# Using crop residues for bioenergy

**By Jan Suszkiw, Agricultural Research Service USDA**

In February 2006, US President Bush launched an ambitious plan called the "Advanced Energy Initiative". Its aim is to reduce America's crude oil imports from the Middle East by 75 per cent by the year 2025. One key milestone calls for displacing 15 per cent of US gasoline with 132.5 billion litres of renewable and alternative fuels, such as ethanol, by 2017.

Corn, America's most widely grown crop, currently plays a central role in supplying the starch-derived sugars used to make ethanol. Bioenergy researchers are also exploring ways to use corn's cellulosic residue, called 'stover', as a feedstock for ethanol production.

Stover consists of the stalks, leaves, and cobs that remain in the field after grain harvest. Left in place to decay, stover builds soil organic matter and reduces erosion by protecting soil during strong winds or intense rainfall. It also helps sequester carbon in the soil. And now it's being eyed as an abundant feedstock for ethanol production.

These competing uses for stover create a quandary.

Wally Wilhelm, an ARS plant physiologist in Lincoln, Nebraska, is leading a team to help determine how much corn stover can be harvested without increasing erosion or hampering the soil's ability to build organic matter and sequester carbon.

## REAP takes a long view

In June 2006, Wally became lead scientist for the Renewable Energy Assessment Project (REAP), a five-year multilocation research project to obtain what he calls 'ground-truth' data. Of particular interest to the REAP team is determining where, when, and how much stover can be harvested without harming the soil.


Immature corn ears. (Photo by Doug Wilson)

"Growers, ethanol producers, and action agencies need information and guidelines based on current, geographic-specific yield potentials and production practices," Wally says.

A project of this magnitude requires the expertise and resources of a broad range of experts at nine locations around the country:

- In Minnesota a team is experimenting with winter cover crops and living mulches such as kura clover, which is interseeded with corn, as possible ways to harvest biomass without jeopardising soil health or productivity.
- Another Minnesota-based project had established experimental plots and on-farm trials to find a balance between stover used for protecting the soil and stover used for bioenergy. They're measuring carbon in the soil and the amount of carbon dioxide and other greenhouse gases returned to the air. They also want to know how much stover needs to stay in the field with different tillage methods.
- In Nebraska, the ARS is collaborating with two brothers who operate a family farm. ARS scientists are helping conduct studies on 40 hectares of corn. The research involves the use of field-scale equipment and will provide a real-world opportunity to examine stover harvesting's effect on organic matter, grain yield, and carbon sequestration.
- In South Dakota, Shannon Osborne leads a long-term study initially designed to examine the impact of removing corn stover on soil quality. In 2006, cover crops were incorporated into the experiment to determine whether maintaining

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Bales of corn stover collected from a REAP experiment near York, Nebraska. Stover is often left in place to protect soil, but it also has potential as a feedstock for cellulosic ethanol production. (Photo by Wally Wilhelm)


ARS technician Todd Schumacher installs soil moisture monitoring equipment in a kura clover living mulch experiment at a University of Wisconsin research farm in Arlington, Wisconsin. Row locations of recently planted no-till corn are evident from the effects of band-applied herbicide directly over the rows. (Photo by Tyson Ochsner)

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a continuous cover will replace some of the soil carbon that's lost when residue is harvested for biofuel production.

