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Natural Resources Conservation Service

Energy Management

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Key Points:

On-farm energy management has a huge potential for improving the environment, lowering farm and ranch production costs, and decreasing reliance on foreign energy supplies. An energy audit is the first step toward successful energy management planning.

Efficient energy management includes:

- Reduce or eliminate tillage and manage residues to reduce fuel use and improve soil, water and air quality. Switching from conventional tillage methods to no-till can result in fuel savings of 3.9 gallons per acre.
- Adjust nutrient management and crop rotations to include legumes to offset use of petroleum-based nitrogen fertilizers.
- Adjust irrigation timing to directly reduce energy consumption as well as other resource concerns.
- Use integrated pest management strategies to optimize petroleum-based inputs and produce environmental benefits. With precision application, better weed control, lower herbicide runoff and energy savings of 45 percent are being realized.
- Plant perennial crops and introduce rotational grazing to reduce energy associated with planting and harvesting.
- Switch to more energy efficient machinery such as grain dryers, milk chillers, and irrigation pumps. Improvements in water efficiency of a modest 10 percent

Issue

Agriculture in the United States consumes more than 2 quadrillion Btu (10,551 quadrillion Joules) of energy each year. About 28 percent of energy used in agriculture goes to fertilizer manufacturing, 7 percent goes to irrigation, and 34 percent is consumed as diesel and gasoline by farm vehicles used to plant, till, and harvest crops. The rest goes to pesticide production, grain drying, and facility operations (Earth Policy Institute, 2005). Dwindling supplies, increasing costs and dependence on foreign sources put our fossil fuel driven food supply at risk. Assistance to farmers and ranchers concerning their energy use and management can decrease reliance on fossil fuels while improving environmental quality and reducing farm and ranch production costs.

On-farm energy use, conservation and generation are directly linked to natural resource concerns including water quantity and quality, soil erosion and organic matter, and air quality. Indirect energy use is also embedded in farming inputs and implements via the resources used in their manufacture and transport to the farm. Conservation practices such as crop residue management, irrigation water management, nutrient management, wind breaks, contour farming, and rotation grazing, among others, can contribute to protecting soil and water resources and help reduce the nation's dependence on fossil fuels. Farm energy use can be direct use, such as fuel or electricity, or indirect use embedded in farming inputs and implements (via the resources used in manufacture and transport to the farm). Both direct and indirect energy management, as determined during an energy audit, should be considered as part of a farm or ranch conservation plan.

Current Trends and Technology Status

Current and projected declines in domestic oil production, high energy prices, and national security concerns create a long-term need for energy conservation and the development of alternative energy sources. Agriculture can play a large role in both energy conservation and production through technologies such as biomass production for biofuels, wind farms, and anaerobic digestion of animal waste (see figures below).

could reduce diesel consumption by 80 million gallons or \$192 million dollars on irrigated farmland.

- Convert to bio-fuels, such as ethanol and bio-diesel, to directly reduce demand for petroleum-based liquid fuels as well as to potentially improve air quality.
- Recycle lubricants and other petroleum-based material to reduce demand for petroleum and reduce potential environmental damage associated with other disposal means.
- Develop alternative energy sources, such as anaerobic digestion, solar and wind, to directly substitute for purchased energy supplies and reduce carbon and GHG emissions.

Research results and many practical and experimental demonstrations indicate that farms and ranches have a number of opportunities to conserve energy, replace petroleum-based liquid fuels with renewable energy supplies, as well as generate energy from biomass sources. Research and applied practices have shown where no-till planting and state-of-the-art and well-managed irrigation systems (enhanced border irrigation, sub-surface drip irrigation, and low pressure precision application through either center pivots or linear irrigation systems) can be appropriate energy conserving practices for many areas. Ongoing research also suggests that biomass energy production is feasible with dedicated, perennial crops but must proceed with caution when annual crop residues are used as a feedstock. (In the latter case, additional resource conservation measures are essential to avoid environmental degradation). Other research also shows that anaerobic digesters and wind turbine technology can viably generate energy in many situations. Further research and pilot activities are needed in all the above examples to explore remaining technological and economic concerns. These concerns are a major focus in several of incentive and grant programs.

Contact:

NRCS Web site at www.nrcs.usda.gov.

