

## Predicting Switchgrass Ethanol Yields

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The truck pulls up to the ethanol biorefinery with a load of switchgrass. A technician greets the driver, inspects the load and samples several switchgrass bales on the truck. The samples are brought to the nearby office lab and quickly analyzed for biomass composition and the maximum and expected ethanol yields per ton of switchgrass. This information enables the biorefinery to pay switchgrass producers for both the tonnage and the quality of their crop. A biorefinery could even reject a subpar shipment of switchgrass before the truck is ever unloaded.

That future has been made possible by a team of Agricultural Research Service (ARS) scientists--including Ken Vogel, Rob Mitchell and Steve Masterson at Lincoln, NE; Hans Jung at St. Paul, MN; Bruce Dien at Peoria, IL; and Michael Casler at Madison, WI. They developed the use of near infrared sensing (NIRS) to measure 20 components in switchgrass biomass which determine its potential value to biorefiners. These components include cell wall sugars, soluble sugars and lignin. With this information, 13 more traits can be determined. These traits include the total theoretical or maximum ethanol yield as well as the efficiency of the conversion from sugars to ethanol. Measuring cell wall sugars can be also used to calculate the maximum yield for fermentation to other biofuels and chemicals.

Vogel is at the ARS Grain, Forage and Bioenergy Research Unit in Lincoln, NE. This is the first use of NIRS to predict maximum and actual ethanol yields of grasses from a basic conversion process. This capability already exists for corn grain using NIRS. "Corn is the easiest crop to grade for ethanol yield," Vogel says.

Predictions of actual ethanol yields were based on hexoses, or six carbon sugars, present within the plant cell wall and as soluble sugars. Since additional ethanol could be produced from pentose or five-carbon sugars as conversion technology improves, the NIRS method can be used to estimate what the total potential yield of ethanol or other biofuels would be if all sugars in the plant were converted.

The scientists tested switchgrass varieties and experimental lines adapted to the Midwest with the NIRS analyses and found significant differences for actual and potential ethanol yield per ton and per acre. The lowland variety, Kanlow, had the highest crop yield but the lowest ethanol conversion efficiency, resulting in the lowest predicted ethanol yields per ton, but the largest ethanol yields per acre. An experimental upland strain, NE 2229, had the highest predicted ethanol yields per ton, with the third highest crop yield.

### **\$5 Makes Ethanol Estimate Practical**

Vogel says, "The importance of this study is that we've shown it is feasible to use NIRS to estimate ethanol yields of switchgrass at about \$5 a sample, instead of \$300 to \$2,000 a sample using conventional analytical methods. The low price makes the method available for use in research by breeders and agronomists and biorefineries."

The calibrations developed in this study, and improved future versions, can be used in all aspects of plant research, including basic genetics, harvest and storage research for a variety of perennial grasses, including those used for forage as well as those used for ethanol production. Casler says, "The NIRS equations are already being used for developing new cultivars in the ARS breeding programs in Nebraska and Wisconsin."

"This method can also be used to find ways to grow grasses for the highest ethanol yields, as well as to breed the highest ethanol-yielding crops," Vogel says