

Switchgrass proves to be a valuable source of energy

Adapted from the U.S. Department of Energy brochure: *Biofuels from Switchgrass: Greener Energy Pastures*

The grass stretched as far as the eye could see and hundreds more miles beyond that. An ocean of grass—deep enough to swallow a horse and rider—swayed in the steady wind of the Great Plains. The American prairie—tens of millions of acres—once looked like this. But that was centuries ago, before the coming of the white man, the railroad, and the steel plow. Today, corn and beans hold sway, and the remnants of

America's tallgrass prairie are confined mostly to parks and preserves. Now, in research plots and laboratories in the Plains states, including those of the Noble Foundation, and even in the Deep South, the seeds of change

are germinating. The tall, native grasses of the prairie, so vital to our land's ecological past, may prove equally vital to its economic future.

Such grasses once fed millions of bison. Soon, grown as energy crops, they may help fuel millions of cars and trucks, spin power turbines and supply chemicals to American industries.

The U.S. Department of Energy (DOE) believes that biofuels—made from crops of native grasses, such as fast-growing switchgrass—could reduce the nation's dependence on foreign oil, curb emissions of the "greenhouse gas" carbon dioxide and strengthen America's farm economy.

Despite this potential, research is necessary to better understand switchgrass as a cultivated, production crop. Today, there are no significant acres of switchgrass in production.

Questions exist with regard to crop establishment and production management, including input

requirements to optimize production.

Further, the size and potential yield of this crop will ultimately require new harvest and collection techniques.

The U.S. Department of Energy (DOE) believes that biofuels—made from crops of native grasses, such as fast-growing switchgrass—could reduce the nation's dependence on foreign oil.

Initially, it is anticipated that switchgrass will be cut and baled with standard farming equipment. However, it is likely that other harvest and collection methods, including



Dr. Joe Bouton of The Samuel Roberts Noble Foundation inspects switchgrass at one of the institution's many research and demonstration fields.

equipment, will evolve that will be more suitable, more efficient and realize improved economics.

Researchers at universities, national laboratories, agricultural research stations, private research institutions and industry are now seeking to answer these challenging questions.

The goals of this research are to deliver a crop with a productive, economical management plan that can be reasonably harvested and collected in a manner that will allow the effective conversion to ethanol and other biofuels, and at prices competitive with fossil fuels, such as gasoline and diesel.

Switchgrass is big and it's tough—after a good growing season, it can stand 10 feet high, with stems as thick and strong as hardwood pencils.

Not the grass in your backyard or pasture

Agricultural producers unfamiliar with switchgrass often seek to compare it to grasses that they better understand, for example, grasses found in their

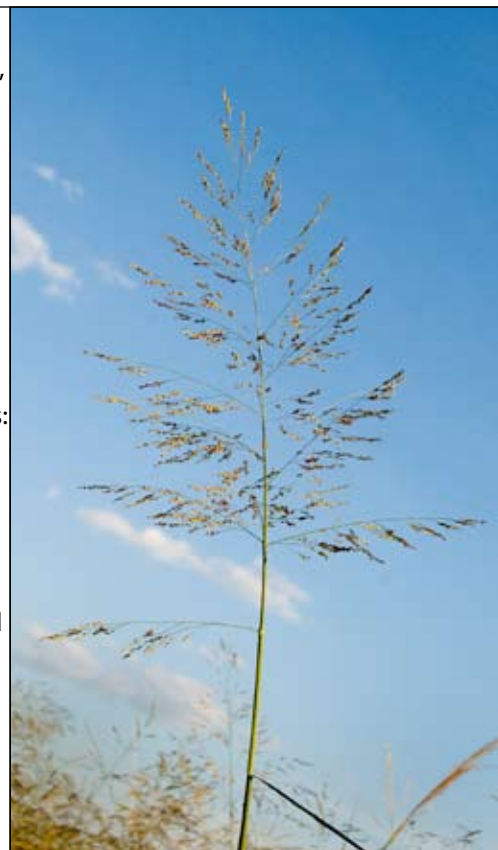
yard (bluegrass or zoysia grass) or their pastures (bermudagrass). Unfortunately, these comparisons are not possible—in other words, apples to oranges.

Switchgrass is big and it's tough—after a good growing season, it can stand 10 feet high, with stems as thick and strong as hardwood pencils. As a perennial, switchgrass is characterized by growing in clumps.

What makes switchgrass unsuitable for lawns makes it ideal for energy crops: it grows fast, capturing lots of solar energy and turning it into lots of plant material—cellulose, hemicellulose and lignin—that can be liquified, gasified, or burned directly. It also reaches deep into the soil for water and nutrients, and uses water and such nutrients as it finds very efficiently.

Because switchgrass spent millions of years evolving to thrive in climates and growing conditions spanning much of the nation, it is remarkably adaptable.

Now, to increase the overall production potential of switchgrass, researchers across the country are working to boost switchgrass hardiness and yields, adapt varieties to a wide range of growing conditions, and reduce the need for nitrogen and other chemical fertilizers. Using the plant's DNA and physiological characteristics of numerous switchgrass varieties, these researchers are steadily identifying and breeding varieties of switchgrass that show great promise for the future.



