Answering the Call:

Practices that Improve the Balance of Greenhouse Gases

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"**AGRICULTURE** has a great opportunity to help mitigate climate change by stashing carbon dioxide as carbon in soil and vegetation. Practices requiring good agricultural husbandry, which should be implemented anyway, can be quite effective for sequestering carbon. For cropland, these practices include building soil organic matter levels, improving soil fertility, and growing more food on less land."

Dr. C.E. Hess, Former Assistant Secretary of Agriculture for Science and Education

- U.S. crop production assimilated 1.6 billion tons of carbon dioxide (CO_2) in 1992. This total will increase as yields increase.
- North American grain farms are now thought to be a net sink for CO_2 through carbon (C) sequestering in soils.
- Agricultural soils contribute an estimated 11 percent of the annual nitrous oxide (N_2O) emissions worldwide.
- In the U.S., nitrogen (N) fertilized crops are estimated to contribute 3.5 percent of the 4.4 million tons N_2O emitted annually.
- North American grain farmers are adopting N management technologies that increase the efficiency and decrease the losses via denitrification.

Gases such as CO_2, N_2O and methane (CH_4) are labeled greenhouse gases because they absorb the long-wave invisible solar radiation as glass absorbs radiation in a greenhouse rather than allowing the heat to be radiated away from the earth. A steady enrichment of the atmosphere by greenhouse gases is suggested to cause global warming. While agriculture is considered a minor source of these gases, policy debates tend to target agriculture as a major factor.

Carbon Dioxide

Fixation of CO_2 by photosynthesis is the ultimate source of organic C in soils. Crop production practices that enhance photosynthetic activity and help retain the sequestered C in soils can reduce atmospheric CO_2 and any effects that it might have on global warming. Estimated CO_2 assimilated, oxygen (O_2) released, and the potential C levels available for sequestering in soils are shown in **Table 1**.

Table 1. Estimated carbon dioxide assimilated, potential carbon levels available for sequestering, and oxygen released by U.S. crop production in 1992.

Crop	Total production grain + residue (DM)[1]	Carbon dioxide assimilated	Total carbon in residue	Oxygen released
		million tons		
Corn	448	739	101	537
Wheat	160	264	43	192
Soybeans	143	236	39	171
Grain sorghum	38	63	9	46
All other crops	176	290	40	211
Total	965	1,592	232	1,158
Fertilizer contribution	338	557	81	405

[1]Root dry matter (DM) would add to these totals, but has not been included.

Past estimates have shown U.S. agriculture to have a relatively small negative CO_2 balance, emitting about 150 million tons annually. This compares to an estimated total emission from all sources in the U.S. of 4.9 billion tons CO_2. The major factors considered in net CO_2 losses from agriculture are fossil fuel burning and electricity uses.

Estimated CO_2 emission from agriculture is dwarfed in comparison by the almost 1.6 billion tons CO_2 assimilated by the major crops grown in the U.S. in 1992. The positive CO_2 assimilated value for the major crops produced will increase further as crop yields continue to increase.

In the past, the amount of CO_2 assimilated by production agriculture has not been included in global analyses because it has been assumed that CO_2 assimilation and emission levels from the soil/vegetation complex (including forests, range, grasslands . . . all vegetation) are equal. Some recent estimates indicate that U.S. agriculture may now be a net CO_2 sink. This positive indication seems more likely because of the tremendous contribution from production agriculture.

Nitrous Oxide

Biological denitrification is believed to be the major source of N_2O. The energy for this reaction and a prerequisite for the process is a readily available supply of organic materials. Denitrification proceeds most rapidly in soils with a limited O_2 supply.

It is estimated that agricultural soils, on a global scale, contribute approximately 11 percent to the total atmospheric N_2O level. Non-agricultural soils contribution is estimated to be 43 percent. The total U.S. N_2O emission, from all sources, is estimated at 4.4 million tons per year.

