price, which could increase farm income by another $2 billion. This assumes about 40% of the total residue is collected and the rest is left to maintain soil quality.

Opportunities

One opportunity for energy crop development is to use land that is currently idle or poorly suited for food crops, such as that in the Conservation Reserve Program (CRP). The program encourages farmers and ranchers to adopt long-term conservation practices on environmentally sensitive land. In 2000, approximately 33.5 million acres were enrolled in the CRP. Much of this land is already planted in native grasses and trees to help reduce erosion, protect water quality, and provide wildlife habitat. With careful management, farmers could harvest energy crops on some of this land. This would allow them to earn an income instead of collecting a subsidy, while still maintaining the environmental benefits of the program.

A co-op in Iowa is testing this concept. In the Chariton Valley, farmers have planted 5,500 acres of CRP land with switchgrass to be burned with coal in a large utility power plant near Ottumwa. If successful, the project will scale up to 50,000 acres, producing 200,000 tons of switchgrass each year and supplying 5% of the plant's fuel.

This example also shows that selling biomass feedstocks as a commodity to energy producers may be a more attractive option than producing biomass energy on the farm. They have greater access to capital and energy markets, can typically produce energy at a lower cost in larger facilities, and have the expertise to operate and maintain these facilities.

Since establishing an energy crop takes time and harvesting occurs over a number of years, long-term contracts with energy producers are likely to be necessary to make a profit. Long-term contracts also offer greater income stability by allowing farmers to avoid some of the fluctuations of commodity markets.

Another option is for farmers to form a local co-op to produce energy and other value-added products in jointly owned facilities. This approach can increase profits by achieving economies of scale and scope in production and by gaining access to low-cost financing. It can also help improve the viability of family farms and strengthen rural communities by creating new jobs and keeping money in the local economy. This approach has been particularly successful in Minnesota, which provides incentives for small community-based ethanol plants.

For more information

US Department of Energy, Biopower and Biofuels Programs *www.eren.doe.gov*

Institute for Local Self-Reliance
1313 5th Street SE,
Minneapolis, MN 55414-1546
612-379-3815 *www.carbohydrateeconomy.org*

National BioEnergy Industries Association
1616 H Street, NW, 8th floor
Washington, DC 20006-4999 202-628-7745

National Renewable Energy Laboratory
1617 Cole Boulevard, Golden, CO 80401
303-384-6979 *rredc.nrel.gov/biomass*

Regional Biomass Energy Program
rredc.nrel.gov/biomass/doe/rbep

Centre for the Analysis and Dissemination of Demonstrated Energy Technologies
www.caddet-re.org/html/techbiomas.htm

To find out more about renewable energy and agriculture, visit the UCS web page at www.ucsusa.org/energy. Or write: Energy Program, Union of Concerned Scientists, Two Brattle Square, Cambridge, MA 02238. Or call: 617-547-5552.

Union of Concerned Scientists

FACT SHEET

Growing Energy on the Farm: Biomass Energy and Agriculture

Tripling US use of biomass for energy could provide as much as $20 billion in new income for farmers and rural communities and reduce global warming emissions by the same amount as taking 70 million cars off the road.

Photo: Warren Gretz, National Renewable Energy Lab

Many farmers already produce biomass energy by growing corn to make ethanol. But biomass energy comes in many forms. Virtually all plants and organic wastes can be used to produce heat, power, or fuel.

Biomass energy has the potential to supply a significant portion of America's energy needs, while revitalizing rural economies, increasing energy independence, and reducing pollution. Farmers would gain a valuable new outlet for their products. Rural communities could become entirely self-sufficient when it comes to energy, using locally grown crops and residues to fuel cars and tractors and to heat and power homes and buildings.

Opportunities for biomass energy are growing. In June 2000, the federal government passed a law that will provide $49 million per year for five years to develop advanced technologies and crops to produce energy, chemicals, and other products from biomass. A number of states also provide incentives for biomass energy.

Biomass Energy Sources on the Farm

Biomass Residues

Agricultural activities generate large amounts of biomass residues. While most crop residues are left in the field to reduce erosion and recycle nutrients back into the soil, some could be used to produce energy without harming the soil. Other wastes such as whey from cheese production and manure from livestock operations can also be profitably used to produce energy while reducing disposal costs and pollution.

Energy Crops

Crops grown for energy could be produced in large quantities, just as food crops are. While corn is currently the most widely used energy crop, native trees and grasses are likely to become the most popular in the future. These perennial crops require less maintenance and fewer inputs than annual row crops, so they are cheaper and more sustainable to produce.

Grasses. Switchgrass appears to be the most promising herbaceous energy crop. It produces high yields and can be harvested annually for over 20 years before replanting. Other native varieties that grow quickly, such as big bluestem, reed canarygrass, and wheat grass, could also be profitable.

