The Nitrogen footprint of European food production

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1. Background & Objectives

There are increasing concerns about the ecological footprint of global food production. Research shows that high rates of meat and dairy consumption in human diets could have adverse effects on the environment, through losses of reactive nitrogen. Lowering of meat and dairy consumption could have various beneficial effects, including a substantial lowering of the societal cost for mitigation of NH_3 and greenhouse gas emissions. Firstly, we assessed the Nitrogen (N) footprint for twelve agricultural food commodities, of which six are animal products (dairy, beef, pork, eggs, poultry and lamb and mutton) and six crop products (cereals, potato, fruit and vegetables, sugar, vegetable oils and pulses) in the EU-27. Secondly, we assessed the total reactive N emissions for scenarios in which a reduction in consumption of animal products and proportional reduction in animal numbers were simulated for the EU-27.

2. Materials & Methods

The MITERRA-Europe model was used to calculate N emissions from agriculture following a life-cycle approach to the farm-gate. MITERRA-Europe (Velthof et al., 2009; Lesschen et al., 2011) is an environmental assessment model that calculates annual nutrient flows and GHG emissions from agriculture in the EU-27. Main input data were derived from CAPRI (crop areas, livestock distribution, feed inputs), GAINS (animal numbers, excretion factors, NH_3 emission factors), FAO statistics (crop yields, fertilizer consumption, animal production) and IPCC (CH_4, N_2O, CO_2 emission factors). NH_3, N_2O, NO_x emissions and N leaching and runoff were calculated from the following sources: housing and manure management, application of manure and mineral fertilizers, deposition of manure by grazing animals, use of fossil fuels, manufacture of mineral fertilizer, indirect N_2O emissions from atmospheric volatilization and leaching and cultivation of organic soils. The N footprint is expressed as the sum of these reactive N emissions on a per kg product basis. We assessed a 25% and 50% reduction in 1) beef and dairy and 2) pig, poultry and egg consumption and production and the combination of these two scenarios. For the reduction in feed intake we first reduced the amount of imported feed (mainly oil meals), whereas the cereal use was adjusted to match the remaining energy demand. Reductions in fodder intake were mainly obtained by conversion of temporary grassland and fodder maize areas into cereals. Crop production is no longer used in EU-27, as feed or additional food, is assumed to be exported.

3. Results & Discussion

Figure 1 shows the N footprint for the 12 food commodities. Total reactive N fluxes are about 200 g N per kg product for ruminant meat, about 50 g N per kg product for pork and poultry meat and about 15 g N per kg product for dairy products. The differences are smaller when expressed on a per kg protein basis. All crop products have (much) lower total fluxes of reactive nitrogen than animal products. N leaching and runoff and NH_3 emissions are the main losses of reactive N. Among EU countries there is a large variation in the N footprint, although this is lower for crop production compared to animal production.

