

EXECUTIVE SUMMARY

ACHIEVING SUSTAINABLE PRODUCTION of Agricultural Biomass for Biorefinery Feedstock



Bio[®]
BIOTECHNOLOGY
INDUSTRY ORGANIZATION

INDUSTRIAL AND ENVIRONMENTAL SECTION HELPING THE BIOBASED INDUSTRY GROW

EXECUTIVE SUMMARY

Demand for alternative feedstocks for fuels, chemicals and a range of commercial products has grown dramatically in the early years of the 21st century, driven by the high price of petroleum, government policy to promote alternatives and reduce dependence on foreign oil, and growing efforts to reduce net emissions of carbon dioxide and other greenhouse gases.

Ethanol production has more than tripled since 2000, with annual U.S. production expected to exceed 7 billion gallons by 2007. Sales of biobased plastics are also expanding.

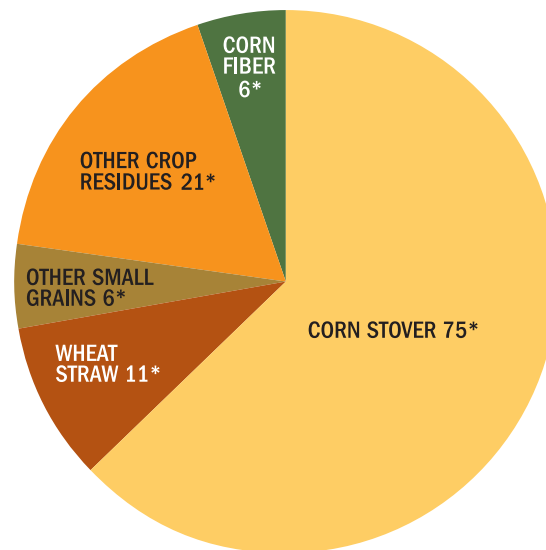
The growing availability of economically competitive biobased alternatives to petroleum can be attributed in large part to advances in the production and processing of corn grain for industrial uses. Steady increases in corn yields made possible by agricultural biotechnology continue to expand the supply of available grain-based feedstock. Rapid advances in the relatively new field of industrial biotechnology are greatly enhancing the efficiency of ethanol production and making possible a range of new biobased polymers, plastics and textiles from agricultural starting materials.

In order to meet the U.S. Department of Energy (DOE) goal of 60 billion gallons of ethanol production and 30 percent displacement of petroleum by 2030, new feedstock sources will be required to supplement high-efficiency production from grain. A robust sustainable supply chain for cellulosic biomass from agricultural residues and dedicated energy crops will be needed within a few years.

Nearly 1 billion dry tons of cellulosic biomass could be supplied by U.S. agricultural lands in the form of crop residues and dedicated energy crops. A growing list of companies has announced intentions to begin construction of cellulosic biorefineries. One challenge for the emerging cellulosic biomass industry is how to produce, harvest and deliver this abundant feedstock to biorefineries in an economically and environmentally sustainable way.

Corn stover and straw from cereals such as wheat and rice are the most likely cellulosic feed-

USDA/DOE Estimated Current Sustainable Availability of Cellulosic Biomass from Agricultural Lands



* Figures above represent millions of dry tons per year.

Source: Perlack, Wright, et al., 2005.

stocks for commercial-scale production of ethanol in the near term, potentially supplying more than 200 million dry tons of feedstock annually within three to five years, enough to triple current ethanol production. Dedicated energy crops such as switchgrass will follow as a feedstock supplement once a market for cellulosic biomass develops further.

Corn stover has the largest potential as a near-term biorefinery feedstock, given its high per-acre yields. Current cropping practices require that most or all stover remain on the field to maintain soil health. As biorefinery construction creates markets for crop residues, farmers will be more motivated to adopt practices that lead to economic and sustainable removal. An environmental and economic 'optimum' removal will balance sufficient retention of residues to avoid erosion losses and maintain soil quality while using excess residue as biorefinery feedstocks. The impact of varying levels of stover and straw removal will depend considerably on local conditions and practices.

Under a range of conditions, no-till cropping allows for substantially greater residue collection than current practice, enabling biorefinery siting in areas where suitable supplies are currently unavailable. Further evolution toward greater no-till cropping is needed in order to supply adequate feedstock while complying with erosion guidelines and maintaining soil quality. Lower operating costs and recent successes have spurred an increase in adoption of no-till, with 16 percent of wheat acreage and 20 percent of corn acreage now under no-till practice. However, no-till is not yet widely utilized in regions of the country with the greatest potential to supply biomass.