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Helping People Help the Land

Major Opportunities and Barriers

Energy conservation and generation have the potential to provide a new source of income (or cut costs of production) and bolster farm and rural economies in the future. While opportunities to generate and conserve energy on farms and ranches exist, these activities create new challenges for farm and ranch operations (in labor, management, and marketing) and in natural resource concerns. NRCS can assist producers and communities identify and adopt technically and environmentally sound means to achieve these goals through several programs, primarily through the Conservation Security Program (CSP). Additionally, the Environmental Quality Incentive Program (EQIP) provides cost share funding in conservation areas that can contribute indirectly to energy management. Also, two grant programs sponsored by NRCS are active in energy-related issues: Conservation Innovation Grants (CIG), which targets practical applications and on-farm pilot projects, and the United States Department of Agriculture-Department of Energy Biomass Initiative program, for primary research on new technologies that will replace our petroleum-based economy.

A logical first place to start is to conduct an energy audit of the farm or ranch. An energy audit consists of an assessment of how energy is being consumed and suggestions about how reductions can be made and alternative energy may be produced. The CSP provides a financial incentive to eligible producers to conduct an energy audit. Other groups that also can assist producers include the local rural electric utility, local energy auditing companies, and the university Extension Service.

Challenges

Producers on farms and ranches face higher energy prices for their direct energy supplies and energy-intensive inputs. Energy conservation can reduce energy demands to some extent. On-farm energy generation also presents an excellent opportunity for producers to reduce their dependence on purchased energy supplies. The success of producers in these efforts depends on many factors including: their specific crop and livestock enterprises, their location with respect to feasible energy alternatives (see maps above), their personal abilities in adopting alternative energy technologies in their farm or ranch operation, and others. NRCS, and other USDA agencies, are available to assist and reward producers who take on these challenges.

Table 1. Energy savings and production potential from conservation practices and measures.

Conservation Practice	Conservation Measure	Resource Savings		Energy Costs reduction
		On-Farm	Total	\$ million
Crop Residue Management	62.4 million acres of No-Till (CTIC)	\$11.70 /acre	243 million gallons	730
	Conversion of additional 50 million acres to No-Till	11.70/acre	195 million gallons	585
Irrigation water management	Improve pumping system efficiency 10 percent on 16 million acres	\$15/acre	80 million gallons	240
	Conversion of medium pressure sprinkler systems to low	\$ 40/acre	560 Kwhr/acre	390
	Conversion of high pressure sprinkler systems to low	\$55/acre	770 Kwhr/acre	120
Pesticide and Nutrient Management	Reduction in spray overlap by 5 percent	Variable	For 250 million cropland acres	1000
On-Farm Energy Production	Production Activity		Potential Production	Potential Market (\$million)
Biofuels	Substitute petroleum based liquid fuels with bio-diesel and ethanol		628 trillion BTUs or 1.1 billion gal gasoline and 3.5 billion diesel	11000

Reduced Field Passes

Reduced number of trips across the field not only lowers energy consumption, but reduces the demand for labor in many peak-work periods cause less soil compaction. Passes could be reduced in planting, nutrient and pest management, or harvest practices. The CSP energy enhancements specifically encourages producers to find those situations where fewer field passes with less soil disruption potential are possible. These enhancements complement other CSP enhancements in nutrient, pest, and soil management which encourage precision placement of nutrients, spot spraying, and lower soil tillage intensity ratings. Several of these activities may also qualify for incentives under the EQIP.

Residue Management/Conservation Tillage

Less intense tillage also requires less energy, reduces soil organic matter loss, and minimizes CO₂ (a greenhouse gas) release to the atmosphere compared with conventional tillage practices. Information from the Conservation Technology Information Center (CTIC) indicates that a farmer can save 3.9 gallons of fuel per acre by going from conventional tillage methods to no-till. With diesel prices (\$2.40/gal) this amounts to \$9.32 per acre in production cost savings. The CTIC tillage survey indicates that no-till is practiced on about 62,400,000 acres. This saves the Nation an estimated 243 million gallons of fuel each year and saves farmers \$581 million dollars each year.

Alternative Nutrient Supplies

Increased use of perennial and annual legumes in crop rotations can directly reduce energy use needed for field application of nutrients. Energy use is also indirectly reduced through decreased use of energy-intensive inputs, such as farm chemicals and fertilizers (especially nitrogen). Several CSP energy enhancements encourage this management direction.

Precision Agriculture

One of the benefits of precision agriculture is the opportunity to reduce overlap of field operations. This is especially significant in fertilizer and pesticide applications. Achieving a modest 5 percent reduction in application overlap on the 250 million acres of cropland used to produce the major crops would result in about \$1 billion in reduced petroleum-based fertilizer and pesticide costs. There would also be a corresponding reduction in fuel use.

