

## STRATEGIC DISCUSSIONS FOR **nebraska**

OPPORTUNITIES FOR NEBRASKA  
ENERGY, CLIMATE AND SUSTAINABILITY



University of Nebraska-Lincoln  
College of Journalism and Mass Communications

# Acknowledgements

We are grateful to the Robert and Ardis James Family Foundation for their vision, guidance and financial support. The James family founded Strategic Discussions for Nebraska in 2007 and their funding and support continue to make this program possible.

Beginning July 1, 2010, the UNL Institute of Agriculture and Natural Resources began a three-year financial and programmatic collaboration with Strategic Discussions for Nebraska. We are deeply appreciative of their support.

Strategic Discussions for Nebraska benefits from the involvement and advice of an external advisory board.

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*This publication is dedicated to Robert and Ardis James, who founded Strategic Discussions for Nebraska in 2007 and have generously funded the program since then. Their philanthropy at the University of Nebraska-Lincoln also includes the founding of the International Quilt Study Center and the Marvel Baker Endowed Professorship. Ardis James passed away July 7, 2011.*

Cover image:  
Corn field in Lancaster County  
Courtesy of Nkem Kalu

James photo courtesy of Geoff Johnson.

## STRATEGIC DISCUSSIONS FOR **nebraska**

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# From Lab to Living Room, UNL Research Makes a Difference

*A message from University of Nebraska-Lincoln President James B. Milliken*

Energy, climate and sustainability have long been high priorities for the University of Nebraska. As you will see by the diversity of stories in these pages – water conservation and law, alternative energy, innovations in agriculture, climate change and others – the task of creating a more sustainable future for our planet will require putting all of our best minds to work. The University of Nebraska is committed to this collaborative approach, and we are positioned to make key contributions to global advancements in these fields.

The Robert B. Daugherty Water for Food Institute is one excellent example of how the university, as a land-grant institution, is leveraging its resources – the talents of our faculty, staff and students; partnerships with constituents across the state; and generosity and support from visionary philanthropists – to serve Nebraska and the world. The Daugherty Institute was established in 2010 with a mission of providing research, education and policy analysis related to the use of water for agriculture. The need for the institute is clear: By 2050, the world's population will increase by 40 percent, and demand for food will double. We must develop strategies to produce much more food with the same amounts of land and water... and we must do it quickly.

The Institute is off to an impressive start: we are close to hiring an executive director, actively collaborating with a number of partners internationally in both the private and government sectors, and advancing a highly targeted and strategic research agenda. This May, together with the Bill & Melinda Gates Foundation, we hosted the third annual Water for Food Conference, attracting internationally renowned speakers and 400 participants from more than 20 countries. During the conference, we signed an international education partnership agreement focused on water and food security with the UNESCO-IHE Institute for Water Education in The Netherlands – an important opportunity for Nebraska students and students abroad.

The man for whom the Board of Regents chose to name the Institute, Bob Daugherty, was the founder of Valmont Industries, the largest center-pivot irrigation company in the world, and a pioneer of modern agriculture. He saw the potential of the University of Nebraska to play a leading role in improving the world's condition by working to alleviate hunger and food insecurity. He recognized that the university has a rich history in water research and education, a network of farmers and ranchers in Nebraska on whose wisdom we can rely, and that our state offers a “natural laboratory” that makes it an ideal place for the study of



water and agriculture. This is why Bob provided the \$50 million founding gift to the university to establish the Water for Food Institute.

Sadly, Bob passed away in November 2010. Through the Daugherty Institute, we are now working to carry out his vision – a vision to create healthier, higher-quality, more productive lives for people in Nebraska and around the world. Look for great things from the Institute in the years ahead.

*A message from University of Nebraska-Lincoln Chancellor Harvey Perlman*

I am pleased to present the latest iteration of Strategic Discussions for Nebraska, a project of the University of Nebraska-Lincoln College of Journalism and Mass Communications. This edition, Opportunities for Nebraska, Volume Two: Energy, Climate and Sustainability, explores important topics that engage the very best scientists and researchers at the University. This edition also represents two milestones. For the first time, the contents of this magazine were researched and written entirely by UNL students. And this is the first time that the University of Nebraska Institute of Agriculture and Natural Resources has been a key partner and collaborator.

UNL's most important strategic priorities are undergraduate education and research and economic development. These are rooted in our primary missions of teaching, research and engagement and outreach. Strategic Discussions for Nebraska is a project that encompasses all these missions. Opportunities for Nebraska, Volume Two: Energy, Climate and Sustainability allowed students to dig deeply into diverse issues such as water conservation, climate change, innovations in plant and animal science, drought policy, and biofuels. UNL scientists and researchers are among the leaders in these areas. This publication bridges the gap between the laboratory and living room – giving Nebraskans the facts and materials necessary to make critical decisions about issues that will affect the future. We hope these publications spark discussion, comment and further inquiry.

We are indebted to the Robert and Ardis James Family Foundation whose generous contributions launched Strategic Discussions for Nebraska. Congratulations to Project Director Mary Garbacz of the College of Journalism and Mass Communications and to the students who researched, wrote and created this publication. I thank the many faculty members across the University, particularly those in IANR, who served as sources for the project. Thanks also to the members of the Strategic Discussions for Nebraska Advisory Board, who come from the University and the wider Nebraska business and educational communities. This group's aid in identifying and targeting topics of interest has proven invaluable.

I know you will find this publication to be a useful tool in formulating opinions and policy that advance Nebraska's progress.



*A message from NU Vice President of Agriculture and Natural Resources and Harlan Vice Chancellor, IANR, Ronnie D. Green*

We in the Institute of Agriculture and Natural Resources (IANR) at the University of Nebraska-Lincoln are part of Nebraska's land-grant university – the people's university – and we take that privilege and responsibility very seriously.

Our mission as part of Nebraska's land-grant university is to take the university's resources to Nebraskans through teaching, research and extension education. All three closely intertwine in IANR, where food, energy, water and natural resources, and people are at the core of all we do.

That's because the security – and by security I mean enough for everyone -- of food, renewable energy, water and natural resources for people are the biggest challenges facing our state and world today. Given that, you'd expect the people's university to seek solutions to Nebraska's greatest needs. It's how we're at work for Nebraska.

We know people can't make their best decisions for their lives, families, businesses and communities without the best knowledge available – knowledge based on and proven by research and results.

We do such research in IANR and throughout the University, moving new knowledge quickly into our classrooms and carrying it throughout our state through University of Nebraska-Lincoln Extension.

Providing thoughtful, factual, carefully researched information to Nebraskans also is the base for Strategic Discussions for Nebraska (SDN), and IANR is pleased to have this opportunity to partner with UNL's College of Journalism and Mass Communications (CoJMC) to provide this SDN magazine.

Opportunities for Nebraska, Volume Two: Energy, Climate and Sustainability, contains topics vital to all our state and world, and key to our work in IANR.

Our thanks to Mary Garbacz in CoJMC who heads the SDN project, and the students who worked with her to deliver this report. We value the opportunity to provide rich learning experiences for students.

Our thanks, too, to the Robert and Ardis James Family Foundation for the James's considered belief that people must have factual information to promote statewide discussions leading to wise decisions for Nebraska and its people. SDN began with the James's support.

A quick look through the stories in this magazine makes it clear why this is information worth reading, digesting and putting to use. Topics include renewable energy; water and other natural resource sustainability; climate change; innovations in horticulture, agricultural crops and animal science; and more.

These issues are hugely important to our powerhouse agricultural state's future success and sustainability, whether a person farms or ranches or lives and works in our most urban areas. They affect our entire planet, and the ability to feed and sustain our world's population.

It is a pleasure for the Institute of Agriculture and Natural Resources to be part of this issue of Strategic Discussions for Nebraska. We hope you'll help us carry the discussions forward, making your ideas and opinions known.



*A message from College of Journalism and Mass Communications Dean Gary Kebbel*

Food, energy and water are strengths of Nebraska, pairing beautifully with the research strengths of the University of Nebraska. The state's rich agricultural heritage and economy, combined with the knowledge and careful stewardship of its people, make Nebraska a perfect place for real-life research.

It's also a perfect place for journalism students to write about science and technology. It's a specialized skill to be able to turn complex information into a story that is both interesting and easy to understand, in a variety of media platforms. It's the future of journalism.

Opportunities for Nebraska, Volume Two: Energy, Climate and Sustainability was produced by Strategic Discussions for Nebraska, a program in the College of Journalism and Mass Communications and by undergraduate and graduate students enrolled in a Magazine Writing course in the spring of 2011. The 40-plus stories provide a snapshot of just some of the research being conducted at the University of Nebraska – research that is providing the science to feed a global population that will grow to nine billion by 2050.

Opportunities for Nebraska, Volume Two: Energy, Climate and Sustainability is the second magazine produced as part of a financial and programmatic collaboration with the founding funder of Strategic Discussions for Nebraska, the Robert and Ardis James Family Foundation; the UNL Institute of Agriculture and Natural Resources; and the UNL College of Journalism and Mass Communications. Public and private partnerships like this provide the diverse perspectives and shared funding that result in accomplishments that would not otherwise have been possible. We are grateful to the James family and to the Institute of Agriculture and Natural Resources for joining us in this collaboration.

The University of Nebraska takes its land grant mission seriously. Its commitment to what is often called the "three-legged stool" – teaching, research and outreach – is a part of everything we do. Students involved in the production of this magazine have learned to conduct interviews with scientific researchers; they've captured video and still photos; they've learned a new kind of writing; they've learned to edit; they've learned a culture of accuracy. Now, we have the honor of delivering this magazine to you.

The website – [www.unl.edu/sdn](http://www.unl.edu/sdn) – contains all of the content in this magazine. Additionally, you can see short video montages of the interviews students conducted with the university researchers.

Enjoy this magazine!





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A wide-angle photograph of a vast wheat field. The foreground is filled with golden wheat stalks, some of which are in sharp focus, showing their texture and color. The field extends to a flat horizon under a clear, light blue sky. A black horizontal bar with a thin white border is positioned across the upper part of the image, containing the word 'Agriculture' in white text.

# Agriculture

*Wheat field near Lincoln*

# Soil: Techniques and Production Methods, How They Conserve Resources

By Patrick Radigan

In the overall task of finding the means and technology to feed the world, Mark Kuzila said one critical factor is how we maintain and understand a key building block of the agriculture industry: soil.

While there are still big questions yet to be answered, Kuzila, a professor of soil science in the University of Nebraska-Lincoln's School of Natural Resources, said one of the first things that needs to be addressed is the ability for the world's soil to produce the food people need. By understanding what's going well, he said, as well as the mistakes that are being made both in Nebraska and around the globe, people can better understand what needs to be done or improved to be able to produce the food the world is going to need in the future.

## Sustaining Nebraska's Soils

Looking at the sustainability of soil within Nebraska, Kuzila said it comes down to finding the best way to use the soil while trying not to deplete one of the state's most prominent natural resources.

"I always tell my students we have to farm the soil," Kuzila said. "We may not have done the best job back then, but we're working toward no-till and these things to help us maintain the physical properties of the soil that are better for everybody's use."

Kuzila said there are a number of potential practical applications of soils research. One area Kuzila said the scientific community has made advances in is the study of how Nebraska's soil has been changing in the past century. Starting with studies done in the early 1900s, geologists have kept a close eye on Nebraska's soil. The 1950s marked the implementation of more modern soil survey techniques. What they've learned, Kuzila said, is that the natural properties of soil have changed depending on how it has been used and maintained, either by natural or man-made means. Changes range from the level of organic carbon in the soil, to altering the actual structure of the soil depending on its use of the soil. What this information can tell us, he said, is how farmers can adjust the means of production to best care for and protect the soil.

## Preparing for the Future

One of the aspects of soil study that Kuzila said has made a major impact is looking at how new technology and research can be put into effect in the field. Tools like the ability to measure soil quality and properties with meters that are pulled over the ground may be able to increase efficiency both in soil quality and water use.



*Mark Kuzila*

"Young students have the ability, with technology, with the age of the computer... to understand certain ways to analyze things, and to work with machinery," Kuzila said.

A specific example is a developing concept of a smart water distribution system. By using a GPS map of the different soil varieties, Kuzila said technology could potentially distribute different amounts of water in each section, depending on how much water that type of soil requires.

For Kuzila, this type of technological change is what the farming industry needs to be able to meet future food production demands.

"It comes down to quality use of water and efficient use of water," he said.

## Connecting Nebraska to the World

When looking at how the research done at UNL can affect the future of agriculture around the world, Kuzila said it starts with the first identifying characteristic of soil: climate.

By studying the soil in Nebraska, Kuzila said others can apply the research on different soil types in the state to other places around the world that have similar climates.

Another way research at UNL can help around the world is by working with areas that have soil similar to the many soils present in Nebraska. Kuzila said studying soils like loess, which is a wind-blown silt soil found throughout eastern, central, and southern Nebraska, can help other

places across the globe that have similar soil composition and structure.

On top of simply studying the soil found naturally in the state, Kuzila also said work done in the lab is starting to pay off. Experiments where soil samples similar to those found in Africa are analyzed for ability to hold and transfer water are examples of the work Kuzila said could pay off in the efforts to provide food in areas of need.

As the need grows for food and water in places like Africa, he said, so does the demand for soil research. Kuzila said that by studying soils here in Nebraska, he and his team could help work with other communities around the world to maximize their ability to irrigate and maintain crops.

### Soil and Production Agriculture

Kuzila's primary area of research is identifying soils and learning how soils were formed, as well as understanding the chemical and physical properties of soils and how they impact agricultural production.

In his work at the university, Kuzila also works with the Nebraska Geological Survey, meaning much of the funding he receives comes from state sources. However, to make his work possible, he also said he receives funds from outside sources such as the United States Department of Agriculture and local government entities.

"Most of my work deals with resources in the state of Nebraska," Kuzila said. "So to be frank, external monies aren't readily available to support studies that focus on research to be applied to serve the citizens of Nebraska."

Through that work, Kuzila said he has come up with a method that helps him understand what type of soil he is dealing with, as well as what that means for the potential production.

To properly understand a soil, he looks at five different factors in determining the type and properties of soil. The first, climate, is simply the weather and natural conditions of the soils environment, while the second property, parent material, is a little more complicated.

"Number two would be the parent material, and that's just what it says: Parent material is the stuff the soil formed in," Kuzila said. "So what stuff do we have in Nebraska?"

After climate and parent materials comes the concept of location in relation to the landscape, or more simply where the soil is located. Is it on a hill? Is it at the low point of a valley? Kuzila said considerations like these are crucial towards understanding soil and how to best use it.

The final two factors, vegetation and age, are also physical properties important to soil development and the potential for production. By understanding what plants live on certain soils, and how long the soil has

been there, Kuzila said he can have a better understanding of what he's working with when it comes to potential for production.

"My interest is studying all those things, determining what soil is where it is on the landscape and then the properties of those soils, how we use those soils," he said. "That changes drastically across the state." ●



For more information visit [www.unl.edu/sdn/opportunities](http://www.unl.edu/sdn/opportunities)

# Soil Productivity Vital for Economical Crop Production

By Farooq Baloch

Increasing food prices have been a concern not only in America but also in the rest of the world. However, the research at the University of Nebraska-Lincoln helps farmers to reduce the cost of food with minimum impact on the environment.

According to UNL Professor of Agronomy, Richard Ferguson, increasing the efficiency of nitrogen fertilizer helps maintain soil and water quality.

Improved soil and water quality, he said, will increase crop productivity, reduce the costs of food and prevent soils from environmental degradation.

"Soils in Nebraska are naturally quite productive compared with much of the rest of the world," Ferguson said. "Nebraska today has the largest area of irrigated production in the United States."

He said these resources in Nebraska provide great capacity for crop and livestock production. "It's a resource that we want to be able to maintain or build."

Ferguson, who specializes in soil science in the Department of Agronomy and Horticulture, said if farmers can produce more with the same inputs, it will help protect their incomes.

He further said while increasing efficiency, farmers have to minimize environmental impacts, and at the same time maintain the soils for production in the future.

Ferguson's research deals with a broad scope of soil science. His specific research interests include soil fertility and crop nutrition — within that, his primary areas of research and extension relate to understanding the variability of the soil as a resource and management techniques, a process called site-specific crop management, or precision agriculture. In precision agriculture or precision farming, Ferguson said the inputs such as fertilizers, seeds or water can be managed differently in different areas of the crop field to best utilize the soil resources.

He said it is important to sustain and even improve the quality of soil, which has been degraded by agricultural use over the years.

"Soil quality or productivity is

foundational to our existence as humans," Ferguson said. "Our economies, our livelihoods and our existence are based primarily on plants as a food source and in many cases, plants may be fed to animals, which also become a food source for humans."

The professor said a lot of basic human life relates back to soil quality and its ability to serve as a resource to produce food. "Our primary interest is in maintaining that as a resource for human health," he said.

## Environmental and Economic Benefits

Ferguson said improving the efficiency of nitrogen fertilizer helps protect the soil from environmental degradation caused by leaching or gaseous loss of nitrogen.

Improving the efficiency of nitrogen fertilizer also can help protect groundwater from nitrate contamination. Infants and nursing mothers are particularly susceptible to potential health hazards caused by high levels of nitrogen in groundwater. He said young infants don't have the enzyme that helps protect against nitrate issues, which affect a body's ability to carry oxygen.

Ferguson said the use of nitrogen fertilizer to some degree is a global warming contributor because of the nitrous oxide emissions; thus, minimizing nitrogen use by improving its efficiency can reduce nitrous oxide emissions.

"We are working on ways to improve efficiency of nitrogen fertilizer use, particularly through spatial tools," he said.

He said his research team is using optical sensors, also called crop canopy sensors, to detect the nitrogen status of a crop and adjusting the fertilizer rate based on sensor output.

Ferguson said food in the U.S. is relatively inexpensive, but its prices are going to increase because of global demand. "So our goals are to try and be as efficient as we can, not just for consumers in Nebraska but also for those in the world."

Ferguson said nitrogen fertilizer is one of the largest expenses that farmers have in producing a crop. Improved efficiency can reduce farmers' expenses as well as the cost of production, which will ultimately reduce the cost of food.

"Our main goals are continued



*Richard Ferguson*





improvements in productivity and efficiency,” he said, “and fertilizer inputs to maintain or improve profitability for the farmer.”

Doing so, Ferguson said, will benefit the economy of the state significantly. “We have seen that farmers have done an excellent job, over the last 20 years plus, of steadily improving how efficiently they use fertilizers,” Ferguson said.

He said the yields farmers produce every year are higher with the same or less fertilizer input.

“The amount of fertilizer farmers apply to raise a bushel of corn, for example, is about half now what would have been 20 years ago,” Ferguson said, “and that’s through collective efforts of many scientists. That’s an area that we’ve really been able to show significant progress in.”

### **Soils in Nebraska: a Comparative Advantage**

“In Nebraska, at least we have soils that are fairly young meaning that they have not been heavily weathered through climate,” he said, adding that in the southern and eastern U.S., soils are more heavily weathered and their natural nutrients have been more depleted.

“Soils in Nebraska need very little additional inputs for optimal crop production,” Ferguson said, “but as you go farther elsewhere in the U.S., soils may need more inputs to maintain high productivity.”

According to Ferguson, agriculture research is not well-funded compared to some other types of research.

“Funding is always an issue. There are always things that we’d like to do more gracefully or more broadly that we

don’t have resources to do,” he said. Ferguson said nitrates in groundwater is an issue. He said Nebraska farmers are doing better than they used to, but they still have areas of the state with high-nitrate groundwater.

In those areas, communities have to either treat the water or drill new wells and that can be quite expensive. “My research is trying to mitigate them out of fertilizer that moves to ground water. We can protect against those costs.”

Soil carbon, which has been reduced by tillage, is a central issue in Nebraska and is also becoming more of a global issue since it has ramifications for climate change and productivity of soils.

Ferguson said many of the soils have about half of that soil carbon now than what originally was present in native prairie.

“So one aspect of our research is how to maintain or build soil carbon through reduced tillage or no tillage through inputs of fertilizers,” he said, “so nitrogen is key in that process to allow us to build soil carbon.”

### **Global Similarities**

He said there are soils and climates worldwide that are similar to what one would find in Nebraska and therefore, the research conducted in Nebraska is very translatable to those climates and those soils in other parts of the world.

