Energy from Biofuels:

The Greening of America

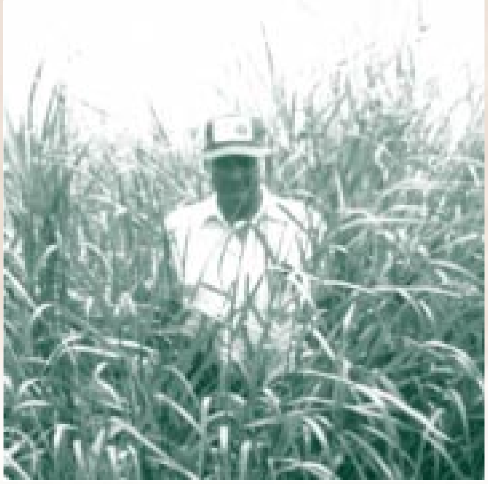
Fast forward: Twenty years down the road, you drive up to a fuel pump and notice that the labels have changed. Instead of "regular," "midgrade," and "premium," the pumps offer "poplar," "willow," and "switchgrass." The labels may never read quite that way, but there's a fair chance that within a decade the liquid gushing out the nozzle and into your car will have its roots in a farm field rather than an oil field. The Office of Energy Efficiency and Renewable Energy in the U.S. Department of Energy (DOE) is laying the groundwork for a new class of fuels, called *biofuels*, made from fast-growing trees, shrubs, and grasses, known collectively as *biomass* crops.

Biofuels offer several important advantages over fossil fuels such as petroleum and coal. Biofuels recycle carbon dioxide during each growing season, taking it from the air and converting it into biomass, rather than simply releasing carbon from prehistory's warehouse, as burning coal or oil does. They're renewable, so they don't deplete Earth's limited natural resources. They're based on agriculture—on energy crops—so they're good for America's rural farm economy. And, they're domestically produced, not imported.

About half the nation's oil today is imported—far more than at the time of the oil embargoes of the 1970s, when DOE began exploring the potential of biofuels. Most of today's oil imports still come from parts of the world that are politically volatile. Greater reliance on domestic energy resources—*renewable* domestic energy resources—is a smart policy. In an important step toward that policy, DOE is sponsoring a program of biomass research, involving scientists at universities, private companies, and federal laboratories across the nation.

One part of the DOE program focuses on the technology to convert energy crops into liquid fuels, such as *ethanol*, to power the nearly 200 million vehicles on U.S. roads. Ethanol, a form of alcohol, is already the most common biofuel. U.S. production of ethanol—mainly from corn—is approaching 1.5 billion gallons per year. The DOE program is aiming far higher, though, by developing technologies for converting many different types of biomass to fuels more efficiently, with little waste. Such conversion technologies are being developed by DOE's National Renewable Energy Laboratory.

The other part of the program focuses on developing hardy, high-yield crops that are virtually designed with energy production in mind. Overseeing this effort is the Bioenergy Feedstock Development Program, located at Oak Ridge National Laboratory (ORNL), one of the nation's largest and most experienced energy-research centers.



Fast-growing trees and grasses, grown as energy crops, could yield billions of gallions of gallons of biofuels each year.

Down on the farm

Most people know that some American farmers have a tough time turning a profit. Fewer people realize that farmers are victims, in part, of their own success. Dramatic gains in farm productivity have led to increased production from less land. The result? Falling prices, shrinking profits, and growing tracts of surplus land. During the 1990s, for instance, an average of 50 to 55 million acres of agricultural land have been taken out of production each year for conservation and economic reasons.

ORNL researchers envision biomass crops on much of that farmland—especially land that's erosion-prone or, for other environmental reasons, unsuitable for row crops. One biomass crop that can readily be grown on most cropland is *switchgrass*, a native American prairie grass. Because it's sometimes used for hay—and planted to control erosion—switchgrass is already familiar to some farmers. Also promising are fast-growing trees and shrubs such as *hybrid poplars* and *willows*. Both tree and grass crops can produce annual yields as high as 10 dry tons of biomass per acre—enough to make 1,000 gallons of ethanol per acre every year.

If two-thirds of the nation's idled cropland were used to grow energy crops, the result could be dramatic: those 35 million acres could produce between *15 and 35 billion gallons* of ethanol each year to fuel cars, trucks, and buses.

Banking on biomass

Dick Schultz stands on an Iowa streambank and looks upstream and down. The banks are thickly clustered with willows; alongside grow silver maples, ash, and hybrid poplars. A strip of waist-high switchgrass borders the trees, separating them from a large cornfield. Between the stream's gently sloping banks, the water flows slowly and clearly.

Three years earlier, the view from this same spot was far different, says Schultz, a forestry researcher at Iowa State University. Cornstalks ran all the way to the bank, some tipping crazily off the edges. The stream ran hard and fast between steep, collapsing banks. Drainage lines dumped runoff water laden with fertilizer and insecticides directly into the stream.

What's saving this stream is a *buffer zone* of trees and grass—in other words, biomass. Just 22 yards wide, the buffer zone protects the stream's banks and water from *erosion*, *siltation*, and *chemical runoff*. Eventually, Schultz hopes to see hundreds more miles of rivers and streams protected by thousands more acres of buffer zones. He also hopes to see those buffer zones harvested regularly for biomass—the switchgrass annually, the trees every 10 years, perhaps—to produce income for farmers and energy for America.

