Cornell University

Nitrogen Fertilizer Management & Greenhouse Gas Mitigation Opportunities

Information Sheet #5 – OVERVIEW

Peter Woodbury & Jenifer Wightman
Soil and Crop Sciences Section, School of Integrative Plant Science
College of Agriculture and Life Sciences, Cornell University

FAST FACTS

- **Impacts**: Nitrogen fertilizer is critical for crop production but applying too much at importune time reduces profitability and increases water pollution, air pollution, and greenhouse gas (GHG) emissions.
- **An imperative to act:** A fraction of the nitrogen in fertilizer or manure is lost from soils in the form of nitrous oxide gas, a much more potent greenhouse gas than carbon dioxide.
- **A concern for implementation:** Farmers often apply extra nitrogen as 'insurance' to ensure highest yield, but this practice reduces profits and causes unnecessary water pollution and GHG emissions.
- **An opportunity for proactive change:** Applying nitrogen fertilizer using the right source, right rate, right time, and right place increases crop yield and profitability. These management practices can also greatly reduce greenhouse gas emissions while improving profitability.

The three most important agricultural greenhouse gases (GHGs) are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) (see Information Sheet #1). Nitrous oxide is 298 times more potent than carbon dioxide and is a very important GHG emitted from field crops. For example, 61% of GHG emissions from corn production are from N_2O and production of nitrogen (N) fertilizer (Wightman and Woodbury 2015). Nitrous oxide is a gas produced naturally by soil microbes. Much more N_2O is produced when there is abundant nitrogen in the soil, such as after application of manure or synthetic nitrogen fertilizer. Improving nitrogen fertilizer management is one of the most effective GHG reduction strategies that farmers can adopt (Snyder et al. 2009). This information sheet explains how good management of nitrogen fertilizers can reduce N_2O emissions from crops.

ENVIRONMENTAL CONCERNS

Society expects agriculture to produce food in a manner that maintains environmental quality. Manure and nitrogen fertilizer management is very important for soil, water, and air quality. Agricultural practices affect nutrient cycling. For example, some practices can cause nutrient leaching to nearby streams and groundwater, and volatilization to the atmosphere. For more information about such impacts other than GHG emissions, see AEM Information Sheet on Nutrient Management.

SUMMARY OF REGULATION OF GHG EMISSIONS

While there are regulations on GHG emissions from the electric sector, there are no regulations of GHG emissions from agriculture. However, for confined animal feeding operations (CAFOs), there are regulations about nutrient management (see Information Sheet #1, Information Sheet #2, and AEM Information Sheet on Nutrient Management).

GOAL

This Information Sheet is intended to help educators and technicians assist farms in navigating voluntary methods for reducing GHG emissions from nitrogen fertilizer management.

SUMMARY OF POTENTIAL GHG MITIGATION PRACTICES

Description of BMP	Opportunities	Considerations
Develop a comprehensive nutrient management plan (CNMP).	A **comprehensive nutrient management plan** (CNMP) can help prevent erosion, water contamination, air contamination, and GHG emissions.	It can be challenging to account for nutrients from prior application of manure, residues, compost, cover crops, and crop rotations and any other soil amendment. The CNMP must also be kept up to date with changes in livestock numbers, cropping systems, and management practices, including manure management and livestock feed.
Optimize N fertilizer source.	Using the appropriate chemical form and formulation increases crop N use efficiency and reduces losses.	Cost, availability, and logistics limit practical choices of fertilizer source. Coatings or inhibitors are expensive and not always effective.
Optimize N fertilizer placement.	Incorporating fertilizer into soil can reduce losses due to volatilization, particularly of ammonia.	Placing fertilizer at depth or in bands can in some cases increase N_2O losses, particularly if timing, source, and rate are not optimal.
Optimize N fertilizer timing.	Applying most N fertilizer as a side-dressing reduces N_2O and increases yield.	Fertilizer requirements vary among years but use of an adaptive in-season N rate helps manage this variability.
Optimize N fertilizer rate.	Using appropriate source, placement, and timing reduces the total rate, reducing N losses including N_2O.	Fertilizer requirements vary among years, but use of an adaptive in-season N rate and timing can help manage this variability.
Reduce use of synthetic N fertilizer.	Creating synthetic nitrogen fertilizer requires lots of energy and emits GHGs, so reducing its use reduces GHG emissions upstream of your farm.	Synthetic N fertilizer is valuable and useful as part of a comprehensive nutrient plan.
Use appropriate crop rotations.	Crop rotations can increase yields and profitability, and if legumes are included, reduce N fertilizer requirements.	Farm management and marketing may limit the choices of profitable and appropriate crop rotations.
Use a winter cover crop for annual crops.	Cover crops reduce nitrate in soil and reduce erosion, N leaching, and N_2O emission, but must account for N availability from cover crop for subsequent crop.	Cost and logistics may be challenging for both planting and plow-down of cover crops.

Funders: This work was supported in part by the USDA National Institute of Food & Agriculture Project 2011-67003-30205, Hatch Projects 223995 and 1004302, and by the NYS Soil & Water Conservation Committee's Climate Resilient Farming program.

More In Depth Information is available at: http://blogs.cornell.edu/woodbury/publications/