the soil and climate conditions of the northern USA, but through the use of the model these and other management practices are being evaluated in other regions of the world. Farm and watershed scale models are also being linked to predict the effects of farm management on the surrounding region and beyond. A version of the farm model is available at http://pswmru.arsup.psu.edu

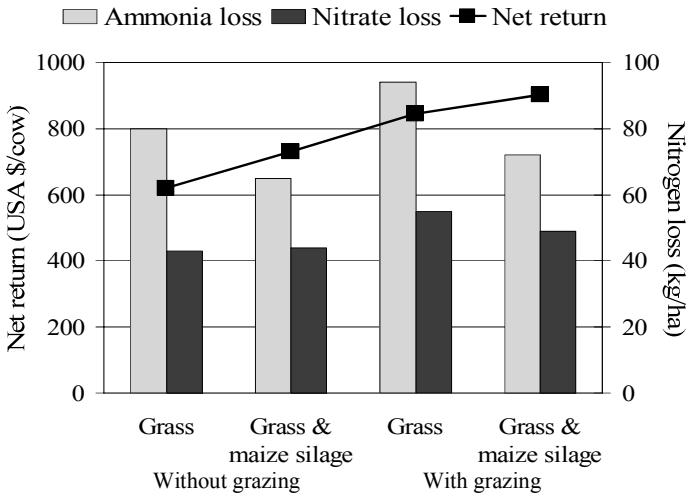

Figure 1 Farm net return and nitrogen loss for production systems using grass and maize silage with or without grazing

Conclusions When properly supported with field observations, whole-farm simulation provides an effective research and teaching tool to integrate farm processes and predict farm performance, profitability and environmental impact. This tool is very useful to develop, evaluate and transfer more sustainable grassland systems to commercial livestock production.

References

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