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Biofuels, Water Resources and Climate Change: Solving the Sustainability Puzzle

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Holzfaster Farms

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Symposium 2
Biofuels, Water Resources and Climate Change: Solving the Sustainability Puzzle

Panel
Ralph Holzfaster, *Farmer, Holzfaster Farms*
Duane Kristensen, *Senior Vice President of Operations/General Manager, Chief Ethanol Fuels*
Todd Sneller, *Administrator, Nebraska Ethanol Board*
Larry Tieszen, *Project Manager, Land Cover Applications and Global Change Research, USGS Earth Resources Observation Science*

Moderator
Kenneth Cassman, *Director, Nebraska Center for Energy Sciences Research, UNL*

Nebraska is now the second-largest producer of corn ethanol in the U.S. This is largely because of the state's comparative advantages. For one, the state's water resources enable a huge capacity for irrigation – Nebraska ranks second in irrigated crop acres, behind California. Nebraska is the third-largest corn producer in the U.S., with 75 percent of the crop irrigated. The state also produces nearly 5 million acres of soybeans, half of them irrigated. Both provide a large, dependable supply of feedstock for production of ethanol and other biofuels. Nebraska's cattle feeding industry, with more than 4.5 million head on feed, utilizes ethanol byproducts such as distillers grains and enables biorefinery systems to attain high energy efficiency and profitability.

From left: Larry Tieszen, Ken Cassman, Ralph Holzfaster

This powerful nexus of agriculture, water and biofuels is highly vulnerable to changes in climate. The panelists represented a cross-section of these interests, including a manager of the state's longest-operating ethanol plant, a farmer with extensive knowledge of ethanol production, the administrator of the state ethanol board and a project manager from a federal agency charged with tracking land use and its ties to biofuel production and climate change.

The past three years have marked historic shifts in agriculture, said moderator Ken Cassman, UNL professor of agronomy and horticulture and director of the Nebraska Center for Energy Sciences Research. "The world has moved from a time of food surplus to food scarcity; from a 50-year trend of steady, continuously lower food costs to very large food price increases; and from a time when the highest value for crops was as a human food or livestock feed, to a time when their highest value is as a feedstock for energy," he said.

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The global population is predicted to reach 9 billion by 2050, a 40 percent increase from today. Many of these people will be much wealthier, and as people become wealthier, they eat better food – including more livestock products, Cassman said. Three kilograms of grain are required to produce each kilogram of livestock product, so it takes much more grain to feed people who eat these products. Wealthier people also use more energy. "The link between agriculture and energy is here to stay, and the implications for biofuels, water and climate change are substantial," Cassman said.

Status of corn ethanol biofuel

Corn ethanol production has become a major industry throughout the Midwest. The panelists expressed concerns about the conflicting information in the media about ethanol and how that shapes public and policymakers' perceptions. A 2004 report published by the Nebraska Department of Agriculture noted that ethanol would continue to be one of the most important economic catalysts in Nebraska's economy into the future and this has held true, said Nebraska Ethanol Board administrator Todd Sneller. He recognized the growing interest in new conversion technologies and alternative feedstocks, such as cellulosic ethanol production from switchgrass. "But the only significant biofuel in production today is corn ethanol, and it will be awhile before this changes," he said.

Duane Kristensen, vice president of operations for Chief Ethanol Fuels, agreed, saying that corn ethanol is now the most viable renewable fuel and will remain so for 10 to 20 years. Since the Chief ethanol plant opened in 1985, he has observed significant changes in the efficiencies of the ethanol production plant but also in the hybrids and farming technologies that provide feedstock to the industry. Although ethanol is being blamed for high corn and food prices, the global economy affects rising commodity prices. This is especially true with commodities like corn, Kristensen said. The devastation of Australia's wheat crop by drought and a poor wheat crop in Europe have contributed to higher prices, as have other factors.

Ralph Holzfaster, a farmer, irrigation dealer and former employee of the Nebraska Public Power District and the Nebraska Ethanol Board, acknowledged that current ethanol and biofuel technology isn't the long-term solution to decreasing U.S. dependence on oil, but asserted that "it's the best alternative we have data on that's economically viable in a commercial scope." Ethanol plants are an economic boon to rural communities, Holzfaster said, citing the town of Madrid, Neb., where a new $80 million plant employs 40 people and has created 120 ancillary jobs in industries such as trucking. "That plant is the biggest thing since the railroad came through in the 1880s," he said.

There is a critical short-term need for corn ethanol, said Larry Tieszen, project manager for land cover applications and global climate research at the USGS Earth Resources Observation Science (EROS) Data Center. "Corn ethanol is a critical, valuable short-term need – but in the near future, cellulosic ethanol will become important and gasification will come after that," he said. Federal researchers are exploring these areas.