A versatile and multipurpose crop

Many farmers use switchgrass, typically as a component of a native grass mix, for forage, as a habitat for a wide variety of birds and wildlife, or to protect soil from erosion. Besides showing great promise for energy production, switchgrass also restores vital organic nutrients to farmed-out soils.

Cultivating switchgrass as an energy crop instead would require only minor changes in how it's managed and when it's harvested. As mentioned above, switchgrass can be, and will be initially, cut and baled with conventional mowers and balers.

Switchgrass is a hardy, adaptable perennial, so once it's established, it is believed that it can be harvested as a cash crop, either annually or semiannually, for 10 years or more before replanting is needed. Further, because it has multiple uses—as a biofuel feedstock, as forage, as ground cover—a farmer who plants switchgrass can be confident knowing that a switchgrass crop will serve one or more uses.



Strong environmental roots

Annual cultivation of many agricultural crops depletes the soil's organic matter, steadily reducing fertility. But switchgrass adds organic matter—the plants maintain approximately as much biomass below ground as above. And with its network of roots, switchgrass holds onto soil even in winter to prevent erosion.

Besides helping slow runoff and

anchor soil, switchgrass can also filter runoff from fields planted with traditional row crops. Buffer strips of switchgrass, planted along stream banks and around wetlands, could remove soil particles, pesticides and fertilizer residues from surface water before it reaches groundwater or streams—and could also provide energy.

Additionally, because switchgrass

removes carbon dioxide (CO₂) from the air as it grows, it has the potential to slow the buildup of this greenhouse gas in the Earth's atmosphere. Unlike fossil fuels, that release that CO₂ that has been in geologic storage for millions of years, energy crops of switchgrass "recycle" CO₂ over and over again, with each year's cycle of growth and use.

The road ahead

Cellulosic feedstocks, such as switchgrass, are capable of dramatically changing the current ethanol landscape in the United States.

"Producing ethanol from corn requires almost as much energy to produce as it yields," Sandy McLaughlin, a scientist at Oak Ridge National Laboratory, explains. "While ethanol from switchgrass can produce about five times more energy than you put in. When you factor in the energy required to make tractors, transport farm equipment, plant and harvest, and so on, the net energy output of switchgrass is about 20 times better than [today's] corn."

Moreover, served by its unique characteristics, switchgrass also does a far better job of protecting the soil, virtually eliminating erosion, and sequestering carbon captured from the CO₂ in the air, in both the roots and soil.

Back to the future

At The Samuel Roberts Noble Foundation, scientists and agricultural specialists are utilizing decades of experience working with forages, both grasses and legumes, and applying that knowledge to assist Oklahoma's biofuels efforts.

The main effort of the Noble Foundation's feedstock improvement research includes traditional and molecular breeding to gain high-value traits, such as increased yield per acre. The Noble Foundation has already developed an improved switchgrass variety, which is planned for commercial release in 2009.

Additional research will target new approaches for switchgrass,



such as the development of hybrid varieties to achieve even greater yield performance. The goal is to produce a perennial crop capable of 15 tons per acre – or even more, according to Joe Bouton, Ph.D., Senior Vice President and Director of the Noble Foundation's Forage Improvement Division.

Oklahoma's bioenergy foundation: the agricultural producers

The Noble Foundation is addressing critical agronomic issues as well as answering the economic questions that will assist in the creation of this industry in Oklahoma and impact its successful development across the nation.

The Noble Foundation is developing crop management plans for farmers and ranchers. These plans will provide the state's agricultural producers with the tools to establish and productively maintain these crops, said Wadell

Altom, Senior Vice President and Director of the Agricultural Division at the Noble Foundation.

"Education will be one of the keys to the success of this industry," Altom said. "Farmers and ranchers must be able to understand how to integrate bioenergy crops into their existing production systems, such as a livestock system. They must have tools to help them succeed, because without [these producers] there is no industry."

Likewise, Noble Foundation economists are conducting a thorough study of the actual costs required to establish and maintain dedicated bioenergy crops as well as assessing their long-term sustainability and environmental impact.

Noble Foundation agricultural specialists working with industry and government laboratories through their involvement in the Oklahoma

Bioenergy Center will soon begin to look at the complex issues involved with harvesting, collecting and transporting biomass to support a commercial biorefinery.

"The ultimate goal of the Noble Foundation's research and initiatives in the area of cellulosic feedstock development is to facilitate and foster a strong biofuels industry in the southern Great Plains," Bouton said. "This could rejuvenate rural economies, give our agricultural producers new opportunities and continue this region's reputation as an energy provider to our nation."

Adapted from the U.S. Department of Energy brochure: Biofuels from Switchgrass: Greener Energy Pastures, found at <http://bioenergy.ornl.gov/papers/misc/switgrs.html>.

Switchgrass evaluation plots at the Noble Foundation have consistently produced more than 8 tons per acre with only 70 pounds of applied nitrogen per acre in dryland conditions. Small switchgrass plots at other locations in the southeastern United States, for example at Auburn University, have produced up to 15 tons per acre, and five-year yields average 11.5 tons.