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### **Consolidated Bioprocessing: Corn as a Whole-Plant Feedstock**

LANSING, MICH. – As interest in cellulosic ethanol continues to grow, corn remains a primary focus as a cellulosic feedstock. Many of the most advanced cellulosic research facilities utilize corn stover and corn cobs as their raw materials. This feedstock has traditionally been harvested through conventional harvest methods, with the stover and cob components harvested separately from the grain in the field. The two components are then processed separately at different biorefineries that are starch-based (grain) or cellulosic-based (stover/cob). The separate harvest of the grain and stover results in increased harvest time, more equipment crossing the field and higher input costs, including the fuel necessary to operate machinery.

In an effort to increase efficiencies for the farmer and the ethanol plants, new research is being done to analyze the benefits of harvesting and processing the whole corn plant together in a procedure known as consolidated bioprocessing. Should the primary research on the new consolidated bioprocessing system prove it to be effective, farmers who sell their crop to ethanol facilities will have new options for crop harvest and storage. In order to help Michigan's corn farmers understand the new process and what harvest and storage methods are most profitable, the Corn Marketing Program of Michigan (CMPM) has partnered with Michigan State University (MSU) to conduct consolidated bioprocessing research. The main objective of the study was to determine if the consolidated system is a viable method for ethanol production and if it is more efficient than the traditional dual systems of separate harvest and fermentation.

To accomplish these objectives, Dr. Kurt Thelen, principal researcher and crop and soil science professor at MSU, set-up a four zone research project that spanned across the state of Michigan. Harvest sites were located in Branch, Huron, Ingham and Menominee counties. Three different strategies were assessed to determine if consolidated bioprocessing is a viable alternative to conventional separate processing. First, the study was split into traditional (separate) and whole-plant (consolidated) bioprocessing. The consolidated bioprocessing method utilizes an ammonia fiber explosion (AFEX) pretreatment plus a broad spectrum enzyme treatment for specifically-tailored microbial fermentation. Second, the study looked at timing of harvest to determine which time was optimal; green phase or mature phase. Green phase harvest is when corn is traditionally chopped for silage (prior to dry-down) and mature phase harvest is when the plant has dried-down and is typically harvested for grain. Additionally, green whole-plant corn was tested to assess when maximum ethanol yields were obtained; when processed fresh or after ensiling.

The results of the study show detailed information on sugar content, an important component of ethanol production, and ethanol yield from different corn fractions and harvest strategies. The sugar content of green-cut, whole-plant corn showed no difference when processed fresh or ensiled. Additionally, all whole plant samples, both fresh and ensiled green-cut and mature, were higher in sugar content than separated fractions. The ethanol production results showed that mature whole-plant corn produced higher yields than those from both types of green whole-plant processes and grain and stover fractions. This indicates that the consolidated system surpasses the existing source-separated system in terms of ethanol yield and efficiency.

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When comparing the two green-cut methods against one another, six percent dry biomass loss was estimated during the ensiling process. However, there was no significant decrease in ethanol yield from the ensiling harvest strategy compared to the green-cut fresh processed strategy. This result indicates that ensiling may be an effective post-harvest storage method that would facilitate a year-round feedstock supply to the bioprocessor. An additional benefit of a green-cut system is an earlier harvest time which facilitates integration of a cover crop, manure applications, or other strategies to augment carbon loss associated with whole-plant harvest.

“Dr. Thelen’s research will help Michigan’s farmers be better prepared for future advancements in combined bioprocessing and new harvesting strategies,” said Clark Gerstacker, CMPM president, National Corn Growers Association Corn Board member and a corn grower from Midland. “The gained efficiencies of the one-pass harvest and single bioprocessing strategy, such as faster harvest, ability to store in on-farm bunker silos and the eliminated need for in-field stover pick-up mechanisms, make the consolidated approach an attractive alternative to the current strategy of separating the starch and cellulosic feedstocks. With Dr. Thelen’s work proving viable yields using the consolidated process, ethanol plants can now give the single stream method serious consideration for the future. Should they implement consolidated bioprocessing, corn farmers across the state will have options to help increase ethanol plant productivity and lower input costs while reducing environmental impacts through new consolidated harvest and storage methods.”

For more information on this research or the CMPM, call 1-888-323-6601 or visit [www.micorn.org](http://www.micorn.org).

Headquartered in Lansing, the CMPM is a legislatively-established statewide program that utilizes one-cent per bushel of Michigan corn sold. Investments are made in the areas of research, education, market development, and new uses in an effort to enhance the economic position of Michigan corn farmers. The CMPM works cooperatively with the Michigan Corn Growers Association (MCGA), a grassroots-membership association representing the state’s corn grower’s political interests since the 1970’s. Michigan’s corn industry adds more than one billion dollars to the state’s economy annually and in 2010, Michigan’s corn farmers harvested a record setting crop of more than 315 million bushels. For more information, visit the website of the MCGA and the CMPM at [www.micorn.org](http://www.micorn.org).

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