SMALL FARM *digest*

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Bioenergy

PHOTO: Canola field, Dr. H. Bhardwaj

Small Farms and the Bioeconomy

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Iowa is widely considered to be the epicenter of the "biofuels boom" in the United States. It consistently leads in corn and soybean production, and currently has more corn ethanol and soy biodiesel production capacity than any other state. As such, the effects of the burgeoning bio-economy on Iowa's farm sector have been substantial, small farms included. Yet, one's notion of what a small farm is will greatly influence one's opinion on the amount of opportunity extended to small farmers by the current intense focus on grain production for biofuels.

According to the USDA's farm typology, nearly 85 percent of the 88,400 farms in Iowa in 2007 were categorized as small farms (i.e., annual farm sales totaled less than $250,000). Many of the Iowa farms in this category do indeed grow commodity grains and thus had the opportunity to take advantage of surging commodity prices that were due, at least in part, to the demand of the biofuels industry. Generally speaking, increased farm income has allowed many growers to pay down debt, or to further capitalize their operations in terms of land, facilities, and equipment. Plus, much of this commerce took place in rural communities, hopefully with some lasting economic benefit.

However, if the definition of a small farm is abstracted beyond sales into something arguably more intuitive, then the opportunities for small farms lie farther below the surface. Take, for example, Diana Bell Mayerfeld's conception of a small farm as having a small to moderate physical and financial footprint, with the farm family providing the majority of labor and management. Opportunities for this kind of small farmer are more likely to be created by the biofuels industry rather than to be created within it. Smaller farmers with integrated livestock operations, like cattle producers located in the vicinity of an ethanol plant, can take some advantage of the plant's co-products by adding distillers grains and solubles to their cattle ration. Also, for smaller farmers with horticultural pursuits, USDA's Agricultural Research Service research has shown some promise in using surface-applied distiller's dried grains with solubles, by-products from ethanol plants, to reduce weed emergence in greenhouse containers. Ongoing research is identifying value-added uses of co-products.

Extending Bell Mayerfeld's sketch, small farms are likely to be more diversified in their production, integrating multiple complementary ventures rather than pursuing economies of scale in a specialized cropping system. Small farms are likely to rely more heavily on human capital embodied in

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physical labor and intensive management, rather than financial capital embodied in modernized equipment and a large land base. And, small farms are likely to have the flexibility in their production and marketing systems to adapt to local market conditions and pursue opportunities in differentiated farm products, rather than producing commodities at the lowest possible cost. In short, small farmers are more likely to succeed by pursuing diversified enterprises in which they apply high levels of management to produce a differentiated product.

Iowa's current grain-based biofuel production infrastructure currently demands uniform, abundant feedstocks, with just a few opportunities for product differentiation, mainly through identity preservation (e.g., corn varieties with elevated levels of certain enzymes or soybeans with a particular fatty acid profile). However, these differentiation opportunities do not convey any particular advantage to small farmers; they still involve broad-acre grain production and the larger farmer that can spread his or her costs over more production units is going to have the competitive advantage. If small farmers want to pursue the ostensible profit potential of commodity grain for biofuels, they are going to have to be forward-thinking and come up with innovative ways to spread risk and create economies of scale (e.g., cooperative ownership of equipment or sharing of skilled labor).

As the bioeconomy diversifies and cellulosic ethanol production from high-lignin feedstock (e.g., corn stover, switchgrass, *miscanthus*, ect.) continues to be tested for viability from an economic and agronomic standpoint, the small farmer is going to have to be vigilant for new opportunities. Small farmers may have more available labor to apply to higher-management cellulosic crops if that demand ever fully manifests itself, or they may be able to provide the handling and storage that researchers expect will be required for bulky feedstocks that must be sourced from a limited geographic area. A different suite of co-products may offer new possibilities for diversified farm operations, new incentives may be created by legislation (such as the Biomass Crop Assistance Program), or perhaps small farmers will even be able to provide some intermediate biofuels processing on a township basis in order to simplify further transport and refining. Still, much is yet to change in this nascent industry.

The "biofuels boom" has occurred along with record-setting levels of volatility in the commodity market. Plus, as grain prices have climbed and land prices have followed, along with cash rents and input costs. This is creating serious barriers to entry for beginning farmers and a fiercely competitive environment for existing farmers. As such, small farmers, broadly defined, would be wise to assess their skills and resources, evaluate their local market environment, and pursue diversified farm strategies that will spread their risks and maximize the value they capture from their farm products. Iowa farmers have done this by entering into certified organic crop and livestock production, on-farm processing of meat and dairy products, and production of fresh produce to be marketed directly to end consumers or high-end retailers, to name just a few examples, but the possibilities are limited only by imagination, innovation, and careful planning. Biofuels will continue to impact Iowa's agricultural economy, but small farmers will likely need to expand their search for opportunities beyond the realm of commodity grains.

Saving on Energy Costs and Helping the Environment

Diana Friedman, Research Associate,
Sustainable Agriculture Research and Education Program

With so much of the nation's attention focused on huge ethanol plants crowding the Corn Belt, many smaller farmers have been left wondering if they will be able to participate in the bioeconomy.

The answer is a resounding "yes." Although each farmer will have to chart his/her own course, many producers across the country have already enlisted home-grown innovation and savvy know-how to use and create their own biofuels, saving on energy costs, and helping the environment.

In Macon, MO, for example, Dan West hit upon a novel approach while pondering his fruit waste problem: Why not turn the fruit waste into energy? As tree fruit growers know well, after harvest, a great deal of fruit is left behind littering the orchard floor.

West had already had been distilling the waste fruit into natural wine using a still he designed out of a beer keg. (West has a distilling permit from the Bureau of Alcohol, Tobacco, Firearms, and Explosives.) But driven by an over-supply of waste fruit, coupled with his growing concern about the supply and cost of fossil fuel, West decided to produce ethanol from his fruit wine.

"Using waste was the main thing," recalled West, who has been running an orchard on 10 acres since 1995, and received a grant from the Sustainable Agriculture and Education Program (SARE) program in 2003 to experiment with ethanol production. "I thought it would be nice to be self-sufficient, using our ethanol to power our mower and tractor."

West built a second still from a 500-gallon propane tank, in which he heats his fruit wine to just below boiling, gathers steam in a fractionating column, and distills the alcohol portion of that steam to 190-proof. This still should easily produce 4–5 gallons per hour, although he expects to speed up the distillation as he improves the second still.

When he started, fuel was $2-a-gallon and his ethanol distillation process was cost-effective even then. As gas prices continue to rise, his home-brewed fuel will look even better. Discounting the labor to gather and crush fruit—now his most time consuming task—distillation costs only 65 cents per gallon in electricity costs. Those gallons of ethanol, however, now power his farm engines at a higher octane than gasoline and provide a cleaner burn. "It's exciting," he said, reflecting on the first time he powered up his lawn tractor with homemade ethanol.