Research also is needed on land use, Tieszen said. USGS-EROS is conducting a new study using its best understanding of economic drivers for land use to project the trajectory for land use change in the northern Great Plains. Demand for corn for ethanol and other uses is driving up prices and causing farmers to convert Conservation Reserve Program land to corn, and corn may be

moving into vulnerable grasslands in the Dakotas. The researchers are seeking to determine the optimal uses of land in this large region where the soils and climates differ for biofuel applications of all types, not just corn-based ethanol. "We want to be able to suggest what those optimal uses might be for sustainable land use for biofuels applications," Tieszen said.

Ethanol life-cycle energy use modeling

Each panelist spoke of the urgent need for recent, relevant data for calculating the carbon footprint of corn ethanol and for other renewable energy systems that will follow. Sneller cited the U.S. Environmental Protection Agency's (EPA) responsibility to develop life-cycle assessment models for renewable fuel standards mandated by the 2007 Energy Independence Act. This will involve a complex set of compliance requirements related to the carbon footprint of biofuels in several different categories, from a variety of different feedstocks, as they are produced and used. This is a major change, Sneller said.

"Research has played a significant role in positioning Nebraska as a national leader in biofuels for over three decades," Sneller said. "Research will continue to play a very important role in helping us to quantify and meet these new requirements."

The life-cycle energy use model used by EPA will affect how corn ethanol is perceived by policymakers and the general public, Sneller said. More than 60 percent of the current corn ethanol production capacity comes from ethanol plants that have begun production since January 2005, and that will increase to 75 percent by the end of 2009. Yet the Greenhouse gases, Regulated Emissions and Energy use in Transportation (GREET) model, developed by the U.S. Department of Energy's (DOE) Argonne National Laboratory and which EPA and other federal agencies currently use, is calculated with values for energy generated by older ethanol plants that often use outdated, less efficient processing technology.

"It's important to establish the carbon intensity of the current corn ethanol industry, which is best estimated by the newer, much more efficient ethanol plants," Sneller said. He cited the Biofuel Energy Systems Simulator (BESS) model developed at UNL, which uses default scenarios that utilize updated energy use data, including operating data for the last two years collected from dozens of plants in Nebraska and Iowa. Sneller believes the BESS model is more transparent and more thoroughly documented than the version of GREET currently being used to estimate the carbon intensity of corn ethanol. Research providing current data for these models is essential, Sneller said. "If we don't get this model right, ethanol producers will have a difficult time producing ethanol from corn, and the economic consequences of that are significant."

From Left: Larry Tieszen, Todd Sneller, Duane Kristensen

Research is needed to understand all the possible biofuel opportunities across the network of climate and soil types that characterize Nebraska and the Great Plains.

Tieszen agreed that complete life-cycle analysis of the crop used as a feedstock is critical in quantitatively modeling sustainability of any biofuel. There also is a need to consider carbon credits and how those relate to biofuel production and agriculture. Research is needed to understand all the possible biofuel opportunities across the network of climate and soil types that characterize Nebraska and the rest of the Great Plains.

Water use and ethanol production

Questions about water use by ethanol plants are being expressed by the public and in the media. By far the greatest amount of water use is for corn irrigation, but older ethanol plants can use seven or eight gallons of water to produce one gallon of ethanol. Sneller reported that a recent water audit of a four-year-old ethanol plant in Trenton, Neb., indicated consumptive water use of 2.88 gallons of water per gallon of ethanol, a substantial increase in efficiency. "We are also seeing a real interest on the part of those companies who are trying to do business in states like Nebraska, Kansas and South Dakota in low water use systems, and there's an economic factor associated with that as well," Sneller said.

Cassman summarized the issue. "The question is, essentially, can we both produce corn for ethanol in Nebraska, in the Great Plains, and protect water resources within tolerable limits that people in this room would set? And I think that's really the million-, billion-dollar question. And I think it's solvable, and I think the answers about how to do that come out of the creative thinking of a group like this, and that's what's so exciting about it."

Recommended research needs

- Recent, relevant data and complete life-cycle analysis for quantitatively modeling the sustainability of biofuels
- Determine optimal uses of land for production of all types of biofuel feedstocks in the High Plains region, where soils and climates differ widely
- Increase the efficiency of the corn ethanol production process
- Develop cellulosic ethanol and other second-generation biofuels
- Improve yields for biofuel feedstocks – corn, soybeans and proposed second-generation feedstocks such as switchgrass
- Improve efficiency in consumptive use of water by ethanol plants