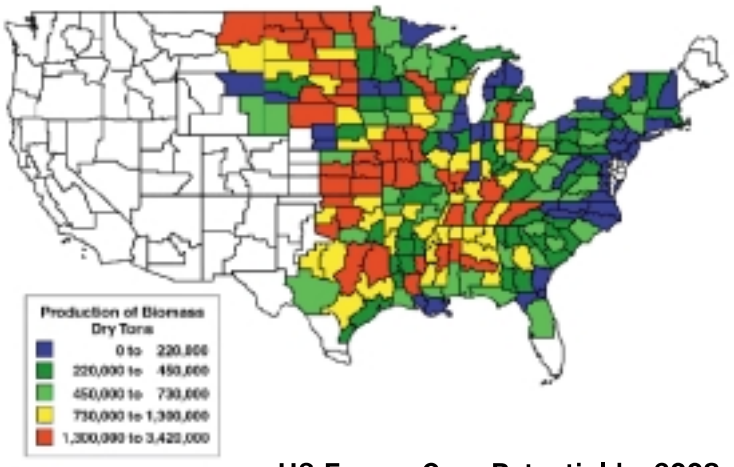
Trees. Some fast growing trees make excellent energy crops, since they grow back repeatedly after being cut off close to the ground. These short-rotation woody crops can grow to 40 feet in less than 8 years and can be harvested for 10 to 20 years before replanting. In cool, wet regions, the best choices are poplar and willow. In warmer areas, sycamore, sweetgum, and cottonwood are best.

Oil plants. Oil from plants such as soybeans and sunflowers can be used to make fuel. Like corn, however, these plants require more intensive management than other energy crops.

Protecting the Land

With thoughtful practice and management, perennial energy crops can improve the soil quality of land that has been overused for annual row crops. The deep roots of energy crops enhance the structure of the soil and increase its organic content. Since tilling occurs infrequently, the soil suffers little physical damage from machinery. One study estimates that converting a corn farm of average size to switchgrass could save 66 truckloads of soil from erosion each year.

Perennial energy crops need considerably less fertilizers, pesticides, herbicides, and fungicides than annual row crops require. Reduced chemical use helps to protect ground and surface water from poisons and excessive aquatic plant growth. Furthermore, deep-rooted energy crops can serve as filters to protect waterways from chemical runoff from other fields and prevent sedimentation caused by erosion.



US Energy Crop Potential by 2008

Source: Daniel G. De La Torre Ugarte, Marie E. Walsh, Hosein Shapouri, and Stephen P. Slinsky The Economic Impacts of Bioenergy Crop Production in U.S. Agriculture, *1999, online at http://bioenergy.ornl.gov/papers/wagin/index.html.*

The study assumed that energy crop production is limited to areas where these crops can be produced without irrigation and where sufficient research has been done to provide reliable information on yields and management requirements. Thus, other areas of the US may also be suitable for growing energy crops.

Finally, perennial energy crops can create more diverse habitat than annual row crops, attracting a wider variety of species, such as birds, pollinators, and other beneficial insects, and supporting larger populations. Furthermore, the long harvest window for energy crops enables farmers to avoid nesting or breeding seasons.

Converting Biomass to Energy

Most biomass is converted to energy the same way it always has been — by burning it. The heat can be used directly for heating buildings, crop drying, dairy operations, and industrial processes. It can also be used to produce steam and generate electricity. For example, many electric generators and businesses burn biomass by itself or with other fuels in conventional power plants.

Biomass can also be converted into liquids or gases to produce electricity or transportation fuels. Ethanol is typically produced through fermentation and distillation, in a process much like that used to make beer. Soybean and canola oil can be chemically converted into a liquid fuel called biodiesel. These fuels can be used in conventional engines with little, if any, modification.

Biomass can be converted into a gas by heating it under pressure and without oxygen in a "gasifier." Manure too can be converted using a digester. The gas can then be burned to produce heat, steam, or electricity.

Other biogas applications are still in development, but show great potential. One promising technology is direct combustion in an advanced gas turbine to run a generator and produce electricity. This process is twice as efficient as simply burning raw biomass to produce electricity from steam. Researchers are also developing small, high-speed generators to run on biogas. These "microturbines" have no more than three moving parts and are as small as 30 kilowatts, which could operate a medium-sized farm. Several companies are also considering converting gasified biomass into ethanol as a less expensive alternative to fermentation.

Alternatively, biogas can be processed into hydrogen or methanol, which can then be chemically converted to electricity in a highly efficient fuel cell. Fuel cells can be large enough to power an entire farm or small enough to power a car or tractor.

An innovative experiment in Missouri provides one example of the possibilities. Corn is used to produce ethanol, and the waste from the process is fed to cows for dairy production. Cow manure fertilizes the corn and is also run through a digester to produce biogas. A fuel cell efficiently converts the biogas into electricity to run the operation. The end products are ethanol, electricity, and milk. All the waste products are used within the project to lower costs.

Potential

In 1998, biomass provided about 2% of America's electricity, 1% of the fuel used in cars and trucks, and some of the heat and steam used by homes and businesses. With more energy crops and better conversion technology, it could gain a much larger portion of the market. Energy crops and crop residues could provide 14% of US electricity use by 2008 or 13% of the nation's motor fuel.

An Oak Ridge National Laboratory (ORNL) study found that farmers could grow 188 million dry tons of switchgrass on 42 million acres of cropland in the US by 2008 at a price of less than $50 per dry ton delivered (see map). This level of production would increase total US net farm income by nearly $6 billion. ORNL also estimates that about 150 million dry tons of corn stover and wheat straw are available annually in the US at the same

Background Photo: Oak Ridge National Lab