West never stops thinking up innovative ways to get the most from his farm. In 2006, he received another SARE grant to design a closed-loop energy production system using a solar concentrating method that reduces electricity needed to heat the still. The prototype has produced 170-proof ethanol. "When it worked after three or four tweaks, I was jumping up and down," he recalled.

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"Winning the initial grant opened up many doors for me."

Across the country, Mike Collins and Rebecca Nixon of Old Athens Farm in southeastern Vermont decided to switch to straight waste vegetable oil to heat their three greenhouses after using as much as 3,000 gallons of No. 2 oil one winter. Each greenhouse now has a waste oil burner, generating 350,000 BTU for 3,200 square feet. Collins and Nixon, who on 2 acres grow organic vegetables and berries for direct markets, and produce greenhouse tomatoes, cucumbers, and eggplants, collect waste oil from nearby restaurants. The restaurants are within normal vegetable delivery routes, saving transport-related time and energy.

Collins and Nixon avoid oil with hydrogenated fats as it does not perform well in waste oil burners. The oil, generally kept in containers ranging from 5 to 50 gallons, is brought to the farm, filtered through a screen and then stored in large plastic tanks in the greenhouse. Because it solidifies in cold weather, any oil kept outside in the winter must be pre-warmed before use.

Like all new energy systems, a vegetable oil system requires initial start-up costs. For Collins and Nixon, each burner cost about $5,000 and another $500 to set up. About 4 hours per week are required to collect the oil, and maintain the heaters. Assuming labor costs of $10 per hour, their waste vegetable oil system costs them an additional $2,000 annually in labor. But the payback is quick. Eliminating expensive fuel purchases meant that during the 2005–2006 growing season, the farm saved almost $7,000 in fuel costs. When they installed the system, heating oil cost around $2.25 per gallon, and payback was estimated at about 3 1/2 years. As oil prices continue to rise, payback should become even shorter.

Also in Vermont, at State Line Farm in Shaftsbury, SARE grant recipient John Williamson is attempting to create a sustainable and community based biodiesel facility. Williamson began by making biodiesel from waste vegetable oil and has since constructed a passive solar facility on his 110-acre farm to turn locally-grown oilseed crops, such as sunflower, canola, and mustard into biodiesel. He also grows sweet sorghum to distill into ethanol with the eventual goal of producing all of the alcohol needed for biodiesel production.

Williamson strives for a closed-loop system that, when fully operational, could have an annual production capacity of 100,000 gallons of biodiesel, and will produce a valuable by-product: tons of seed meal for sale as animal feed.

"These systems have great potential," said Vernon Grubinger, extension specialist for the University of Vermont and Northeast SARE coordinator. "But the devil is in the details. We're still learning how to grow, harvest, and process crops that have not been traditionally grown here, and we're also figuring out the regulatory and market issues. Pioneers such as State Line Farm are laying the groundwork for survival of small-scale farms when the time comes that fuel costs a whole lot more."

For more information on these projects and other tips on saving money, improving energy efficiency, and renewable energy for small farmers, see http://www.sare.org/publications/energy/energy.pdf, a new energy bulletin from SARE.

The FAMU Whole-Farm Sustainable Biofuels Research and Demonstration Project

Jennifer Taylor, Small Farm Programs
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Biofuels from plant and vegetable oils are an important part of the energy mix for alternative sustainable energy sources of the future. Producing biofuels from agricultural crops grown by farmers is one way to reduce dependency on fossil fuel. On-farm production and processing of oilseed plants contribute to a less toxic environment and environment-friendly biofuels, and value-added food grade vegetable oil. A sustainable production of biofuels from agricultural crops is important for the country, energy stability, and the protection of its citizens' public health and environment.

In an effort to steer small farmers and rural and urban communities toward a thriving sustainable development, Florida A&M University's (FAMU) State Wide Small Farm Programs, in collaboration with Crescent Moon Organic Farm, ATTRA/National Center for Appropriate Technology (NCAT), and Piedmont Biofuels, has held several capacity-building hands-on workshops on alternative sustainable energy—biodiesel fuel/using vegetable oil as an alternative fuel. Our first capacity-building workshop was held in December 2006, where participants learned how to make clean-burning biodiesel fuel and how to build a biodiesel processor.

A successful small farm sustainable biofuels model

The 2006 pilot project equipped innovative farmers and owners of Crescent Moon Organic Farm with a biodiesel processor the and knowledge and skill to make biodiesel fuel—which they now use to power on-farm tractors, backhoes, farm equipment, and trucks. Eight capacity-building hands-on training workshops have been held to date, with nearly 300 people participating. The 1- to 2-day workshops provide participatory education and hands-on training for the community and farming populations, and sessions cover beginning through advanced

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biofuels/biodiesel levels. Our whole-farm sustainable biofuels model provides a demonstration of what can be done to impact lives today and glimpse into the future. Our most recent intermediate biofuels capacity-building sessions took place October 14, 2008, at the FAMU Whole-Farm Sustainable Biofuels Research and Demonstration Farm. On October 30, 2008, Atlanta's Pearl Academy Agriculture and Environmental Center (elementary–middle school) participated in a day of hands-on learning about alternative biofuels and sustainable biodiesel production and a successful small farm tour.

The FAMU Whole-Farm Sustainable Biofuels Research and Demonstration Project was developed to implement an on-farm learning model for sustainable renewable biofuels production and energy.

The Whole-Farm Sustainable Biofuels Demonstration Project, located in Wakulla County at Crescent Moon Organic Farms in Sopchoppy, FL, produces bioenergy from used vegetable oil (from restaurants). The next goal is production of biofuels from oilseed crops, which are harvested, pressed, and converted on-farm to produce sustainable renewable biofuels and electricity. Sustainable renewable biofuels will power the entire farm, equipment, tractors, trucks, and farm house electrical utilities. Crescent Moon Organic Farm is a FAMU partner farm. Crescent Moon provides organically grown vegetables and fruit to local markets and several gourmet restaurants.

Collaborators for this sustainable development project included FAMU StateWide Small Farm Programs/Cooperative Extension Program, Crescent Moon Organic Farms, ATTRA/NCAT, USDA's Agricultural Research Service Sustainable Agricultural Systems Laboratory, and FAMU's College of Engineering Sciences, Technology, and Agriculture.

For additional information about this and other sustainable development efforts, contact: Jennifer.Taylor@famu.edu/ 850-412-5260.

Alternative Fuels in the Greenhouse*

Michael Collins
Old Athens Farm, VT

Since I started growing greenhouse tomatoes in 1989, I have heated with many different fuels and have researched others. I will summarize my experiences and what I feel are the advantages and disadvantages of the two fuels I have settled on as best for my farm.