Ferguson said the goal of the research is to maintain soil productivity, which comes back to playing their part of doubling the food production by 2050. ●

*For more information visit [www.unl.edu/sdn/opportunities](http://www.unl.edu/sdn/opportunities)*



# Leading Through Sustainable Management of Natural Resources

By Christine Hunt

“With agriculture there are always challenges,” said Charles Wortmann, soil fertility nutrient management specialist in the University of Nebraska-Lincoln’s Department of Agronomy and Horticulture. In the next 30 years or so, the amount of agricultural commodities needed will double, he said. “Part of it is because of population growth around the world but it’s also because of rising standards of living,” Wortmann said. For instance, in China, population growth is actually declining but the standard of living is increasing. An increased standard of living results in more consumption, which creates a demand for more production, he said.

The challenge for the future will be managing the use of natural resources such as soil and water so the resources are not depleted or permanently damaged. “We have to keep in mind that we need practices that allow us to maintain our production while being sustainable and not just locally or in the field, but globally,” he said.

Wortmann has years of experience and first-hand knowledge of farming practices in many parts of the world, especially Africa: Ethiopia, Uganda and Mozambique. After earning his bachelor’s degree, he spent two years in Tanzania. He returned to the U.S. to earn his master’s degree, returned to Africa for five years, earned his doctorate in the U.S., and then returned to spend 12 years in Uganda. While in Uganda, Wortmann worked with the Center for International Tropical Agriculture (CIAT), focusing on conducting agronomic and soils research. Recently, Wortmann did a short-term assignment with the Alliance for the Green Revolution in Africa, a Gates Foundation-funded program, with activities throughout sub-Saharan Africa.

Based on his experience in other countries, Wortmann believes that Nebraska has great resources for agricultural production compared to other parts of world, where the resources can be much more fragile.

## Increased Production Through Research

Wortmann looks for research opportunities with multiple

benefits, such as the efficient use of nitrogen fertilizers. Nitrogen fertilizers are produced using fossil fuels, which emit carbon dioxide and are a finite global resource. “If we can use less nitrogen and use it more efficiently, it means less emission of carbon dioxide,” said Wortmann. His recent work on nitrogen fertilizer management for high-yield corn found that high yield levels, 240 - 250 bushels per acre, can be achieved while using nitrogen fertilizer much more efficiently than researchers have been able to achieve at lower yield levels.

This efficiency is the result of different technologies coming together, said Wortmann. “First of all, it would be on irrigated land in order that the crop has enough water that it doesn’t come under stress; it means the water use has to be efficient...very well-managed water usage efficiency to avoid leaching of nutrients from the soil.” It means having a hybrid of good genetics in the field, good soil management and good crop management all the way through, Wortmann added. “It’s different specialists working on different elements of this that enable us to continue to advance our technology.”

## Collaboration in Research

Wortmann works primarily with corn, soybean and sorghum research and believes it’s important to get research results distributed quickly to producers, the agribusiness community and natural resource management agencies. “When we get this information quickly to farmers, we continue to see increased production in what we think is a sustainable manner,” he said.

Wortmann has collaborative relationships with Iowa State, Kansas State and the University of Missouri on water quality and climate change issues.

He explained that collaboration and research is important locally, but also globally. “The new information and techniques can be applied where there are food deficits,” he said, adding that producers have the capacity to help meet those needs. “The research, getting the information out to producers quickly, in addition to the teaching component, has a big impact.” To illustrate his point,

Wortmann cites a study by Battelle, an

“When we get this information quickly to farmers, we continue to see increased production in what we think is a sustainable manner.”

independent consultant in Columbus, Ohio, that concluded the Institute of Agriculture and Natural Resources at the University of Nebraska-Lincoln annually returns at least \$15 in benefits to Nebraskans for every dollar of state support. Those benefits come back to Nebraska in jobs, economic growth and the ability to maintain the state's high standard of living. According to Wortmann, in 2005, the State of Nebraska invested about \$75 million. The impact is estimated to be about 1.1 billion dollars per year.

### **Funding Future Research**

Research funding comes from a variety of sources, but Wortmann's is mainly from federal sources such as the U.S. Department of Agriculture (USDA) and the U.S. Agency for International Agriculture (USAID). However, state funding pays salaries and provides some operating funds, he said. Other funds come from commodity boards, such as the

Nebraska Soybean Board and the Nebraska Corn Board, with additional funds from industry sources.

### **Nebraska Initiatives, Global Opportunities**

According to Wortmann, the Robert B. Daugherty Water for Food Institute at the University of Nebraska will benefit irrigated and rainfed agricultural production in Nebraska, but also has tremendous potential for other countries.

"Ethiopia is investing quite a lot in irrigation technology and expanding their capacity for irrigation. But they realize they lack the experience – and we are so strong in that – not just the water management, the irrigation management, but producing the crops and managing the soils under those irrigated situations," said Wortmann. "I think great things are happening. I always wish we could do more."



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*Charles Wortmann*



# Scientific Trait Development: Soil

By Jaclyn Tan

When it comes to small grains breeding, P. Stephen Baenziger is the only university expert in the entire state of Nebraska.

“The best piece of advice I ever got when I was a graduate student was that most states can only afford one person in the job you’re hired in, so do your job,” Baenziger said.

Baenziger is the Eugene W. Price Distinguished Professor of Biotechnology at the University of Nebraska-Lincoln. Since 1986, he’s researched winter triticale and winter barley, but his main focus is winter wheat. It’s his job to breed new varieties of these small grains crops that yield more grain, are more disease resistant and grow with fewer inputs such as water and fertilizer, but still are of good quality.

## New Grant Leads to New Possibilities

Baenziger said he is always trying to do three things: 1) create new cultivars, or varieties, of wheat to solve new challenges, 2) create new breeding methods and 3) teach the next generation of plant breeders.

Thanks to a \$2 million endowment from Bayer CropScience, Baenziger will soon be able to do all those things as he becomes the first Nebraska Wheat Growers Presidential Chair for wheat breeding.

Bayer CropScience, one of the world’s largest agriculture chemical companies, produces chemicals such as insecticides and herbicides to protect crops. The company also invests in research and development of agricultural crop seeds and it is currently an industry leader in cotton seed, canola and hybrid rice, Baenziger said. “They’ve decided that they want to go into wheat, and so they came to the University of Nebraska because we have a longstanding wheat improvement program,” he said.

The collaboration will fund more research on wheat, and will also fund graduate student assistantships. He said the Bayer collaboration is in addition to the funding he gets from the Nebraska Wheat Board, companies such as ConAgra and BASF, and various other federal and state grants.

More recently, however, Baenziger has had to consider two new challenges: climate change and sustainability.

## Climate Change Challenge

There are two aspects of climate change, Baenziger said. “The first aspect is that the climate will be changing as a trend,” he said. “So if you believe in global warming, which I do believe in, you will see that in Nebraska we will get progressively warmer.”

Baenziger said he believes global warming will happen based on data trends observed by researchers and experts in his field. These progressively warmer temperatures means wheat varieties will have to be more heat tolerant to grow well. “Right now we know that Oklahoma is warmer than

Nebraska,” Baenziger said. “So maybe I breed wheats that today would be adapted to Oklahoma, but tomorrow will be adapted to Nebraska. That’s easy to do.”

The complicated part to deal with is the second aspect of climate change, which Baenziger described as “increased variations around the trend line.” That means the weather will fluctuate to greater extremes, he explained, such as extreme heat or cold, or extreme rainfall or drought.

Going back to the example with the Oklahoma wheat varieties, Baenziger said, those heat tolerant varieties are daylight-insensitive. Daylight-insensitive wheat varieties depend on temperature to flower, which works in Oklahoma because there are few late frosts, he said.

But in Nebraska, he added, late frosts are possible, which is why the state currently grows daylight-sensitive wheat varieties. Daylight-sensitive wheat varieties depend on the amount of daylight to flower, and more importantly, they are more winter hardy than the Oklahoma varieties, Baenziger said.

“So the question becomes,” he said, “what do you do if you go into a climate scenario where you’re colder in the winter, and then warmer in the summer and you still can have the late frosts?” That becomes a problem, Baenziger said, because researchers haven’t managed to breed wheat varieties that can handle those conditions in the same growing season.

The difficulty of responding to climate change is mainly because it takes up to 12 years to create a new variety of wheat, Baenziger said. Researchers say sometimes climate changes take place quickly, and there may not be enough time to produce a new wheat variety to meet this change, he said.

## Managing Sustainability: Quantity Versus Quality

Another challenge for plant breeders is balancing the demand for quantity of grain that their varieties will yield, as well as the quality of grain.

Conventional wheat growers are paid based on the weight, or the amount of grain, that they harvest, Baenziger said, so crop yield is more important to them than other aspects of the grain such as disease resistance and end-use quality. The best agronomic lines of wheat have excellent yields and test weights, which is the gain volume weight based on which the grower is paid, and also have acceptable end-use quality and acceptable disease resistance, he said.

However, he added, a growing number of organic growers market their products on the basis of the wheat quality. These farmers use organic methods that don’t use modern inputs such as pesticides and chemical fertilizers. Baenziger said they focus less on the crop yield and more on the end-use quality because they can get a higher price for that quality of wheat. As a result, the organic market would

be good for a line of wheat with high end-use quality, but fewer bushels per acre, he said.

### The Future of Wheat Breeding: Genomics

Baenziger said current small grains breeding methods rely heavily on the process of visually selecting and measuring the seeds and plants, known as phenotyping.

In the near future, he said advances in genotyping – looking at a plant's genetic markers to figure out which gene results in higher yield, crop quality, disease resistance and so on – could result in a more efficient method of wheat breeding that would result in better varieties.

This new technology will bolster the current aims of researchers at the wheat program at UNL, which is to produce wheat varieties that have four characteristics: 1) they must be able to survive winter, 2) they must be resistant to stem rust, which is a devastating cereal crop disease caused by a fungus, 3) they must grow well in the field and mature at the right time, and 4) they “must make a good loaf of bread or a good Asian noodle,” Baenziger said.

### Making a “Good Loaf of Bread”

So what kind of wheat makes a “good” loaf of bread or Asian noodle?

One important aspect is the wheat's protein content, he explained. A good loaf of bread starts with wheat that is at least 12 percent protein, as opposed to more carbohydrate and lipids.

This amount of good quality gluten protein helps create smaller holes in the bread, Baenziger said, which allows peanut butter or butter to be spread evenly across a slice of bread. “Ideally, what you want is a loaf of bread that when you spread peanut butter or butter on it, ... the bread stays where it is, and the peanut butter is the one that gives, that has to be spread, not the reverse,” he explained.

### Beyond the Research and Into People's Lives

Baenziger measures his success based on his impact in two areas: his research and his students. He said it's easy to tell if his research has been useful. “As a plant breeder, the easiest way to measure whether or not you've done something well is how your products have been received,” Baenziger said.

The evidence is clear: More than 60 percent of the wheat grown in Nebraska are varieties released from the UNL's wheat breeding program, he said, and these varieties are also grown in surrounding states such as South Dakota, North Dakota, Minnesota, Wyoming, Colorado and Kansas.

In the spring of 2011, Baenziger won the Outstanding Research and Creative Activity award, a UNL-wide award recognizing faculty members for outstanding research and creative activity of national or international significance.

As for his students, Baenziger said he's proud to have trained students who have gone on to do well.

“One is a member of parliament in Turkey, and he will probably be the most knowledgeable person in agriculture in that parliament. A couple of students have just gone to major seed companies in corn.

One is literally Dr. Pepper - he breeds peppers for one of the big vegetable seed companies. I've another student who's also with that same company who's not in vegetable breeding, but in corn breeding. Other ones have gone on to be very successful in the USDA,” he said.

But Baenziger said the part he loves most, and his original reason for becoming a plant breeder, is that his research has helped feed so many people. “I personally think that people should be fed,” he said.

Baenziger said his work at the University of Nebraska, together with collaborations with other institutions, has allowed him to do that. He said thanks to genetic improvements to wheat varieties, there is enough wheat produced to feed almost 3 million people daily who otherwise wouldn't have enough to eat. ●



P. Stephen Baenziger



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# Center for Plant Science Innovation: Developing Better Foods and Fuels

By Tim Duey

Ed Cahoon's earliest years were spent on a Virginia soybean farm. Now, decades later, he's on the cutting edge of soybean research.

"I'm interested in things like engineering soybeans to make new types of oils to alter the fatty acid composition to make the soybean more healthy, or more useful for applications like biodiesel production," he said.

Cahoon has conducted research in both the public and the private sectors and is now director of the Center for Plant Science Innovation that operates at the University of Nebraska-Lincoln.

The center and its staff of nearly 100 researchers, technicians, graduate students and undergraduate students perform a diverse array of research that has the potential to impact millions of lives. They meet challenges ranging from developing renewable fuels to combating world hunger with genetically engineered crops.

Though researchers worldwide are participating in much of the center's work, Cahoon's team specializes in areas of study that have a particular impact on Nebraskans, such as work with camelina, a crop that is used to make biodiesel fuel and is productive in areas of low rainfall such as western Nebraska.

## Innovations in Food

Perhaps the Center for Plant Science Innovation's most commercially successful project involves the genetic engineering of soybeans.

"Within the Center for Plant Science Innovation, two of our researchers, Don Weeks and Tom Clemente, came up with a way to take a gene from a bacterium that can break down a particular type of herbicide called dicamba, and they've isolated the gene and introduced it into plants," Cahoon said. "The resulting plants are dicamba-resistant. This is an important trait for farmers and worth a lot of money."

That research is worth a lot of money because it is being adopted into industry-leading agricultural technology. Monsanto licensed the dicamba-resistance gene to supplement their Roundup Ready™ soybeans, which dominate upwards of 80% of the soybean market. Roundup Ready™ soybeans are so dominant that weeds have begun to adjust to its advantages, becoming resistant to the same herbicides to which Roundup Ready™ soybeans are resistant.

Those same weeds aren't resistant to dicamba, which has proven to be extremely effective in trials at UNL's

Agricultural Research and Development Center farms near Mead, Neb. The dicamba-resistant plants are in the commercial production phase with Monsanto, and should become an integral part of its second generation Roundup Ready™ seeds soon. This innovation benefits soybean farmers by eliminating pesticide-resistant broadleaf weeds and thus increasing their crop yields.

"We hope in a few years these crops will actually be on the market that started from this basic research on a bacterium at UNL and now will soon generate a product that will benefit farmers throughout the world and benefit the university financially, and also be a product that farmers in Nebraska can use," Cahoon said.

In addition to increasing productivity at home, the center is also using its research to add value to agricultural products abroad. It is part of a large research effort to increase the nutritional value of the potato-like cassava, funded in part by the Bill and Melinda Gates Foundation.

The cassava is a staple food for people in sub-Saharan Africa and is confined mostly to subsistence agriculture and back yard gardens since it is very easy to grow, Cahoon said. But it offers little nutritional value, apart from its high caloric content. In regions where food is scarce or relatively unaffordable to a large segment of the population, the cassava can stave off starvation. The problem is that a diet high in cassava can be deficient in certain micronutrients. That is the challenge the center is trying to address, he added.

"We're trying to engineer cassava to make higher levels of pro-vitamin A, which is an essential nutrient that is limited in the diets of large portions of Africa and parts of the developing world," Cahoon said.

## Biofuel Research

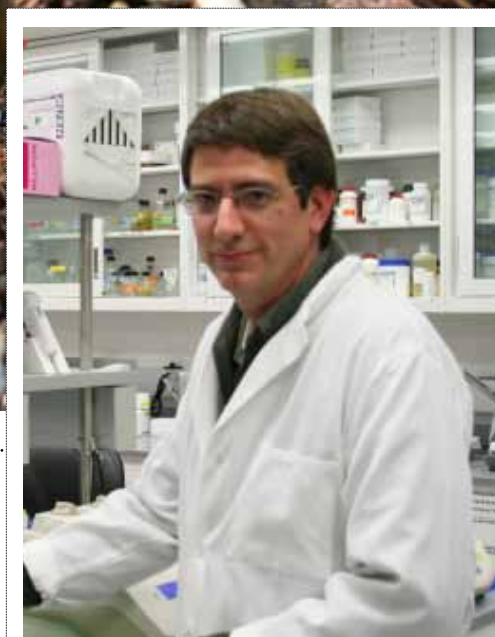
The center is also involved in biofuels research, that is, the attempt to create fuel from plants. The center's research with camelina focuses on trying to turn it into a viable source of fuel. An eastern-European food crop, camelina has some unique traits that make it especially attractive to Nebraskans.

"It doesn't require a lot of inputs, such as fertilizer, to grow well. So it's a low-input crop that grows well under low rainfall conditions similar to what we have in western Nebraska," Cahoon said. "There's a lot of interest in this as an alternative oil seed crop to get vegetable oils out of to use for biodiesel production."





*Edgar Cahoon*



In addition to camelina, researchers at the center are also trying to turn other plants into biofuels. Algae could potentially produce more biofuel than any other plant because of the huge biomass it's capable of producing in a relatively small area, Cahoon said. A lot of it can be grown in a relatively small space. But according to Cahoon, it's still a long way from being a useful source of fuel.

"The problem is that people really don't know how to tap the potential of algae and that's really where the research is," Cahoon said. "Algae doesn't produce oil under normal conditions. You have to stress it ... and cause it to accumulate oil that can then be converted into biodiesel."

The amount of nitrogen in the media in which the algae is growing needs to be decreased to get it to produce oil. Even when that's done there are still problems with harvesting the algae and extracting the oil in a way that is cost-effective, he said.

Cahoon said research at the Center for Plant Science Innovation is funded from a variety of sources. Some funding comes from the Bill and Melinda Gates Foundation; some from the U.S. Department of Agriculture, the National Science Foundation and other

federal sources; some from private industry and some from the soybean checkoff fund.

Additionally, Cahoon is one of the principal investigators of an Energy Frontiers Research Center grant that is funded by the U.S. Department of Energy.

According to Cahoon, time to focus on the underlying biology of plants is the major advantage the Center for Plant Science Innovation has over private corporations, which are often constrained by tight commercialization timelines. Cahoon said that the center's university setting allows researchers to have more flexibility than industry researchers.

"It's a little bit different focus," Cahoon said. "We can spend more time doing the basic research that companies don't do." ●

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# Crop Innovations: An Overview

By Jaclyn Tan

Over recent years, climate change and sustainability have emerged as much-discussed issues surrounding agriculture and food supply.

“When I started in my career, the general public impression was food was abundant, food was cheap. We didn’t have to worry about how we produced our food,” said Mark Lagrimini, professor and head of the Department of Agronomy and Horticulture at the University of Nebraska-Lincoln. “And what I found in the last five years is ... you read it in the papers, you hear it on TV and people are talking about food. There’s been food shortages worldwide, the price of food has gone up, and people are wondering: Is our food supply stable?”

Today, in 2011, more than one billion people around the world are hungry and malnourished, according to a circular by the University of Nebraska’s Institute of Agriculture and Natural Resources (IANR). Furthermore, the world’s population is expected to exceed 9 billion people by 2050. In order to ensure a healthy global population, the global food supply must also double by 2050, according to the IANR document.

And UNL researchers can help figure out how to meet the rising food need. “The university has tremendous resources,” Lagrimini said. “It’s like a living laboratory.”

Lagrimini has been a plant molecular biologist for about 25 years and has been at UNL for five and a half of those years. In August 2005, he became head of the Department of Agronomy and Horticulture, which is part of the IANR. Current research efforts at the UNL Department of Agronomy and Horticulture, Lagrimini said, are focused in five areas: climate change, bioenergy, soil and water conservation, health and well being and fundamental plant science.

## Impact of Climate Change

Because plants depend on sufficient water, sunlight and right temperatures for them to grow, the impact of climate change can affect the crops farmers can grow that year. In a state like Nebraska where almost a third of its residents make their living from agriculture, research to minimize the impact of varying climate on farmers is the top priority at the Department of Agronomy and Horticulture.

“We know we’re going to be getting periods of low water, low rainfall, and periods of probably excessive rainfall. We’re probably going to have more storms, more hail,” Lagrimini said. “And what we have to do is – for farmers to be profitable, for people to always have a consistent supply of food – we have to be able to make plants and do agricultural practices that are going to maintain a sustainable production even under varied years of rainfall, varied years of storms.”

UNL researchers are exploring how farmers can adapt to these problems by varying the crops they plant, changing the way they till the soil, and how and when they water their crops.

While climate change and sustainability may seem to have only recently surfaced in public discourse, Lagrimini said researchers at UNL are well-equipped to study climate change because they’ve been studying the issue for about 80 years.