An approximate value of the N fertilizer used in agriculture escaping as N_2O is 1.84 percent, although the range for this value estimate is very large. It is difficult to be very precise because actual N_2O emissions are greatly affected by soil type, soil temperature, type of crop grown, type of fertilizer used, method of fertilizer placement, timing of fertilizer application and other factors. Based on the estimated amount of N used for crop production in the U.S. (8.55 million tons in 1992), and the 1.84 percent loss approximation, then 156,000 tons N_2O would have been emitted from fertilized crops. This value is about 3.5 percent of the 4.4 million tons N_2O emitted from all sources in the country.

Grain producers, along with help from the fertilizer industry, are adopting crop production practices which reduce current levels of N_2O emission. Modern fertilizer application equipment has the ability to place N fertilizer below the soil surface and at a time for optimum plant uptake.

Other developments include the use of nitrification inhibitors. These compounds inhibit the activity of soil bacteria which convert ammonium to nitrite. Effective use of inhibitors extends the time N fertilizer sources are held available in the ammonium form for crop use. In addition, agronomic best management practices such as soil N and tissue testing, balancing phosphorus (P) and potassium (K) and other nutrients with N, optimum plant populations, earlier planting dates, and more careful selection of varieties and hybrids are being adopted to improve N use efficiency and diminish the level of denitrification.

Legumes, animal manures and sewage sludge can all contribute N_2O to the atmosphere in levels equal to, or greater than, commercial fertilizer. On a per acre basis, soil N from legumes contributes more N_2O to the atmosphere than do commercial fertilizers.

Methane

Methane is produced during microbial decomposition of organic materials under strict absence of O_2. Two major sources associated with soils are paddy rice production and natural wetlands. There is little CH_4 production associated with commercial fertilizer use. The replacement of commercial fertilizers with animal manures or legumes

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percent of moisture above 15.5. The addition of P reduced drying costs an average of 10¢/bu, **Figure 3**. At the optimal N rate, the drying cost was 24¢/bu without fertilizer P compared to 14¢/bu with fertilizer P.

The economic benefit from fertilizer P was calculated as the difference in net revenue at each N rate with and without P. Net revenue was calculated as gross revenue less drying and fertilizer costs. As shown in **Figure 4**, the economic benefit from P varied with corn prices and ranged from about $125/A with a corn price of $1.75/bu to over $200/A with a corn price of $2.75/bu.

The economic benefit from fertilizer P is twofold: it increases yield and decreases drying costs. Phosphorus increased grain yields by 80 bu/A and reduced drying costs by 10¢/bu. Based on a corn price of $2.25/bu, P fertilization increased net revenue by about $170/A.

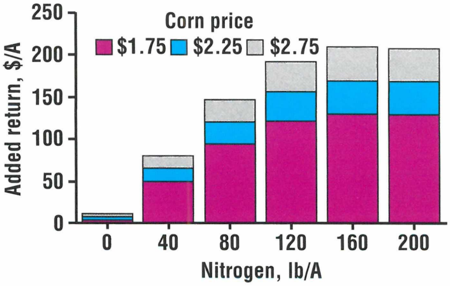

Figure 4. Phosphorus increases economic returns.

In addition to the direct economic benefit of fertilizer P, there are intangible benefits of corn maturing faster, such as: timeliness of field operations, reduced crop lodging, and increased marketing flexibility. It is important that these benefits of P are not overlooked. ■

WHEN adequate P is supplied, corn may mature 7 to 10 days earlier. Notice in this photograph with P applied that the shucks have already turned brown and plant drydown is advancing.

WITHOUT adequate P, plant maturity is significantly delayed. This photograph shows that P-deficient corn still has green leaves, stalks and shucks.

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as an alternate N source would have a negative effect on CH_4 emission levels, that is, more CH_4 would be emitted into the atmosphere.

Atmospheric CH_4 has been increasing 1 percent per year. The contribution from U.S. agriculture is estimated to be 7.7 million tons, or about 14 percent of total U.S. emissions. While it is estimated that rice paddies contribute 28 percent of the world's CH_4 emissions, the amount from this source in the U.S. is negligible. Ruminant animals are a large contributor of CH_4. Methane production from ruminant animals is still increasing on a global basis, but in the U.S. it is believed to be decreasing as animal production efficiency increases. ■