The recent rise in the cost of traditional fuels has sparked a lot of interest in waste vegetable oil (WVO) and biodiesel. Waste vegetable oil is now my primary fuel. I chose to use WVO rather than biodiesel, because I wanted to avoid the extra time and expense of refining my fuel. I also worry about the toxicity of refining waste, as well as the risk involved in storing and handling large quantities of diesel on my farm. The main advantage to using biodiesel is that it can be burned in a standard fuel oil furnace. Last year I heated two 3,200 square foot greenhouses with two 350,000 Btu Clean Burn furnaces. I burned about 3,000 gallons of waste vegetable oil. One greenhouse was planted with tomatoes on February 20; this heater ran just over 800 hours. It burned 3 gallons per hour, or about 2,400 gallons of oil for the season.

Waste vegetable oil is most often collected from small restaurants. I collect from eight different restaurants. The bulk of the oil, however, comes from three restaurants. These are large family diners that change their oil frequently. The oil is not hydrogenated and is fairly clean. I bring the oil home in the 5-gallon jugs in which it is received by the restaurants. I screen the oil as I pour it into 250-gallon plastic totes. After any solids in the oil have settled I move the oil into the tanks that feed my heaters. I pump it from the top and leave any sludge in the bottom of the tank. My pump is an air diaphragm pump. I also bring about 750 gallons inside before the weather turns cold. Vegetable oil solidifies at temperatures near 32 degrees, so I need to have a large supply inside. In the spring I use an electric tank heater to liquefy oil stored outside, so it can be pumped. I will also store some oil in 55 gallon drums that I can bring into the greenhouse as I need it.

While waste oil is free, using it is not without costs. It must be collected and then stored on site. As described above, there is no small amount of handling. During the summer and fall I collect oil whenever I deliver. Many of the restaurants that give me oil also buy my vegetables. Collection is more of an issue in the winter. I try to combine it with other errands in town, but at times I am forced to make a special trip. I am also left with about 1,000 empty plastic 5-gallon jugs, which I must take to the recycling center. I estimate the extra handling costs me about $1,000.

Waste oil furnaces are expensive. I paid $5,000 for mine, a bargain. A friend and I bought 2 each and were able to negotiate a good price. I then spent another $1,000 per furnace for installation. This included a custom made plenum and ducting to force hot

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• ***We are grateful to the author and to the 2007 New England Vegetable and Fruit Conference for permission to use this article. Note that the article reflects 2007 fuel prices.***

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air into the perforated tubes that run down my isles. Furnace prices have also risen. This year the equivalent heater would cost about $8,000, or $5,500 more than a good quality fuel oil heater. These costs can be recouped over time, if you have a good supply of waste oil.

There is less good quality waste vegetable oil than biofuel proponents would have you believe. I am collecting around Brattleboro VT. More than 15,000 people live in this area. It supports my oil needs and that of fewer than 10 people who run cars on oil or homemade biodiesel. What oil is left is of low quality—it is dirty, or hydrogenated. I have also recently heard that Baker, the main hauler of WVO has begun paying restaurants for their oil. In the past, restaurants have paid a hefty fee to have oil removed. In order to compete with Baker, a good relationship must be maintained with restaurants.

Waste oil burners are somewhat more complicated than regular fuel oil burners; they must be maintained regularly. I perform routine maintenance each week, which involves cleaning screens and filters, scraping lacquer that forms on the burner head, and making sure the orifice is clear. I also check the flame, the stack smoke, and oil pressure daily, just to make sure everything is running smoothly. With poor maintenance these furnaces can fail to fire. I recommend using waste oil burners only in greenhouses with adequate backup heat, unless planting late enough that there is no risk of freezing the greenhouse. I have some form of wood heat in all my greenhouses. I also have temperature alarms in each greenhouse.

Using WVO isn't all bad. I save money in the long run and I have the satisfaction that I have chosen an environmentally friendly heating option.

PHOTO: Mike Collins

I have used wood heat since I started growing in greenhouses. At one point I heated three greenhouses, totaling about 8,000 square feet with 6 wood furnaces. I slept in my greenhouse and woke every 3 hours to put wood on my fires. While I was able to do a passable job with my wood furnaces, I don't recommend such a system. I was a zombie by winter's end and I also sacrificed the fine environmental control that I now know is necessary to produce high greenhouse tomato yields. After 4 years I bought oil heaters to take over when my wood furnaces needed help. However, until I changed to WVO wood remained my main source of heat.

I have a wood boiler in my main early greenhouse. It was an old oil-fired steam boiler onto which I built a 4 ft.x4 ft.x5 ft. masonry fire box. The boiler has 72 2-inch x 3 ft. flues and was rated close to 1,000,000 Btu when it burned oil. I believe it gives me about 600,000 Btus when the flues are clean. I use it to heat a large reservoir of water (750 gal.). The heat exchange comes from two 150,000 Btu unit heaters. A large domestic coil heats the soil in three greenhouses and tempers my irrigation water. Much of this equipment was used and I did most of the set up myself. Still, it cost me close to $1,500.

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I burn primarily scrap hardwood stakes that come from a local mill. I pay about $15 per cord for this wood. Its low cost compensates for the extra handling it requires. Because I have a large reservoir of water, I can begin heating early in the day and store some heat for the night. When this boiler served as my primary heat source I would load it throughout the evening, until bedtime. Burning 50 cords of wood annually ($750) I can provide about half the heat in one greenhouse (3,200 square feet) and the soil heat in three others (7,600 square feet total). Using propane water heaters to heat my soil would cost at least $3000 annually. I save about 1500 gallons of fuel oil (or $3000 at current prices) in my main greenhouse. The wood boiler as my primary heat source saves me between $3,000 and $4,000, minus the cost of handling my wood.

My tomato seedlings are started in a small, 24 ft. x 40 ft., greenhouse. Half the floor is a heated concrete slab on which I directly place my pots and seed trays. The other half has raised beds where I can plant crops after I no longer need the space for seedlings. These beds are also heated. The primary heat comes from a propane heater, but the slab and beds are heated by a Kerr wood boiler. I also have a small 50,000 Btu unit heater attached to the boiler. I burn about 5 cords of wood to heat this slab. The propane water heater it replaced burned about 1,000 gallons of propane. It is tough to guess exactly how much I save overall with this system, but it is significant. I bought the boiler used for $200. I paid a plumber to install it, at a cost of $800. I burn a combination of cordwood and scrap wood.

PHOTO: Mike Collins

Before my change to WVO, my second tomato house was heated with fuel oil, supplemented with a large wood furnace that I made from a 275-gallon oil tank. The wood furnace provided me with up to 200,000 Btu per hour. The advantage of a simple furnace is that it is very cheap to make, easy to install, and needs no electricity to run. Mine was set up under my oil heater. I depended on the blower from the oil furnace and my horizontal air flow fans to circulate the heat. I have had problems providing proper draft to this type of furnace. At times, if the fire is too big the furnace can chug and puff smoke. I have taken care of this by forcing draft air into the fire chamber. A 2-inch pipe can be run out through the greenhouse end wall. A small blower pushes air into this pipe.

