IPNI Stewardship SPECIFICS

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Crop Fertilization and Greenhouse Gas Emissions

Fertilization with plant nutrients, including both organic and inorganic sources, accounts for over half of crop production around the world. In some countries, up to 75% of total production is the result of proper nutrient use. Proper fertilizer use is essential if farmers are to continue to grow sufficient amounts of nutritious, affordable food to meet the needs of a growing world population. Without an adequate supply of plant nutrients, billions of people could face starvation.

All nitrogen (N) sources—fertilizer, manure, biologically fixed N—can also impact environmental quality by returning certain global warming gases back to the atmosphere. The three gases of primary concern are nitrous oxide (N_2O), methane (CH_4), and carbon dioxide (CO_2). Each of these gases is very important in their proper place. For example, N_2O is a valuable anesthetic (laughing gas), CH_4 is a valuable fuel source (natural gas), and CO_2 is essential for photosynthesis. In agricultural settings, farmers are working to limit the uncontrolled release of these gases from their fields to avoid changes in the atmosphere.

All forms of N fertilizers, as well as N-containing materials such as crop residue and manure, have the potential to release N_2O gas to the atmosphere. Nitrous oxide gas is released from the soil as it escapes from bacteria while they are converting various N compounds for their growth. Direct loss of N_2O from fertilizer is often less than 1% of the total N applied. Other factors, such as cropping systems, soil management, and unpredictable rainfall can have a much greater influence on N_2O losses than do the various inorganic N fertilizer sources. Applying the N fertilizer at the right rate and at the right time will keep N_2O losses to a minimum.

Liquid manure often has much greater rates of N_2O loss than fertilizer. In one southeastern U.S. study where high rates of liquid manure were applied to soil, denitrification rates were between 10 to 100 times higher than when only inorganic N fertilizer was applied. Denitrification is a key step in the production of N_2O gas in the soil and, thus, its loss to the atmosphere. Losses of N_2O from manure are often greater than from fertilizer because they commonly contain soluble carbon (C), which is used by microbes as an energy source.

Methane gas is also associated with agriculture, but the major sources are from ruminant animals, livestock manure, wetlands, and rice production. Very little is directly associated with crop fertilization.

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Carbon is a part of soil organic matter. Increased biomass production helps capture more CO_2 from the atmosphere, maintains and restores soil organic matter, and results in lower emission of CO_2 gas.

Careful fertilizer management can help to eliminate most associated losses of the global warming gases. High yields of efficiently produced crop can actually contribute to a drop in the production and release of global warming gases, especially per unit of food produced. As crop yields increase with appropriate plant nutrition, more biomass is produced, resulting in the maintenance and buildup of soil organic C. Carbon is a component of soil organic matter, and holding it in organic form prevents its release as CO_2 to the atmosphere.

Although crop fertilization has the potential to contribute to the emission of global warming gases, proper cropping system and nutrient management minimizes their release from soil, while significantly increasing the amount of food grown worldwide. **Farmers and scientists are working in partnership to stop these losses from their fields by applying the right nutrient source, at the right rate, time and place (4R Nutrient Stewardship).**

FOR FURTHER READING:

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Snyder et al. 2009. Agriculture, Ecosystems and Environment 133: 247-266.

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