Integrated evaluation of changes in agriculture in view of climate, biodiversity and water goals

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Abstract

Agricultural practices are causing a diverse variety of environmental impacts such as airborne emissions of ammonia and greenhouse gases and leaching and runoff of nutrients to ground water and surface water. In order to achieve environmental goals related to ground and surface water (nutrient leaching and runoff), biodiversity (ammonia) and climate (greenhouse gases), a wide set of mitigation measures ranging from changes in feed composition, housing systems, manure application, crop and water management was defined. We evaluated the effects of those measure by using the integrated crop, soil and nutrient management model INITIATOR in view of the various environmental goals.

Keywords: Agriculture, Nitrogen emission, Climate, Modelling

1. Introduction

Agricultural practices are causing a diverse variety of environmental impacts such as (i) emissions of ammonia (NH_3) and greenhouse gases (GHG; CO_2, CH_4 and N_2O) from animal housing systems and agricultural soils and (ii) accumulation, leaching and runoff of carbon, nutrients (such as nitrogen, N and phosphorus, P) from agricultural soils to ground water and surface water. In order to achieve the goals related to the Habitats Directive (HD), Nitrates Directive (ND), Water Framework Directive (WFD) and the Paris Agreement emission goals are set, amongst others, for NH_3 emissions, N leaching and runoff and GHG emissions. We constructed a wide set of measures ranging from changes in feed composition, housing type, manure application, crop, soil and water management. We evaluated the effects of those measure by using the integrated crop, soil and nutrient management model INITIATOR (Kros et al., 2013) and checked whether a reduction of the extent of the agriculture sector is needed on top of the mitigation measure in other to achieve the environmental goals.

2. Material and Methods

For NH_3 emissions, N leaching and runoff and GHG emissions, we set goals related to current policies (CP) and for achieving full compliance in view of national and international agreements (FC), implying no exceedances of critical nitrogen concentrations in surface waters and critical nitrogen loads on nature areas and climate neutrality. For both goals two alternatives were made: intensive/high tech farming and extensive farming, leading to four scenarios, while focusing on the year 2050. We quantified the reduction potential of the measures and linked those to the four scenarios, depending on the character of the measure

and the scenario. E.g. the measure precision agriculture is linked FC-High Tech, whereas diversifying crop rotation is linked with FC-Extensive. We also calculated the reduction in animal numbers, if needed, on top of the measures in order to achieve the emission goals by using an optimization procedure.

3. Results and Discussion

The derived emissons are illustrated in Fig. 1. Results show that for almost all scenarios the GHG goals are most stringent. For the CP-Intensive and FC-High tech scenarios we calculated that most of the goals are achieveble with no or slight reduction (<10%) in animal numbers. For the CP-Extensive and FC-extensive goals larger reduction in animal numbers are inevitable.

It was assumed that all measures are fully implemeted and effictive. This requires, however, a full commitment and huge investments. It is therefore not likely, that all measure will be implemeted. The results of this study only provide an explorative outlook on the transition needed in agricultural to comply with agreed emission goals.

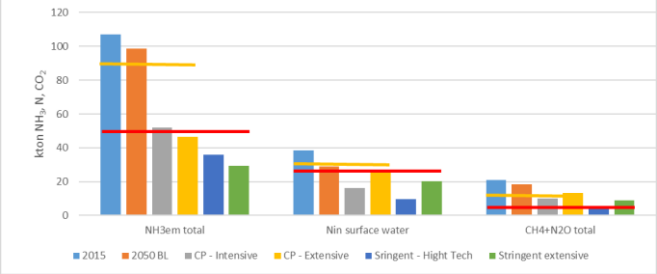

Fig. 1: Calculated total fluxes NH_3 emission (kton NH_3), N leaching and runoff (kton N) and GHG emission (CH_4+N_2O; kton CO_2), for the current situation (2015), Baseline 2050 and the four scenario for 2050 together with the current policy ceilings (orange line) and full compliance ceiling (red line).

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References

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