People didn’t talk about climate change back then, Lagrimini said, but during the Dust Bowl years in the 1930s, NU researchers played key roles studying methods of tilling soil to figure out how to prevent soil from being blown about by the wind, causing erosion. This research included soil and water conservation and is strongly linked to sustainable agriculture.

Lagrimini’s research interests include improving drought tolerance in crops. He said he’s been able to do a good job because of UNL’s research resources and the state’s diverse climates and ecosystems.

“Nebraska is very representative for types of agricultural and natural resource lands on the East Coast all the way to the West Coast,” Lagrimini said. “It’s like a microcosm of the whole country, so it’s a great place to do research.”

For example, the eastern part of Nebraska is similar to Iowa because it has large amounts of rainfall and crops can be grown easily without irrigation, he said. “In the western part of the state it’s the opposite: you get very low rainfall,” he added, “and it’s difficult for farmers to make a living there. They have to be more creative, they have to vary their crops year-to-year and they make key decisions on what crops they’re going to grow.”

Another kind of region is the Sandhills, which form the largest sand dune area in the Western hemisphere, according to UNL’s Sand Hills Biocomplexity Project. Sandhills make up one-third of Nebraska, Lagrimini said, and is another unique ecosystem.

## Limited Resources Require Shift to Sustainability

Another big agricultural challenge to meet is sustainable food production. “It’s an important issue for people these days and what it means to them is being able to keep the food available for them to buy, at a reasonable price every year, no matter what happens to the climate, no matter what happens to our water resources.”

“Sustainability simply means being able to produce an adequate amount of food without consuming all of our finite resources such as water, soil and fossil fuels,” Lagrimini said. In the last 70 years, he said farmers could increase the



amount of crops they produce by simply expanding their operations. But now, they can't.

"We've done that by increasing the number of acres we planted on. We can't do that anymore - we're planting all the land we have right now," Lagrimini said. "We did that by improving our equipment - putting more energy into producing larger tractors and planters and combines. Well, we pretty much hit the top there, as far as we can go, so we're not going to be able to do that. We can't put more fuel into it 'cause we're running out of fuel. We have to worry about how much fuel we put into the farms."

Increasing yield with limited resources is already a challenge, but additionally the department aims to improve the nutritional quality of crops produced, Lagrimini said. "We have an epidemic of obesity and diabetes [in this country] but we also have a lot of hungry people in this country at the same time," he said. "So we need to be able to produce food that's more nutritious so people can be healthier. And yet, we got to get that food to people who need it, so it's kind of a difficult problem."

### Solutions in Plant Science, Conservation and Bioenergy

UNL researchers are exploring three solutions to sustainability problems: plant science, soil and water conservation and bioenergy.

By studying plant genetics, Lagrimini said researchers hope to understand enough about plants' genetic makeup to breed crops that are more adaptable to different climates, more resistant to disease and insects, and more efficient in taking up water and drawing nutrients from the soil. In this way, farmers don't have to use as much water for crops or apply as much pesticide and herbicide, but can still attain greater yield during harvest season.

However, more efficient crops means smart management of soil and water is necessary as well. "Because if we're going to be growing more food, we're going to have to not destroy our soil and our resources in the process of doing that," Lagrimini said.

One of the department's greatest achievements is in the soil area, he said. For example, researchers did a lot of research in methods of tilling soil, especially during the Dust Bowl years of the 1930s. What they found was that the no-tillage method, meaning farmers not tilling the soil every planting season, led to less soil erosion problems and maintained better soil quality. This achievement helped farmers through those tough drought years.

Similarly, researchers have managed to conserve water and soil by creating two computer programs, called Water Optimizer and Hybrid Maize, that model plant growth. Farmers can use these programs to select the variety of crop they're growing.

Because the programs hold information on the growth cycle and characteristics of specific crops, it can give farmers instructions on when and how much to water or fertilize the crop. Lagrimini said by simply timing when



*Mark Lagrimini*

they water their crops, farmers can maximize yield while saving up to 25 percent in water usage.

But even with better crops, soil and water management, Lagrimini said "the country has to find another form of fuel" because "we are running out of fossil fuels." One fuel alternative is biofuel, meaning fuel made from animal waste or plant material. Some of the research at UNL involves improving switchgrass and sorghum as a raw material for making biofuel, Lagrimini said. Researchers are also studying the lifecycle of biofuels systems, he added.

### Future Research Goals

In September 2010, the Department of Agronomy and Horticulture celebrated 100 years of agricultural innovations, education and outreach to Nebraska's community.

One future goal is trying to make plants as adaptable to change as possible, so they don't require as much management by the farmer. "We want smart plants, if you can call it that," Lagrimini said, such as plants that can automatically adapt to low rainfall without much intervention on the part of the farmer.

These plants would also be able to "communicate" to the farmer in some way about what it needs, Lagrimini said. He doesn't know how researchers will achieve this yet, but he said they do have some ideas already. For example, through genetic modification, researchers may be able to create plants that emit a signature color when they need more nutrients or water, Lagrimini said. ●

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# Grapes and Wine: Adding Value to Nebraska's Economy

By Christine Hunt

“When a winery gets established in a small rural community, it attracts people. It becomes a destination,” said Paul Read, professor of horticulture and viticulture at the University of Nebraska-Lincoln. When people visit Nebraska wineries, like Whiskey Run Creek in Brownville or Five Trails in Paxton, they patronize the winery and support winery jobs. They also buy fuel at the gas station, drop in at the antique shop around the corner, eat dinner at the restaurant and stay at the Bed and Breakfast. They infuse money into the town's economy, he said.

Read's research, teaching and extension programs are closely tied to the developing grape and wine industry in Nebraska, which has 26 wineries and more than 150 vineyards. The greatest profit in growing grapes is selling their value-added products, such as juice, jams, jellies and gourmet vinegars. Wine, the most important value-added product of grapes, has the greatest profit margin, said Read.

## Creating a Sustainable Industry

Read's research is focused on finding grapes that will successfully grow in Nebraska, which can be challenging since conditions can vary widely throughout the state, he said. Typically, Western Nebraska has a shorter growing season and colder winter temperatures. Some grapes that flourish in Southeast Nebraska will not survive in Western Nebraska. Other variables often include soil conditions, humidity and rainfall amounts, he said.

In order to assist growers, Read has tested more than 75 cultivars, or types of grapes, for almost 15 years in his research vineyards located across the state.

In addition, Read has focused part of his research on reducing the inputs of chemicals. He tests for grapes that can grow with minimal inputs of fungicides and insecticides, which are chemicals that are used to control diseases or pests. Fewer chemicals protect the soil and air while saving



the growers' money. "If we can do it with fewer inputs, we become more sustainable," said Read.

Read explained that in some cases, the grape plant itself can contribute to sustainability by stabilizing the soil. For instance, wind erosion of the soil is a problem in Western Nebraska. Winds blow the soil off the land and into the streams and rivers, with the soil often ending up in the Gulf of Mexico, he said. If soil continues to be lost, growers will lose their productive land and profits, he said.

Grape vines are perennial crops with extensive root systems. These root systems allow them to exploit large volumes of soil for both nutrients and moisture, explained Read. The root system also anchors the soil, holding it down and protecting it from the wind, which is another contribution to sustainability, he said.

According to Read, the simple definition of sustainability is "can you continue to produce profitably enough to stay in business over a period of years?" If vineyards and wineries are not able to produce a quality product that the buying public wants to buy, it doesn't matter whether the vineyards have reduced inputs, he said. "The true test of sustainability is 'can this industry continue?' 'Are they going to be able to continue to produce profitably?' 'Are they environmentally responsible?' 'Have they been good stewards of the land?'" said Read.

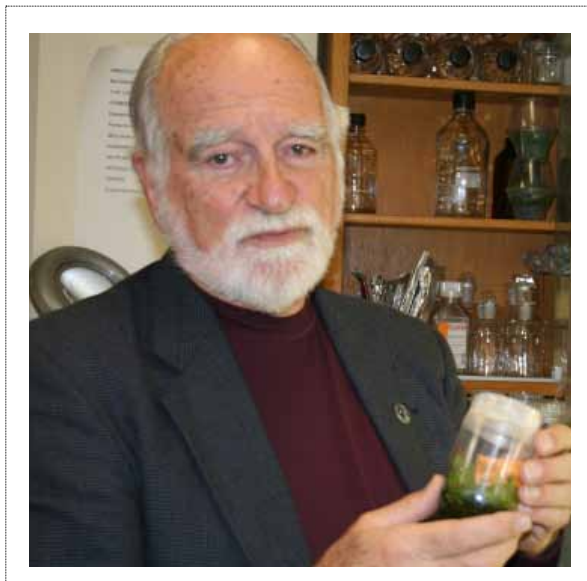
### Research Guides Business

Read's research is helpful for individuals considering either expanding a vineyard or starting a vineyard. His research helps each individual choose the appropriate grape for the conditions and how to prepare the land before planting, as well as other considerations, he said.

Much of Read's research takes many years before it is considered complete. One particular grape was in the ground at one of Read's research vineyards from 1999 until 2009. The grape was in the ground for 10 years of tests before it was actually introduced to the public.

He reports on a grape's pros and cons and other observations while growing it over a 10- year period. "There's no perfect grape. There are some that have more advantages than others," said Read.

Read is currently working on a project comparing grapes grown in many different parts of the country: Iowa, Nebraska, South Dakota, Minnesota, Wisconsin and others, he said. An important part of Read's work is the sharing of study results at international conferences so other researchers may benefit from his work.



*Paul Read*

### Funding

The University of Nebraska-Lincoln funds Read's salary and part of the salaries of his field technologist and lab technician. The rest of the funding has come from the State of Nebraska, the Grape and Wine Board and the Sustainable Agriculture Research and Education Program, said Read.

Last spring, through a grant from the Grape and Wine Board, Read and his technician visited more than 40 Nebraska growers and wineries in a two-week period, said Read. "That was really positive. You'd be amazed at what some of the people said. 'We thank you so much for coming.' 'Boy, that's been helpful.' You just feel good about what you are doing," said Read. Since funds are scarce, Read doesn't often get that opportunity, he said.

### Award-Winning, Quality Product

"Our industry is growing steadily, our wines are winning awards in international competitions," said Read. In the last two years, four different wines have been selected as the best white wine in competitions with wines from Europe, Australia, and California. "It's pretty good company we're traveling in. The quality is there. The growth is possible," said Read.

Read added, "Beyond the added value of transforming juice into wine, is the impact on the economy. This is what's really important." ●

Beyond the added value of transforming juice into wine, is the impact on the economy. This is what's really important.



# UNL Plant Trait Research Saves Water, Grows More Food

By William Whited

“Being able to produce food at a reasonable cost is very important for those parts in the world that are underdeveloped,” said James Specht, University of Nebraska-Lincoln professor of agronomy and horticulture. “They have to spend most of their funds on food rather than other things.”

Specht said the plant engineering research at UNL impacts the world’s population by helping to keep food production costs at practical levels at home and abroad. What matters most, he said, is not how many awards a research team may receive, but how UNL’s plant engineering affects people’s lives from the field to the dinner table. “Boost crop productivity, feed the world,” Specht said.

## Food: A Global Commonality

The need for food rises each day as the world’s population grows. Experts estimate Earth’s population will swell to 9 billion by 2050. According to Specht, genetic research helps improve staple crops like rice, corn and soy. The focus of UNL research is finding ways for crops to produce more food per acre while conserving water around the world, he said.

For Specht, soybeans comprise an important area of agricultural research that yields more protein-enriched and healthier food to people, in the form of cooking oil.

“Most of the vegetable oil you buy in the supermarket is soybean oil and you can buy corn oil, olive oil, and some others,” Specht said. “But by and large the mass-produced cooking oil comes from soybeans.”

Tofu, margarine and soy sauce are examples of products people directly consume, Specht said, but soybeans more commonly are used as food additives in everything from bodybuilder protein shakes to baked goods and commercial chocolate. After removing the oil, the remaining soy protein is used to feed livestock, primarily swine and poultry, because soy protein contains critical amino acids and other essential nutrients, he said.

## Feeding More People Through Soybean Research

Specht earned his Ph.D. from UNL in 1974 and was hired by the University of Nebraska-Lincoln in 1975 as a soybean researcher. In 1999, he collaborated with a national soy genetics team working with the United States Department of Agriculture and Department of Energy, during which team members mapped the entire soy genome sequence, giving scientists a time-saving method to study the genes of the

soybean plant. Scientists use the genetic mapping to know each experimental breed’s features without having to grow a crop. This knowledge allows today’s genetic engineering of soybean plants, Specht said.

The genetically-engineered seeds offer numerous benefits, including stronger traits for disease and pest resistance, higher yield, more usable plant mass for less water, and greater protein and oil content. According to Specht, all these benefits allow for a bigger, higher-yield crop that’s less expensive for farmers to produce, and result in less expensive food for consumers. Part of this money-saving process requires careful monitoring of crops and climate to minimize fresh water use.

## Saving Water Through Technology

According to Specht, one way UNL connects with local producers to save water is through the university’s recent SoyWater website ([www.soywater.unl.edu](http://www.soywater.unl.edu)). The website features a soil water analysis system, which was made available to the public in May 2010. The site can be used to track weather changes and soil moisture levels of the previous few days or predict these for the next few days. The website uses data that comes from Nebraska’s High Plains Regional Climate Center, which is located at the University of Nebraska-Lincoln.

The one-page printable data summary allows farmers to project when and how much irrigation water their soybeans will need, Specht said. This electronic advantage saves hours that used to be spent doing manual calculations for crop watering, he said. The system summarizes data into one page that farmers can read quickly, or will provide a chart of data, if that option is preferred.

“UNL SoyWater allows producers to better schedule their irrigations to save at least an inch of water at the beginning of the season and perhaps an inch of water at the end,” Specht said. An acre-inch of rain or irrigation is 27,154 gallons of water per acre. He said his ultimate soybean research goal would be to grow three-and-a-half bushels of soybean per acre for each acre-inch of water from rainfall and irrigation.

## Balanced Plant Traits Save Water, Are Sustainable

Specht said genetic engineering also has the potential to reduce natural water loss from evaporation and transpiration by having a balance of traits for growth. These traits include leaf formation, reflectivity of heat from sunlight, canopy height and roots.

Researchers are developing plants with root systems developed to take up only the amount of soil-stored water that is annually rechargeable, Specht said, therefore creating a more sustainable soybean plant. Research is also improving the plants' durability by engineering experimental breeds that are about six to 10 inches shorter than current soybean plants. Taller plants are prone to being knocked over during storms or irrigation, he said; the shorter ones may better withstand those challenges.

Still, Specht and his research colleagues continue to engineer more efficient systems for related areas. One future project might be the engineering of photosynthesis, called the C-4 pathway, into soybean, which has the C-3 pathway. Improving the photosynthetic pathway in soybean, or the plant's light-absorbing ability, would lead to "more crop per drop," he said.

### What Powers Soybean Research?

Specht said the thrill of science comes from discovering knowledge nobody else knows. He said discoveries from research make science fun and allow sharing of new knowledge that benefits the global community. But continued sharing requires funding.

Recent funding included a \$38,000 grant from 2007 for mapping soybean genes. Other funding includes an \$89,000 United States Department of Agriculture grant in 2008 for studying drought tolerance. Research grants allow new hires to expand research, he said.

"In order to conduct research you have to have the ability to pay some of the operating expenses in research and hire critical people, like graduate students and research technicians and post-doctoral research associates," Specht said.

### Advancing Projects in the Future

While grants and awards help increase the world's food supply through research, his prime motivation is developing technologies that ultimately benefit society, Specht said.

"One always has to judge oneself not by the number of publications and not by the number of grants, but whether you have had an impact, impact in influencing the lives, improving lives, enhancing agriculture," Specht said. "I feel I've had an impact." ●

*James Specht*



# Feeding the World from Nebraska's Research Technology

By Gabriel Medina

Nebraska is already playing a strategic role in the future of food production in the U.S. and the rest of the world because of three main reasons, said Larry Berger, head of the Department of Animal Science at the University of Nebraska-Lincoln.

First, the state has a large amount of unpopulated land available for agricultural production. Second, the High Plains Aquifer underlies much of the state and supplies water for agriculture, industry and domestic use. Third, Berger said, Nebraska has efficient food processing plants.

"Scientists estimate that we're going to need to almost double food production in the next 40 years," he said, "and consumers will increase their protein level, the animal products in their diet. So we're no longer producing food just for Nebraskans, we're producing food for people in other parts in the world. That's an exciting opportunity."

Berger explained that as a result of technology, the amount of food produced per beef animal today is about 40 percent greater than in 1950, the result of improvements through research.

"I got interested in animal science because I grew up on a farm," said Berger. "But as I went college and as I studied I saw the critical importance of animal products in meeting the global food demand."

The main goal of the animal science department is to provide agricultural producers in the state and the rest of the country with information that can help them to be more efficient today and to have long-term sustainability, he said. The department also provides technology to help the producers identify how to improve the productivity of their animals. Faculty teaches producers how to feed animals so, while animals are still in-utero, they develop appropriately and have maximum productivity.

Consumers will also benefit from this research. Berger pointed out that his department is trying to minimize the cost of food production in the U.S. and the rest of the world. Currently, Americans spend less than 10 percent of their disposable income on food, while in some developing countries people spend between 30 and 40 percent of their

income on food. These percentages should decrease further as the cost of food production decreases.

## Biofuels Are Part of the Solution

Nebraska is the second largest producer of ethanol in the United States and Berger said the state currently has 23 or 24 plants that use fermented corn to produce ethanol. During that process, about 40 percent of the nutritional value of that corn is returned to producers in high-protein byproducts in the form of dried distiller's grains, which are fed to animals.

"What we found is that these byproducts have some

unique properties that are different from the corn that it was derived from," he said. "We are learning how to blend that with other ingredients to maximize its nutritional value for the animals. It's been a major reason why Nebraska animal agriculture has continued to flourish compared to other states."

Ethanol byproducts in the future will be used in many different ways to feed animals with diverse needs, he said.

"Now we're making a high-protein byproduct, a high fat byproduct or a high-fiber byproduct for different animal diets. So the industry is headed to try to maximize the value of each component of the distilled, dried grains, rather than just to feed it as one conglomerate of ingredients."



Larry Berger

## Educating the Future Beef Industry Leaders

Nebraska produces between 20 and 25 percent of the high quality beef in the U.S., which makes the state a leader in the country, according to Berger.

That is one of the reasons why the UNL Department of Animal Science has the Nebraska Beef Industry Scholars Program, which is a four-year certification program to educate leaders in that industry.

"Our focus is to provide personal, human capital to lead the beef industry in Nebraska, in the United States and even in the world in the future," he said. "The average age of the beef producer is about 58 years of age, so many of those people will be retiring in the next 5 to 10 years. And so we need to train young people."

Besides giving students academic training through this program, UNL is helping them to understand what happens



in politics related to the beef industry and how international trade influences future beef production.

Research at the University of Nebraska-Lincoln is focusing on ways to decrease the amounts of the nitrogen and phosphorus that accompany beef production.

“Dr. (Galen) Erickson did some research a few years ago to show that we can feed less phosphorus to animals and not cause any negative impact on health or growth or product quality than what we previously believed to be the case,” Berger said. “So that will reduce the amount of phosphorus excreted into the environment.”

However, he also explained that phosphorus is recycled because beef animals’ excrement is used as fertilizer for crops.

### **Inter-Institutional Agreements and Multidisciplinary Research**

The UNL Animal Science Department partners with others to better benefit farmers and each other. One partnership, with Iowa State University, involves both faculties working with the food producers of both states.

Berger said that considering the fact that universities have tight budgets, Iowa State University specialists can spend up to 10% of their time working with Nebraska farmers and University of Nebraska specialists can spend up to 10% of their time working with Iowa farmers. That is necessary because Iowa specialists have expertise that those in Nebraska don’t have, and vice versa. The objective is to meet the needs of livestock farmers from both states in the most cost-effective manner. The UNL Animal Science Department also has agreements with universities in countries like Mexico, where they give seminars about food safety and American standards in the food processing industry.

According to Berger, the department has cooperative arrangements with other UNL departments, including the Department of Agricultural Economics.

The Animal Science department is also cooperating with the UNL Department of Food Science and Technology to look at how modifying animal products might change nutritional value for humans.

“By changing the fatty acid profile of eggs, we can increase the nutritional value in human diets,” he said.

Berger also explained that his department does multidisciplinary research with the Department of Statistics, Department of Agronomy and Horticulture and the School of Veterinary Medicine and Biomedical Sciences.

