Biofuel from corn residue

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WEST LAFAYETTE, Indiana – After the massive combines sweep the millions of acres of corn in the fall and remove the kernels, what is left are millions of tons of stalks, cobs, husks and leaves of the corn plants.

Although this leftover material, called corn stover, provides nutrients for the soil and prevents erosion, it also has the potential for a new use: making ethanol.

Purdue University scientists say they believe they can put some of this corn stover to use as a fuel for automobile engines by converting it to ethanol.

Ethanol can be used to boost octane and reduce engine knock, and it also can be blended with gasoline to make an environmentally friendly fuel. Currently ethanol can only be made in industrial quantities from starch extracted from corn kernels.

However, Michael Ladisch, distinguished professor of agricultural and biological engineering, and biomedical engineering, together with colleague Nancy Ho, research molecular biologist, have developed a pre-treatment process that can also convert the fibre left over when the starch is processed out of the corn kernel. The process uses genetically engineered yeast, which were developed by Ho.

Now Ladisch says the process is ready for development with corn stover.

Corn stover fibre is different from the fibre found in the kernel. However, both materials contain cellulose, which can be converted into sugars, which can then be fermented into ethanol.

The research is being conducted in Purdue's Laboratory of Renewable Resources Engineering (LORRE, pronounced "Lori"), an integrative center for biotechnology and engineering.

To aid this next step in ethanol research, the Indiana Department of Commerce has given LORRE an $80,000 grant to modify the process. Pilot-scale testing of the new process will be conducted at the Williams Bio-Energy facility in Pekin, Ill.

Making fuel from the corn stover could benefit Indiana's economic development, says Indiana Lt. Gov. Joe Kernan.

"Finding ways to produce ethanol more efficiently by using our own agricultural resources is important to Indiana's economy," he says. "This grant promotes this goal while helping Indiana take a leadership position in the critical biotech industry."

Kernan also serves as director of the Indiana Department of Commerce, which made the grant to Purdue, and as the state's commissioner of agriculture.

Ladisch says developing a process that uses existing industrial equipment is a key to getting the technology accepted by the ethanol industry. "Then this process has the potential to greatly increase the amount of ethanol that will be produced from non-grain sources," he says.

To enhance the process, Jonathan Wilker, assistant professor of chemistry; and Nathan Mosier, graduate student, are in the process of developing new catalysts that mimic organic enzymes that convert cellulose into sugars that can be fermented into ethanol.

In addition to the work being done at Purdue, scientists at Williams Bio-Energy, the National Renewable Energy Laboratory and the U.S. Department of Agriculture's National Centre for Agricultural Utilization Research are working with the Purdue scientists to adapt the process to commercial production.

The need for ethanol is increasing. Ethanol can be used in automobile engines as a replacement for methyl tertiary butyl ether (MTBE), which is a chemical derived from petroleum that is used to boost octane levels in gasoline. MTBE itself was a replacement for tetraethyl lead, but like the lead compound, scientists have found MTBE causes environmental damage, and the U.S. Environmental Protection Agency is phasing out its use.

According to the Renewable Fuels Association, in 2001 the United States made a record 1.77 billion gallons of ethanol.

But the U.S. Department of Energy's National Renewable Energy Laboratory estimates that converting one-third of the nation's corn stover to ethanol could produce an additional 5 billion to 8 billion gallons of ethanol, enough to have a significant effect on the amount of petroleum used in this country.

Nationally, about 244 million tons of corn stover is produced each year; more than 22 million tons are produced annually in Indiana.

Finding a market for corn stover could mean $10 more per acre for farmers, according to the National Renewable Energy Laboratory.

However, Purdue Extension corn specialist Bob Nielsen cautions that before farmers strip their fields of corn stover more needs to be known about the economic and agronomic effects.

"Crop residues provide benefits in terms of erosion control and soil moisture conservation in no-tillage systems. Corn stover also provides nutrient recycling in the soil as it decomposes," Nielsen says. "The potential value for harvesting the stover for ethanol production would require gross returns to the farmer in excess of the cost of any additional nutrients that would be needed."

Purdue is a national leader in developing new technologies to enhance the production of ethanol.

One such process, developed by Ladisch, uses modified ground corn grits to remove water from ethanol. This environmentally friendly, low-cost technique replaces methods that use chemicals such as benzene or cyclohexane. The Purdue-developed method is being used in the United States by companies such as Archer Daniels Midland and by other companies around the world.

Nancy Ho developed a type of genetically modified yeast that can convert sugars other than glucose, which is made from cornstarch, into ethanol. When other materials, such as corn stover, tree leaves, grass clippings or wood chips are broken down; they produce other sugars, such as pentose and hexoses. Ho's yeast converts these sugars to ethanol, too. In 1998, R&D Magazine selected this breakthrough as one of the top 100 significant research developments of that year.

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