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### Economics of ethanol

ET researchers seek dedicated energy crop to use for biofuels

By **ANDREW EDER**, [edera@knews.com](mailto:edera@knews.com)  
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Don Cox looks at the idle farmland in Henry County and sees opportunity. The 60-year-old farmer and Paris, Tenn., fire chief is one of five farmers participating in a University of Tennessee Extension pilot project to grow switchgrass, a hardy perennial grass that many believe will play a vital role in the country's future energy needs. Cox has switchgrass growing on 28 acres of his 350-acre farm.

But in his northwest Tennessee county, he points out, the federal government pays a number of farmers to set land aside through the Conservation Reserve Program.

"Wouldn't we be much better off to grow switchgrass on this ground and help our fuel needs?" Cox asks.

It's one of many unanswered questions related to cellulosic ethanol, a fuel made from a wide range of plant-derived materials grouped together under the umbrella term "biomass."

Almost all of today's domestically produced ethanol is made from corn, whose sugars are converted to alcohol more easily than cellulose, a material found in plants and fibers. Ethanol can be blended with gasoline in varying quantities to reduce petroleum consumption.

President Bush has set a goal of producing 35 billion gallons of alternative fuels by 2017. The U.S. ethanol industry produced about 4.9 billion gallons last year, and corn-based ethanol is the only biofuel produced in massive quantities - in the billions - in the United States, although biodiesel production is growing fast.

Those facts account for the strong interest in ethanol made from unconventional sources. Federal and state government money is flowing to cellulosic ethanol projects, and East Tennessee is becoming a center for research on the subject.

Researchers at UT and Oak Ridge National Laboratory are studying cellulosic ethanol from all sides. The questions are numerous and varied, but there are three big ones at the heart of the matter:

How will the biomass for ethanol production be supplied? Can producers make cellulosic ethanol economically enough to be competitive? And will consumers buy into the idea and create demand for renewable fuels?

Supply A 2005 ORNL study found that the country could produce - with modest changes in land use, agricultural and forestry practices - 1 billion tons of biomass by 2030. That could produce enough ethanol to displace 30 percent of fuels used for transportation.

"The fundamental answer is yes, there will be enough biomass," said Reinhold Mann, ORNL's associate lab director for biological and environmental sciences.

The issue now is to take the ideas in that study from theory to practice.

The UT Extension project in Henry and Benton counties, made possible by a U.S. Department of Energy grant, is measuring yields and trying to determine at what income levels switchgrass would be an attractive alternative for farmers of corn or soybeans.

The five West Tennessee farmers involved in the project planted 91 acres of switchgrass in the spring of 2005.

"It's a very easy crop to grow," said Cox, the Henry County farmer, who grows corn and soybeans and raises cattle. "It's hardy, it's drought resistant, insects don't bother it."



CLAY OWEN / News Sentinel

Dry samples of corn stover and switchgrass, two kinds of biomass that can be broken down by bacteria and converted directly to ethanol.

Ken Goddard, Henry County extension director, coordinates the farm project for UT. He said the switchgrass produced in the last two years has been sent to a coal-fired power plant in Alabama, where they've substituted 10 percent of the coal with switchgrass and supplied thermal energy data to UT.

"I think we're involved in some of the most exciting times, as far as agriculture is concerned, in the history of production," Goddard said.

Part of the excitement is the idea of a dedicated energy crop. The demand for corn for use in producing ethanol can have wide-ranging effects on the market for food.

"Corn prices have shot through the roof, and cattle producers are going broke because of the high price of corn," Cox said. "You can't continually make ethanol out of food products without disrupting the food chain somewhere down the line."

Dedicated energy crops, on the other hand, don't face the competing uses of corn, used for ethanol, and soybeans, used for production of biodiesel.

Such energy crops include not just switchgrass, but also woody feedstocks like poplars, willows and eucalyptus.