The Department of Animal Science receives its main funding from the State of Nebraska and the federal government through the U.S. Department of Agriculture. Basic research is also supported by the National Institute of Health (NIH). Commodity organizations such as the producers of beef, corn, soybeans, sorghum and ethanol are among the department’s strongest supporters, Berger said. ●



# Research Means Better Ag Productivity, Better Marketing Opportunities

By Tim Duey

Whether he's monitoring elections, working on agricultural projects in the Peace Corps, or working at the University of Nebraska-Lincoln as an agricultural economics professor, Wesley Peterson is always doing something interesting. And while teaching economics at UNL might seem a little more tame than monitoring elections in corrupt eastern European countries or growing crops to feed hungry people in Africa, as far as agriculture is concerned, Nebraska is a pretty exciting place to be. The United States is the world's leading agricultural producer, and according to Peterson, Nebraska is always one of America's top five agricultural producers.

"The agriculture in Nebraska is hugely productive; most farmers in Nebraska would not be very happy with anything less than 200 bushels to the acre of corn," Peterson said. "The average in the United States is probably about 150," he added. "In the United States we were getting 35 bushels to the acre for corn back in the 1930s and today we're getting 150, and that's all technology, that's what this whole campus

is doing. They're out there trying to think up better ways to produce food," Peterson said.

According to Peterson, the United States average is far above world standards in terms of the quantity and quality of its agricultural output. But even though Nebraska produces a relatively large amount of high-quality agricultural products, it still needs a place to sell these products. Nebraska's 1.8 million people can't consume anywhere near the amount of food produced in the state. According to Peterson, Nebraska needs to export its agricultural products for its economic well-being and suggests a "thought exercise" to help readers get a better understanding of just how important a role exports play in the state economy.

"Run the



Wes Peterson





hypothetical ‘thought experiment’ through. What if we didn’t export anything?” Peterson said. If Nebraska didn’t export anything, the state would have probably a third of the farmers that it does now and the only ones able to make any money out of it at all would be the largest farming operations. Prices would drop to about \$1.80 a bushel for corn instead of its current price of nearly six dollars a bushel.

“Through trade we have access to a large world market ... that benefits Nebraska farmers,” Peterson said.

The price of corn is historically high right now due to a number of global factors including floods and droughts that have affected some of the world’s most productive grain-producing regions in Russia and Australia. While these disasters have increased demand and Nebraska farmers have reaped the benefits, Peterson warns that it is difficult to predict how long grain prices will stay this high.

Peterson points out that experts predict the world population will increase by about two billion people over the next 30 to 40 years and because of that, Nebraska farmers might be able to expect food prices to go up for the foreseeable future. But Peterson’s best guess is that, even with such an increase in world population, improved technology and agricultural techniques will probably keep prices from getting too out of control and eventually force them back down.

Increased grain prices could have a negative effect on some economic activities. They drive up the price of the inputs used in other agricultural and industrial sectors. Particularly hard hit by the increase in the price of grain are the Nebraska cattle and ethanol industries.

Nebraska’s cattle producers are currently selling more beef for more money than they have in almost a decade, Peterson said. That’s because in 2001, Japan banned U.S. beef imports due to a case of bovine spongiform encephalopathy, more commonly known as mad cow disease. Japan was the United States’ largest trading partner in beef products at the time. South Korea, America’s third-largest beef importer, followed suit shortly thereafter. According to Peterson’s colleague and fellow agricultural economist, Darrel R. Mark, Nebraska’s beef market is finally starting to recover despite the increasing price of feeding cattle.

“On a volume basis we are exporting almost as much now as we did in 2001,” Mark said. “So when we lost those export markets on December 21st 2001, it’s taken us basically from then until now to get back to the point where we’re exporting almost as much as we did at that time.” ●

For more information visit [www.unl.edu/sdn/opportunities](http://www.unl.edu/sdn/opportunities)



# The Debate: Food for Fuel

By Tim Duey

Perhaps more than anything else, agriculture is responsible for the security that Nebraskans enjoy today. According to Nebraska Department of Agriculture statistics, Nebraska exported \$4.799 billion in agricultural commodities during 2009, and by their estimate every dollar in agricultural exports generates \$1.36 in economic activities such as transportation, finance, warehousing and production, thus turning that \$4.8 billion into \$6.5 billion.

In addition to exporting its agricultural products to the world, Nebraska producers also sell their corn to in-state ethanol producers, which produce 1.7 billion gallons of ethanol a year or 13 percent of the total U.S. supply, according to statistics provided by the Nebraska Energy Office. In years like 2010 and 2011 when the price of corn on the world market is much higher than normal, this has sparked controversy, according to University of Nebraska-Lincoln agricultural economist Richard Perrin.

“We have some people who think it’s a terrible idea, and there are of course some people who think it’s a great idea,” Perrin said. “The big issue with respect to biofuels, at least biofuels as we now know them, is whether or not to use food crops for fuel.” Many people are worried that by using corn for fuel instead of for food that Nebraskans are helping to drive up its price. According to Perrin, fears that rising grain prices could make food unaffordable to many Americans are greatly exaggerated.

“In the U.S., there’s no threat,” Perrin said. “If we double the price of grains, that’s equivalent to an increase of about three percent in the cost of our food purchases if we were to

just pass that cost on ... and a three percent increase in the cost of our food would not be equivalent to a fraction of a percent of consumer income.”

But while a three percent increase in the cost of food might not affect middle class Americans very much, Perrin also said that it might have more of an effect on Americans who spend a greater portion of their income on food. And while a three percent increase in the cost of grain might affect America’s poor more substantially than it would most Americans, Perrin said the most profound effects could be felt abroad in the countries where a relatively high percentage of people spend more of their income on food.

“If you are a poor person in India or a poor person in Africa spending 60 to 70 percent of your income on food and most of that food is grain, it just prices you out of the market; you’re going to be hungry,” Perrin said.

## Market Fluctuations

Despite fluctuations in worldwide grain prices over the past decade, Perrin believes that increases in the scale of U.S. biofuels production are not the primary cause. He said that although some experts did blame increased biofuels production after grain prices rose nearly 40 percent in 2007 and still higher in 2008, they eventually came back down and Perrin says that most experts now believe that biofuels played a role, but not necessarily the most important role.

According to Perrin, it is more likely that increased prices have been caused by droughts and other natural disasters in the world’s grain-producing regions that have created short



crops. These shortages have driven prices up, Perrin said. And though grain prices have been on the rise again and have returned back to 2008 levels, Perrin said that they will probably go back down.

“The spike has been the result of shortfalls in production; those shortfalls, most of us expect are temporary,” Perrin said. “I expect that there will be a rebound in grain production in the next couple of years around the world that will bring prices back down to where they were a year ago. That’s my expectation, and I think that’s the general expectation among economists,” he added.

### What to Expect Going Forward

In Perrin’s estimation, there shouldn’t be much of a problem feeding the world in the near future. While there are many factors such as transportation infrastructure, war and politics that contribute to world hunger, producing enough food in the first place should not be one of them, at least in the short term. Perrin said the world’s agricultural industry should have no problem keeping up with increased biofuel demand and still producing enough food for now. But looking further ahead he sees a big challenge.

“In the long run, the increase in demand for food products is going to be relentless, and it is going to tax the capacity of the agricultural industry to produce enough (food) that will keep prices in line with where they have been in recent decades,” Perrin said. “It’s going to be difficult to produce 70 percent more agricultural output, which is what the FAO (the Food Agricultural Organization of the United Nations) and others are anticipating that we would need to meet the increase in demand due to increases in population and incomes. If we don’t

meet the 70 percent extra agricultural output just for food purposes, then the prices are going to go up. And that’s going to jeopardize food security for a lot of areas of the world.”

Perrin estimates that advances in agricultural technology should increase world capacity for grain production enough to cover the increase in world demand. That’s not to say that there won’t be tough decisions ahead.

The amount of biofuel produced in Nebraska and in the rest of the country could have a major impact on how well the world’s agricultural industry is able to provide food for people who need it sometime in the distant future. Perrin said that if oil prices rise much higher, demand for ethanol might be high enough to put a serious strain on the world’s grain supply. If that day comes, Perrin said there will be enough competition between ethanol and food producers to significantly contribute to the world’s hunger problems through higher grain prices than we are seeing now. He said new fuel alternatives will have to be found by the time the world’s population is estimated to peak around the year 2050.

“If energy prices are high, corn is an attractive feed stock for the energy industry,” Perrin said. “In the future, I think corn ethanol is going to be too attractive even without subsidies. ...that’s why in the long run I think it really is a threat to food supplies even though I don’t think it’s a threat right now.” ●

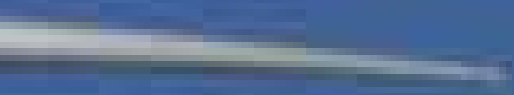
*Richard Perrin*







# Energy



# Harnessing Nebraska's Wind Energy

By Farooq Baloch

Wind energy – a sustainable energy source – can be of great economic benefit to Nebraska communities, according to Jerry Hudgins, professor and chair of the Department of Electrical Engineering at the University of Nebraska-Lincoln.

Hudgins said the wind resource, coupled with the agricultural use of the land in Nebraska, makes it possible to install wind farms – power plants that use wind turbines to generate electricity – in the rural areas without causing much disturbance in land use. Large amounts of electrical energy can be generated through these wind farms, he added.

Theoretically, these wind farms can generate enough energy to even meet the electrical demand for the state, he said. However, it will be practical only if scientists are able to find an efficient way to store large amounts of energy – something his research team is working on through the Nebraska Center for Energy Sciences Research (NCESR), of which Hudgins is interim director.

The research is looking at improving the energy density and response speed of intermediate energy storage components or looking at mixed generation systems, such as wind and photovoltaic, to minimize the storage needs, Hudgins said.

## Economic and Environmental Benefits for Nebraskans

Hudgins said there is willingness among developers to do wind energy projects and it will be an economic benefit for the local communities to provide their land for production of wind energy. “I see a long-term market here,” he added.

He explained that besides the blades, wind turbines have many other parts – both mechanical and electrical – which are supplied by secondary manufacturers. Once there is a more extensive transmission infrastructure for the wind farms, Nebraska will become attractive as a location for developers and manufacturers, bringing investments worth millions of dollars.

In addition to attracting those manufacturing businesses, wind energy projects can also provide large

amounts of electricity for residential consumption.

Hudgins, who also is the director of Nebraska Wind Application Center, said wind power is a cost-effective energy source that can supply electricity to the residents of Nebraska.

While this sustainable energy source could be a great economic benefit for Nebraska, it is also non-polluting, as no fuels are combusted to produce electrical energy through wind power. He added that unlike large thermal power plants using nuclear, coal and natural gas, wind energy production doesn't use water for cooling.



*Jerry Hudgins*

## Challenges

One of the biggest challenges with wind energy systems, according to Hudgins, is the variation in the wind, which makes it hard to plan a consistent production of electrical energy that can be used by the consumers. To address that challenge, practical energy storage solutions must be found to store the large amounts of energy that can be used when the wind isn't blowing, he said, but that, too is a problem. “If you try to build a large system out of batteries, it's very expensive and batteries don't last very long,” he said.

Another challenge, Hudgins said, is creating a transmission infrastructure that can capture wind energy so it can be used. “For instance, the heaviest electrical load is in the summer, when you have irrigation and air

conditioning load,” he said. “That’s the biggest time when you use electricity.” He added that the wind resource is the lowest in summer so there is a need to find efficient ways of storing large amounts of energy to use when it is needed.

## Solutions

Hudgins said the sustainable energy source is available but there is a need to build better and more efficient machines to capture wind energy and do it economically, on a large enough scale.

For instance, he said, when the wind blows, excess energy can be captured, stored and made available for when the wind is not blowing. Similarly, during the day solar energy can be captured and stored to recover that energy when it is needed because one can’t rely solely on one type of renewable energy system, he said.

According to Hudgins, solar and wind energy systems together can cover a large percentage of the energy uses on a typical day. “The technology is available, but needs refinement to improve efficiency and affordability. I would call it applied research at this level.” He further said there are manufacturers of small wind turbines and small photovoltaic systems, which use solar cells to convert light into electricity. These systems could power a small building or a large office building. For large scale production, he said, “you need a large wind industrial plant.” He said it is possible to scale these systems and make them off-grid systems — though off-grid systems often require another form of standby or back-up power source.

If the wind resource is reasonable, Hudgins said, and if there is that interplay between the photovoltaic and wind systems, it can work well. For instance, he said, if the photovoltaic system is running while the wind turbine is not, or the wind starts blowing but the photovoltaic system is not working, the energy can still be captured.

## The Future of Wind Energy

Hudgins believes a practical energy storage solution is at least many years away. The use of renewables will continue to grow, he said, but not at the pace to replace base load sources like coal plants, nuclear plants or natural gas plants because they provide nonstop electricity 24 hours a day. “However, you never know when someone may make a technology breakthrough that changes the paradigm,” he added.

Hudgins said the future of wind energy is very good for the next half century or maybe even three-quarters of the century, while a solution is found for the energy storage problem. Hudgins said the storage problem can be solved with improved transmission infrastructure where one can put geographically-dispersed wind energy systems across the entire United States. If there is a transmission setup to move power around where needed, he said, and the wind is blowing in enough places, then enough energy can be generated. Hudgins said once the energy storage problem is

solved, wind and then solar can be used as the longer term sustainable energy source.

## Global Perspective

“The wind energy research that’s conducted at the University of Nebraska has applicability to renewable energy systems all over the world,” Hudgins said.

He said researchers are working on how to improve performance of the wind turbines, how to use small through large size turbines and integrate those as stand-alone generation systems.

He said in countries that have either almost no electrical service or intermittent electrical service, this is a perfect application for them because these systems can provide power varying demand sizes of a very small house to the size of a large building. ●



# Nebraska's Solar Potential Bright

By Gabriel Medina

Even though Nebraska has long winters, the sun shines brightly many days a year, which means that solar energy could be a good source of energy in the near future, according to Natale Ianno, who is Blackman Lederer professor in the UNL Department of Electrical Engineering.

"There's a lot of use for solar cells in Nebraska," he said. "We get 250-some days of sun a year here. When you start to rank locations with respect to their availability to solar energy, Nebraska falls into the group 2, which is right below places like Arizona and Hawaii."

Ianno, who is working with his colleagues to create solar cells out of new materials, said that Nebraska farmers could be self-sufficient if they would install solar cells in the roofs of cow feed lots.

"For example, there is a farm in eastern Nebraska where there are cow feedlots and they make ethanol," he said. "They developed a way to convert the remainder of the corn, coupled with algae and cow manure into methane, which then they use to power their ethanol plant. If they'd put solar cells on the roof of their cattle feedlots, they'd be much closer to taking no energy off the grid to generate ethanol."

Ianno said that within the next 20 to 30 years, solar energy will be used much more to provide electrical power generation in the United States. He envisions that in the future there will be more cars with solar cells on the roof, which will control the air conditioner and recharge the battery.

Ianno also believes there will be more houses and even entire residential neighborhoods where electricity will come completely from solar cells. Ianno explained that solar cells will also be more present in space exploration, because it is not practical to use fossil fuels in space and it is difficult to refuel ships or bases whenever it is required.

"Solar cell satellites are an absolutely wonderful thing," he said. "GPS, DirecTV, Satellite TV, all of those things are direct results of solar-cell-powered satellites. So that's a tremendous societal impact."

According to Ianno, the U.S. Army and the Department of Defense are also developing tents covered with solar cells.

"It's excellent in the desert battlefield," he said. "It can power fans, can power recharge of radios and even of soldiers' iPods."

Ianno said these tents with solar cells could even save soldiers' lives because many casualties occur when convoys transport fuel and they are ambushed. So if bases would use solar energy instead of fossil fuels for their needs, those deaths could be avoided.

Solar energy has not been used more frequently in the U.S. because it is still very expensive to produce solar cells and there is an abundance of other useful materials, according to Ianno.

"Natural gas and coal for generating electricity, that's really what solar energy is competing with," he said, "and that's just still very cost-effective."

Ianno pointed out that the U.S. has many decades of coal reserves, as well as natural gas and fossil fuels, so that is one of the reasons why there is not so much investment in solar energy. On the other hand, he said that Europe and Japan don't have an abundance of these materials, so that is why they rely more on nuclear power and they are investing more in solar energy than does the United States.

## Solar Energy and the Environment

Solar energy has many advantages over other kinds of energy, among them that it does not damage the environment, said Ianno.

"The operation of the solar cell is zero environmental impact," he said. "It's pollution free, there is nothing generated by it. There is no gas, no solid waste, nothing."

However, Ianno said that manufacturing solar cells does pollute if they are made with cadmium. That is one of the reasons why he and his team are developing solar cells made of environmentally-friendly materials.

To avoid pollution, when the solar cells' useful lifetime is over, companies that produce them buy them back to recycle them, reuse them or dispose of the materials, according to Ianno.

Solar energy also is safe, unless an external source causes a fire.

"There's no physical or chemical reactions involved in solar energy that make it any kind of a threat to catch on fire, to explode or to release hazardous gases into the environment," Ianno said.

## New Development of Solar Technology

Most of the solar cells available in the market have a conversion efficiency of about 20 percent, but Ianno said that the solar cells used in satellites have a conversion efficiency between 30 and 40 percent.

Currently, solar cells are made of materials like cadmium, which is not environmentally friendly, as well as indium, tellurium and gallium, but the supply of those resources will only last about 30 more years, according to Ianno.

For that reason, Ianno and his colleagues are working to develop solar cells made of sulfur and iron, which are



plentiful and environmentally-friendly materials.

“Both of those things exist in the earth’s crust in general, so they’re everywhere,” he said. “The challenge is to be able to make a solar structure device that actually has enough efficiency to make it worthwhile to market and to use.”

However, Ianno said “sulfur is extremely corrosive and reactive and so you have to deal with that and that presents a set of technological issues that you have to overcome or you can’t even make the solar cell.”

Ianno and his team are working with new materials – that won’t be corroded by sulfur – to build a thin, atomic monolayer of cost-effective substrate in order to develop a cost-competitive and efficient solar cell.

“We want a thin layer of substrate because the iron sulfide needs to be in contact with a metal in order to provide good electrical conductivity for the current and so the solar cell efficiency is high,” he explained.

Ianno said this is an extremely complex task, so to develop this new kind of solar cell could take him and his team between 10 and 20 years.

But to achieve that increase in efficiency is a very expensive and complicated process, according to Ianno. He explained that a solar cell converts light energy of the sun into electrical energy.

“The light is absorbed by the solar cell and the photon, which is light energy, is converted into an electron or electronic energy.”

### Multidisciplinary Research and Funding

UNL’s Department of Electrical Engineering is developing solar cells with the Department of Chemistry at the University of Nebraska-Kearney, in a project funded by the Department of Energy, according to Ianno.