Alternative fuels are not for everyone. Using them creates more work, especially during the transition phase when your new system may not be running smoothly and you have not yet become efficient at handling your new fuels. They are never free. Your time must be figured into their cost. However, using alternative fuels will save money in the long run and will sometimes increase yields by taking away the incentive to cut corners by turning the thermostat down.

I am very happy with my WVO system, but before running out and buying an $8,000 furnace I recommend researching the availability of oil in your area and asking yourself if you are willing to spend the time and effort to make sure you can take good care of your oil accounts.

For many in New England wood is often the best alternative fuel. Although the simplest heater is a wood stove, I prefer a boiler. A hot water system offers thermostatic control and the ability to run ground heat from the same system. Some growers are using large central outdoor boilers, a choice I recommend looking into.

For Ethanol Production, Small Can Be Beautiful

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The United States has the world's largest industrial ethanol program. In 2007, 20 million acres of corn (25 percent of our corn fields) were harvested and processed, and nearly 7 billion gallons of ethanol were blended into gasoline.

So far, this ethanol has displaced less than 5 percent of our gasoline consumption, reduced our energy use by under 1 percent, and has not substantially reduced America's dependence on petroleum. (A similar savings might have been achieved by a program to ensure that the nation's tires were properly inflated.) It is possible, however, that emerging technology will allow more sustainable large-scale production from high-cellulose feedstocks, such as corn stover, switchgrass, or woodchips.

In the meantime, a few small farmers are using existing technology to replace much of their own gasoline use with ethanol made in small quantities from a range of locally-available feedstocks. Such small-scale, decentralized ethanol production can save money and enhance the sustainability of small farms.

Intelligently designed and locally appropriate small-scale ethanol production can avoid many of the problems association with our current industrial corn-to-ethanol program. Ethanol will not get the nation off foreign oil, but it can get some farms off purchased gasoline. The rise of gasoline prices past $4 per gallon offers considerable motivation to give it a try.

Sustainable on-farm ethanol fuel production requires an assessment of the resources available on the farm, and knowledge of the principals of fermentation and distillation. Gasoline engines must be modified to run on ethanol, which requires a lower air:fuel ratio than gasoline, and delivers only two-thirds as much energy per gallon as gasoline. Producing ethanol on the farm also requires a fuel alcohol producer permit from the Alcohol and Tobacco Tax and Trade Bureau.

Principals of ethanol production

In the absence of oxygen, yeast converts **sugar** to carbon dioxide and ethanol through **fermentation**. Bakers use this reaction to get the carbon dioxide that makes their dough rise; brewers, wine-makers, and distillers of spirits use it to make alcohol. Most ethanol fuel makers rely on exactly the same reaction.

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Many plants traditionally used for sweeteners, such as sugarcane, sugar beet, or fruit crops, produce sugar that can be used for fermentation. Starchy plant parts, such as tubers or grain, can also be sugar sources for fermentation because **starch** is a long string of sugar molecules that are easily broken apart by common enzymes. Plants use starch as an energy storage medium because it is easily converted to sugar: The starch in this fall's grain or tuber provides an energy source for next spring's seedling.

Sugars and starches are called **carbohydrates**. They provide most of the calories in most human diets. Another carbohydrate, which humans cannot digest, is **cellulose**. (We call the cellulose in our food **dietary fiber**, and it goes right through us.) Like starch, cellulose is a string of sugar molecules, but unlike starch, cellulose does not break down into sugar easily. Plants use cellulose to make cell walls because it is stiff and durable. Few organisms produce enzymes that convert cellulose to sugar. The ones that do are mostly fungi and bacteria, such as the bacteria in the guts of termites and cattle that allow these animals to digest wood, grass, and other cellulose-rich plant parts.

Because of the difficulty in converting cellulose to sugar, it is not used for on-farm ethanol production. Almost all ethanol fuel—like the ethanol in alcoholic drinks—currently comes from starchy or sugary plant parts. Considerable research efforts are focused on finding economical means of converting cellulose to sugar, to allow **cellulosic ethanol** production.

Yeast dies when ethanol content exceeds about 18 percent, so **distillation** is needed to achieve higher ethanol concentrations. Ethanol boils at a lower temperature than water, so it can be evaporated out of the mixture by heating, then condensed on water-cooled coils. The distillation process yields a mixture that is up to 94 percent pure ethanol, called **hydrous ethanol**, which can be burned as fuel but cannot be mixed with gasoline. Another step, called **dehydration**, is needed to produce **anhydrous ethanol**, which is less than 1 percent water and mixes with gasoline.

Resource needs

Put simply, the major resources needed for ethanol fuel production are sugar, water, and energy for distillation. The key to sustainable small-scale production is identifying locally-available and renewable sources of these resources. Many low-input crops produce more sugar per acre than corn, and are more compatible with diversified small farming systems. Sweet sorghum, sweet potato, and Jerusalem artichoke grow well without fertilization or irrigation in my part of Kentucky, and our large pawpaw orchard generates a lot of sugar-rich fruit waste. Another small farm would likely have an entirely different mix of potential sugar sources.

Some farms are blessed with ample water resources and others are not. The beauty of decentralized production is that solutions can be tailored to take advantage of available resources. On-farm ethanol production may be more sustainable in areas where rainfall is plentiful than in areas where water comes

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from dwindling aquifers.

High-cellulose plant materials—like hay bales, corn stover, or wood chips—are not currently usable sugar sources for on-farm ethanol production, but they can still be useful renewable energy sources for distillation. In Brazil, most of the heat for ethanol distillation comes from burning the high-cellulose material left over after sugarcane is squeezed to extract the fermentable sugary juice. This is part of the reason that Brazil's ethanol production is energetically and environmentally superior to most ethanol production in the United States, where coal and natural gas are burnt to generate heat for distillation. In areas where sunlight is plentiful, solar thermal systems can also contribute renewable heat for distillation.

Dehydration is an energy-intensive step that is only necessary if ethanol will be mixed with gasoline. On-farm ethanol systems can produce hydrous ethanol, which cannot be mixed with gasoline, for exclusive use in engines that have been adapted to run on ethanol.

An intriguing small-scale ethanol production apparatus that includes the dehydration step will be commercially available by the end of the year. Called the MicroFueler, it will integrate fermentation, distillation, dehydration, ethanol storage, and pumping steps into a single machine designed to make 35 gallons of ethanol each week from sugar, water, and electricity. At $10,000 this machine is more expensive than a traditional fermentation and distillation system with similar ethanol output. Nonetheless, I am intrigued by the design's focus on ease-of-use, and pleased to see innovative technology applied to small-scale production.