Nutrient management/Manure use

The proper collection, storage, and handling of manure can not only help protect the Nation's waters from excess nutrients and bacteria, but it can provide a significant nutrient source for crop production. Commercial nitrogen fertilizer is largely derived from natural gas: a ton of commercial nitrogen has about 40,000 cubic feet of natural gas. Currently, about 2.7 million tons of manure-based nitrogen is applied on agricultural land. If commercial fertilizer application is reduced by a like amount on a national basis, agriculture is saving up to 108 trillion cubic feet of natural gas with a market value of about \$0.67 billion each year.

The USDA study entitled "Costs Associated with Development and Implementation of Comprehensive Nutrient Management Plans" reported that nationally about 1.8 billion pounds of nitrogen manure cannot be agronomically applied on land operated by the farms producing the manure. Roughly 200 million tons of excess manure is available. If 200 community-based 30 ton per hour manure processing facilities were to treat 25 percent of this excess manure, the processing would significantly reduce the potential water quality, air quality, and pathogenic issues associated with this farm excess manure. In addition, significant natural gas could be produced. The annual gas production from these 200 facilities could be between 10 and 15 billion cubic feet of natural gas per year.

Pest Management

Pesticides are heavily dependent on energy resources in their production. In certain agricultural sectors biological control has virtually eliminated the use of chemicals. Scouting and spot spraying have also reduced the application in areas where the chemicals were not needed. Integrated Pest Management can be credited with reduction of environmental risk, improved product quality, reduced energy use, and improved returns to producers.

A recent innovation in herbicide application in wheat-fallow production systems in the Northwest U.S. provides an example of the benefits that are possible with precision agriculture. More precise herbicide application, triggered by chlorophyll sensing devices mounted on each individual herbicide sprayer, is beginning to be practiced on fallow wheat ground. Better weed control and lower herbicide runoff are the two main stated objectives of these new systems, but energy savings of 45 percent are also being realized. These savings result from fewer trips from the field to replenish herbicides used by sprayers and lower average herbicide quantities being carried in the application operation.

Windbreaks and Shelterbelts

Windbreaks and shelterbelts can not only reduce wind-induced erosion they can save heating and cooling costs associated with farmsteads. When properly placed, windbreaks can reduce heating and cooling costs by up to 20 percent.

Stationary Equipment

Stationary motors, pumps, fans and dryers can be managed to reduce energy use (compared with a baseline established by energy audits). These energy reductions contribute to the overall reductions needed (5-, 10-, or 20-percent) to qualify for CSP energy conservation enhancements. Such energy use reductions, brought about by energy enhancements, may also contribute to improved irrigation enhancement index levels and qualify producers for other CSP-related incentives.

Irrigation

Greater efficiencies in irrigation water management are being called for in regions where ground and surface water supplies are increasingly under pressure due to declining aquifers or greater competition from other users. If realized, these management gains could not only lower water use, but lower energy use, reduce nutrient application, and improve air quality. For example, low energy precision application (LEPA) center pivot and other drip, trickle and low-flow micro sprinklers require less water per unit of production thereby placing lower demands on available water supplies, reducing energy used in extracting and applying water, allowing superior nutrient placement for plant utilization and, where stationary pumps using petroleum-based fuels are used, improving air quality through lower exhaust emissions.

Based on a USDA Farm and Ranch Irrigation Survey, about 38 million acres of farmland were irrigated with pumps powered by liquid fuels, natural gas, and electricity, costing a total of \$1.2 billion (USDA NASS, 1999). Although electricity is the main power source (used on about 20 million acres at a cost of \$800 million), diesel powered pumps are used on about 10 million acres and natural gas on six million acres. Improvements in water efficiency of a modest 10 percent on this acreage could reduce diesel consumption by 80 million gallons or \$192 million dollars (based on selected University of California, Davis crop budgets).

The 2003 Agricultural Census reports about 27 million acres are under sprinkler irrigation. About 80 percent of these acres utilize center pivot systems. Of these center pivot systems, 45 percent are low-pressure systems, 45 percent are medium pressure systems, and 10 percent are high-pressure systems. Applying irrigation water management practices and reducing pressures are having significant results. If the acres under medium pressure were converted to low pressure, the per acre energy savings approaches \$40 per acre. This is a 560 Kwhr reduction in energy use per acre.

Nationally, this would be an energy cost reduction of \$390 million dollars. The conversion of the high-pressure systems to low pressure would result in savings of \$55 per acre or \$120 million nationally if all acres were converted.

Intensified Grazing Systems

Increased use of well-managed rotational grazing systems increases the productivity of pastures and reduces the demand for baled feed. Fewer trips by farm machinery harvesting, hauling, or making haylage reduce energy use as well as soil compaction.