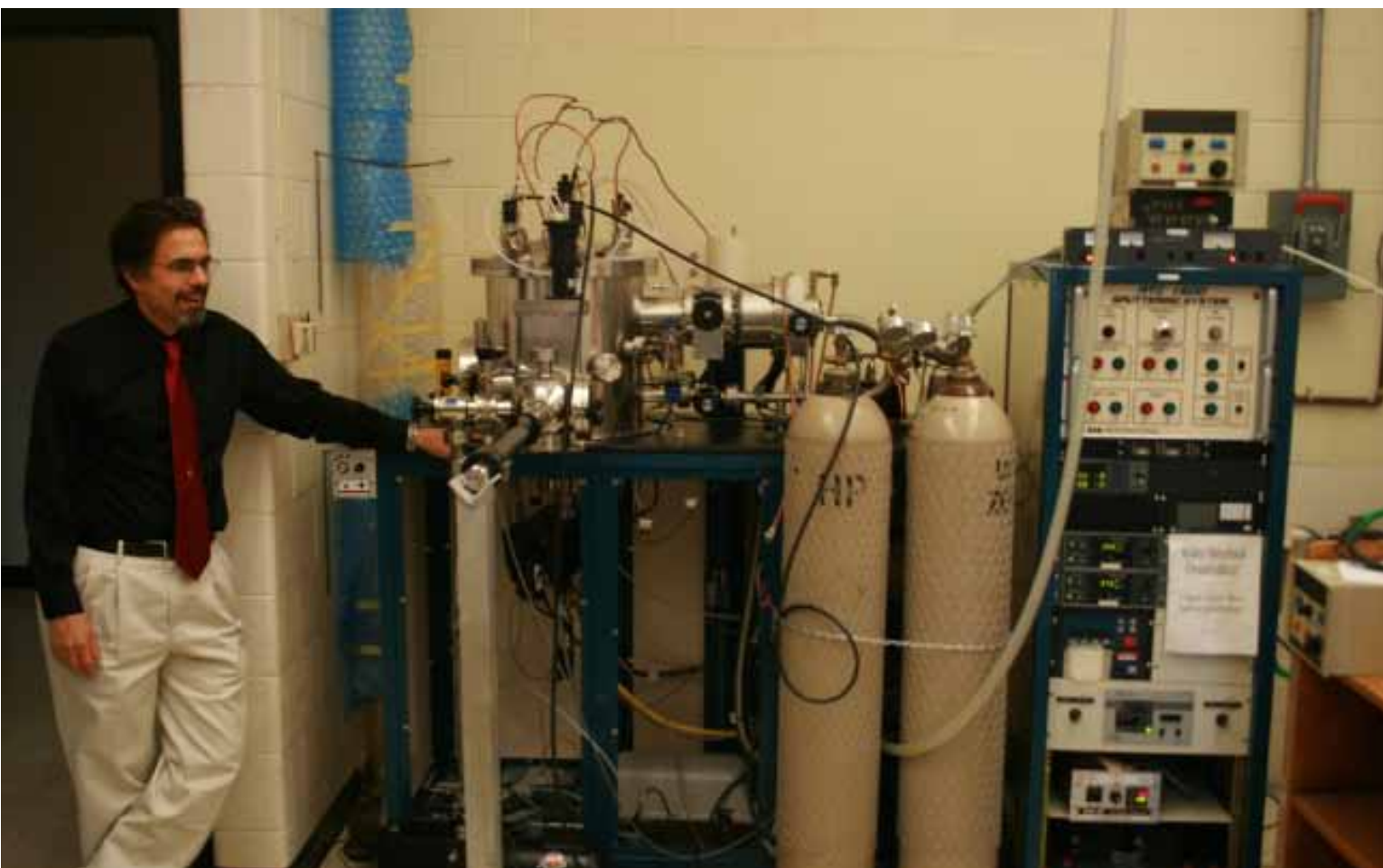
Ianno and his colleagues have sent solar cell samples to the Institute of Energy Conversion at the University of Delaware, because they have more facilities than UNL.

In April 2011 the National Science Foundation released a call for proposals in their international research program, which will focus on sustainable energy. So, Ianno and his team will work with the Czech Academy of Sciences in Prague to apply for that program.

Ianno’s work with solar cells is funded by the Department of Energy, the Nebraska Center for Energy Science and the Nebraska Research Initiative. ●

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*Natale Ianno*



# Green Slime Slides into Biofuels Arena: How Algal Biofuels May be Next Alternative Fuel

By Seanica Reineke

Despite skepticism from biofuels critics, a University of Nebraska-Lincoln researcher and associate professor of biochemistry believes as more research is applied, advanced biofuels will continue to develop – and at a faster pace.

“It is in our nation’s interest to invest in that committed research to allow our country to be oil-independent so that political upheavals in the Mideast or offshore oil rigs in the Gulf of Mexico, while they are going to be a factor far into the future, don’t have as much potential to upset our economy and national security as they do now. That requires investments that may take five, 10, 20 years to reach their fruition; but without them, we don’t have any chance of avoiding the catastrophes that greater dependence on oil will bring,” said Dr. George Oyler.

Algal biofuels research is quickly expanding, and the University of Nebraska-Lincoln has become a research hub for this type of biofuels, involving between 12 and 16 principal investigators and funding from the United States Department of Energy and the National Science Foundation. Oyler, UNL algae research facilitator, calls the University of Nebraska “a haven for world-class algae research,” adding that although it makes up a small portion of the national and international efforts in algal biofuels, UNL holds a “prominent position in those groups.”

“It was a little unexpected when I entered algae to find, in the heartland of the United States, such a successful group of researchers involved in something that grows in water,” said Oyler, “but as it turns out, this is an excellent place to be addressing the problems of our bioenergy needs through algae.” He said UNL already is a major contributor of energy necessary to support the world population through agriculture, including ethanol production, and believes the state is well-positioned in the food and energy sectors to help advance the nation’s goals.

## How is Algae Different from Other Advanced Biofuels?

Algae brings to mind green pond scum on top of water, but this research uses a fast-growing microalgae. Oyler said microalgae are capable of growing 10 times faster than earthly plants on a per-acre basis. Oil can make up 30 to 50 percent of algae’s weight, compared to just 15 or 20 percent oil from a soybean, Oyler said. This means algae has the potential to produce more oil than crops traditionally grown for biodiesel. Even though ethanol has been successful, it can’t replace all oil uses completely, such as jet fuels, but algae can replace those uses. “The potential’s there to make

much more fuel per acre with algae,” Oyler said.

With the right systems in place to allow algae to reach just half of its maximum production capabilities, Oyler said the United States’ requirements for transportation oils could be replaced with algae using 1/20th of the acreage necessary with ethanol. One example of an efficient algae oil-production system includes a photo bioreactor, which is a self-contained device providing a controlled environment for algae to grow. Oyler said it can be as simple as plastic enclosed clear tubes, but the system is very expensive.

Another approach to growing algae is in raceway ponds, which are open ponds shaped like ovals, that are stirred with paddlewheels. However, with the raceway ponds being open – not enclosed, like the photo bioreactor – the algae is exposed to the environment and can become contaminated from outside elements.

Beside issues of appropriate systems for growth, there are other factors slowing the advancement of algal biofuels.

## Challenges Confronting Algal Biofuel Production

Cost is the biggest barrier to expanding production of algal biofuels, Oyler said. Not only are costs high for setting up systems to grow algae, but so is the cost of a barrel of algae oil. In the mid 1990s, researchers estimated algae oil could be made at \$60 to \$80 per barrel. Now, the estimated cost per barrel of algae oil is at least \$300. Oyler said the current research will lower that price, though it may take five years or more to happen. Even so, he said algae will represent a “substantial contribution to the biofuels mix.”

Another challenge is how to harvest algae and extract the oil. Currently, once algae reach a certain density, water must be removed from it. Then, once the algae become a certain consistency, like that of a semi-solid paste, the oil must be extracted. Oyler said “one of the biggest breakthroughs in the future will come when the algae actually secrete the oil or other biofuels right into the liquid media.” Then, theoretically, he said the oil could be skimmed from the top of the water and converted, solving the problem of efficiently harvesting and extracting the oil.

Still another issue is the fact that algae uses sunlight and removes carbon dioxide from the air. Oyler said high-productivity systems are necessary to allow algae to reach its full potential, which would also reuse carbon dioxide, not waste it. He said algae can be grown on under-utilized land and can use water in a way that doesn’t compete with other agricultural uses. “All the way around,



*George Oyler*

growth won't be limited just to biotechnology, Oyler said. "It will be engineering, nanotechnology, genetic modification, a whole range of issues that will allow us to address bioenergy issues."

algae can benefit the ecosystem and reduce the nation's energy security issues," Oyler said. It has taken thousands of years in agriculture and agronomy development for other crops, but that spread of time cannot be taken with algae, according to Oyler.

"We need to compress those thousands of years of technology advancements and farming achievements into a decade or so with the algae," said Oyler. "It's doable. It will require resources. We're well-suited to do that here in Nebraska along with other universities and companies throughout the United States," he said.

### **Bright Future for Algae**

In the future, Oyler expects to see biotechnology and bioenergy develop quickly, much like medical applications of biotechnology in the 1980s and 1990s which resulted from research with the National Institute of Health. That

Both the opportunities and challenges are great in scale, he said, but they are also exciting.

The future may also include steps in one of Oyler's research goals: how to develop an integrated system in Nebraska that works, incorporating algae and animal waste. Cattle waste would be used in anaerobic digestion fluids, which are alternative solutions to livestock waste management. The waste would then be used to fertilize the algae, which would be used not only for biofuels, but also for animal feed and proteins and chemicals for various biotechnologies. "This provides an integrated system between animal agriculture, bioenergy from the anaerobic digestion to algae and how to use algae most beneficially in Nebraska," Oyler said. ●

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# Biofuels: Progress and Importance

## *Research Applies to Human Issues of Diabetes, Obesity*

By Tim Duey

Nebraska's biofuels industry is changing and growing quickly. Ethanol is currently the state's dominant biofuel, but tough new standards in California, a state that consumes 27 percent of all Nebraska ethanol, according to the Nebraska Corn Board, threatens to take a billion dollar chunk out of the market.

The University of Nebraska-Lincoln is attracting top talent and investing millions of dollars in research to improve the marketability of Nebraska ethanol by lowering its carbon footprint, proving that it is environmentally-friendly enough to meet California's environmental standards so it can continue to compete in that market. Solutions such as burning corn stalks to fuel ethanol plants and using the distiller's grains created as an ethanol byproduct have been proposed, and in the case of distiller's grains, even implemented. But though it still may be years from viability, algal biofuels may be a permanent solution to some strict environmental standards. Dr. George Oyler, a UNL research scientist who has earned both M.D. and Ph.D. degrees, is on the cutting edge of algal biofuel research.

"Corn-based ethanol has taken a lot of criticism over time," Oyler said. "We believe that there is huge potential for corn-based ethanol to continue its improvement and efficiency and in fact, by coupling corn-based ethanol processes with growing algae, we hope to move corn-based ethanol from a first-generation biofuel to an advanced bio-fuel."

Biofuels made directly from food crops are known as first-generation biofuels, while biofuels made from non-food crops and waste products are known as second-generation biofuels. Since George W. Bush signed the first Renewable Fuels Standard, or RFS, into law in 2005, ethanol production has become an important player in Nebraska's agricultural economy. Agriculture is the state's most important industry, and according to a fact sheet by the USDA Economic Research Service, there are about 50,000,000 acres, or 92% of the state's land, being used for agricultural purposes.

California has passed the Low Carbon Fuel Standards (LCFS) program, which will mean that Nebraska will have to reduce its ethanol carbon footprint by 10% by the year 2020 if it is to continue to sell ethanol to California, according to a policy analysis factsheet produced by the University of California for the California Energy Commission. Currently, Nebraska sells roughly a billion dollars of its ethanol to California.

### Leading a Technological Revolution

Though ethanol is currently the most economically-viable of all biofuels, it is by no means the only one. Oyler is the business face of a large research effort aimed at developing the viability of algal biofuels. The team of researchers he works with hope to genetically engineer algae that eventually will produce enough oil to help fuel the world, but they are starting from the beginning.

"This is a new frontier, really. If you look at corn, let's say, it's taken 8,000 years to go from a small grass to these beautiful ears of corn that are highly productive, and in fact if you go from 1920 to the year 2000, there's been a quadrupling or more of productivity of corn," Oyler said. "We're starting where we were 8,000 years ago with algae to make it an agricultural crop and we need to use research to do that in 20 years rather than 8,000 years, or to compress that 80 years of huge increase in productivity of corn down to eight years." It will be at least five years and probably closer to a decade before algae-based biofuels are ready to go to market, according to Oyler.

### The New Technology

In addition to developing biofuels, there are also important non-biofuel-related technologies being developed from the algae research being done at UNL. Technology is being developed to make algae useful for cleaning up pollution from feedlots and also to further medical research, such as the study of lipids.

Understanding how lipids are used in algae actually can have impact all the way up to understanding how lipids are used in human tissues (like) the liver and fat cells. And that can help us understand diabetes and obesity.



“Understanding how lipids are used in algae actually can have impact all the way up to understanding how lipids are used in human tissues (like) the liver and fat cells,” Oyler said. “And that can help us understand diabetes and obesity.”

According to Oyler, by melding algal biofuel technology with existing corn-based ethanol technology, Nebraska can eventually make its ethanol more environmentally-friendly and competitive. UNL researchers hope to do this by feeding biofuel-producing algae with ethanol byproducts like carbon dioxide from fermentation. This would reduce ethanol’s carbon footprint while producing more fuel. But in order to do that, university scientists must first find efficient ways to grow algae.

“To make algae successful in leading to a biofuel, we really have to start with engineering the containers of the systems called photobio reactors that the algae are grow in,” Oyler said. “Those can be as simple as paddlewheel-stirred ponds, to something much more sophisticated.”

After that’s achieved, the researchers have learned to keep their newly-developed crop alive long enough to get oil from it. There are a host of viruses that prey on algae,

and they could pose a major obstacle to any kind of large-scale exploitation of a single kind of algae for biofuel.

“What we know from agriculture is when you have a single crop in an area, ultimately you’ll get some ... potentially disastrous diseases,” Oyler said. “We don’t even know the viruses that are out there, and if you look at a gallon of ocean water, it’s filled with algae viruses and we’re going to need to understand those much better ... a lot of that world-leading work is coming from here.”

### Funding

Oyler and his research associates have found national sources of funding for their research. The U.S. Department of Energy is contributing almost \$2 million to the biofuels research of Dr. Paul Black, a member of the UNL algae research team, and The National Science Foundation is contributing almost \$9 million over five years towards algal biofuels research through its Experimental Program to Stimulate Competitive Research (EPSCOR.) ●

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# Camelina as a Biofuel, Biolubricant

By Jaclyn Tan

Camelina is not a well-known crop in Nebraska, but its potential as a biofuel and biolubricant crop could soon be realized in western Nebraska, said Ed Cahoon, professor of biochemistry at the University of Nebraska-Lincoln.

“It seems that a lot of people in Nebraska don’t know about camelina, even within the university,” Cahoon said, “and part of my mission is sort of to educate people about camelina and about its usefulness for Western Nebraska.”

## Camelina’s Versatility

In 2010, Cahoon and fellow UNL researcher Tom Clemente received a \$500,000, three-year grant from the U.S. Department of Agriculture to study how camelina oil can be used as an industrial lubricant, such as in car engines or hydraulic machinery. In addition, Cahoon also has a grant from the U.S. Department of Energy to study the use of camelina oil as a jet fuel.

Camelina, a member of the mustard family, is an oilseed crop. It would grow well in Western Nebraska, Cahoon said, because camelina can thrive in areas of limited rainfall and in less fertile soil. “Camelina can be more productive on land in Western Nebraska that is not used for soybean production and therefore is not competing for the land that soybean, a food and feed crop, would be grown,” Cahoon said.

For example, he said, the plant can grow well in land such as in Western Nebraska, Montana and parts of Colorado. “It’s my hope that for Nebraska, that camelina could be some alternative or additional crop for the western part of the state,” Cahoon said.

Camelina can also be a source of income on land that “would normally sit unproductive” during a fallow year in the Great Plains, Cahoon said. “In parts of the Great Plains, they don’t grow crops in certain years to sort of build up the moisture in the soil,” he explained.

Cahoon said researchers in Montana and Washington, who are also trying to develop camelina as a biofuel, think camelina could be an alternative crop for those years. “They think they can grow camelina in these fallow years because camelina doesn’t require a lot of rain [or] a lot of moisture in the soil, and wouldn’t really compromise that fallow year.”

Camelina naturally has high levels of Omega-3 fatty acids, Cahoon said, which are great for health. However, camelina is not widely used as a food crop in the U.S. because alternative nutritional oils, such as flax oil are plentiful, he said. So, Cahoon said, researchers won’t have to worry about camelina seeds that have been modified for biolubricant or biofuel uses being accidentally mixed in with the food crop camelina, as may be the case with some other crops.

## Characteristics of Camelina as a Biolubricant and Biofuel

Right now, Cahoon said, researchers are trying to tweak camelina genetics so that the plant produces oil that is functional both as a biolubricant and biofuel. He said bio-fuels and biolubricants need to have two characteristics: 1) they must be oxidatively stable and 2) they must have the right pour properties.

An oxidatively stable oil won’t oxidize, or spoil, so easily,



Cahoon said. Polyunsaturated fatty acids, such as Omega-3 fatty acids, are very oxidatively unstable. Fish oil, for example, contains high amounts of polyunsaturated fatty acids, he said. So when these fatty acids oxidize, Cahoon said, it results in “this rancidity and these off-smells and off-flavors,” which is why fish can smell.

Since camelina is high in polyunsaturated fatty acids, Cahoon said researchers are working to create seeds with more monounsaturated fatty acids, because those don’t spoil as quickly. “You want something that you can have in a tank of a car or a tractor or a truck or something,” Cahoon said, “that is stable for long periods of time.”

In addition to being oxidatively stable, an oil must have the right cold flow properties to be used as a biolubricant or biofuel, Cahoon said. The cold flow property of an oil is measured by an oil’s ability to remain liquid and not freeze at lower temperatures. For example, he said, it’s important for a jet fuel to have good cold flow properties. “So when you’re up in a jet, you’re at very high elevations and altitudes and it’s very cold under those conditions. So you don’t want a vegetable oil that will freeze up in the tank,” he explained.

### Genetically Modifying Camelina

Cahoon said researchers have been successful so far in manipulating the fatty acid content of camelina seeds through genetic modification, allowing them to create more oxidatively stable oils. The time and skill required to modify a crop’s genetic makeup varies for each crop. For example, “When we try to make these genetic modifications to soybeans, it requires a lot of time and people that have really a lot of skill,” Cahoon said.

In contrast, camelina gene modification requires a much simpler and less time-consuming process, Cahoon said. “And so you can do a lot of manipulation, a lot of changes in the oil composition, very easily ... very quickly,” he said, which is another reason camelina is a favored crop for biofuel and biolubricant research.

### Challenges and Future Goals

Sometimes, modified seeds don’t germinate as well as unmodified ones, Cahoon said, resulting in a lower yield. Researchers are currently working to make genetic modifications that “minimize the negative agronomic impacts,” he said. “We want to have a high-yielding crop that has the oil quality that we desire.”

Aside from that, Cahoon said the next step is to produce a lot more modified camelina crop so that researchers can harvest enough oil to test the functionality of it. “For the jet fuel,” he said, “we would hope that perhaps in five years we would have some modifications made where we can put it out in the field [and] get enough oil where we can actually test it in a jet to see if it really does have the utility that we want.” ●



*Camelina seedling*

# Ethanol: Powering the Vehicles of the Future

By Patrick Radigan

With the creation of an annual Renewable Fuel Standard in 2005, a yearly set of projections for ethanol production, the question about the ethanol industry changed from if ethanol production would increase to what was the best way to properly grow the industry.

Due to that commitment to ethanol, the task has shifted from how to produce ethanol, to product distribution and how to grow the ethanol industry as a whole, according to Loren Isom, Technical Assistance Coordinator with the University of Nebraska-Lincoln Industrial Agricultural Products Center. Isom said the most prominent issue currently faced by the ethanol industry is finding a better way to distribute the fuel and create and develop more products that can efficiently operate on ethanol. According to Isom, the corn industry increased ethanol production to meet the needs of ethanol producers; now the task is finding a way to increase ethanol consumption and distribution.

"We now have enough production built up to where if people are using (ethanol), if consumers are using a 10 percent blend it really isn't enough for the current capabilities of supply," Isom said. "So that becomes an issue of can we increase the content of consumption in some way."

## Adapting the Industry

In increasing the production and distribution of ethanol, Isom said the first step is establishing the renewable fuel as a viable choice for consumers. Isom said it's important that consumers realize there is little difference between E10 ethanol fuel blends and traditional gasoline.

"It's just not that much difference," he said. "There are a lot of myths out there, or errors out there, where people are complaining there is a 10 percent drop in fuel economy between gasoline and E10 ethanol blends, and it's absolutely impossible."

On the other side of the distribution issue are auto producers, both domestic and foreign. Flex Fuel vehicles have demonstrated they can run on fuel that is up to 85 percent ethanol, so producers have the ability to evolve, it's just a matter of cost, Isom said.

According to Isom, the question isn't about if producers can make ethanol-friendly vehicles; it's about how cost-efficient those vehicles could be.

"If the industry, the transportation industry, the motor vehicle industry is willing to adapt," Isom said. "The Flex Fuel vehicles clearly can go up to 85 percent."

Once the industry makes a concerted effort to implement these ethanol-friendly vehicles, Isom said, the next step is fine-tuning the vehicles' engines to work best when operating on the renewable fuel.

"There is new research going on for engines that are



*Loren Isom*

designed specifically for ethanol," he said, "which would improve the efficiency of ethanol because it would be an engine designed to use that high octane. That's one of ethanol's unique attributes."

