Ammonia and Nitrate Losses from Agriculture and Their Effect on Nitrogen Recovery in the EU and U.S.

Producing more food with less nitrogen (N) pollution is a major challenge for both the U.S. and European Union (EU), and it was the topic of a meeting in Kansas City in August 2013 looking at opportunities to improve N use efficiency in crop and livestock agriculture. While the meeting was on U.S. agriculture, the European case was also considered because of contrasting approaches for reducing environmental problems associated with N from agriculture. Out of this conference came 14 articles published as a special section in the March–April 2015 issue of the Journal of Environmental Quality.

Whereas the EU approach to reduce N pollution by agriculture mostly relies on a regulatory approach, the U.S. has a tradition of voluntary and incentive-based schemes. Core environmental instruments employed by the EU approach are coded into the Nitrates Directive and the National Ceilings directive for ammonia, which provide both environmental targets and impose measures (like a ceiling on the use N in animal manure) or install more or less binding best management practices for applying manure and fertilizer to reduce N runoff and emissions of ammonia. Although the term “directive” suggests otherwise, EU member states have considerable freedom to customize and implement these directives.

Since the 1980s, the EU approach has been successful in decreasing emission of ammonia, N surpluses, and N loads to rivers. However, environmental targets to protect terrestrial and aquatic ecosystems are not yet within reach. In the U.S., public awareness of N pollution issues from agriculture arose at about the same time as in Europe. As a result, the 1980s gave rise to environmental quality standards for N compounds in air and water in the U.S. that were similar those in the EU. However, to a lesser extent than in the EU, N mitigation measures were imposed and more emphasis placed on extension education and outreach.

In this special section in the Journal of Environmental Quality, in order to analyze and compare the agricultural N budgets for the EU and the U.S., researchers used the PBL global IMAGE model to reconstruct the N history from 1900–2005 and to generate scenario results for 2050. IMAGE representation of U.S. agriculture and policies were improved by collaboration with U.S. colleagues, which provided insight about the U.S. N budgets and effectiveness of policies. IMAGE results show that U.S. agriculture has managed to halt the increase in N surplus in the 1980s, and on average, surpluses for arable land are now similar to those in the EU (around 30 kg N/ha). Average N surpluses for total agriculture in the U.S. are still considerably lower than in the EU in view of presence of the huge area of extensive grassland in the U.S.

The question of whether reduction of agricultural N pollution is best achieved by regulatory or voluntary policy schemes is confounded by initial starting conditions. For example, it can be argued that the EU needed greater reliance on regulatory measures because nutrient surplus problems during the 1970s and 1980s were more severe in the EU than in the U.S. A marked difference between the U.S. and the EU is that ammonia is not regulated at all in the U.S. As a result, ammonia emissions in the U.S. still increase although they are only half as large as in the EU on a per-hectare basis. Despite differences in agro-environmental policies and structure of agricultural sectors between the EU and U.S. (e.g., more N-fixing soybean and more spatially separated feed and livestock production in the U.S. than in the EU), current N use efficiency in U.S. and EU crop production is similar.

Models like IMAGE are useful tools to analyze future scenarios. To make such scenario analyses meaningful, however, model outputs should be validated against empirical and census data. The researchers in this study were able to do so for N budgets, ammonia emissions at EU country and U.S. state spatial scales, as well as for N loads in the Rhine and Mississippi basins. Agreement between IMAGE estimates and the empirical/census data were reasonably good. Future projections from IMAGE indicate that N loading to the environment in 2050 will be similar to current levels, but in the U.S., this occurs with a 30% increase in agricultural production relative to 2005 as compared with an increase of 8% in the European Union. So the U.S. is expected to make significant progress in the challenge to produce more food with less N pollution. However, even rigorous mitigation assuming maximum recycling of manure N and a 25% reduction in fertilizer use will not achieve the policy targets to halve N export to the Gulf of Mexico.

The authors conclude that both the U.S. and the EU will therefore encounter continued challenges to meet the combined ambition of delivering food security and healthy ecosystems because current technology options are not adequate to achieve policy targets with regard to water quality.

Adapted from van Grinsven, H.J.M., L. Bouwman, K.G. Cassman, H.M. van Es, M.L. McCrackin, and A.H.W. Beusen. 2015. Losses of ammonia and nitrate from agriculture and their effect on nitrogen recovery in the European Union and the United States between 1900 and 2050. J. Environ. Qual. 44(2). View the full article online at http://dx.doi.org/doi:10.2134/jeq2014.03.0102