Stewardship SPECIFICS

No. 19

Nitrous Oxide: Reducing Emissions From Fertilizer and Manure Nitrogen

Whenever a source of nitrogen (N) is added to soil, it almost always results in a loss of some nitrous oxide (N_2O) into the atmosphere due to natural soil microbial processes (nitrification and denitrification). On average, 1% of the applied N may be directly lost to the air as N_2O, but the magnitude of the loss can vary greatly.

Nitrous oxide:

- is a colorless, odorless gas and one of the three major greenhouse gases which include carbon dioxide (CO_2) and methane (CH_4).
- has a global warming potential, or radiative forcing potential, roughly 300 times greater than that of CO_2 on an equivalent mass basis.
- concentrations in the atmosphere have increased from 270 parts per billion (ppb) in pre-industrial times to >324 ppb.
- is now the world's leading ozone-depleting substance in the stratosphere; surpassing chlorofluorocarbons (CFCs). Ozone depletion increases exposure to ultraviolet light, which may pose possible health issues, including increased risk of skin cancer.

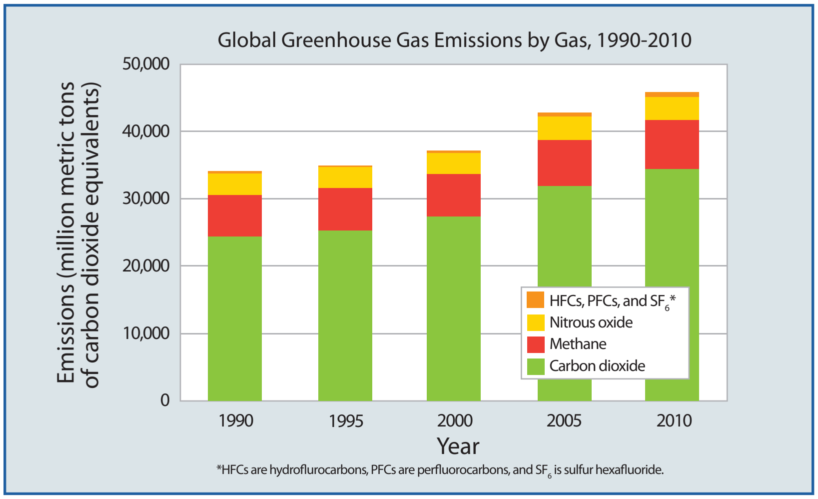

Figure 1. Global emissions of greenhouse gases, 1990-2010. **Source:** http://www.epa.gov/climatechange/science/indicators/

Emissions of N_2O represent <8% of the global CO_2–equivalent (CO_2-e) emissions of greenhouse gases, while CO_2 accounts for about three-fourths of those CO_2-e emissions (**Figure 1**).

Nitrous oxide emissions from oceans, wetlands, and uncultivated land account for about 67% of total emissions. Human sources of N_2O include soil receiving fertilizer or manure N, fossil fuel combustion, and various industrial activities. The human sources of N_2O are about 33% of the total global emissions, and agriculture contributes about 66% of those human sources.

The good news is that by using careful N fertilizer and manure management, combined with appropriate soil and cropping system conservation practices, losses of N_2O from agricultural soil can be greatly reduced. Research has clearly shown that 4R nutrient management practices (right source at the right rate, time, and place) can improve crop recovery of applied N and significantly lower N_2O emissions from fertilized land. Some of the 4R techniques to minimize N_2O emissions include keeping fertilizer N in the ammonium form after application as long as possible (source), avoiding a surplus of fertilizer in excess of plant demand (rate), applying fertilizer as close to the time of plant uptake as possible (time), and placing N close to growing roots and avoiding use of nitrate fertilizers in wet and waterlogged soils (place). These and additional techniques will optimize the agronomic and economic benefits of added fertilizer while minimizing the risks for N_2O emissions and accumulation of nitrate in the soil.

Progress is being made to reduce N_2O emissions from agricultural land. For example, global consumption of fertilizer N has increased by 36% since 1990 (based on IFADATA, 2014), but N_2O emissions have grown the least (9%) among the principal greenhouse gases.

It is possible to improve crop recovery of applied N and reduce the risks for environmental N losses through careful soil and crop management, and a keen understanding of N loss pathways.

FOR FURTHER READING:

IPNI. 2012. 4R Plant Nutrition Manual. International Plant Nutrition Institute. (link to manual and other 4R resources: http://www.ipni.net/4R).

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UNEP. 2013. http://www.unep.org/pdf/UNEPN2Oreport.pdf

U.S. EPA. 2012. Summary Report. EPA 430-S-12-002. http://www.epa.gov/climatechange/Downloads/EPAactivities/Summary_Global_NonCO2_Projections_Dec2012.pdf

World Resources Institute. 2014. CAIT 2.0. http://cait2.wri.org/wri/Country%20GHG%20Emissions?indicator[]=Total%20CH4&indicator[]=Total%20N2O&indicator[]=Total%20F-Gas&indicator[]=Total%20GHG%20Emissions%20Including%20LUCF&year[]=2011&sortIdx=3&sortDir=desc&focus=&chartType=geo)

INTERNATIONAL PLANT NUTRITION INSTITUTE

3500 Parkway Lane, Suite 550
Peachtree Corners, Georgia 30092-2844 USA
Phone (770) 447-0335
www.ipni.net

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