## Establishing the Local Economy

One reason that Isom said it is important to increase the distribution of ethanol is the positive effect it could have on the local economy. Isom said it is important to counterbalance exported profits with the sale of a domestically-produced fuel like ethanol.

By doing that, Isom said, local consumers could make a significant impact on the bottom line of local fuel producers. "If we're burning ethanol fuel from corn that is raised and grown here in our state, that's money that is turning over in our local economy," Isom said. "Compared to gasoline, which is a world economy that's going all the way over to the Middle East, primarily to get the fuel and come back." To further study the issue of local money being spent on foreign oil, Isom said he looked at Nebraska's net energy import/export. In comparing Nebraska's energy consumption to the state's energy usage, Isom said people might be surprised at what he found out.

"In general, people would think with all the ethanol we're an exporter of energy and liquid transportation fuels," Isom said, "but really we're still a net importer of energy with all the ethanol we produce and the small population of the state. We still import more transportation fuel that we export in ethanol."



## Building Toward the Future

In looking at the future of the ethanol industry, Isom said there are a number of possibilities and questions about ethanol's use as a renewable fuel. What Isom does know, however, is that fuel-powered vehicles are going to be around for years to come, even with the growing popularity and availability of electric cars.

According to Isom, the pre-existing infrastructure makes gasoline-powered vehicles easier to refuel, so currently they are a more viable option than the electric alternatives. However, Isom said he thinks the best option is finding a way to use ethanol to power and operate an energy-efficient electric hybrid.

"A bucket of coal isn't nearly as convenient as a gallon of gasoline to get you down the road," Isom said. "Neither is electricity that can come out of an outlet. There's a convenience issue there." As far as using ethanol in a broader area, Isom would like to see a vehicle with a flexible fuel power generator as a hybrid.

The Renewable Fuel Standard (RFS) calls for the eventual production of 36 billion gallons of renewable fuels a year. Isom said the ethanol industry has been able to meet the supply of corn-based ethanol; however, there have been some setbacks in its attempts to meet the benchmark for cellulosic ethanol. In addition to 15 billion gallons of fuel that is supposed to be produced from corn-based ethanol, the RFS also calls for 21 billion gallons of advanced biofuels, primarily cellulosic ethanol, to be produced in the near future. Cellulosic ethanol is produced from organic matter other than food products. However, issues with getting cellulosic ethanol production to an industry level have limited its production, Isom said, and created a more prominent marketplace for its corn-based alternative.

"Even by 2015 we're probably not going to have dramatic cellulosic ethanol production out there, but maybe by 2022," Isom said. "But in the meantime, we have an opportunity to supply an even greater amount of corn-based ethanol."

## Hands-On Research for UNL Students

To better shape consumers' ability to use ethanol in an efficient manner, Isom said it is going to be critical to keep students interested in working on a practical issue, like ethanol production. With the tools available to students, Isom said there are a number of ways that undergraduate and graduate students are getting hands-on experience in trying to find a viable option for a renewable fuel.

"From a fuel economy standpoint, we've got some equipment that looks at energy content," he said, "so we've got undergraduate students that we've trained to use that equipment, and they can apply that in a lab setting."

One area Isom believes research and development can pay off is in understanding the true issue of fuel economy and how it relates to consumer spending. According to Isom, recent research has shown that finding the best

option isn't always about maximum output: it's about getting the most use for every penny invested.

"You really have to think that you have fuel efficiency as one parameter, energy density as another parameter, but those two combined make fuel economy," Isom said. "So often, people look at lower energy content in ethanol and automatically assume it's a less efficient fuel. That's doesn't always mean it's a less economic fuel, though."

"In the end, you want to get down to cents per mile, cents per hundred miles, and a lot of times E85 is the more economic fuel in those cases." ●



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# Active Efficiency: A Closer Look at the Use of Ethanol Byproducts

By Patrick Radigan

While the direct benefits and issues with ethanol production are the subject of widespread debate, it's hard to deny the positive effect the byproducts from ethanol production are having in Nebraska and beyond.

Although there are a number of feasible uses for the byproducts of ethanol production, Galen Erickson, a University of Nebraska-Lincoln animal science professor, said the most practical use for ethanol remnants comes in the form of use as cattle feed. Erickson said the byproducts, known as distiller's grains, have had a major impact on the cattle industry in Nebraska and other areas of the country and world, and will continue to have an impact as ethanol production continues in the future.

"There is enough livestock and poultry to handle all the distiller's grains that will be produced here in the U.S.," Erickson said. "Many people don't realize that; many people think we're going to have so much ethanol and so many distiller's grains produced that we can't possibly feed it all to livestock. That's just not the case."

## Understanding Distiller's Grains

In determining the best possible use for ethanol byproducts, Erickson said the first step is looking at the different types of distiller's grains. These grains are produced when leftover materials of the ethanol process are combined with water to break down the nutrients in the leftovers.

From there, this newly-created substance, known as wet distiller's grain (WDG), is either distributed and used as feed or further refined into dry distiller's grain (DDG). The difference between the two, Erickson said, is that the wet grains are not only more potent and efficient, but they also are more cost-effective due to the low amount of energy required during production. Although they are a more potent choice, wet grains can only be transported to feedlots near ethanol plants, making them a limited resource.

On the other hand, dried distiller's grains lack the potency and efficiency of WDG, but DDG has the advantage over the wet option as far as distribution goes, due to the fact they can be shipped around the world once they've been dried. No matter which option cattle producers pick, Erickson said, there are a number of obvious benefits from using distiller's grains as feed.

"You can generally buy distiller's grain at about 80 percent the price of corn or less," he said, "and that distiller's grain will give you performance that is 120 or 130 percent of corn. "So you're buying something at 80 percent and you're getting 130 percent back from it, relative to corn. That's a pretty good deal."

## Distiller's Grains in Nebraska

To understand the issues and concerns of using ethanol byproducts as feed, Erickson said it is important to first consider the resources and markets available to ethanol and cattle producers. In a state with large corn and cattle industries, like Nebraska, Erickson said using distiller's grains could have a major impact if done right.

By having easy access to ethanol plants, and thus having the ability to use wet distiller's grains, Erickson said Nebraska producers have an edge on others around the country.

"Our plants here in Nebraska don't have to dry it down, they can just ship it out of the plant wet, straight to the feedlot," Erickson said. "That doesn't sound like a big deal, but it saves about 10 percent of the energy cost for the whole corn ethanol-cattle system, so it's a big deal relative to environmental issues and greenhouse gas emissions."

Erickson also said that the high costs of feeding cattle make distiller's grains all the more important, especially in Nebraska. According to Erickson, the costs of feeding account for around two-thirds the total cost of maintaining a herd of cattle.

Due to the volume and cost of feed required for cattle production, Erickson said the savings from using ethanol byproducts have equaled substantial profits for Nebraska cattle producers.

"They're making \$30 to \$60 more per animal; our average profitability across the last 20 years has been about \$10," Erickson said, "so they're able to increase their revenue by three to six times what their average profitability has been for the last 20 years. That's a big deal."

## Sharing the Wealth

Outside of the economic boost for local producers, Erickson said there are benefits other areas of the country and world can get from the use of ethanol byproducts here in Nebraska. In his work as a feedlot specialist for the University of Nebraska-Lincoln Extension, Erickson said he and his colleagues are looking at a number of ways to affect the cattle industry as a whole.

"Because we have such a large cattle industry, we have a lot of support for beef cattle research," Erickson said. "Things we do here in the beef cattle area are generally adopted in most of the other states as well."

With the resources available, Erickson said they are able to study practical matters, like how much distiller's grain can be fed safely to cattle, as well as improving the process and finding ways to maximize the efficiency of the grain shipped around the country.

One way the UNL community has already affected the feed industry is in work done with Cargill, a multinational agricultural corporation based in Minnetonka, Minn.

Erickson said a lot of the work done on a grain product called Sweet Bran® was completed at UNL. Almost 20 years later, that work is helping to increase the quality of feed being used by the Texas cattle community.

“A lot of that original work was done here in the ‘90’s,” Erickson said. “Now, Cargill actually ships Sweet Bran®, which is a wet corn gluten feed product from Iowa, to Texas and the Texas cattle industry is using that product.”

With the availability of wet grains in markets and areas that have previously had only dry grains, Erickson said the practical example set by Nebraska in using WDG will also have a major impact on the feed industry.

“A lot of the early work that we did, and a lot of the early adoption that the Nebraska cattle industry had, has really benefited them down there, because now they’ve had a better understanding of what this is like,” he said.

The UNL community also contributes to producers through the information and research provided through [beef.unl.edu](http://beef.unl.edu), a site run by the university that provides prices, forums and other interactive content in addition to research reports. In addition to the support from UNL, Erickson said the research and information provided through the site is largely thanks to contributions from the Nebraska Corn Board.

## Evaluating the Alternatives

Although distiller’s grains are used primarily as feed, Erickson said there are other uses for these byproducts that are being applied in other areas of the country and world. Areas around the globe have implemented the use of

distiller’s grain as a source of protein for human consumption, while other places closer to home have discussed the possible use of distiller’s grain as a fertilizer.

While Erickson acknowledged that other uses for ethanol byproducts have proven to have practical value, he said the efficiency of grains used as feed, as well as the high demand and economic impact of grain-based feed make it the logical choice for how to best use the leftovers from the ethanol process.

“Many people have looked at how we could use them for human use,” Erickson said. “That’s fine, but given the amount that we’re producing, there’s no way, even if every one of us consumed distiller’s grains every day directly, we can consume enough distillers grains to use them up.

“So we’ve got to feed them to livestock in one form or another.”

Another option is to use the dry distiller’s grains as a source for biodegradable plastic.

In February of this year, The Kearney Hub reported that the Kearney Area Ag Producers Alliance has raised more than \$3.5 million to put towards an \$18.7 million proposed project that would build a plant to turn resin from distiller’s grains into plastic bumpers, seed bins,

shipping pallets and parts for automobiles and tractors.

Laurel BioComposite LLC is the only corporation with the rights to use resin for production in the United States after the technology was initially developed in New Zealand.

No matter what the use for the grains, Erickson said there is a large demand for the byproducts of ethanol, should production increase in the future.

“Interestingly, we still could use about twice as much of the distiller’s grains that we are currently using in the state,” he said, “so we have a lot of room to use more.” ●

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*Galen Erickson*





# Biofuels: The Economics of Environmental Impact

By Gabriel Medina

California buys much of its ethanol from the states in the nation's Corn Belt – including a third of Nebraska's annual production. That amounts to about \$1 billion of the approximately \$3.5 billion dollars in ethanol that Nebraska sells every year. However, new state and federal environmental standards regulating greenhouse gas mean biofuels produced in Nebraska and other states must meet new requirements to continue to reach restrictive state markets like California. Adam Liska, University of Nebraska-Lincoln assistant professor of biological systems engineering, studies the greenhouse gas balance and the climate change implications of producing biofuels compared to using fossil fuels – and how Nebraska's ethanol can meet those new state and federal standards. He said the Environmental Protection Agency (EPA) and state-level regulators use science-based calculations to determine the greenhouse gas footprint of fuel and if it meets those requirements, the fuel can be sold to markets with stringent regulations and also can be eligible for billions of dollars in federal subsidies.

"A third of our ethanol production in Nebraska is subject to the calculations of the footprint in California to enable our ethanol to be imported into that state," he said. "Understanding how these calculations are done is really pretty important for the state of Nebraska, as these regulations could begin to restrict ethanol imports in 2013."

## Biofuels vs. Fossil Fuels

"When we think about developing biofuel systems, we want to determine whether those biofuel systems are more harmful for the environment or less harmful than our existing fossil fuel systems," Liska said.

The EPA has specific sustainability standards for biofuels, he said. They are also interested in the greenhouse gas footprint, or the carbon footprint, of the fuel. Liska is most interested in understanding the carbon footprint of the fuel and whether some fuels are above or below that EPA standard.



*Adam Liska*

"Overall, corn ethanol has generally been shown to be less harmful in global warming than gasoline. So, traditional fossil fuels, that we can just pump out of the ground and use, those are generally shown to be greater contributors to climate change," he said.

Liska, whose research interests focus not only on biofuels and greenhouse gas emissions, but also on energy security, said the U.S. uses about 20 million barrels of oil per day and imports about 11 million barrels per day.

"We have this 140 billion-gallon-per-year transportation gasoline market and we have to think about what are the

fuels that we can produce economically, on a very large scale, to make a dent in that," Liska said. "We're producing, in the Corn Belt, about 13 billion gallons a year of ethanol. That's substituting about 10 percent of our domestic gasoline, and that's a pretty good start."

## Economic Stability of Agriculture

Liska said that besides generating \$3.5 billion in annual sales, Nebraska's ethanol industry has generated 13,000 high-paying jobs in the past 10 years.

"Overall, agricultural commodities in Nebraska are about \$9 billion in sales. Corn alone is \$5 billion annually," he said. "We're talking about billions of dollars in increased revenue for Nebraska farmers, which then

increases state taxes as well, and state revenue. And state tax revenue goes to pay for roads and schools and jobs for lots of people," he explained. "We are heavily-based in agriculture and ethanol has made our economy much stronger," adding that Nebraska's low unemployment rate is largely attributed to the state's stable agricultural economy.

Ethanol production is likely to increase the price of grain by using close to 40 percent of U.S. corn production for that product, he said. That increased price of grain not only brings in additional revenue to the state, but has also increased the market for corn. "It has strengthened a lot of auxiliary industry around ethanol," he said.

## Sustainability of Biofuels

Liska said sustainability of biofuels currently depends on the stability of the crops grown to produce the specific biofuel. In the case of ethanol, corn production in the Corn Belt has been increasing for the last 60 years, so yields have



been increasing and more acres have been planted to corn, soil erosion has been reduced and lesser amounts of pesticides have been required. Overall, the Corn Belt has had stable production.

“We could have problems with diseases and weather, as weather from a changing climate becomes more variable,” he said. “That’s one of the problems with biofuels – you’re dependent on the weather, and variability in weather happens from year to year,” he added. Some years there may not be enough rain, some years there may be too much rain – both could hurt yields.

In addition to his work on the environmental impact of biofuels compared to fossil fuels, Liska has

multidisciplinary collaborations with other University of Nebraska faculty in studies of soil carbon issues, water issues, biodiversity, and greenhouse gas emissions from livestock production.

Liska said he does not receive research funding from either the oil industry or the biofuel industry. His research is funded by organizations such as the U.S. Department of Energy; the U.S. Department of Agriculture; the University of Nebraska Agricultural Research Division; the Nebraska Center for Energy Sciences Research and through that, from the Nebraska Public Power District. ●

“We are heavily-based in agriculture, and ethanol has made our economy much stronger.”

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# Engineering Efficient Electric Vehicles: Powering the Future With Batteries

By Patrick Radigan

While ethanol, biodiesel and other renewable fuels look to replace gasoline as the fuel for America's automobiles, one University of Nebraska-Lincoln professor said it's not the fuel that's the problem.

It's the engine.

According to Dean Patterson, a visiting research professor at UNL, the issue with using gas-powered cars is not just the fuel going into them; rather, it's the inefficiency of the internal combustion engine. Through his work as a faculty member at the UNL College of Engineering, Patterson said that the best choice for the future of automobiles is using more efficient, electric motors to power the cars of tomorrow.

The problem, Patterson said, is not only that combustion engines are relatively inefficient overall, but that their efficiency drops even further when driving in a city setting. Yet even with efficiency in their favor, Patterson said it's going to be an uphill battle for electric engines to take control of the automobile industry.

"People are having issues adapting because in order to get the best kind of vehicle, we need to make radical changes," Patterson said. "People get nervous about that, so the thing we primarily face is conservatism on the part of the user."

## Finding the Right Choice

As the industry attempts to introduce electric engines on a massive scale, Patterson said the first step is finding the right choice for an electric hybrid. While a solely electric engine has received criticism for a lack of range, the introduction of the Toyota Prius, a car that uses a complex combination of combustion and electric engines, has sparked interest in electric vehicles.

Patterson said that the next step is finding a car that can handle the average American's daily commute, which he said is around 26 miles a day, while also having the ability to have an extended range.

And although he said the wide-scale production of such a vehicle is still in the future, Patterson said one car shows

promise for leading the way: the Chevrolet Volt.

"The simple answer is that you put on board a separate gasoline engine, quite a small one, whose job is to simply come on when the battery gets low and charge up the battery," Patterson said. "That's what the Chevrolet Volt does. It's perfect. You can go 600 miles in a Chevrolet Volt using both engines, and it's still fully electric for those 26 miles on most days."

What makes such a difference, Patterson said, is how efficient electric motors are when it comes to daily driving. In a traditional combustion engine, Patterson said a large amount of energy is lost as heat every time you brake. Couple that with the inefficiency of using a combustion engine at reduced revolutions per minute, Patterson said, and you have a system that wastes a large amount of energy.

By using a combustion engine to simply charge a larger electric engine, though, Patterson said cars like the Volt give consumers an economic option for dealing with the daily commute.

"That's what's so bad around town," he said. "It's not all the braking and stopping that does it, it's the fact that the engine is way off its peak point of efficiency."

"So instead you have a separate little engine, just a small one, a liter or less, that is only ever running at its peak conversion efficiency or it's shut down."

## Finding Solutions, Getting Jobs

As far as research into electric engine technology goes, Patterson said UNL faculty and student researchers have had the freedom to work on the idea of a series hybrid, or an electric car with a small on-board combustion engine. Through work in the lab and with students, Patterson said that he and his colleagues in the UNL research community have been able to provide industry professionals with valuable research and ideas that have helped develop modern technology.

"I have a Ph.D. student and we have a small Honda stationary engine downstairs right now, and we're doing the exact same job of converting gasoline to electricity for



Dean Patterson

possible application,” Patterson said.

“We were going to build the ultimate series hybrid but General Motors beat us to the punch, but we’ve been working on it for years,” he added.

Not only have major automotive companies picked up that research, but the students doing the research have also been sought after by industry professionals, Patterson said. With the work students are doing on electric engines and associated technologies, Patterson said UNL students may have an easier time finding jobs out of college.

“We have the best generators in our labs, we have the best lithium ion batteries and we have the best motors,” Patterson said, “and we’ve been working on those for decades now. So all the young people we graduate are being snapped up.”

### Looking Beyond the Automobile

Outside of the development of electric automobiles, Patterson said electric engines could also play a role in the future of other mechanical industries. In a farming state like Nebraska, Patterson said the advancement of electric engines in farm implements could have a major impact on

local producers.

“If I mention names like John Deere and Caterpillar, you’ll find that they are working in the exact same lines of hybridization,” Patterson said. “We’ve been doing work, actually, with John Deere that goes back a decade on electric vehicles and generators and it’s coming to fruition as we speak.”

In addition to simply operating farm implements with electric engines, Patterson said there is also the potential to replace parts of complex industrial machinery with more efficient electric parts. Mechanisms like hydraulic pumps and lifts operate on all sorts of farm machinery, and Patterson said it may be possible to make them more efficient by using electricity for operation.

“Hydraulics are actually, in general, pretty inefficient. They lose about 50 percent of the energy they use,” he said. “We can’t make a motor as small as a hydraulic motor, but we’re getting close now with our electric motors.” ●

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# Climate

# Creating the Next Generation of Sustainable Nebraskans

By Christine Hunt

“It’s really an ethic. It’s about how you ethically understand your place in the world today,” said Wayne Drummond, dean of the University of the Nebraska-Lincoln (UNL) College of Architecture and co-chair of the Chancellor’s Commission on Environmental Sustainability. According to Drummond, people have a responsibility not only to themselves but also to their immediate family, their institution and the entire global population. Drummond wonders how the world’s increasing population is going “to make it all work” to clothe, feed and support everyone. “Population rates are increasing much faster than anybody had predicted. That relates to our consumption, it relates to our climate, it relates to who we are as a human civilization, collectively and globally,” he said.

“I think there is a very fine line between having the resources and not having the resources. We’re watching that throughout the world today. We’re watching it in the Middle East. We’re looking at it in the Far East. We’re looking at it right here at home and throughout every society,” he said. Drummond has served as dean of the College of Architecture since 2000, but announced in May 2011 that he would step down as dean effective in the fall of 2011.

“From my point of view, it’s obviously a passion,” said Drummond, adding “how do we make sure those future generations are going to be served as well as we have been served?”

Drummond believes it is incredibly important that students are aware of the dynamics in the world today in terms of these critical issues.