Summary

America's large-scale corn-to-ethanol program has many disadvantages that are not inherent to small-scale ethanol production. Small farms that can sustainably produce starch or sugar and have access to renewable water and heating fuel can make ethanol using existing technology. The ability of small farms to use locally-appropriate technology to convert their most plentiful resources may make small-scale ethanol production more sustainable than the industrial systems currently used for most ethanol production. Ethanol can do little to make the nation energy-independent, but can significantly reduce the dependence of some small farms on purchased gasoline.

Canola and Biodiesel: On-farm Small-scale Production and Utilization

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Introduction

The new 21st century is shaping up to become the biofuel and bioenergy century**.** Communities involved in the production of food and feed will need to be involved in the production of feedstock to supply the biofuel industry in the near future. This will provide an opportunity to all farmers (large and small) to produce for the green energy market and prosper as the new bioenergy market keeps expanding. The 21st century may create a new paradigm for rural development. Rural communities have been depressed in the past few decades. Biofuels can provide an opportunity to champion the biofuel and biorefinery industry for the benefit of our small farm clients.

The U.S. Department of Energy's (DOE) strategic energy goal is to "protect our national and economic security by promoting a diverse supply and the delivery of reliable, affordable, and environmentally sound energy." Applying agriculture to build a new U.S. bioenergy industry can provide American farmers with important new sources of revenue.

Biodiesel, produced from domestic, renewable resources, is a clean burning alternative to petroleum-based diesel. Pure biodiesel does not contain petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend. At lower blend levels, biodiesel can be used in diesel engines with little or no modification. Biodiesel is biodegradable, non-toxic, and essentially free of sulfur and aromatics. Most of 75 million gallons of biodiesel produced in 2005 came from soybean oil. Alternative feedstocks for biodiesel manufacturing include oils from established oil crops, such as cotton and peanuts, and new crops (e.g., canola, mustard, and camelina). The future for biodiesel looks bright, both near and long term. As with ethanol, the Energy Policy Act of 2005 is expected to encourage growth for biodiesel, and is a major reason that the biodiesel production was projected to reach 1.7 billion gallons by mid-2008. The U.S. Environmental Protection Agency (EPA) estimates that biodiesel generates 50 percent more energy than the fossil energy used to produce the feedstock. According to EPA, biodiesel reduces petroleum use by about 85 percent compared to diesel fuel. In 2004, the latest year for which sales information is available, approximately 75 million gallons of B100 biodiesel were sold.

The current domestic biodiesel production equates to less than two-tenths of 1 percent blend rate. A B2 blend (2 percent biodiesel and 98 percent petroleum diesel) blend is attainable in the United States. It will require 1.1 billion gallons of pure biodiesel, which will

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consume all the soybean oil from 18 million acres (about 25 percent of U.S. soybean production). This is an area where research for development of alternate oil crops to provide feedstocks for biodiesel can play an extremely important role.

In order to change the way we use energy and to realize the benefits of biodiesel, not only will research and development need to persist by engineers and scientists, but farmers, business, community, and government leaders will need to make informed public policy decisions and continue to support research and development as well as deployment activities. Consumers will need to have an accurate understanding of the benefits of biodiesel and the long-term goals and opportunities.

An on-going project at Virginia State University promotes small-scale production of biodiesel from on-farm produced canola. This technology involves production of canola, conversion of canola oil into biodiesel, and use of biodiesel in farm machinery.

What is Canola?:

Canola (Scientific name: *Brassica napus* L.), is a member of mustard family (Cruciferae) and is closely related to turnip, cabbage, cauliflower, broccoli, and mustard. It is now the third most important source of vegetable oil in the world. Canola is the name given to a group of rapeseed varieties that are low in erucic acid and low in glucosinolates. The rapeseed oil is not fit for human consumption due to presence of erucic acid in its oil, whereas canola oil is considered very desirable for human consumption due to its desirable fatty acid composition. Rapeseed meal is not suitable for use as livestock feed due to the presence of glucosinolates, whereas canola meal is essentially free of glucosinolates and is a good livestock feed. Oil from both rapeseed and canola is suitable for conversion into biodiesel. Both winter and spring types of varieties of canola exit.

PHOTO: Canola Seed, Dr. H. Bhardwaj

Canola Production Details

Based on research conducted in Virginia and information available from elsewhere, the following recommendations are made for canola production in Virginia:

- Planting time: middle of September to early October in the Northern Piedmont region; October in the Southern Piedmont region; and middle of October to early November in the coastal plain region of Virginia
- Seeding rate: 5 pounds of seed per acre. Canola should be planted as shallow as possible
- Fertilizers: 100 pounds/acre each of N, P, and K (on soils testing medium in P and high in K) and 30 pounds/acre of sulfur

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- Row spacing: Even though canola can be planted in rows varying from 6 to 36 inches or broadcasted, preliminary recommendation is for canola to be planted in rows varying from 12 to 24 inches
- Canola should be harvested promptly upon maturity. Canola, in Virginia, generally matures in mid-to-late June

What is Biodiesel?

Biodiesel is the name of a clean-burning alternative fuel, produced from virgin or used vegetable oils. Biodiesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend. It can be used in compression-ignition (diesel) engines with little or no modification. Biodiesel is simple to use, biodegradable, nontoxic, and essentially free of sulfur and aromatics.

Biodiesel is made through a chemical process called "transesterification," whereby the glycerin is separated from the fat or vegetable oil. This process generally involves mixing methanol and lye with an oil, then allowing for sufficient time for the reaction to take place. The process leaves behind two products -- methyl esters (the chemical name for biodiesel) and glycerin (a valuable byproduct usually sold for use in soaps and other products). Biodiesel is defined as mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats that conform to ASTM D6751 specifications for use in diesel engines. Biodiesel refers to the pure fuel before blending with diesel fuel. Biodiesel blends are denoted as "BXX," with "XX" representing the percentage of biodiesel contained in the blend (e.g., B20 is 20 percent biodiesel and 80 percent petroleum diesel). Most farm machinery can easily use B50 biodiesel. However, older equipment may need replacement fuel lines and hoses, as biodiesel acts as a solvent. In older equipment, biodiesel tends to dissolve deposits and erode rubber hoses.

Biodiesel is better for the environment because it is made from renewable resources and has lower emissions compared to petroleum diesel. It is less toxic than table salt and biodegrades as fast as sugar. Since it is made in the United States from renewable resources such as soybeans, its use decreases our dependence on foreign oil and contributes to our own economy.