Ultimately, growing demand for crop residues will likely prove a strong additional driver for the transition to more widespread no-till cropping. Once a market for agricultural residues develops, individual farmers or groups of farmers may elect to adopt no-till cropping to attract biorefineries to their area. Residue collection may also enable no-till cropping in wetter regions, such as the northern Corn Belt, where excess residues currently hamper germination and reduce yields.

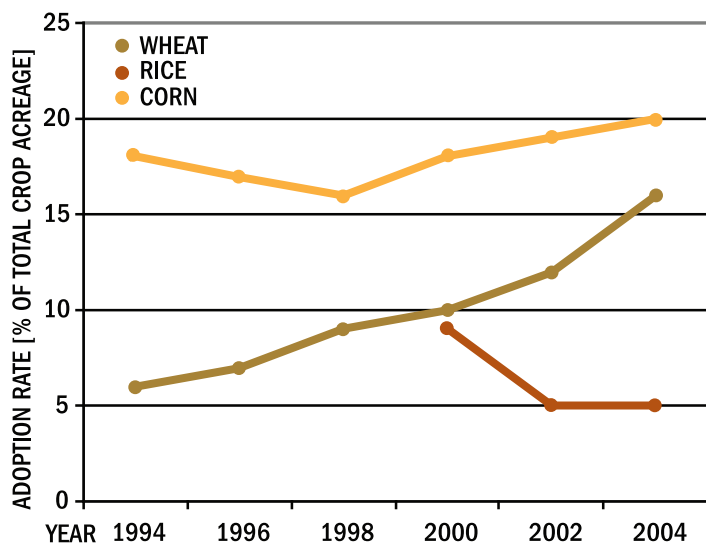
While the economics depend on regional and local conditions, for those not currently practicing no-till the benefits of converting may justify the time to learn new methods and the \$50,000 to \$100,000 investment in new planting equipment. For instance, a 1,000-acre farm could expect to recover the additional costs through revenue from residue sales in as little as two years.

New markets that commoditize the environmental benefits of no-till farming could provide even greater incentive to convert. Carbon credits for no-till transition currently sell for roughly \$1 per acre on the voluntary Chicago Climate Exchange. If mandatory greenhouse gas limits are established in the United States, the carbon credit benefits of no-till adoption could exceed \$10 per acre.

In addition to economic benefits for farmers, sustainable production and collection of agricultural residues has the potential to deliver substantial benefits for the environment, such as reduced runoff of soil and fertilizers. But the greatest environmental benefits may be to the global climate through reduced emissions of fossil carbon and enhanced sequestration of soil carbon.

With no-till cropping, sustainable collection of 30 percent of current annual corn stover production would yield over 5 billion gallons of ethanol and reduce net U.S. greenhouse gas emissions by 90 million to 150 million metric tons of carbon dioxide equivalent annually if burned as E85 fuel. This would more than offset the net annual

No-till Adoption History



Source: Conservation Technology Information Center, <http://www.conservationinformation.org>

GHG Mitigation from Corn Stover Feedstock

30% US Stover (80 million dry tons) to Ethanol [MMTCO₂ eq]

Source	Range
Fossil fuel offset	50-70
Soil carbon increase	30-50
N fertilizer reduction	0-10
Reduced field operations	10-20
Total	90-150

growth in emissions from all sectors of the U.S. economy experienced in 2004.

To realize these benefits, additional infrastructure in collection, storage and transportation is needed to supply biorefineries. Rail transport greatly reduces transportation costs relative to trucking, allowing for a much larger collection area. One-pass harvest, in which grain and residues are collected simultaneously, also offers strong opportunities to lower cost.

To facilitate development of the infrastructure necessary for sustainable production and collection of cellulosic agricultural feedstocks, and to achieve the DOE goal of 30 percent displacement of petroleum with renewable biobased feedstocks by 2030, Congress should consider adopting supportive policy measures in the 2007 Farm Bill, including:

- Funding for accelerated development and production of one-pass harvesting equipment;
- Development and distribution of simple-to-use soil carbon models to allow farmers to compute how much crop residue can be collected without degrading soil quality;
- Assistance to farmers to encourage the transition to no-till cropping for biomass production;
- Incentives for the development and expansion of short line and regional rail networks;
- Funding for demonstration projects to streamline collection, transport and storage of cellulosic crop residue feedstocks;
- Development of a system to monetize greenhouse gas credits generated by production of ethanol and other products from agricultural feedstocks; and
- Funding for programs to help farmers identify and grow the most suitable crops for both food production and cellulosic biomass production.

Cellulosic biomass from agricultural residues and dedicated energy crops represents a highly promising new source of feedstock material for the production of ethanol, renewable chemicals and a range of commercial biobased products. Residues from existing crops can be utilized to greatly expand current biofuels production. American farmers are poised to deliver.



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