## Sustainability on Campus

One way to engage students, as well as faculty and staff, is through the Chancellor’s Commission on Environmental Sustainability (CCES), the 16-member volunteer commission created in 2008. The commission’s co-chairs, Drummond and Kim Todd, UNL associate professor of agronomy and horticulture, have been at the helm since the commission was formed, said Drummond, leading the CCES in its mission to develop and recommend policies, practices and educational programs that ensure the University of Nebraska-Lincoln is environmentally sustainable. The Chancellor’s Commission on Environmental Sustainability defines environmental sustainability as the movement toward redesigning the way society’s ecological, economical and social needs are met so that they can be accommodated within the long-term carrying capacity of the environment.

The CCES reaches across the state with members in extension, administration, facilities, research, human resources, the chancellor’s office, faculty and both undergraduate and graduate students.

The commission members recommend policies to UNL Chancellor Harvey Perlman that will preserve UNL resources, conserve energy and make certain that construction decisions affecting the environment – natural and built – will serve many generations to come, said Todd.

It is also important for the commission to recognize and communicate the practices and activities that are already going on all over campus, whether they’re student-driven or initiated by faculty or staff, said Todd, adding that there is much to talk about, including Earth Day celebrations, teaching of environmental ethics or systems, repurposing materials for environmentally-friendly building projects, collaborating on possibilities for different energy use, transportation, bike routes, biodegradable cafeteria trays, food policies and even smoking policies.

## Creating the Next Sustainable Generation

“People tend to think about sustainable efforts as being physical: the architecture, the engineering, the energy,” said Todd. “One of the things that’s really important to us is to thread it all together. It’s the education piece. It’s the outreach piece.” Todd explained the importance of not focusing on a building, its site or transportation networks independent of the people that are using each. “If we did focus on those physical elements rather than the attitudinal or educational pieces, we would ultimately not succeed,” she said. “You can’t force those things on people and expect them to stick.” It takes a long time, and sometimes generations to change people’s thinking, she added.

Instilling sustainable thinking is especially challenging in Nebraska since energy is inexpensive. We don’t tend to think “let’s save it,” said Todd. To get people to understand, think and care about sustainability because they want to and should, rather than because of shortages or high prices, is integral to the commission’s real mission, said Todd. “If you think about it, a sustainable lifestyle is everything – in the choices people make in their daily lives – from the time they get up until the time they go to bed at night,” Todd explained.

## Sustainable Impact

The CCES has delivered two years of policy statements to the chancellor, said Drummond. Purchasing policies, recycling, sustainable information technology policies,

conservation of the natural environment and LEED-standard buildings have combined to create a more sustainable campus. The ability to influence and encourage policy changes at a collective level across the campus is the real value of having the commission, said Drummond, not the creation of one new piece of legislation or one high impact policy. “If you add all of those up one layer at a time, it’s really more sustainable than to say, ‘we did this,’” said Drummond.

### Challenges

“It is important to point out that this is a volunteer committee structure,” said Drummond, so trying to find an agreeable time for 16 volunteers to meet between classes and job duties is one of the biggest challenges. “As a volunteer

commission, it’s worked beautifully from the point of view that the people who are assigned are passionate and committed,” said Drummond.

Looking at the work of the commission and the current emphasis on sustainable practices, Todd sees it as part of a cycle. “We’ve done this before as a human population. We’ve been ‘green’ without using those words and then we got a bit complacent,” she said. “Now, we’re becoming green again and as I look at the progression we should make, we should be truly optimistic that we can do this,” she said. “And we should NOT be frustrated with making small steps in the right direction as long as we’re going the right direction. And as before, you end up with a generation or two generations of people who have done something differently that will make a difference to their next generation,” said Todd. ●

*Kim Todd and Wayne Drummond*



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# Climate Research Provides Economic Opportunities

By Farooq Baloch

Climate change, often referred to today as global warming, will have a tremendous impact on the economy as well as the environment. It will affect agriculture and water resources in Nebraska as well, said University of Nebraska-Lincoln scientist Don Wilhite.

Nebraska farmers have learned to operate in a climate that is highly variable. However, research conducted at the university will enhance the understanding and adaptability of the state's agriculture while also enhancing economic opportunities.

Wilhite, UNL professor and director of the School of Natural Resources (SNR), said SNR researchers are working on large-scale climate modeling to get a better picture of how climate change is going to affect Nebraska.

He said the outcomes of their research will hopefully provide for better forecasts, especially seasonal forecasts, to help water managers and agricultural producers in terms of what crops to plant, and when.

Wilhite – who specializes in drought monitoring and mitigation, drought preparedness and other areas related to climate variability and change – said the research about climate change can translate into economic opportunities for the U.S.

For example, he said, by reducing greenhouse gas emissions – one of the main contributors to global warming – there are opportunities to develop green technologies that can be exported and the U.S. can be a leader in this new economy.

Wilhite said climate change is a natural feature of the earth's climate as noted by warm periods and ice ages in the past – increases and reductions in earth's temperature over time. These fluctuations in the earth's climate are closely tied to changes in atmospheric concentrations of carbon dioxide. Global warming, he said, has been used more recently as a synonym for climate change, since humans are most likely causing a change in climate through the emission of greenhouse gases into the atmosphere. These greenhouse gases are naturally occurring but make up less than one percent of the volume of earth's atmosphere.

## The Process

Wilhite said greenhouse gases, such as carbon dioxide, methane, and nitrous oxide trap heat in the atmosphere. The emission of these gases increases their concentration in the atmosphere, which increases the ability of the atmosphere to hold more heat, thus, upsetting the natural heat balance for the earth. "So we're retaining more of that heat for longer periods of time," Wilhite said. "If it wasn't for these

greenhouse gases, the surface temperature of the earth would be about 55 or 60 degrees cooler than it is today," he added.

## Sources of Global Warming

According to the global mean temperature records of the last 100 years, Wilhite said the largest portion of global warming is due to the increase of carbon dioxide in the atmosphere. He added that methane and nitrous oxide are also contributors.

"The main source of greenhouse gases is the burning of fossil fuels such as coal, petroleum, and natural gas," he added.



Don Wilhite

## Consequences of Global Warming

Wilhite said the world has experienced about 1.5-degree F to 1.8-degree F warming over the last 60 to 100 years. "While a few areas have experienced some cooling, most areas have experienced significant warming, especially in the middle and higher latitudes," he said. In addition to increasing temperatures, the amount and seasonal distribution of precipitation will be affected for most regions. "The combination of these changes in climate will have a profound effect on water supplies for many locations and our ability to adapt to these changes," he added.

Wilhite said that one of the other areas of expected change in climate is that the severity, frequency, and the duration of extreme climatic events, such as drought, floods, and heat waves, will likely increase.

"An increase in population means more pressure upon our limited water resources. If droughts are going to become



more severe, then that will result in greater impacts as demands for water increase with expanding population,” he said.

Wilhite said increasing atmospheric temperatures causes the oceans to warm as well, thus, oceans are expanding, resulting in rising sea levels. Sea levels are also increasing due to the melting of glaciers around the world.

This rise in sea level is going to have a tremendous impact upon land development and on the environment, especially in coastal areas, he added.

For example, Wilhite said, coastal cities may need to build sea walls, at enormous costs, to try and protect from waters as they rise.

He explained that flooding of coastal areas will also affect salt (sea) water intrusion into the aquifer system. In some areas, aquifer water may become more saline and even undrinkable.

### Impact on Nebraska Agriculture

“The length of the growing season in Nebraska is increasing because of the warming that we have experienced,” Wilhite said. Changes in precipitation amount and distribution are also likely to occur. He added that farmers will have to adapt to changes in precipitation, in terms of the amount or the seasonal distribution within a year. Farmers need to be aware of these changes, which may be outside of the range of what they have experienced in the past.

Wilhite said a rise in temperatures causes a substantial increase in the evaporation and transpiration rate – that is, how much water plants will use. “That may affect the types of crops that we can grow in Nebraska.”

He explained that the increasing evaporation rate may mean that the aquifers will get less recharge.

“If aquifer levels decline, there is less water to pump for irrigation that might affect the viability of agriculture in the future,” Wilhite said, adding that farmers will likely need to adapt to these changes by altering the crops grown or by switching to more drought-resistant varieties as they become available. Farmers might need to grow other crops that can thrive in a drier climate where there is less water available through irrigation. “So all of these things may have tremendous impacts on agriculture down the road,” he added.

“Nebraska farmers have adapted quite well to the natural climate variability that exists in Nebraska,” Wilhite said, and added if the climate becomes more variable in the future, farmers’ ability to adapt to a far different climate may be very difficult.

He said one of the other concerns is that the warmer

winters that have been experienced in Nebraska over the last decade or more is the impact it is having on the overwintering of insects and diseases that affect plants. “Insects are overwintering and then creating more problems for agriculture,” he said.

### The Role of Research

The scientists at the University of Nebraska-Lincoln are working on climate modeling. They are trying to understand how these changes in global climate will affect the Great Plains area.

“Researchers in SNR and UNL are trying to understand how the climate of our region will change in response to these changes in the concentrations of greenhouse gas emissions,” Wilhite said. “Increasing our understanding of these changes will allow us to provide better information to farmers and others in climate-sensitive businesses,” he added.

He said a more accurate, advance forecast about a growing season will help farmers and agricultural producers to make better decisions about the types of crops they should plant and when they should plant them.

Wilhite said the climate of the future may be much different than today’s so researchers at UNL are also working to develop new crop varieties that will be adapted to a changed climate.

While the research can help farmers adapt to this changing climate, there is also a need to reduce the amount of warming in the future.

“We have to agree on some limitations on the amount of fossil fuels that we’re burning,” Wilhite said, “and we have to reduce the emissions of carbon dioxide and some of these other trace gases.”

He said there is concern that if the U.S. puts a ceiling on carbon dioxide emissions, it will have a substantial reduction in America’s economy.

Wilhite said in the U.S., the issue of climate change has become politicized. He added he would like to see more science-based decisions associated with the issue of climate change in the future.

“What I think our politicians are not considering is that by not doing anything, it’s costing us a lot in terms of impact on our environment and the sustainability of our planet for future generations. We are conducting a global experiment with potentially dire consequences,” he said. ●

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# Helping Nebraskans Navigate Climate Change

By Christine Hunt

Nebraska is going to get warmer. It's just a matter of how much warmer, according to Martha Shulski, director of the High Plains Regional Climate Center (HPRCC) and assistant professor in the University of Nebraska-Lincoln School of Natural Resources. Rising temperatures are just one concern Nebraskans have about the changing climate. Most questions asked are on a very local scale, said Shulski. "They want to know 'how is climate change going to affect me in Lincoln in order for me to make informed decisions and better decisions for planning purposes?' It's very difficult to give them an answer. It's hard to tell them in 50 years, high temperatures in Lincoln are going to be exactly X degrees," she said.

"I think we've got a pretty good indication of where the global mean temperature is heading but the finer the scale you go, the more difficult it gets to understand climate change," said Shulski.

Climatology is complex and involves a number of different systems. "If you look at the climate system on the whole, you've got the ocean, the land, everything that's on the land, the atmosphere and how all of these things are connected and how the feedbacks interact. It's a very, very complex system, so it's good to have an oceanographer, an atmospheric scientist, a terrestrial scientist and a glaciologist," said Shulski. As climatology evolves it is becoming more interdisciplinary. "All of these disciplines come together to help solve climate issues and climate problems," said Shulski, who hopes that climate science will continue to improve, providing people with more localized answers.

The HPRCC collects and analyzes climate data for the entire country, focusing on Kansas, Nebraska, North and South Dakota, Wyoming and Colorado and is one of six regional climate centers in the United States.

The HPRCC's activities can be put into one of three categories:

1. Applied research on climate issues in the region
2. Education and outreach activities and maintaining a network of weather stations throughout the region and

gathering climate data

3. Quality control and making data available to the public  
"It's really all centered around climate services and helping people find the climate data and information that they need for whatever purpose that may be, whether it's engineering or legal purposes or somebody doing a school project," said Shulski.

The HPRCC relies on the National Oceanic and Atmospheric Administration (NOAA) and the National Weather Service for much of its data. These organizations have large numbers of stations throughout the country, ranging from automated stations at airports that take observations hourly or even every 15 minutes, to people in the community who volunteer and take manual observations once a day, said Shulski.

All the high-quality weather data, weather information and climate information from these sources are put into a uniform system that is accessible to anyone through the Internet. "Anybody in the country can

grab data and it looks the same whether you go to the Western Center or our Center or the Northeast," said Shulski, "We try and have this seamless way in which we can serve our users."

Originally from Nebraska, Shulski earned her undergraduate degree in meteorology from North Carolina State University, a master's degree in agricultural meteorology from the University of Nebraska-Lincoln and a Ph.D. in soils and climate from the University of Minnesota. After finishing her degree in Minnesota, she worked for seven years in Alaska before returning to Nebraska to become the director of the HPRCC.

As an applied researcher, Shulski seeks to understand what issues are important to people and how climate data and climate products can help people to solve problems.

## Studying the Past, Predicting the Future

One way to help people is by predicting future weather conditions. According to Shulski, it's important to look into the future and predict climate variability and change throughout the next century. "That's obviously very important for sustainability in providing some sort of



*Martha Shulski*

guideline in terms of, 'how is the climate going to change in theory, in the future and what sort of sustainability practices would you need to use given a certain amount of climate change?'" she said.

The HPRCC's historical database of weather and climate information shows a long historical record of what has happened in the past, including how past weather conditions related to various environmental factors. These records assist scientists like Shulski in making predictions about future climate and weather conditions.

### **Trends Predict Warmer, Drier**

When Shulski and her colleagues study the historical climate and weather data, they see mainly two trends. One trend is the variability in weather conditions from year to year and decade to decade due to Nebraska's highly continental climate. The second is a general warming trend. According to Shulski, the warming is on the order of about a degree or so per century. "There's a greater amount of warming from the nighttime low temperatures as compared to the daytime high temperatures. If you look across the region, the further north you go, the more warming there is. The rates in say, North Dakota are greater than the warming rates are in Nebraska. And that's something that's true globally," she said.

Precipitation, according to Shulski, is more difficult to predict due to year-to-year variability and lack of a strong signal in the historical record. "In precipitation, there's not a lot of confidence in terms of what direction we'll go. It's likely, though, that there will be a drying rather than wetter than normal conditions," said Shulski.

Warmer and drier conditions for the state could have a big impact during the growing season when crops are in need of water, said Shulski. If we get warmer summertime temperatures and drier weather, what does that mean for agriculture?

### **Consequences of Climate Change**

Shulski believes water availability might become an issue in the future. With over eight and a half million irrigated acres in Nebraska, how does the state sustain that demand? "Right now it comes from ground water but that's not an infinite source," said Shulski. "Where is it going to come from and is the quality going to be good enough for your purposes?" That's the next big thing in Nebraska, nationally and globally, she said.

Shulski believes climate change will force many to change their energy use practices. If temperatures increase during the summer time and Nebraskans become more reliant on air conditioning, energy use will

increase. As temperatures warm, people at a higher altitude or higher latitude location who normally don't need air conditioning or use much energy in the summertime, will now need to use more energy. It might have an opposite effect in the wintertime. If the winters are not as cold, on average, then the energy use is going to be different, she said.

### **Climate Affects Everyone's Food**

Climate affects water, energy and personal comfort but also food and food prices, not only in Nebraska but nationally and globally, said Shulski. Everyone is affected by the conditions of crops growing in various areas. "What's going on in California could have an impact on the kinds of vegetables we can get in the wintertime. Or if there's a freeze in Florida, then that could impact citrus prices and the price of grapefruit we have here in Lincoln," she said. Nebraska weather conditions influence crop yields to some degree and that could influence grain prices or prices for beef or cattle.

According to Shulski, we don't live in an isolated state where what happens here only affects us here. Nebraska weather conditions affect not only producers, the people who grow the food, but the people who eat the food or process the food.

### **Global Climate Partners**

Climate is truly global and the climate center shares knowledge with universities and countries all over the world. Recently, the HPRCC hosted a delegation from Chile needing information on installing similar kinds of weather stations: how the stations are set up, how quality control is performed on the data and how the instruments are calibrated, said Shulski. And in 2010 Shulski traveled to the University of Zagreb in Croatia to learn what kinds of courses they teach and what kinds of research they are doing. Shulski looks for ways the HPRCC and global partners can work together.

### **Funding**

"The HPRCC itself is funded by the National Oceanic and Atmospheric Administration (NOAA)," said Shulski, "that's what makes us go and what funds our staff and what funds our operational products and services." For specific research projects the HPRCC looks to NOAA for other sources of funding, as well as to the United States Department of Agriculture, National Aeronautics and Space Administration and the National Science Foundation, she said. ●

Climate affects water, energy and personal comfort but also food and food prices, not only in Nebraska but nationally and globally.



# Sustainability: a Philosophy, a Goal

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By Becky Gailey

By 2050, the world's population will have doubled but the amount of land and water for agricultural use will have remained the same or even decreased. How will the world be able to feed these people? University of Nebraska-Lincoln Professor Charles Francis, sustainable agriculture coordinator for the University of Nebraska-Lincoln Department of Agronomy and Horticulture, is working to find the answer to this question. The only problem is, there is not one simple answer.

"Most folks are looking for a menu," Francis said. "They would prefer to have sustainable agriculture mean 'this set of practices.' It's really more of a philosophy and a goal. Sustainable agriculture is looking for ways to keep agriculture going indefinitely to sustain us as a human species, but to also sustain an environment where we'd like to live and raise our kids."

This means maintaining the fabric of rural communities and diversifying farming operations, he added.

Francis said rural communities provide the backbone for sustainable agriculture, but a 2009 study by UNL Extension Professor Randy Cantrell for the University of Nebraska Rural Initiative, reported that 73 of Nebraska's 93 counties experienced population loss between 2000 and 2007 as farming operations have become more consolidated, chain stores have shut down local entrepreneurs and young people have left home looking for greater opportunities. Buying farming equipment from Illinois because it is less

expensive has short-term benefits, but Francis asked what the long-term effects on a community are when consumers no longer patronize local businesses.

"Until we start looking at those kinds of questions and look at ways we can sustain our communities and keep people there, we're going to have a continual drain of the most vital resources we have, which is people, from rural areas," Francis said.

As more people leave the land and private-ownership of farms decreases, so does agricultural sustainability, Francis said. In an article on sustainable agriculture written in 2004 for The Encyclopedia of the Great Plains, Francis wrote that agriculture based on family-farm ownership and entrepreneurship will stabilize food production and conserve resources. Along with supporting the surrounding community, which will in turn support them, family operations look beyond short-term gains to the long-term effects their decisions will have, Francis wrote. Large farms with short-term lease agreements, however, provide little incentive for farmers to plan for the future and conserve resources.

"Agriculture that depends on distant ownership and minimum-wage jobs does not promote conservation of natural or human resources. Building systems that add value to products locally, that generate both food and income for local residents, and that cycle dollars around the community, rather than extracting them from the land and people, can







*Charles Francis*

*Photo courtesy of Carola Strauss*

lead to a more sustainable agriculture and food system for the Great Plains,” Francis wrote.

One issue affecting agriculture, according to Francis, is its reliance on monoculture, which can be defined as growing one crop over a wide area. Although this practice helps increase production, it drains resources.

### **Research into Crop Diversity and Sustainability**

Francis said a more sustainable farming technique is planting a diversity of crops together in one field. He and other UNL researchers are currently exploring different farming methods and crop combinations that will lead to more sustainable agriculture. A major emphasis in the research is planting a variety of crops in the same field and then rotating the crops every season. Francis said these methods can help decrease problems of soil infertility, soil erosion and crop loss from disease. Researchers are currently experimenting with mixtures of two to eight different species in one field to see how they complement each other and how they survive year to year.

“Our current misguided philosophy is that if we just produce more food there’ll be enough for everybody,” Francis said. “When you think about it, we really have just about enough food to feed everyone right now, but it’s not distributed now. We have a lot of food going to waste . . . [and that] can be solved by getting away from single crops and large fields, away from monoculture.”

### **Transportation Costs and Sustainability**

Although the global food system is convenient, Francis predicts that local food systems will prevail in a more sustainable future. The current food system depends on transporting food long distances, which Francis said is unsustainable because it undermines local production, increases the amount of food ruined during transportation and requires more energy. A 2003 study by the Leopold Center on Sustainable Agriculture determined that locally-grown produce traveled an average of 56 miles to reach its buyers, whereas conventional produce traveled almost 1,494 miles to reach the same destinations. Francis said agriculture should move toward peri-urban farming, or having a greenbelt around the perimeter of cities where crops and small animals could be cultivated to feed the nearby population.