Benefits of Biodiesel

- In 2000, biodiesel became the only alternative fuel in the country to have successfully completed EPA-required Tier I and Tier II health effects testing under the Clean Air Act. These independent tests conclusively demonstrated biodiesel's significant reduction of virtually all regulated emissions, and showed biodiesel does not pose a threat to human health
- Biodiesel contains no sulfur or aromatics, and use of biodiesel in a conventional diesel engine results in substantial reduction of unburned hydrocarbons, carbon monoxide and particulate matter. A DOE study showed that the production and use of biodiesel, compared to petroleum diesel, resulted in a 78.5 percent reduction in carbon dioxide emissions

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Moreover, biodiesel has a positive energy balance. For every unit of energy needed to produce a gallon of biodiesel, 3.24 units of energy are gained

- With agricultural commodity prices approaching record lows, and petroleum prices approaching record highs, it is clear that more can be done to utilize domestic surpluses of vegetable oils while enhancing our energy security. Because biodiesel can be manufactured using existing industrial production capacity, and used with conventional equipment, it provides substantial opportunity for immediately addressing our energy security issues

- If the true cost of using foreign oil were imposed on the price of imported fuel, renewable fuels, such as biodiesel, would probably be the most viable option. For instance, it was estimated in 1996 that the military costs of securing foreign oil was $57 billion annually. Foreign tax credits accounted for another estimated $4 billion annually and environmental costs were estimated at $45 per barrel. For every billion dollars spent on foreign oil, America lost 10,000-25,000 jobs

- Increased utilization of renewable biofuels results in significant microeconomic benefits to both the urban and rural sectors, and the balance of trade. A study completed in 2001 by the U.S. Department of Agriculture (USDA) found that an average annual increase of the equivalent of 200 million gallons of soy-based biodiesel demand would boost total crop cash receipts by $5.2 billion cumulatively by 2010, resulting in an average net farm income increase of $300 million per year. The price for a bushel of soybeans would increase by an average of 17 cents annually during the 10-year period

- In addition to being a domestically-produced, renewable alternative fuel for diesel engines, biodiesel has positive performance attributes, such as increased cetane, high fuel lubricity, and high oxygen content, which may make it a preferred blending stock with future ultra-clean diesel

- Biodiesel is registered as a fuel and fuel additive with the EPA and meets clean diesel standards established by the California Air Resources Board (CARB). B100 (100 percent biodiesel) has been designated as an alternative fuel by DOE and the U.S. Department of Transportation. Moreover, in December 2001, the American Society of Testing and Materials (ASTM) approved a specification (D6751) for biodiesel fuel. This development was crucial in standardizing fuel quality for biodiesel in the U.S. market

- The National Biodiesel Board, the trade association for the biodiesel industry, has formed the National Biodiesel Accreditation Commission (NBAC) to audit fuel producers and marketers in order to enforce fuel quality standards in the United States.

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NBAC issues a 'Certified Biodiesel Marketer' seal of approval for biodiesel marketers who have met all requirements of fuel accreditation audits. This seal of approval will provide added assurance to customers and engine manufacturers that the biodiesel marketed by these companies meets the ASTM standards for biodiesel and that the fuel supplier will stand behind its products

- Effective November 1998, Congress approved the use of biodiesel as an Energy Policy Act (EPAct) compliance strategy. The legislation allows EPAct-covered fleets (federal, state, and public utility fleets) to meet their alternative fuel vehicle purchase requirements simply by buying 450 gallons of pure biodiesel and burning it in new or existing diesel vehicles in at least a 20 percent blend with diesel fuel. The Congressional Budget Office and USDA have confirmed that the biodiesel option is the least-cost alternative fuel option for meeting the federal government's EPAct compliance requirements. Because it works with existing diesel engines, biodiesel offers an immediate and seamless way to transition existing diesel vehicles into a cleaner burning fleet

Extensive details about biodiesel are available from the National Biodiesel Board.

Extensive details about canola are available at the US Canola Association Web site, the Canola Council of Canada, or from most land-grant universities.

Equipment:

In order to establish a small-scale unit, following is needed:

1. A seed crusher or a supply of virgin or used vegetable oil
2. A biodiesel processor and appropriate chemicals
3. A well-ventilated shed
4. A source of electricity and water
5. Containers for oil, biodiesel, and glycerin

The seed crusher at Virginia State University was imported from China at a cost of approximately $1,000. We have an automatic biodiesel processor from Utah Biodiesel that costs approximately $8,000. This processor uses 50 gallons of vegetable oil and produces 50 gallons of biodiesel in 48 hours. A bigger version of this crusher (100

PHOTO: Seed Crusher, Dr. H. Bhardwaj

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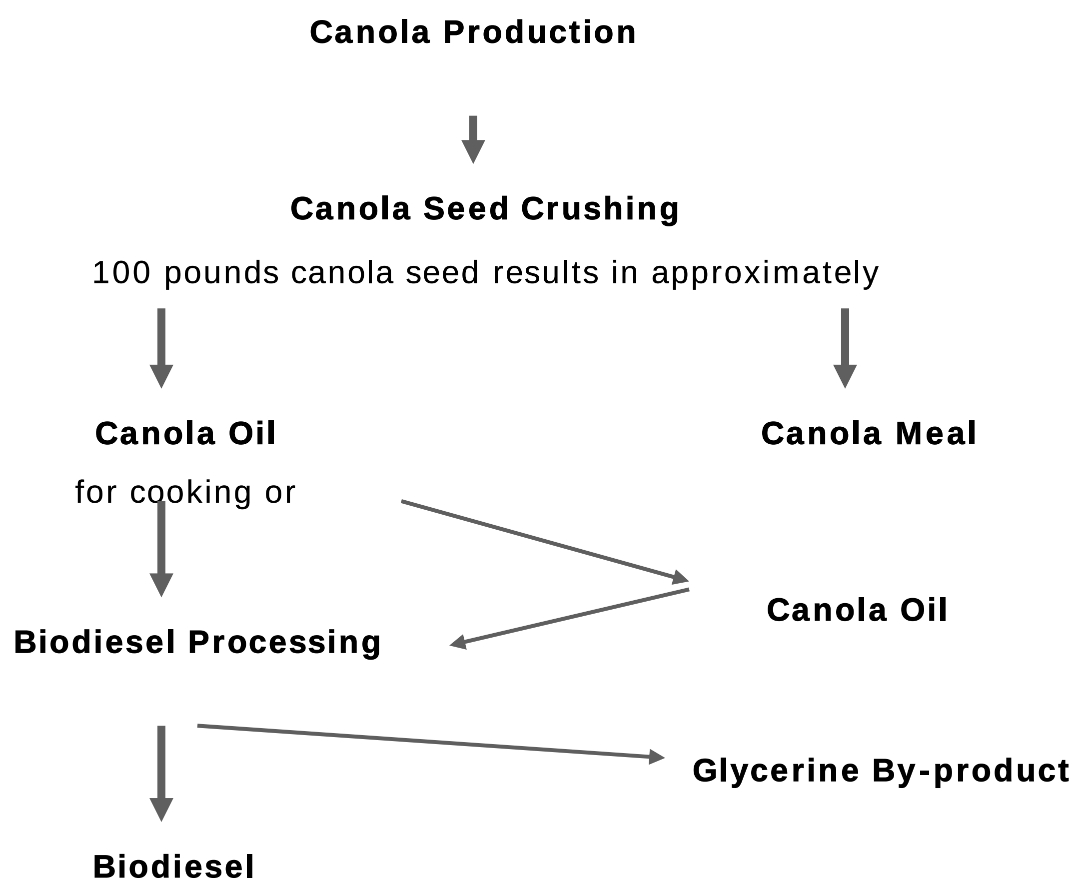
gallons of biodiesel from 100 gallons of vegetable oil) is also available. We have also demonstrated the use of a Fuelmeister biodiesel processor that costs approximately $4,000. Different configurations of Fuelmeister equipment are available. (Use of any trade names or vendors does not imply approval to the exclusion of other products or vendors that may also be suitable.)

