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Global warming – agriculture's impact on greenhouse gas emissions

Eugene Takle
Iowa State University, gstakle@iastate.edu

Don Hofstrand
Iowa State University, dhof@iastate.edu

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Global warming – agriculture's impact on greenhouse gas emissions

by Eugene Takle, Professor of Atmospheric Science and Professor of Agricultural Meteorology, 515-294-9871, gstakle@iastate.edu (pictured, left) and Don Hofstrand, value-added agriculture specialist, co-director AgMRC, Iowa State University Extension, 641-423-0844, dhof@iastate.edu

(Third in a series)

In this article we will examine the size and sources of greenhouse gas emissions from the agricultural sector. We will also discuss greenhouse gas sinks (the removal or sequestration of gases). Finally, we will examine ways agriculture can reduce emissions and increase sinks.

Greenhouse gas emissions (primarily carbon dioxide, methane and nitrous oxide) by sector of the U.S. economy are shown in table 1. Electric power generation accounts for one-third of all greenhouse gas emissions. Although wind and hydroelectric generation are very clean technologies, half of U.S. electricity is generated by coal fired plants.

The transportation sector produces over one-fourth of the greenhouse gas emissions, primarily from gasoline and diesel fuel. Agriculture produces about eight percent of emissions.

Agricultural greenhouse gas emissions

Agricultural greenhouse gas emissions come from several sources as shown in table 2. Each of the sources is discussed along with possible ways of reducing emissions.

Agricultural soil management

These are nitrous oxide emissions and account for about 60 percent of the total emissions from the agricultural sector. Nitrous oxide is produced naturally in soils through the microbial processes of nitrification and de-nitrification. During nitrification, ammonium (NH_4) produces nitrates (NO_3). During de-nitrification, nitrates (NO_3) are reduced to nitrogen gas (N_2). An intermediate step in both of these processes is the creation of nitrous oxide (N_20).

The large increase in the use of nitrogen fertilizer for the production of high nitrogen consuming crops like corn has increased the emissions of nitrous oxide. Although nitrogen fertilizer is essential for profitable crop production, the development of practices for more efficiently using nitrogen fertilizer has the potential to significantly reduce nitrous oxide emissions while also reducing production costs and mitigating the nitrogen contamination of surface and ground waters.

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Handbook updates

For those of you subscribing to the handbook, the following updates are included.

Historic Corn Yields by County – A1-12 (10 pages)

Historic Soybean Yields by County – A1-13 (10 pages)

Corn and Soybean County Yields – A1-14 (2 pages)

Historic Custom Rate Survey – A3-12 (3 pages)

Livestock Enterprise Budgets for Iowa – B1-21 (22 pages)

Farmland Value Survey (Realtors Land Institute) -- C2-75 (1 page)

Please add these files to your handbook and remove the out-of-date material.

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Inside . . .

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Ag Decision Maker is compiled by:
Don Hofstrand, dhof@iastate.edu
Extension Value-added Specialist and
Co-director of the Agricultural Marketing Resource Center

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Table 1. U.S. Greenhouse Gas Emission by Economic Sector (2005) (percent)

Sector	Percent
Electric power industry	33.5%
Transportation	27.7
Industry	18.6
Agriculture	8.2
Commercial	5.9
Residential	5.2
Other	.8
Total	100.0%

Source: EPA, U.S. Inventory of Greenhouse Gas Emissions and Sink (1990 – 2005), Trends in Greenhouse Gas Emissions, Table 2-14.

Table 2. U.S. Agricultural Greenhouse Gas Emissions by Source (2005) (percent)

	Percent of	
Source	Total Emissions	Agricultural Emissions
Agricultural soil management	5.0%	61%
Enteric fermentation	1.5	18
Manure management	.7	9
CO_2 from fossil fuel consumption	.6	7
Other	.3	4
Total	8.2%	100%

Source: EPA, U.S. Inventory of Greenhouse Gas Emissions and Sinks (1990 – 2005), Trends in Greenhouse Gas Emissions, Table 2-14.

Enteric fermentation

Methane is produced as part of the normal digestive processes in animals. During digestion, microbes in the animal's digestive system ferment feed. This process, called enteric fermentation, produces methane as a by-product which can be emitted by the exhaling and belching of the animal.

Because of their unique digestive system, ruminant animals (e.g. cattle) are the major emitters of methane. Beef cattle account for about 70 percent and dairy cattle for about 25 percent of these methane emissions. If beef and dairy cattle numbers increase, methane emissions will also increase.

Feed qualify and feed intake influence the level of methane emissions. In general, lower feed quality and higher feed intake lead to higher methane emissions.

Manure management

Methane is produced by the anaerobic (without oxygen) decomposition of manure. When manure is handled as a solid or deposited naturally on grassland, it decomposes aerobically (with oxygen) and creates little methane emissions. However, manure stored as a liquid or slurry in lagoons, ponds, tanks or pits, decomposes anaerobically and creates methane emissions. Dairy cattle and swine produce about 85 percent of the methane emissions. Methane emissions will increase as the number of large scale livestock confinement systems increases.

