Findings and Recommendations: Nr Mitigation in Crop Agriculture
(Drafted by Cassman April 11)

Findings:

1. Crop agriculture receives ~75% (~Tg amount as fertilizer application) of USA annual new Nr creation and accounts for 58% (7.6 Tg) of total USA Nr losses from terrestrial systems to air and aquatic ecosystems
2. Nr inputs to crop systems are critical to sustain crop productivity and soil quality, for example, soil carbon sequestration in stable soil organic matter requires Nr input in excess of Nr removal in harvested yield.
3. Improving the N uptake efficiency from applied fertilizer (i.e. the proportion of applied N actually taken up by the crop) is the most sensitive "choke-point" for reducing Nr losses and associated negative impact on environmental services.
4. Given limited land and water resources, global population growth and rapid economic development in the world's most populous countries, the challenge is to both sustain (or even accelerate) increases in crop yields on existing farm land while also achieve a substantial increase in N fertilizer uptake efficiency.
5. Current N fertilizer uptake efficiency achieved by farmers is <50% for most crops and cropping systems, which leaves 50% of applied N at risk of loss, but this estimate is highly uncertain due to lack of data based on direct measurements from production-scale fields and results from small-scale research plots cannot be scaled up with any confidence.
6. Current monitoring of fertilizer use statistics by federal agencies is inadequate to accurately track trends in quantities of N applied to major crops and the geospatial pattern by major watersheds.
7. Integrated N management using a suite of currently available technologies should make it possible to increase average N fertilizer uptake efficiency to about 63% (i.e. 25% improvement compared to current average) although adaptive research is needed to fine-tune these options for different crops, soil type, and climatic conditions); Further increases to 70-80% of applied N will require development of new technologies and their integration into sophisticated crop management systems, as well as policies to facilitate adoption (e.g. use of higher cost controlled release N fertilizer which has not been cost-effective on major commodity crops like corn).

Recommendations

1. Improve detail and regularity of data acquisition for fertilizer use by major crop (and for urban residential and recreational turf) and county (or watershed) to better inform decision-making about policies and mitigation options for nitrogen in these systems.
2. *Improve estimates of N fertilizer uptake efficiency for the major N-using crops and cropping systems based on direct measurements from a representative range of production-scale farmer's fields to help guide prioritization of risk mitigation strategies.*
3. *Improve loss estimates of NH3, NOx, nitrate leaching, and N2O; improve estimates of total N storage (or loss in soils coupled with organic carbon); estimates of where the N goes (most losses are currently attributed to denitrification in soils and water),*

and better identify the loss mechanisms from soil(e.g. is denitrification the major loss mechanism or are loss estimates too large?

4. Work closely with USDA, DOE, NSF to help identify research and education priorities for prevention and mitigation of Nr applied to agricultural systems.
5. Research needed on the challenge of BOTH accelerating the rate of gain in crop yields on existing farm land while substantially increasing N fertilizer uptake efficiency.
6. Policies needed to promote the use of “smart” fertilizers in commodity agriculture.