Both of these biodiesel processors, and others, are capable of using used vegetable oil (i.e. the oil that has been previously used for cooking, frying, etc.)

Demonstration

The small-scale biodiesel technology using canola oil was demonstrated on June 19, 2008, at the farm of Paul Davis, a farmer in New Kent County, VA. This field day, a cooperative effort of Virginia State University, Virginia Agricultural Council, Virginia Cooperative Extension and USDA's Cooperative State, Research, and Extension Service, was attended by approximately 70 farmers and consumers. The demonstrations included harvesting canola with a combine, crushing canola seed to obtain oil, converting canola oil into biodiesel, and using biodiesel in farm machinery.

On-farm Biodiesel Production from Locally-grown Canola



Woody Biomass: an On-Farm Opportunity

Daniel Cassidy, National Program Leader, Cooperative State Research, Education, and Extension Service

There is a not-so-subtle change taking place across America. The increasing price of petroleum and our nation's dependence upon unstable foreign powers for its supply has spurred a revival in ethanol, bio-diesel, and other agriculturally-based fuels. The president has challenged the American people to overcome our oil addiction. At the same time, natural gas prices have increased from $3 in 1999 to over $8.50 per thousand cubic feet today.

It costs us more now to fuel, heat, and power our nation than ever before. American farm families have answered this challenge with increases in corn production for ethanol, innovative increases in the production of bio-diesel, and new "energy crops" to co-fire or burn with coal or natural gas to reduce the amount of fossil fuels used. However, another on-farm resource remains mostly untapped. Experts agree that the woody biomass from non-industrial private landowners is still the richest and deepest resource to combat reducing fossil fuel production.

What is Woody Biomass?

Woody biomass is comprised of tops, limbs, branches, stumps, chips, and sawdust that remain on-site after harvest. Currently, most of this debris is left on-site and must be treated (e.g., burned, crushed, or piled) to reestablish the next generation of forest. Woody biomass also consists of trees removed for pre-commercial thinning, timber stand improvements, and salvaging cuts. Over time, forests can become overstocked, consisting of poorly growing trees that hinder the development of higher-valued timber, while also serving as a breeding ground for various insects and diseases. Overstocked forests also pose a wildfire threat. Their closely spaced crowns can propel fire upwards and across the forest canopy, spreading until a mega-fire results. Recent fires in southern California and New Mexico are abject examples of the habitat damage and potential loss of human life and capital investment that can result from overstocked forests. These fires scorch the soil, reducing fertility and creating a greater risk of erosion, while emitting volatile chemicals and gases into the environment. Wildfires have been cited as a cause of climate change and increased greenhouse-gas emissions.

Many Americans are under the impression that our forests are owned, managed, and protected as state or national parks and forests for the public benefit. In fact, less than 30 percent of forested land is managed by the U.S. Forest Service and other public agencies. Over 11 million private family forest landowners manage nearly 60 percent of all the forests in our nation; that is about 423 million acres. The majority of these landowners have 10 or fewer acres in ownership. The woodlots may be small in size but it is vital to keep these working lands working.

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The U.S. departments of Agriculture and Energy released a report that stated America could reduce its dependency on fossil fuels by 30 percent in the year 2030 by replacing it with biomass-generated energy. A majority of this impact will have to come from forestlands, effectively more than doubling the amount of woody biomass currently produced. Currently 142 million dry tons of woody biomass are consumed annually in the United States; the report estimates that this consumption could increase to a near annual level of 368 million dry tons. To achieve this goal, private forestlands would contribute nearly 80 percent of the total.

Clearly this will change how small, private woodlot owners manage their lands. The increased market demand will help improve sustainability of the resource by reducing forest degradation from high-grading the best trees, as well as help to counter some of the development pressures many small woodlot and farmland owners face from urban and suburban expansion. The new markets could also reinvigorate forest-dependent communities that have been in decline and create a sense of rebirth in logging towns. Pellets are one of the fastest growing wood products. The compressed wood bullets are used to heat boilers and wood stoves and are primarily made from wood waste, sawdust, and harvest debris. With over 1.1 million tons of pellets produced annually in North America, many small woodlot owners have already started to take advantage of this growing industry.

Woody Biomass Utilization

Many case studies that show that industries have reaped substantial economic benefits from using heat and energy from woody biomass. Laurel Lumber Co., in Mississippi, estimates an annual savings of $200,000 since it switched from natural gas-fired kilns and began using wood waste commonly found on-site. Public schools in Wisconsin, Vermont, and Montana have also seen increased savings by heating with wood. Darby Public Schools, in Montana, were able to divert almost $91,000 annually from the cost to heat the school with fuel oil back into the school's general budget. The pulp and paper industry is almost self-sustaining with regards to heat and energy by electing to use sawdust, wood waste, and black liquor from pulping to produce heat.

Woody biomass can also play a huge part in reducing on-farm costs. Pellet-fired furnace systems are already being used by many chicken houses in the Southeast where woody biomass is abundant. Many of these small farmers are reporting nearly a 50 percent savings on fuel costs annually. With fuel being one of the major economic inputs into the farming system, this is allowing greater expansion or savings for farming families.

Another area of consideration is the homestead. An average home requires 11,160 kilowatt-hours annually to meet its energy consumption. If a high-efficient wood-fired stove or generator were to be the main source

PHOTO: Wood pellets, North Energy Associates

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of this power, it would require only 2.4 dry tons of woody biomass yearly. Given that West Virginia reported an average of 8 tons per acre of harvesting waste left after operations, the potential for energy independence could be within reach.