- In Iowa, ARS studies encompass field evaluations of how much stover can be harvested using a systems approach that includes either chisel or no-tillage practices, cover crops, and increased plant populations and fertiliser applications. They're also examining the formation and decomposition of organic soil carbon; factors affecting crop-residue decomposition, such as microbial activity; and the impact of returning charcoal to the soil. Charcoal is a byproduct of pyrolysis, an alternative to fermentation for converting biomass into fuel.
- In Oregon, studies to predict carbon sequestration in agricultural soils are helping develop a formula, or algorithm, to guide sustainable residue removal. The computer model simulates yearly losses or gains of organic carbon.
- Ronald Follett in Colorado is leading part of a long-term study designed to develop soil carbon storage information and to examine the potential for biofuel crops (corn, switchgrass) to sequester carbon under improved management (plant type, nitrogen-fertility, and no-till).
- Cotton production under conservation tillage in Alabama often uses cover crops, such as rye and wheat, to provide erosion and weed control during the winter months. ARS scientists are studying the potential of harvesting the winter cover biomass in spring, before cash-crop planting, and its effects on crop productivity and profitability.
- In Indiana, ARS researcher Diane Stott is seeking to better understand and measure the amount and form of soil carbon and nitrogen in fields where stover has been harvested. Diane and ARS colleague Dennis Flanagan are also using water- and wind-erosion models to determine the impact of various levels of stover harvest on soil loss by runoff or wind.

## One piece of the puzzle

Wally Wilhelm says the stover-management guidelines being developed under REAP are one piece of a larger bioenergy puzzle. Elsewhere, for example, research is under way to develop powerful enzymes to free sugars from cellulose and to streamline the ethanol-production process.

Ratcheting up solar-radiation use efficiency may also increase biomass for ethanol uses. Such relatively simple practices as optimum planting dates, proper row-spacing schemes, green manures, and appropriate nitrogen and water management will make initial improvements.

Later advances will include optimising canopy structure, leaf arrangement, and placement.

"We hope molecular engineering technologies will eventually provide plants with enhanced photosynthetic capacity to keep us moving up the radiation-use efficiency scale and provide sufficient biomass to satisfy the soil's need for carbon and the world's needs for fuel," says Wally. ■

CROP DOCTOR SOUTH
*With Peter Reading*

## HARVESTING BENCHMARKING

Harvest is over and it's time to relax and enjoy a well-earned break. But during the down time, please consider this – knowledge is power and to get knowledge, you need information.

The grains industry has no simple or direct means of measuring and tracking the adoption of desirable farm management practices. Yet, to manage a business there has to be information and for this and other reasons the grains industry has developed a simple system to gather information about on-farm practices.

The National Farm Practices Database Survey is organised, managed and run by the GRDC, with support of the Grains Council of Australia.

Dr Martin Blumenthal and Alan Umbers are developing a grains industry environmental plan as part of a Sustainable Industries Initiative project supported by the Australian government. The plan is identifying the key issues impacting on the industry and the environmentally sustainable farming practices that will assist growers to deal with the issues.

Alan has worked to build a database that will assist this by tracking the adoption of these practices.

He describes the database as a powerful tool that allows assessment of the adoption of farming practices around Australia and enables the industry to more effectively report on the extent of use of the most sustainable systems.

In return, each grower who provides their farming system data receives a report showing how their farm and practices compare with others in their shire and region and the degree of progress made in terms of production and sustainability.

This gives the industry data to chart trends driving productivity and sustainability and allows for evidence-based responses.

At farm level it allows farmers to see how they compare with others, in areas including: water use efficiency, yields, rotation, fuel use, area of pasture and native vegetation, area of soil susceptible to salinity and erosion and basic soil parameters, such as water holding capacity, pH and organic carbon.

There are few formal means of tracking performance and showing that there is enhanced sustainability of production and resource stewardship.

For example, a 2001 census showed WA had around 80 per cent adoption of no-tillage and showed significant grain production, even during the drought.

Growers are encouraged to 'have a go' at the survey. Most questions can be answered from memory and it only takes 30 minutes or so.

For your personalised, detailed and emailed report, visit www.farmingpractices.com and click on Data Entry Form under Data and Practices in the left column, or the "Download Now" link in the main window.

About 600 growers, representing two million hectares of information, have already contributed to the database. As more contribute data, the more accurate the report will become. Data on fuel and fertiliser use, livestock, tillage and soil types will be used to develop a greenhouse gas profile for the farm.

The information will allow everyone, from farmers, consultants and researchers to government authorities, to evaluate the industry's environmental and production profile and to better identify areas of need.

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