Changed crop type and crop rotation as a measure to increase N use efficiency and achieve reduction targets for N leaching

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Abstract

This paper presents a method to estimate effects of crop type and crop rotation conversions on N-leaching, economic costs and N efficiencies. Results for a Danish watershed, with intensive agriculture and livestock production and a high need for reduced N leaching, show a significant potential for such measures, in particular when geographically targetted to areas with the highest reduction potential. The point is, that there is a large variation in the effects, and a significant potential to combine reduced pollution with higher N use efficiencies and possible economic benefits, and as put forward by our study, this demands well tested impact assessment models and integrated procedures for stakeholder involvement.

Keywords: crop type, crop rotation, grassland, nitrogen leaching, nitrogen use efficiency

1. Introduction

The nitrogen (N) leaching and N use effciency varies significantly between cropping systems, and consequently, new ways to optimise the selection of crop types and crop rotations can be an efficient measure to reduce N pollution while simultaneously optimising the efficiency of nitrogen use in the crop production (Børgesen et al. 2018).

The present study presents research examples from Denmark, where the Ministry of Environment and Food of Denmark have required assesments of how these measures can help to reach the high reduction targets set for N leaching to the aquatic environment while maintaining a compeditive and environtally friendly food production.

2. Materials and methods

From the 1994 MacSherry reform of the Common EU Agricultural Policy and onwards, digital registers of field crops are available. Based on these data, and a coupling to digital field maps and information on fertiiser use, catch crops etc., a database on crop types and crop rotations have been set up, and combined with digital maps of N leaching reduction targets set for the watersheds of Denmark in accordance with the EU Water Framework Directive. Moreover, information of local soil types and geology have been used to derive factors for the proportion of N reduced from the rootzone to the coastline, and models to simulate N leaching from the rootzone have been set up for relevant

combinations of local climate data (e.g. precipitation), and N-losses from actual crop types, crop rotations and field magnament regimes (fertilisation in form of mineral and organic feertilisers, use of catch crops etc.). Finally, a simple model for the economic costs and returns have been set up for each cropping system, where the cost of reducing N leaching via changes in cropping systems can be assessed for relevant N reduction scenarios.

3. Results

As an example, a scenario has been set up for conversion from present cropping systems with cereal cash crops, winter rape, silage maize etc. to intensive fertilised grasslands harvested as feedstock for a biorefinery. In general, such grasslands has a significantly lower N leaching than the present situation, and moreover a significantly higher production potential, which in a biorefinery can be converted to fractions of livestock roughage, protein feed, and energy from biogas, thereby potentially contributing both to a higher N-use and energy-use efficiency.

Fig. 1 illustrates an example of such conversion to grasslands in a watershed to Limfjorden, a vulnerable eastuary in western Denmark, with a high concentration of agriculture and livestock production, and therefore critical needs for reduced N-losses. In this example, fields with the highest N-leaching reduction potential has been selected for conversion from present land use to grasslands for biomass production until the set N reduction target for the whole watershed has been met, and a situation where the fields have been selected based on estimated leaching from the rootzone is compared to a situation where fields have been selected based on the estimated reduction of N from each field washed out at the coastline of the eastuary, i.e. after the estimated reductions in the pathways from the field to the coast.

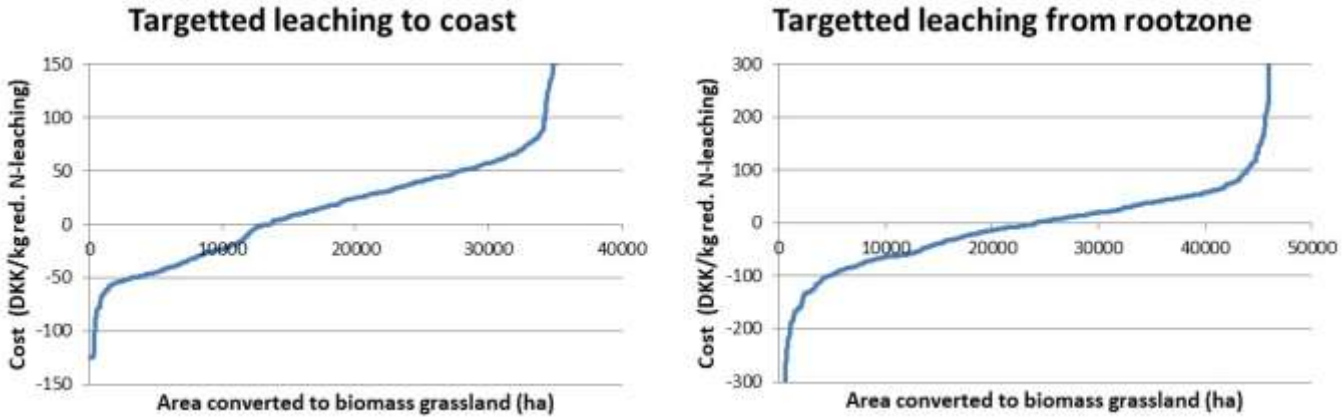

Fig. 1: Example on distribution of costs per N-leaching reduction in two scenarios for conversion of present crops to grasslands (after Børgesen et al. 2018).

4. Discussion and conclusion

Our study illustrate how new cropping systems can be an effective and cost efficient measure to reduce N-losses from agriculture, and present a system where scenarios for such conversion can be illustrated. The examplified scenarios show the importance of targetting the measure to areas with the highest reduction potential, and of taking into account the large variation in effects. Thereby, the method can be used to show where crop type conversions can be the most economic beneficial and efficiencies of different types of conversion can be compared. Procedures for the integration of local stakeholders are now being developed, and in line with Dalgaard et al. (2014) experiences from this will be developed, and recommended as a method to implement more geographically targetted N measures in Denmark.

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References

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