CLIMATE CHANGE FACTS

FARM ENERGY, CARBON, AND GREENHOUSE GASES

Farmers today face rising energy costs and uncertainty about future energy policies that affect agriculture. Many farmers are responding by improving the energy efficiency of their operations and exploring alternatives to traditional fossil fuels such as wind, solar, and biofuel crops. Improving nitrogen fertilizer use efficiency is another important strategy. Fertilizer cost is important because it is tightly linked to energy prices, and excessive applications increase the release of nitrous oxide (N_2O), a very potent greenhouse gas (GHG). More efficient fertilizer management is just one of many win-win strategies for farmers that make economic sense and also address concerns about GHG emissions and climate change.

ENERGY EFFICIENCY AND RENEWABLES

Farmers have always sought ways to improve energy efficiency and reduce input costs. For example, most farm vehicles run on diesel, which is a much more efficient fuel than gasoline. Perennial concerns about energy costs, combined with new concerns about GHGs, such as carbon dioxide (CO_2) emitted from the burning of fossil fuels, have created incentives to take more control of our energy future. Being "energy-smart" when it comes to farm design and management improves the bottom line, is good for crops and soils, and reduces emissions of GHGs to the atmosphere.

Energy Challenges:

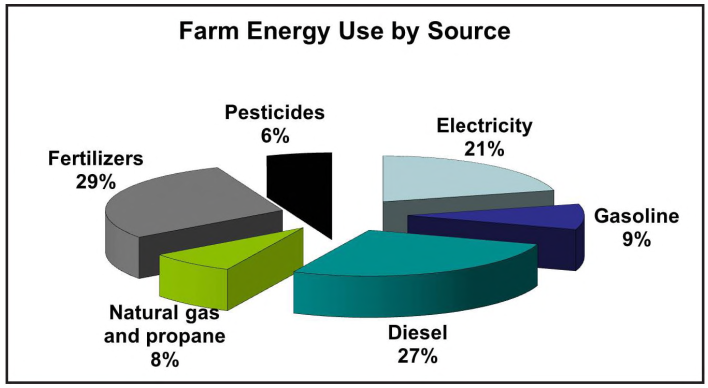
- Fluctuating and rising energy costs reduce profits, making it hard to plan ahead.
- Dependence on foreign oil is a long-term risk.
- Nitrogen fertilizer input costs are linked to energy prices.
- Burning of fossil fuels contributes to climate change.

Energy Solutions:

- Optimize building insulation and ventilation; design landscapes for shade and evaporative cooling.
- Select site and building orientation to optimize summer cooling, winter warming, and natural lighting.
- Replace heating and cooling equipment to meet needs with maximum efficiency.
- Use energy-efficient appliances and keep them well-maintained.
- Periodically conduct a comprehensive whole-farm energy audit.

Crop Production:

- Reduce fuel consumption, e.g., by reducing tillage frequency and intensity.
- Reduce transportation costs and fuel consumption by buying local inputs and exploring local market outlets.
- Purchase fuel-efficient vehicles and equipment and keep them well- maintained.
- Explore use of biodiesel and other renewable fuel alternatives for vehicles or greenhouse heating.
- Minimize use of energy-intensive products such as synthetic fertilizers, pesticides, and herbicides.



A large fraction of farm energy use is associated with the manufacture and transport of fertilizers and pesticides (USEPA 2008).

Renewable Energy

Traditional fossil fuels (e.g., oil, gas, and coal) bring up carbon-rich energy from deep in the earth and add new CO_2 to the atmosphere when burned. In contrast, renewables essentially recycle carbon and energy already at the surface, and so do not add to the CO_2 in the atmosphere. Many farmers are exploring renewable energy options such as "growing" their own fuel in the form of biofuel crops, using animal or other waste as an energy source, or investing in solar or wind energy systems.

- **Fuel crops** (e.g., corn, switchgrass, soybeans, and willow) produce abundant biomass, starch and sugars, or vegetable oils that can be used for energy, either directly or after various levels of processing.
- **Anaerobic digesters**, including covered lagoon systems, decompose manure or other farm waste to create "biogas" fuel. Currently economical for larger-scale operations (greater than 250 head), costs are expected to come down as demand increases and manufacturing becomes more efficient. In the meantime, farmers have found ways to defray some of the costs through grants, low-cost loans, or cost-sharing among several farms.

Anaerobic digesters turn animal wastes into valuable fuel.

- **Solar power systems** range from passive approaches that optimize the use of sunlight for heating or lighting, to the use of photovoltaic (PV) solar cells to generate electricity. Smaller PV systems (e.g., less than 1 kW) are economical for running electric fences, water pumps, and other farm equipment, especially in remote locations.
- **Small wind turbines** producing 75 kW or less are becoming increasingly popular to supplement electricity needs. Factors to consider before investment include adequate wind, local ordinances that restrict height of structures, and net metering/billing laws that affect whether you can store or sell excess energy generated during peak periods.