Jerry Tuskan, a geneticist with ORNL's Plant Genomics Group, has worked for the Department of Energy for 15 years on bioenergy crops. His recent work has involved studying the hybrid poplar's genes to maximize its potential for ethanol production.

"The hybrid poplar is the first energy crop to have its genome sequenced," Tuskan said. "We know that we can change a single gene and increase radial stem growth."

In the projections of 1 billion tons of biomass, Tuskan said about 350 million to 400 million tons would come from dedicated energy crops. Of that, about two-thirds would consist of woody feedstocks and the rest switchgrass.

The other 600 million to 650 million tons would come from corn stover (leaves and stalks), waste products, demolition materials and residuals from harvesting forestry, Tuskan said.

"When we target for biomass crops, we're targeting excess, idle or surplus agricultural land," he said. "We're not talking about taking food crops out of production."

And the Southeast has comparative advantages in the production of certain dedicated energy crops, said Kelly Tiller of UT's Agricultural Policy Analysis Center.

"This is a good fit for us in the big picture of agriculture in general," Tiller said. "I'm very optimistic that this has the potential to dramatically change the agriculture sector in Tennessee and offer opportunities for farmers to earn income off the land."

Production A map of manufacturing plants producing ethanol today looks like a shotgun blast aimed at the upper Midwest, with a few pellets hitting outlying areas, including Tate & Lyle's plant in Loudon.

The reason is simple: The ethanol is usually made near the corn.

Dedicated energy crops offer the chance to expand ethanol production beyond the Corn Belt. But some hurdles must be overcome to make cellulosic ethanol commercially viable.

In the short term, researchers say, the biggest obstacle is finding an efficient process to break down the cellulose in the biomass.

Jonathan Mielenz of ORNL's Bioconversion Science and Technology group is working with bacteria that he said has the capability to attack plant cellulose and convert it directly to ethanol. It's part of the effort to "make a better bug" to break down cellulose.

The payoff, in terms of energy balance, could be huge.

When factoring in the energy inputs needed during the production process, corn ethanol generally puts out a third more energy than it takes to produce it, Mielenz said.

With cellulosic ethanol, "You're looking at multiples of a couple times greater energy efficiency," he said.

Thanks to \$61 million in state money toward alternative fuels, UT is working on plans to build a pilot biorefinery to produce 5 million gallons of cellulosic ethanol from switchgrass, an effort that will allow UT and ORNL researchers to test processes on the pilot scale.

The pilot plant is part of the Tennessee Biofuels Initiative, which envisions 10 biorefineries across the state, producing 1 billion gallons of cellulosic ethanol and adding \$100 million in new farm revenue.

"Once you're to the point of building pilot plants, having full-scale facilities by 2012 should be possible," Mielenz said.

Earlier this week, the Department of Energy proposed more than doubling - to \$385 million - a grant program for private producers of cellulosic ethanol. The nearest recipient is a Soperton, Ga., plant, built by Range Fuels Inc. of Broomfield, Colo., which would produce ethanol from timber scraps.

But even as public money pours into cellulosic ethanol development, much of the private sector seems content to take a wait-and-see approach.

Tate & Lyle, a manufacturer of renewable ingredients, produces 60 million to 70 million gallons of ethanol a year at its Loudon plant. The company brings in most of its corn from the Midwest by rail and supplies ethanol to gasoline blenders from the Northeast to Houston.

Chris Olsen, director of community and government relations for Tate & Lyle, said the company is contacted often about cellulosic ethanol but is only following developments at this point.

"The technology is at an early stage of development and will need some time yet to assess if a viable economic model can be developed," Olsen said.

Brian DeBusk of Pace Energy said past struggles of the ethanol industry might make some companies wary of pursuing cellulosic ethanol.

Pace Energy, a venture of DeBusk and his father, DeRoyal Industries owner and Chairman Pete DeBusk, is part of Heartland Ethanol, a group working to build seven corn ethanol plants in Illinois.