Recycling

In many cases, producers may not be taking the needed precautions to safeguard water and air quality when they dispose of their used lubricants. The CSP energy enhancement for recycling of this material is aimed to reduce the demand for petroleum and reward those that have taken steps to dispose of their used lubricants in a responsible way.

Displacement of Petroleum-based Liquid Fuels with Renewable Fuels

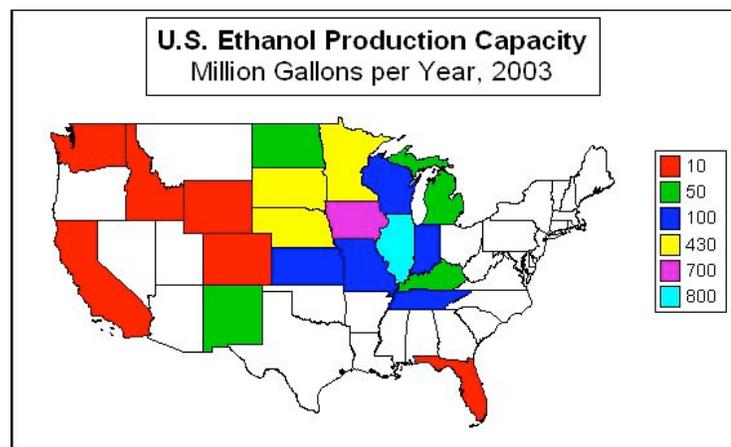
The replacement of petroleum-based liquids fuels with ethanol and bio-diesel has the potential to improve the environment, lower farm and ranch production costs, and decrease reliance on foreign energy supplies. The CSP recognizes this potential by providing a financial incentive for each 100 gallons of bio-fuel used. These incentives take into account the array of existing incentives already in place in many states, but are made to encourage producers that have not switched to alternative fuels in their agricultural operation.



Bio-diesel and Ethanol

About one-half of the energy used on US farms (628 trillion BTUs compared to a total 1,122 trillion BTUs) comes from gasoline and diesel (USDA, 2004). These 628 trillion units of BTUs translate into 1.1 billion gallons of gasoline and 3.5 billion gallons of diesel fuel. This would have annual value of approximately \$11 billion per year.

Increased production of ethanol and soy-diesel has the potential to reduce fossil fuel use, if biofuels are directed to farm applications, although only slight cost savings would be generated. However, such substitution would reduce the country's demand for imported petroleum-based liquid fuels and possibly increase value-added activities of nearby plants producing such agriculturally based fuel stocks.



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Renewable Energy Generation - Anaerobic digestion, Solar, Wind, Water and Geothermal

Producers on farms and ranches have a history of generating their own energy – especially on small operations that were historically isolated from other energy sources. Wind mill-powered water pumps to supply water to livestock herds in isolated areas and water-powered flour mills are only two examples. These old technologies have been replaced with others, spurred on by the development of the national electrical grid and spread of large farming and ranch operations, many of whom rely on purchased energy supplies.

Increased on-farm energy generation for on-farm use or for sale to energy grids (in the form of electricity or methane gas) has the potential of substantial energy savings for the country. Although many of these energy generating activities, such as anaerobic digesters on livestock farms, and wind, solar, and geothermal generators on others, require special skills and equipment, the potential benefits from reduced energy purchases are significant. Further, as technology advances continue, the feasibility for farm and ranch application improves. In addition, the installation of anaerobic digesters or other methods to produce energy from animal manures could also provide improvements in water and air quality in many areas by substantially reducing odor, nutrient, and bacterial content associated with the field application of raw manure.

NRCS programs enhance development and application of alternative energy sources for direct farm use or to sell to the power grid. The CIG program attempts to explore new technologies while EQIP and CSP create incentives for farmers and ranchers to deploy on-farm energy generation systems through cost share and enhancements.

NRCS Program Funding, Energy Management 2002-2005

Program	Financial Assistance Funding 2002-2005	Technical Assistance Funding 2002-2005	% of FA	% of TA
Conservation Innovation Grants (CIG)	\$4,633,213	\$23,137	46%	0%
Conservation Security Program (CSP)	\$5,346,854	\$802,028	54%	3%
Resource Conservation & Development_ (RC&D)	\$0	\$23,294,788	0%	97%
Total	\$9,980,067	\$24,119,953	100%	100%

The RC&D program provides benefits for a multiple number of resource issues. Dollar amounts given reflect a percentage of total program funding for RC&D for FY 2002-2004. This figure is pro-rated based on data analysis conducted for the national program evaluation conducted in FY2004 & FY 2005. The same dollar amounts are under wildlife management, wetland conversion and energy, which are captured under the land management element in the RC&D statute.