The combustion of wood for energy does result in the build-up of ash, a waste material that will need to be eliminated. Typically ash is delivered to landfills but that practice is becoming increasingly costly. However, just like harvesting residues were once seen as wastes, ash might have a benefit to the small family farmer as well. Ash is considered a “low grade” fertilizer, comprised of potassium, phosphorus, magnesium, aluminum, and sodium. Ash is also an excellent liming agent because of its very high calcium content. Just a fuel is a major economic input on a farm, so are fertilizers and lime. Using the ash “waste” might be a wonderful money-saving alternative. With every new approach, caution must be taken; ash can be high in heavy metals and should be tested prior to use.

Resources for Woody Biomass Utilization

Biomass boilers have shown to be environmentally beneficial and reduce the costs of heating and powering homes and farms; however, the initial conversion or replacement of a gas-fed boiler system can be expensive.

The U.S. Department of Agriculture (USDA) has several opportunities for small farm families to request assistance. USDA Rural Development provides both grants and loans under the Section 9006 program. The loans can cover up to 50 percent of the eligible costs and range from $5,000 to $10 million. The grant program covers up to 25 percent of the eligible costs and range from $2,500 to $500,000. Agricultural producers, including ranches, forestry operations, and aquaculture producers, are eligible for this program, provided 50 percent or more of their gross income is generated by these businesses. Interested applicants should contact their state rural energy coordinator.

USDA’s Natural Resources Conservation Service (NRCS) offers assistance through the Conservation Innovation Grant (CIG) program. CIGs encourage the development and adoption of innovative conservation approaches and technologies. One area of the CIG deals entirely with improved on-farm energy efficiency issues, such as enhancements for renewable energy, improvements to energy efficiency, and on-farm energy audits. Recent CIG awards have ranged from $48,000 to nearly $1 million. Limited resource and beginning farmers are highly encouraged to participate in this competitive program. Interested applicants should contact their local NRCS service center.

Woody biomass utilization can play a vital role in developing the energy independence and security that we are aiming for. It can also provide great benefits to small woodlot owners. However, care should be taken to consistently utilize Best Management Practices for harvesting in order to maintain soil, air, and water quality as well as wildlife habitat. You should always work with a certified forester, local county forester, or forestry extension agent while planning your operations.

Online Resources

USDA's CSREES Briefing Room information on research, outreach, and educational programs related to renewable energy, supported by CSREES, its and other federal agencies.

eXtension: An interactive Web site offering educational and information resources from the land-grant university system on a wide range of topics. A new resource area on renewable energy will be available shortly.

Farm Energy Publications from the National Sustainable Agriculture Information Service.

Small Farm Energy Primer**,** produced by the Center for Rural Affairs in 1980, this publication still offers a variety of ways small scale producers can lower their on-farm energy costs.

Renewable Energy Initiatives, produced by the University of Minnesota, provides information on renewable energy.

Bioenergy: Economic Research Service briefing room.

Agriculture and Rural Communities Are Resilient to High Energy Costs, Amber Waves, U.S. Department of Agriculture's (USDA) Economic Research Service (ERS).

Energy Estimators**:** Tools to help farmers and ranchers identify where they can cut their energy use, produced by the USDA's Natural Resources Conservation Service.
Montana Green Power: information on a variety of renewable energy technologies.

Farmstead Energy Audit, tips on how to reduce costs, produced by North Dakota State University Extension Service.

New American Farm Conference, March, 2008. Sustainable Agriculture Research and Education's (SARE) In particular, note track 1: Energy Efficiency and Conservation on the Farm.

Clean Energy Farming: Cutting Costs, Improving Efficiencies, Harnessing Renewables, SARE.

SARE Project Reports, SARE database includes reports on energy-related projects

The Value and Use of Distillers Grains By-products in Livestock and Poultry Feeds: University of Minnesota Web site offers up-to-date information on the use of distillers grains as animal feed

National Biodiesel Board

Ethanol Expansion in the United States: How Will the Agricultural Sector Adjust? A report from ERS.

Sun Grant Initiative, a regionally organized network of land-grant universities and federally funded laboratories working providing research, education, and extension for a biobased economy.

More Online Resources

Energy Newsbriefs from Washington State University.

Renewable Energy Systems and Energy Efficiency Improvements Program**:** USDA's RuralDevelopment offers loan guarantees and grants to agricultural producers and rural smallbusinesses to purchase and install renewable energy systems or to make energy efficiency Improvements.

Small Business Innovation Research program, CSREES offers grants to small businesses, including small and medium-sized farms to support research related to problems and opportunities in agriculture. Projects dealing with agriculturally-related manufacturing and alternative and renewable energy technologies are encouraged across all 2009 topic areas.

U.S. Department of Energy Web site on Bioenergy

Harvesting Clean Energy

Bioenergy and Biofuels, USDA's National Agricultural Library (NAL)

Bioenergy and Biofuels, Alternative Farming Systems Information Center, NAL

Ethanol Expansion in the United States: How Will the Agricultural Sector Adjust? A report from the USDA Economic Research Service

Harvesting Clean Energy

Bioenergy and Biofuels, USDA's National Agricultural Library (NAL)

Bioenergy and Biofuels, Alternative Farming Systems Information Center, NAL

US Canola Association

Canola Council of Canada

Upcoming Events

DATE	2009 EVENTS	LOCATION
January 2 - 3	Saving Rural America	Louisville, MS
January 15 – 17	Women in Blue Jeans	Mitchell, SD
January 21 - 24	Practical Tools and Solutions for Sustaining Family Farms	Chattanooga, TS
January 29 - 30	Overall Women	Bettendorf , IA
February 1 - 4	6th National Biodiesel Conference and Expo	San Francisco, CA
February 1 – 7	Networking Association for Farm Direct Marketing and Agritourism	Savannah, GA
February 4— 5	Midwest Women in Agriculture Conference	Plymouth, IN
February 5—7	Farming for the Future	State College, PA
March 1—3	California Small Farm Conference	Sacramento, CA
March 14	Opening Doors to Success	Wilmington, OH
March 25 – 27	Small Log Conference	Coeur d'Alene, ID
April 1	National Risk Management Conference	Reno, NV
May 31—June 3	North American Agroforestry Conference	Columbia, MO
June 10—11	Changing Lands, Changing Hands	Denver, CO
August 1—2	Florida Small Farms Alternative Enterprises conference	Kissimmee, FL

UNITED STATES DEPARTMENT OF AGRICULTURE

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See the Small Farm Web site for the most up-to-date listing of events. We welcome submissions of events from our subscribers that would be of interest to the small farms community so that our Upcoming Events listing reflects a diversity of events from all regions of the country. Please send submissions to Patricia McAleer at pmcaleer@csrees.usda.gov; 202-720-2635.

PHOTO BY USDA/CSREES

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- If you have questions about the Small Farms Digest, or to subscribe or unsubscribe to this newsletter, please contact Patricia McAleer at pmcaleer@csrees.usda.gov or call (202) 720-2635.