Ethanol has come under fire from some environmentalists for the fossil fuel energy inputs required to produce it and the effect it has on agricultural lands.

"Cellulose is the 1970s corn ethanol," Brian DeBusk said. "If I had just spent the last 30 years slugging it out, and the environmentalists are still turning their noses up a little bit, I'm not going to jump both feet into cellulose."

DeBusk said market forces - the price of corn in particular - will determine when cellulosic ethanol becomes commercially viable.

"I definitely think cellulose is the future of ethanol production," he said.

Demand All the efforts to develop cellulosic ethanol will be moot if consumers don't buy into renewable fuels.

"I think that we need to spend as much time looking into the marketing and posturing of ethanol as we've spent looking into the technology and the production," DeBusk said.

That's where advocates like Jonathan Overly of the East Tennessee Clean Fuels Coalition come in. Overly started the coalition five years ago as a way to encourage the use of cleaner-burning vehicles and alternative fuels in the area.

He said there has been a strong push toward alternative fuels recently from local governments, driven in part by a \$1 million Alternative Fuel Innovations grant program from the Tennessee Department of Environment and Conservation.

"Quite a few cities are starting to buy hybrids as one small way of getting fuel-efficient vehicles in their fleets," Overly said. "We're seeing more and more action among state and local governments."

Overly said the coalition has focused more on biodiesel than ethanol in the past but this year will work to make E85 - a blend of 85 percent ethanol and 15 percent gasoline - more available to East Tennesseans.

Overly said Marathon Petroleum Co. will be bringing ethanol to its Knoxville terminal in May. A Marathon spokeswoman would not confirm that but did say the company is considering such a move.

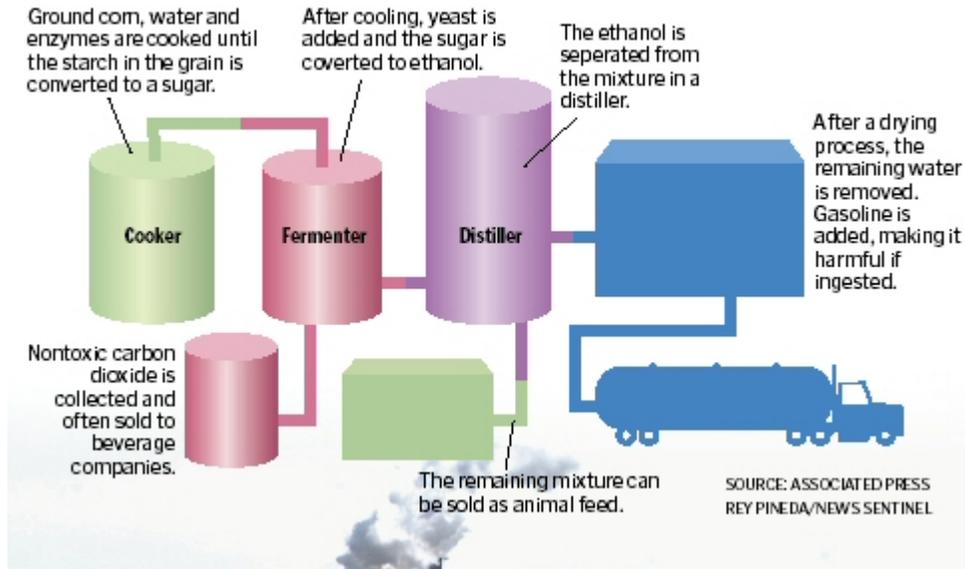
"We are looking at bringing ethanol into the Southeast where it makes sense," said spokeswoman

Linda Casey. "Tennessee is one of the states we're looking at."

Marathon bringing ethanol to its local terminal would help increase availability, Overly said, but consumers ultimately have to make the decision to use alternative fuels.

"It's up to Americans now to take action," he said. "The more they demand these fuels, the more they'll be available."

### HOW CORN-BASED ETHANOL IS MADE



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