Methane emissions can be reduced through the application of technologies designed to capture the methane and use it as an energy source. In addition to reducing methane emissions, methane capture will improve the profitability of the livestock operation by offsetting the need for fossil fuel energy from outside sources.

Carbon dioxide from fossil fuel consumption

The use of fossil fuels in agricultural production accounts for eight percent of the emissions from agriculture. These emissions are primarily from combustion of gasoline and diesel fuel. Using renewable fuels can reduce the carbon dioxide emissions from agriculture production.

Other

A variety of other sources produce greenhouse gas emissions. For example, most of the world's rice and all of U.S. rice is grown on flooded fields, which prevents atmospheric oxygen from entering soil. When rice is grown with no oxygen, the soil organic matter decomposes under anaerobic conditions and produces methane that escapes into the atmosphere.

Agricultural greenhouse gas sinks

A sink is a reduction in atmospheric greenhouse gases by storing (sequestering) carbon in another form. A traditional carbon sink is underground coal and oil deposits where millions of year ago living plants (and other organisms) used atmospheric carbon to build the plant. When the plants died, instead of decomposing and releasing carbon back into the atmosphere, they were stored under high pressure and became oil and coal. When oil and coal are recovered and consumed, the sequestered carbon is emitted into the atmosphere as carbon dioxide.

Greenhouse gas sinks reduce annual greenhouse gas emissions by 11.4 percent. Ten percent of these offsets are due to forests and soils as shown in Table 3.

Forest management practices

Growing trees sequester large amounts of carbon dioxide from the atmosphere through photosynthesis. The carbon is used to build the plant and the oxygen is released back into the atmosphere. An increase in biomass from the growth of forests (both above ground and below ground) provides a carbon sink. As long as the wood does not decompose or is not burned or otherwise destroyed, the carbon is maintained in the wood and the wood continues to be a carbon

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Table 3. Greenhouse Gas Sinks (2005) (percent of total emissions)

	Sink
Forest management practices	9.6%
CO_2 flux from agricultural soils	.4
Other	1.3
Total	11.4%

Source: EPA, U.S. Inventory of Greenhouse Gas Emissions and Sinks (1990 – 2005), Trends in Greenhouse Gas Emissions, Table 2-14.

sink. Trees harvested for building materials maintain the carbon in the new structure (houses, etc.) for decades. Wood disposed of in a solid waste disposal site provides an almost permanent carbon sink. The growth of new trees planted on harvested areas sequesters additional carbon.

The carbon sink created by forests and forest products (9.6 percent) more than offsets the greenhouse gas emissions from agriculture (8.2 percent). Although most forested areas are not located in the Midwest, sinks do occur in Midwest agriculture. Agroforestry practices such as managed shelterbelts and forested riparian zones enhance carbon emission offsets and provide other wildlife and aesthetic benefits.

CO_2 flux from agricultural soils

The soil is a great storehouse (sink) of carbon in the form of organic matter. Currently agriculture soils provide a small (.4%) positive flux (soil sequestration slightly exceeds soil emissions) of carbon dioxide.

Midwest topsoil was created by the decomposition of prairie grasses that grew on these soils. Over the centuries, carbon was stored (sequestered) in the soil. When the prairie was plowed, soil carbon oxidized and became atmospheric carbon dioxide. Tillage of the soil over the decades released more carbon than was added by crop residue and thereby reduced soil organic matter. However, equilibrium has been reached in most soils where the amount of carbon sequestration approximately equals the amount of carbon released. In individual situations, however, excessive tillage continues to release carbon and no-till practices sequester carbon.

No-till farming practices provide a great potential for the future sequestration of atmospheric carbon and building soil organic matter while also minimizing soil erosion and reducing production costs. Carbon sequestration programs created by organizations such as the Iowa Farm Bureau provide the opportunity for farmers to transform the sequestered carbon into "carbon credits" that can be sold (AgDM Newsletter, Aug. 2007). These programs provide a way for farmers to generate revenue while also reducing atmospheric carbon dioxide levels.

Other

Other sinks include the planting of trees in urban areas and landfilled yard trimmings and food scraps.

Opportunities for midwest agriculture

If federal and state governments create incentives for lowering greenhouse gas emissions and expanding sinks, Midwest agriculture will be uniquely positioned to take advantage of these by:

1) Sequestering carbon in agricultural soils by reducing tillage,
2) Reducing nitrous oxide emissions through more efficient use of nitrogen fertilizer,
3) Developing viable technologies for creating ammonia (nitrogen fertilizer) from feedstocks other than natural gas.
4) Capturing methane emissions from anaerobic manure handling facilities,
5) Substituting renewable fuels for gasoline, diesel fuel and natural gas used on the farm,
6) Increasing the generation of electricity from wind and other renewable sources,
7) Expanding the use of practices like managed shelterbelts and forested riparian zones,
8) Others we haven't thought of yet.

The next article in this series will deal with the issues of greenhouse gases from renewable fuels.