Energy Conservation Financial Assistance and Incentive Programs

- The New York State Energy Research and Development Authority (NYSERDA) website describes programs that assist with farm energy audits, improve facility energy efficiency, and explore options with anaerobic digesters or solar and wind systems (www.nyserda.org/programs/agriculture).
- The USDA Natural Resources Conservation Service (NRCS) has an Environmental Quality Incentives Program that can be helpful in meeting energy-efficiency goals (www.nrcs.usda.gov).

Carbon Sequestration: Capturing and Storing Carbon in Soils, Crops, and Trees

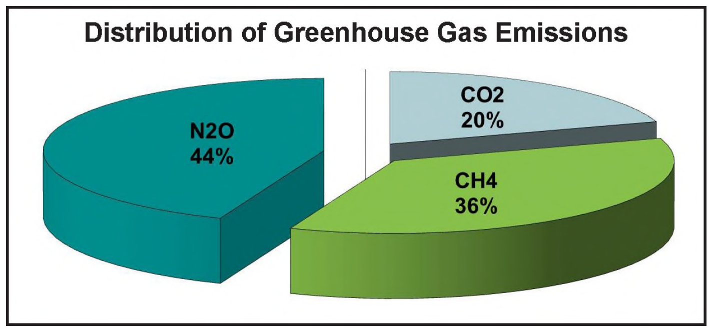
The energy solutions discussed above reduce CO_2 emissions on the farm, but farmers can do more than that. Trees, crops, and soils can capture atmospheric CO_2 and store (sequester) it in the form of carbon-rich living biomass and soil organic matter. Building up the organic carbon content in agricultural soils has the added benefit of helping crops thrive. Some best management practices are:

Soils store carbon in the upper organic layers.

- Reduce tillage to minimize soil aeration, which stimulates the breakdown of organic matter and releases CO_2.
- Use manure, composts, biochar, or other high-carbon soil amendments for improved crop productivity and carbon storage.
- Plant winter cover crops to increase annual carbon capture from the atmosphere.
- Manage woodlots to maximize long-term carbon uptake and storage in trees.

The Other GHGs: Nitrous Oxide (N_2O) and Methane (CH_4)

Nationally and globally, CO_2 is the biggest contributor to climate change, but for the agricultural sector, nitrous oxide (N_2O) and methane (CH_4) are of particular concern. They are such potent GHGs that on a CO_2 equivalent basis, their emissions from the agricultural sector contribute more to global warming potential than CO_2 emissions from the burning of fossil fuels.



GHG Emissions from U.S. Agriculture (CO_2 equivalent basis, 2007, USEPA).

Nitrous Oxide Challenges:

- The concentration of N_2O in the atmosphere has risen by about 20% since the pre-industrial era. It is a potent GHG with 310 times the global warming potential as CO_2. On a CO_2 equivalent basis, N_2O accounts for almost half of GHG emissions from U.S. agriculture.
- Over 70% of annual U.S. N_2O emissions can be attributed to agriculture cropping practices, in particular the use of nitrogen fertilizers.

Nitrous Oxide Solutions:

- Use green manure (legume) rotation crops that provide "free" nitrogen, reducing fertilizer requirements.
- Use manure and composts instead of synthetic nitrogen fertilizers.
- Split fertilizer applications, optimize timing and amount applied based on crop demand, soil tests, and new web tools such as Cornell's Adapt-N program (http://adapt-n.cals.cornell.edu/).

Legume Rotation Crop (Rye-Vetch Mix).

- Plant winter cover crops, such as winter rye, to help store soil nitrogen within the root zone, reducing nitrate leaching and leaving more nitrogen available for cash crops.

Methane Challenges:

- The atmospheric concentration of CH_4 has more than doubled since the pre-industrial era. Methane has about 23 times the global warming potential as CO_2. On a CO_2 equivalent basis, CH_4 accounts for over a third of total GHG emissions from U.S. agriculture.
- On an annual basis, over 25% of U.S. CH_4 emissions can be attributed to agriculture.
- These emissions are largely linked to ruminant livestock (e.g., cattle, sheep) and the bacterial enteric fermentation process of their digestive system.
- To a lesser extent, methane emissions from decomposing manures on wet soils, uncovered lagoons, and from flooded rice fields play a role.

Methane Solutions:

- Utilize new feeding strategies and feed amendments to reduce dairy cow methane emissions and boost milk production efficiency.
- Use covered or tank storage of manure and store at low temperatures.
- Remove manure promptly from barn floors.
- Calibrate manure spreaders for crop fertilizer needs and incorporate manure into soils immediately.
- Create energy from manure waste with an anaerobic digester.

Summary of Best Management Practices

- Improve energy efficiency and minimize use of synthetic fertilizers and other energy-intensive inputs to lower costs and reduce carbon dioxide emissions.
- Explore renewable energy options, such as biofuel crops, biogas capture from manure waste, wind turbines, and solar systems.
- Enhance ruminant animal digestion efficiency to reduce methane emissions.
- Improve manure handling and storage to reduce methane and carbon dioxide emissions.
- Improve nitrogen fertilizer use efficiency to reduce nitrous oxide emissions, and use organic sources of nitrogen such as legume rotation crops and manure when possible.
- Build up soil organic matter to improve soil health, crop productivity and soil carbon sequestration by reducing tillage, planting winter cover crops, and applying organic matter amendments such as compost.

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