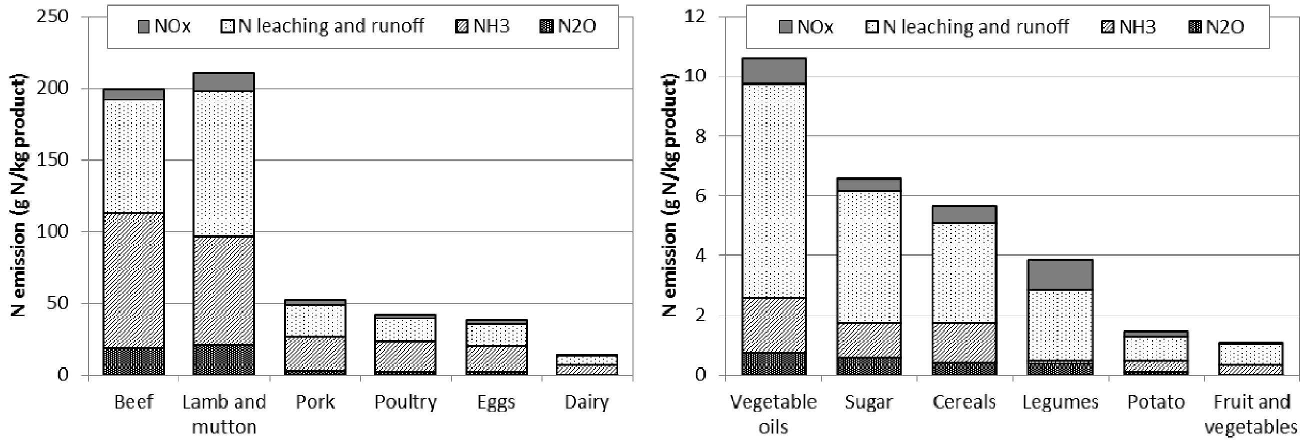

Figure 1. N footprint for six animal products and six crop products for the EU-27

In Figure 2 the reduction in reactive N emissions is shown for the different scenarios. A reduction in beef and dairy consumption and the consequent decrease in cattle numbers results in a greater % reduction in emissions compared to a reduction in pigs and poultry. The largest effect is on NH_3, since N_2O and N leaching and runoff are reduced less due to continuing emissions from the arable sector.

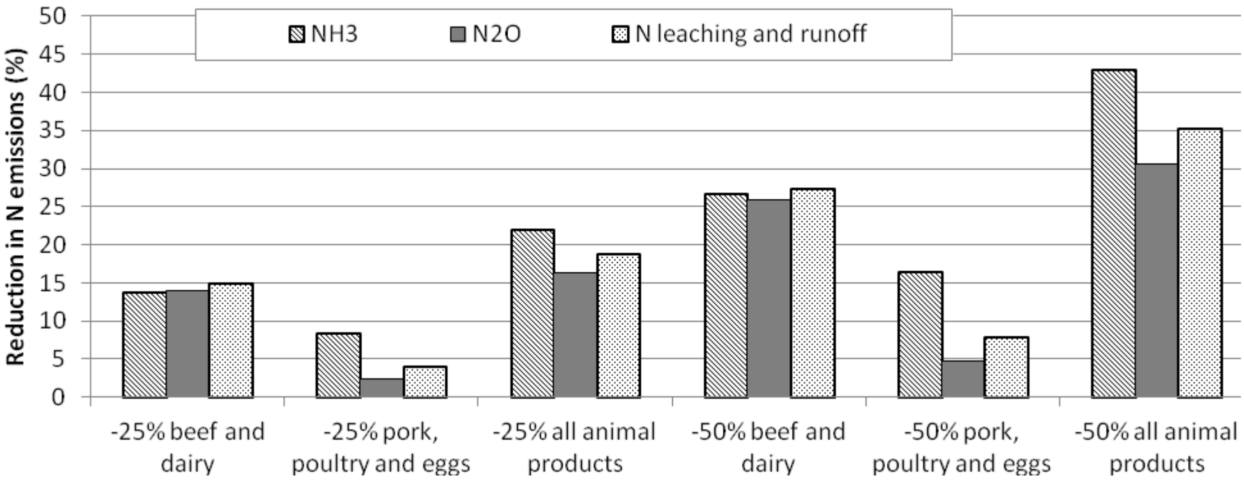

Figure 2. Reduction in EU-27 total NH_3 and N_2O emission and N leaching and runoff for different scenarios with reduced consumption of animal products

4. Conclusion

Our study shows that there are large differences in the N footprint between food commodities. A decrease in consumption of animal products and a proportional reduction in animal numbers can result in a large reduction in reactive N emissions in the EU-27.

References

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Velthof G.L., Oudendag D., Witzke H.P., Asman W.A.H., Klimont Z., Oenema, O. 2009. Integrated assessment of nitrogen emissions from agriculture in EU-27 using MITERRA-EUROPE. J. of Environ. Quality 38, 402-417.