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Research Shows Soybeans Provide Consistent Reduction in Nitrous Oxide Emissions

BY MICHAEL CASTELLANO

The opportunity for farmers to profit from reductions in greenhouse gas emissions has resurfaced. The Climate Trust and Delta Institute are partnering to verify and purchase greenhouse gas reduction credits from upper Midwest corn farmers. Credits result from modified farming practices that reduce emissions of the greenhouse gas nitrous oxide (N_2O) from surface soils by improving nitrogen fertilizer use efficiency.

Although agriculture accounts for a relatively small proportion of total U.S. greenhouse gas emissions, approximately 2/3 of U.S. greenhouse gas emissions from the agricultural sector are due to N_2O that is emitted from nitrogen fertilizer applications. With a warming potential of about 300 times that of carbon dioxide (CO_2), nitrous oxide is among the most effective heat trapping gases in the atmosphere. Reductions in nitrogen fertilizer inputs reduce N_2O emissions. However, farmers and greenhouse gas trading programs require N_2O reduction strategies that maintain or increase yield.

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With the potential for farmers to cash in on emissions reductions, researchers with CSCAP have been testing the magnitude and consistency of several N_2O reduction strategies. There is a positive relationship between nitrogen fertilizer application and N_2O emissions. The first step in reducing N_2O emissions is to ensure that N fertilizer inputs do not exceed the profitable rate. In Iowa, this would be approximately 176–201 pounds of nitrogen per acre for corn following corn and 122–146 pounds of nitrogen per acre for corn following soybeans.

Research from the Sustainable Corn project has shown that soybeans provide a consistent reduction in N_2O emissions, largely independent of the nitrogen fertilizer input to corn in the preceding year. Three years of research demonstrates that N_2O emissions from the soybean year (without nitrogen fertilizer inputs) of a corn-soybean rotation are typically 30–60 percent lower than N_2O emissions from the corn year of the rotation (when corn receives Iowa State University extension-recommended nitrogen fertilizer inputs). Moreover, nitrogen fertilizer inputs to the corn year in excess of profitable rates do not consistently increase N_2O emissions from the following soybean crop. Only in 2013, the year following the drought of 2012, were N_2O emissions from soybeans affected by the amount of nitrogen fertilizer inputs to the previous corn crop. These results suggest inclusion of soybeans in the cropping system is a simple, effective, and relatively consistent way to minimize agricultural N_2O emissions.

In addition to examining the potential for soybeans to contribute to lower agricultural sector greenhouse gas emissions, we have investigated the potential for cover crops to reduce N_2O emissions. In Iowa field experiments, no consistent effect of a winter rye cover crop on N_2O emissions from corn or soybeans in a corn-soybean rotation was found. In general, the effect of cover crops on N_2O emissions was observed to be highly variable. To understand why cover crops sometimes increase, decrease or have no effect on N_2O emissions, published studies were analyzed. What we found is that leguminous cover crops have more potential to increase N_2O emissions than non-leguminous cover crops. Also, incorporation of the cover crop into the soil may increase N_2O emissions. However, these analyses do not provide a complete picture of the cover crop effect on nitrogen fertilizer use efficiency or environmental losses of nitrogen fertilizer. And when considering all environmental goals of an operation it's important to know that, in contrast to N_2O emissions from the soil surface, cover crops consistently reduce nitrate leaching by a wide margin — in the range of 30 to 60 percent. Some of the nitrate that is lost downstream is eventually transformed to N_2O. Accounting for this transformation process will be an important goal of future Sustainable Corn Project work as we broaden our understanding of cover crop effects on yield, nitrate leaching and N_2O emissions.

Nitrogen fertilizer rate and climate are the two dominant factors affecting N_2O emissions. Science-based strategies that recognize and explain these sources of variability can provide farmers with cost-effective practices to reduce N_2O emissions while potentially earning credits for these reductions through new climate-based trading programs.

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^ GHG measurement locations in corn.

Nitrogen fertilizer rate and climate are the two dominant factors affecting N_2O emissions.

^ Installing photoacoustic spectrometer in soybeans to measure greenhouse gases.

^ Measuring N_2O with a photoacoustic spectrometer.