Energy crops provide better wildlife habitat than row crops.

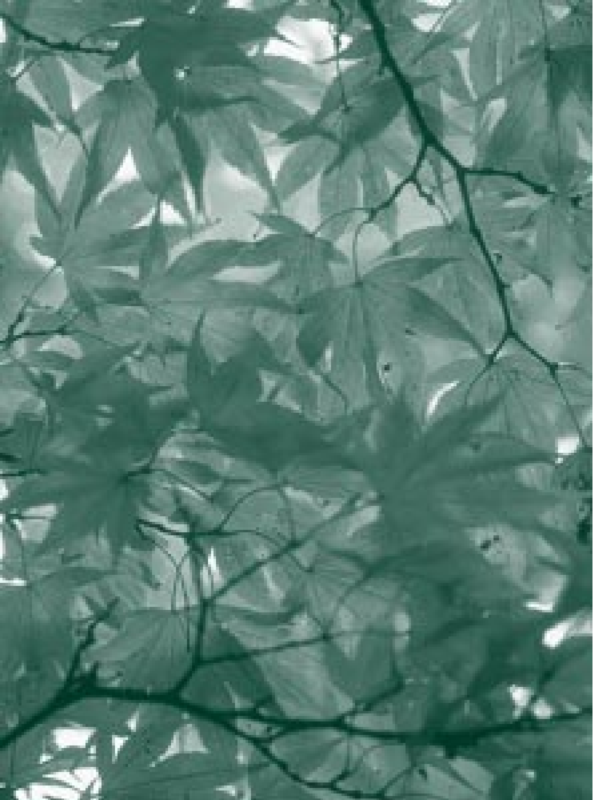
Winging it

At 6:07 a.m., Wayne Hoffman stops at the edge of a stand of trees. He turns in a slow circle, scanning intently, listening keenly. At precisely 6:12, he wheels and heads into the interior of the tract, then stops abruptly to listen and look again. Fugitive? Soldier of fortune? Scientist.

Hoffman is a research biologist with the National Audubon Society, and he's here—in a large tract of hybrid *cottonwoods* in western Oregon—to see how biomass crops affect wildlife habitat. These trees are on James River Corporation's Lower Columbia River Fiber Farm. James River will use them for paper and energy, but they're a result of DOE's energy crop research, growing like the energy crops

Fast-growing cottonwoods being harvested for paper and energy.

Corridors of energy crops can bridge the gap between areas of natural forest or prairie.



Fast-growing hardwoods, such as hybrid poplars and sycamores, are efficient solar collectors, gathering the sun's energy and converting it to useful chemical energy.

Produced for DOE's Office of Transportation Technologies and the Office of Utility Technologies within the Office of Energy Efficiency and Renewable Energy.

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September 1998

envisioned by ORNL. Now in their sixth growing season, these fast-growing cottonwoods already reach *60 feet* or higher, with trunks up to 10 inches in diameter.

During his five-minute count on the edge of the cottonwoods, Hoffman notes an American robin, a song sparrow, a Pacific Slope flycatcher, a Swainson's thrush, another robin, a black-headed grosbeak, and a goldfinch. After counts at four more points inside the plantation, he's logged a total of 26 birds, representing 9 different species.

Hoffman has also assessed the habitat quality of a 50-acre stand of switchgrass in Iowa. In forty minutes of bird-counting in the switchgrass, Hoffman logs 15 different species, 62 birds in all.

Hoffman's conclusion about energy crops? "As a replacement for row crops, biomass is an *improvement for wildlife*," he says. "These crops also have the potential to be very useful not just for fuels, but for other land-management purposes as well—for example, as ecological corridors to bridge the gap between areas of natural forest."

The growing potential of biomass

On thousands of acres of farmland in Minnesota and Iowa, farmers, scientists, and policy makers are getting a sneak preview of what the future may hold for energy crops. In Minnesota, 5,000 acres—most of it land deemed erosion-prone and requiring special care to protect soils—is being planted with millions of hybrid poplars. A decade from now, some of these trees will be harvested, mixed with coal, and burned to spin a power company's turbines. The rest will be available for other uses, including production of ethanol or other transportation fuels.

In four counties in southern Iowa, the harvest may begin far sooner. Plans are being made to plant switchgrass on approximately 4,000 acres. The project is attracting the interest of area power companies, which could mix the switchgrass with coal to reduce emissions and expand use of renewable energy.

Both projects—largest of their kind in the nation—are cooperative efforts involving DOE, area farmers, universities, the U.S. Department of Agriculture, energy industries, and state and local agricultural and forestry agencies. According to ORNL's Mark Downing, who helped orchestrate the efforts, these large-scale plantings will provide unprecedented experience and data and turn once-idle land into productive sources of biofuels. Good results could speed the growth of a strong national biofuels program for both power production and transportation fuels.

By finding ways to boost biomass's productivity, capitalize on its environmental advantages, and convert it efficiently into fuels and power, DOE, ORNL, and their research partners across the nation are working to make sure that when the time comes, biomass is ripe for the harvest.