# Biofuel Production

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A sea of switchgrass once grew in the central and eastern portions of the United States from the Gulf Coast to Canada. Today, switchgrass survives mainly on land not used for other purposes, land that is poorer in quality or land in the U.S. Department of Agriculture's Conservation Reserve Program.

However, if research at Oklahoma State University in Stillwater proves fruitful, this innocuous native grass may once again wave across vast areas grown as a feedstock to make biofuel.

Biofuel is fuel derived from plants. One biofuel, ethanol, is primarily made from corn and grain sorghum and blended with gasoline, but ethanol also can be made from other plant matter, waste dairy products and grasses such as switchgrass. Research has shown that, with the right infrastructure, ethanol could be produced from switchgrass more efficiently than from corn.

Ligno What?

In addition, switchgrass is a "lignocellulosic material" that can be co-fired with coal, reducing costs and pollutants, according to Charles Taliaferro, plant breeder and regents professor in OSU's Department of Agronomy.

Taliaferro and his associates have spent several years breeding switchgrass to produce greater yields, starting with a grant from the Lockheed-Martin Corporation. Based on the progress shown, he recently received additional funding from Lockheed-Martin to continue the work.

"The supply of petrofuels is finite. Burning them produces emissions that include sulfur dioxide, carbon monoxide and others," Taliaferro said. "The United States currently imports more than half of its oil, contributing to the trade deficit. The 1992 Clean Air Act mandated that reformulated fuels be used in high-pollution regions, primarily large cities."

Energy Gain of 344%

"Ethanol is blended with petrofuels to increase combustion and decrease pollutants. The problem is, most ethanol now in use is made from corn, and the total energy output/input ratio is about 1.2. This means the net energy gain from corn ethanol is about 21 percent. The energy output/input ratio for switchgrass is estimated at 4.4, representing a net energy gain of 334 percent."

Taliaferro said the ratio is better with switchgrass because it doesn't require the nurturing of row crops and it is perennial, eliminating the need for annual planting.

"Our research is part of a larger effort to develop switchgrass as a model herbaceous crop for feedstock in the production of biofuels," Taliaferro explained. "It is part of the U.S. Department of Energy's National Biofuels Feedstock Development Program administered by Lockheed-Martin at the Oak Ridge National Laboratory located in Tennessee."

Switchgrass grows on many different soil types, from bottomland to less productive upland soils. The wide distribution of the species is a plus, because strains can be found growing on a variety of environmental conditions, meaning it can be widely planted and cultivated. Additionally, switchgrass has high biomass production with minimal inputs relative to other perennial grass species.

Improving Yields

Taliaferro said his Oklahoma Agricultural Experiment Station switchgrass breeding project has resulted in yield increases of up to 20 percent in biomass production over base populations. In addition, the work to date has assembled a large collection of switchgrass germplasm to provide a basis for long-term improvement through selective breeding.

Though switchgrass was selected as the model herbaceous species for development as an energy crop, Taliaferro noted it is but one of many potential biomass feedstocks available in Oklahoma. The principal existing sources of biomass for energy in the state would be from mixed native grasslands, tame pastures and crop residues such as wheat straw.

The technology to ferment grain starch to ethanol is an ancient technology known at all levels of society, from scientists to moonshiners. The process was augmented in recent years by using enzymes to break plant composition down to basic sugars and submitting them to fermentation. However, the procedure remains both expensive and complicated for mass-scale use.

"There are three plant components to consider with grasses," said Billy Barfield, head of OSU's Department of Biosystems and Agriculture Engineering. "Cellulose is made up of long chains of six-carbon sugars. Hemi-cellulose is made up of long chains of five-carbon sugars, and lignin holds them all together.

Grass to Alcohol

"To bring them to the conversion state, you first have to break the plant components apart, then mechanically or chemically separate them. Enzymes then break them down further to glucose and pentose molecules. You have to ferment the mass to produce alcohol, then distill the alcohol off to concentrate it."

Barfield said work on improving the process of converting biomass to liquid fuel is proceeding at a number of places around the world. Researchers in his department and in OSU's School of Chemical Engineering are evaluating the economics of converting biomass to liquid fuel.

"Growing switchgrass or other species as feedstock for energy production would have to be operated more like a mining operation than farming," said Francis Epplin, professor of agricultural economics at OSU. "Before anyone would invest $100 million in an Oklahoma biofuel facility, they would have to be sure of a steady supply of biomass. This would mean producers dealing with long-term contracts."

Epplin explains that if a farmer plans to plant corn and isn't comfortable with his knowledge of what the price will be, he can hedge the crop and determine how much it will bring in 18 months.

Not Overnight

That sort of infrastructure is not in place for grasses. Epplin's job, along with OSU agricultural engineer Ray Huhnke, is to determine the circumstances under which it would be feasible to produce a profitable crop and to determine the most appropriate place to locate a biofuel facility.

"To really know the economies of size, that is, what size of plant would be needed to be profitable, and therefore how much biomass would be required to keep it going, we will have to have some type of pilot plant. With adequate funding, we hope to see a pilot plant in the not-so-distant future," Barfield said.

"Our overall objectives are to determine how to best use Oklahoma's resources: land, labor and capital. We have to learn if, and under what circumstances, a biofuels industry could produce ethanol without subsidies."

For more information about Oklahoma State University's switchgrass projects, contact Charles Talliaferro, 481 Ag Hall, OSU, Stillwater, OK 74078-6028, phone 405-744-9627.