“The sustainable farm is something extremely special and unique to each place,” Francis said. “We’ve tried to go the other direction. We’ve tried to homogenize the production environment, make it the same everywhere . . . But that’s really the wrong direction.”

Instead of looking for the miracle crop that can be planted anywhere and will produce mass quantities of food, Francis and his fellow researchers are exploring what crops grow best in different ecoregions based on temperature, rainfall and other factors.

Rather than trying to homogenize production, Francis said mixing together compatible combinations of crops and animals suitable for the surrounding environment, just as nature has done, will create a more sustainable future.

“Where this is going is to think more of how we can adapt our crops and our systems to each location rather than spending massive money on fertilizer, water, other inputs to modify every place to make them all the same. So the ideal farm is the one that is a mixture of crops, animals, a wide diversity of crops. That’s sort of the opposite of the direction we’ve sort of gone for quite a few decades here.”

Francis also said that humanity has a deep faith in the ability of technology to solve all problems. After working in impoverished parts of Africa and South America for many years, Francis said he has seen that methods that work in one place cannot just be transplanted to other regions and expect similar results, which is another reason why monoculture will not make for a global, sustainable society.

“You realize solutions are not universal; they have to be unique to each place,” Francis said. “And we can learn that from nature. Nature tells us over and over again, that each niche is different and we have to treat that niche differently.” ●

# Rural Sustainability is Key to Nebraska's Future

By Seanica Reineke

The future of rural communities and the world depends on many factors, such as appreciation for the history and culture of rural areas and regions. Managing the water supply so “future generations have water, forests, wide open spaces and fertile land” without too much urban sprawl is also a factor, according to Sandra Scofield, Director of the University of Nebraska Rural Initiative.

“We want to leave a little something in place: quality streams, wildlife and well-managed farms and ranches, and not just let urban sprawl take over the planet so that this place is a decent place for the next generation to live in,” said Scofield. She is convinced that with population growth and more resources becoming scarce, more people will begin moving back to rural areas. With the future in mind, she said people need to remember the importance of being good ancestors.

“If we continue to protect the land and water for the highest level of productivity, to produce food and fiber and possibly biofuels, that’s an appropriate and effective use of certain parts of the state. If we protect our wildlife, our streams and the things that make rural areas a desirable place for people to get away from it all and have some outdoor fun, that’s not only good for the future of the planet, it’s good for the serenity of the human race. People need to get out of the city once in awhile and connect with nature,” she said.

## Connecting Young Nebraskans: Investing in Rural Communities and Educating Urban Communities

Scofield said more emphasis should be placed on qualities “that make rural Nebraska livable” – the idea that a healthy community is more than its economy. It’s about the environment, social structure and infrastructure coming together to create a place where people want to live.

“People have to take it upon themselves to understand how we’re all hooked together,” Scofield said. This includes making sure everyone understands how the rural

communities and agriculture affect their lives, including where their food comes from and how to manage water wisely. Scofield said individuals should begin conversations about these topics and impacts, and begin to inform themselves. That’s why the Rural Initiative created a program called Connecting Young Nebraskans.

Connecting Young Nebraskans is a group primarily of rural young people between the ages of 20 to 40, who come together to discuss the future and their points of view on what is best for everyone’s future. Scofield said conversations between these young people and others cause a ripple effect, have a bigger impact and make a positive difference because people listen to them.

“Urban people ought to go out and walk around a little bit. ...maybe visit rural Nebraska,” said Scofield. “You really need to get out and talk to people and try to understand what the state is

like. And on the other hand, rural people can’t just sit back and think ‘you’re all going to come and visit’...because it just doesn’t work that way.”

Scofield said rural community investments, particularly public and private investments in infrastructure and education, also are important to be sure rural residents have the necessities to not only run successful businesses and agricultural enterprises, but also to live healthy, productive lives. Rural businesses need access to affordable Internet and other technologies. To be competitive, Scofield said lifelong education upgrades must be readily available to their management and employees. But she said public money is a necessity because these needs, in most cases, cannot be met with private funds.

“A well-educated workforce is essential,” Scofield said, “and to retain that workforce, competitive wages must be paid and the overall quality of life must be good. Good hospitals and healthcare professionals, good parks and civic centers, good housing, clean and reasonably abundant energy for buildings and transportation maintained in a way that is sustainable in the long term.”



*Sandra Scofield*

## Managing Resources, Land is Today's Responsibility

Nebraska sits above an underground water source, the Ogallala Aquifer. The state also has nearly 50 million acres of land, 90 percent of which is privately owned and mainly used for agricultural production. Scofield said people need to appreciate the resources in rural Nebraska and recognize their scarcity by managing them correctly, otherwise a grim future lies ahead.

"To just say 'well, we'll figure out some invention to take care of all this when crisis hits' is not responsible!" Scofield said. "I think because we have been so lucky to have all this land and all this water, we sort of take it for granted." But Scofield said now is the time to carefully consider how to manage resources and be supportive of the people already involved in resource management. Those are the farmers and ranchers across the state, nation and the world, who, she said, do a wonderful job of caring for the land and wildlife, but aren't appreciated because people aren't aware of their work.

Scofield, a native of Chadron and former Nebraska state senator, said the programming of the Rural Initiative is directed toward trying to make rural Nebraska more sustainable. The Rural Initiative's definition of "sustainable" comes from the 1983 United Nations World Commission on Environment and Development which defines "sustainable" as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." Scofield passionately believes people need to be "good ancestors" for future generations.

"I think we all have an obligation to leave the world in at least as good of shape as we found it," Scofield said. "Given some of the challenges facing us in terms of population growth and pollution and so on, we probably have an obligation to try to leave the world in better shape than we found it."

## Globalization, Technology, Urbanization and Population Growth

According to Scofield, the world is moving into a new era where the scarcity of resources will be the driving factor. Certain trends, such as globalization, technology, urbanization and population growth, are already making an impact around the world.

Globalization has completely changed the business

world, especially in rural communities. The small community businesses that used to thrive because they were the only place to purchase certain products, Scofield said, experience difficulties because of consumers' abilities to order anything they need through the Internet. Technology is a major component of globalization because it "has driven the capacity for...relatively few farmers to basically feed the nation."

Urbanization is a major factor because people are moving to cities, not just in the United States, but around the world. "Rural areas have to realize we live in an urban world," said Scofield. "We've got to figure out how to build effective relationships between rural and urban areas... because urban people need the resources and the talents in rural areas; rural people need the urban markets."

By 2050, it is projected that 9 billion people will live on Earth. With this population growth, Scofield said projections indicate more people may begin to move away from crowded, urban areas, which will have an impact on rural areas. Rural areas that see a population increase that doesn't "overtax their 'carrying capacity' will do well," but the areas that get overrun will struggle, according to Scofield.

As a result of these trends, many rural communities already are struggling because there isn't an economic need for them to be around anymore, Scofield said. "If we take up productive land for traditional urban style development, we will see more sprawl and environmental problems." But she said that doesn't have to be an inevitable situation for all rural areas. Community residents have to be engaged, and volunteers and leaders have to be "committed to continuous learning and to working with their citizens to recognize and take advantage of opportunities...and deal with threats." Scofield said determining true opportunities and real threats in the long run can take a lot of analysis.

## Opportunities for Growth During Change

Change is inevitable, Scofield said. "We've already seen dramatic change, and we're still trying to figure out what hit us!" This change can come from people being informed about the issues at hand, and Scofield said that comes from knowing what research says. Scofield added that debates have to take place in order to find answers, but said those debates must be formed from a knowledge base that also must continue to grow. ●

The University of Nebraska Rural Initiative identifies opportunities in rural Nebraska and catalyzes experimentation, innovation and collaboration in partnership with rural citizens to enhance the economy of rural areas while promoting sustainable and socially beneficial use of resources.

# Defining Drought and Its Impacts

By William Whited

Drought is a word some people may define to mean a sudden lack of rainfall, seemingly happening at random, perhaps in desert-like climates.

But Michael Hayes, director of the National Drought Mitigation Center (NDMC) at the University of Nebraska-Lincoln, the only center in the U.S. specializing in mapping droughts and their impacts, defines drought as a naturally occurring phenomenon based on how the atmosphere interacts with land and oceans. He said droughts can happen anywhere in the world.

## Preparing for the Future

“A lot of people think droughts happen in arid or semi-arid regions, and that you can’t have droughts in wet regions,” Hayes said, “whereas the Amazon is a region where you can have a drought, or the southeast United States can experience drought.” Hayes said while drought often brings economic slowdown and human hardship in surviving a period of scarce water supplies, a misconception some people may have is that nothing can be done to combat Mother Nature.

“It’d be like saying, ‘we know tornadoes occur here in Lincoln. There’s really not much we can do about tornadoes,’” Hayes said. “That’s not true. There are a lot of things we can do to deal with tornadoes. And I think there are a lot of things we can do to prepare ourselves to deal with future droughts.” He said this is where the Drought Center comes into the picture, to teach people that each region is affected differently based on climate and water resources, and that people must work together.

“It’s a multi-tiered approach,” Hayes said. “You’ve got to work with kids, but you also have to work with the public, and you have to work with the officials making the decisions. You can’t just focus on one group of people and not the others. I think you have to reach each of those groups to better educate them about climate-related issues in general.”

## Goals: Planning Cooperation

The center focuses on planned cooperation between people in crisis management. Good planning requires gathering and sharing drought information through the center’s monitoring technology, Hayes said. By monitoring data, officials and residents can act to improve a situation.

“You also have to have an idea of what decisions you can make so you have to plan ahead,” he said. “Monitor the conditions and then hopefully continue to adjust, or do a post-assessment of how you’ve responded to drought situations so when future droughts come along, you do a better job.” Hayes said with these decisions may come

regulations for water use and distribution, but first, people need to understand drought’s impacts on human life. Hayes said the center provides information about how drought may affect farmers and urban residents differently, helping them to understand their vulnerability and find ways to reduce their impact. Communicating good strategies to communities can aid in planning for future droughts.

“We’re involved in a project right now called the Engaging Preparedness Communities Project,” Hayes said. “We’re actually trying to get drought managers, or those people that make decisions about drought, together with other people who are making decisions about drought so that they can share their lessons learned.” Still, each education and discussion session should be uniquely tailored to each region in the world and the community members involved, said Hayes.

## Drought – Definition, Impact

“Drought in the United States is a big economic issue. In terms of losses to drought, it’s equal to or on par with big hurricane events. Big drought events cost about the same amount of money as a big hurricane event in the United States,” he said.

“In other countries, when you talk about drought, you’re talking about livelihoods of people and food security and the potential for famine. So droughts look different in the United States than they do in these other countries,” Hayes said. In addition to each geographical area experiencing unique hardship, Hayes said each person will have varying perspectives of drought impacting their livelihood based on two questions: “Where does your water come from?” and “How do you use your water?” The answers to those questions will provide each individual’s definition of drought. “So a farmer who uses irrigation, for example, their definition of drought’s going to be completely different than a farmer who’s dependent on rainfall,” Hayes said.

## Partnering Through Technology

The center’s most notable service is called the U.S. Drought Monitor, a weekly tool that monitors America’s lands, in partnership with the United States Department of Agriculture, the National Oceanic and Atmospheric Administration, and the Desert Research Institute, as well as a nationwide observer network of more than 250 state, federal, and academic participants. In addition to the Drought Monitor, the center and its federal partners use satellite remote sensing systems to record a clearer mapping of drought locations and hazard reports in each state, producing the Vegetation Drought Response Index (VegDRI) maps as a web-based decision-making tool.



“If you go back and look at the U.S. Drought Monitor map over the last 10 years, you’ll see that drought has occurred in a lot of places,” Hayes said. “California, for example, just experienced a very severe drought and they’re now out of that. Texas and the southeastern part of the U.S. have also had droughts in the last several years.” Still, Hayes said, remote sensing can examine details down to the level of Earth’s vegetation.

“The value of that information is it’s generally at a higher spatial and temporal resolution than a lot of the climate data,” Hayes said. “So what you’re doing is you’re supplementing a lot of the climate data that’s collected by other agencies, whether here in the United States or around the world.” In addition to drought mapping, Hayes said the center started a comprehensive database in 2005 to measure environmental, economic and social hardships experienced by populations. The center does this through a service called the Drought Impact Reporter.

Inadequate resources – human, technical infrastructure, and financial – are probably the biggest obstacle to successful drought planning, Hayes said. “In a lot of countries internationally, sharing of data and information is not easily done or done at all,” he added. In visiting foreign countries, Hayes said communication and education focuses on government officials and residents.

“One of the first conversations we’ll have is ‘where’s your data, and can you share that data with other people?’ That seems to be the first obstacle, the major obstacle to actually moving things forward.” Hayes said when staff of the center interacts with residents in other countries to show them how to deal with drought, societal values may need to change, including government investment in new technology and support staff.

“We can work socially and get people to understand the value of water, and how to make better decisions related to the value of water,” he said.

### Lingering Domestic Problems

Still, while some states in the U.S. stay on top of drought preparation and communication, some get left behind. According to Hayes, not all states react equally to drought, nor do they use the latest technology to better plan for the future. He said those states that do not update their knowledge may have no cushion for potential economic trickle-down effects, especially for businesses and agricultural industries like cattle feeding. Better-prepared states like Nebraska may still suffer, even at a personal level, he said.

“During the big drought that Nebraska and the High Plains had from 2000-2006, one of the big impacts happened for livestock producers,” Hayes said. “For a livestock producer, if they don’t have enough feed for their livestock, they’re either going to have to find it somewhere, or, they’re going to have to curtail the size of their herd.

“For some of the livestock producers, that was a very difficult decision to make. ‘Do I go and spend extra money to haul in feed for my cattle, or do I reduce the size of my herd?’ And so that was a very emotional decision that they had to make. You can reduce your herd fairly quickly, but it’s not an easy thing to pick up the size of the herd rapidly. The impact to that then lingers on for multiple years.” To ease this loss, Hayes said the NDMC also works with the Internal Revenue Service (IRS) to provide drought severity data the IRS then uses to defer some taxes producers would otherwise pay from selling their livestock. While strategic planning partly preserves the livelihood of people affected by drought, drought by its nature isn’t entirely preventable, Hayes said. “I think the drought events are always going to occur.” ●



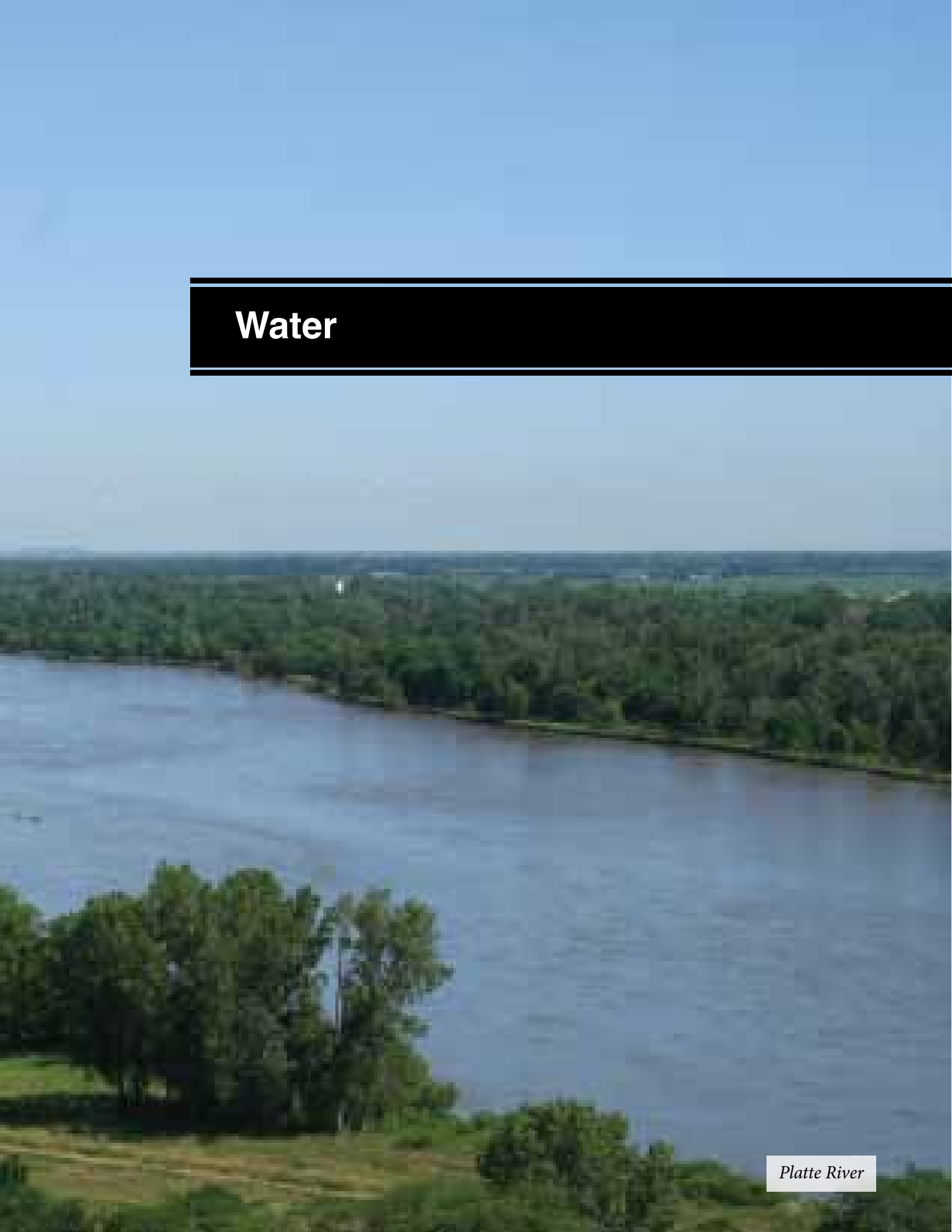
*Michael Hayes*



*Photo courtesy of Brian Fuchs and accessed for the NDMC website at [drought.unl.edu](http://drought.unl.edu)*



# Water



*Platte River*

# Increasing Ag Water Productivity

By Farooq Baloch

“By 2050, there will be about 9.2 billion people,” according to Kenneth G. Cassman, University of Nebraska-Lincoln professor of agronomy, “this is going to require massive increases in demand for food, energy and water.”

He said the world is short on land and water to feed those people so the answer has to be producing more food with less water.

The professor said industries will not be able to grow further unless they find ways to conserve water. “When current supplies are stretched to the limit and you want to expand,” he said, “the only way to do that is through conservation.” Cassman’s research group at UNL works on trying to understand how to increase water productivity of agriculture, including water use, efficiency and conservation. His research concerns how to quantify water and what can be done to improve its efficiency.

“Water in Nebraska is connected with agriculture,” he said.

“The easiest way of saving water is not to irrigate,” Cassman said, “but that’s not the answer because irrigated agriculture contributes 40 percent of the human food supply.”

He said pricing water consumption could also help conserve water.

The UNL agronomist said there is a massive need to increase agricultural yields using less water per unit of food produced. “If this isn’t done there is both economic and environmental disaster on the road ahead,” he said.

## The Big Picture

Cassman said dropping water tables across major production areas of the world are a real concern because it’s a key measure of the energy required to lift the water from the aquifer to the surface for irrigation, industrial or domestic uses.

The former director of UNL’s Center for Energy Sciences Research said in the U.S., one of the major production areas is the Great Plains — a vast prairie region extending from south Canada into Texas through west central U.S. — where irrigation helps grow crops such as corn, wheat, sugar beets, alfalfa and dry beans.

“There isn’t enough rainfall for highly productive agriculture, therefore water levels are also dropping in this region,” he said.

Cassman said there is concern about the long-term viability of the Ogallala aquifer — a vast yet shallow underground water table aquifer located beneath the Great Plains.

He said water levels are also lowering in Nebraska, which is a water-limited state.

Some areas in the U.S., including Nebraska, are under water stress, according to the United Nations Environment Program’s report: *An Overview of the State of the World’s Fresh and Marine Waters*, 2nd Edition, 2008.

Cassman said “water levels are lowering in Pakistan, Northern India, Southern China and Bangladesh — a major breadbasket of the world — because they are over-drawing.” He further said the water level is dropping in the North China, which is a major producer of corn and wheat. “There’s a concern that it’s going to be able to continue in irrigated agriculture,” he added.

## The Challenge

Cassman said the challenge is to double the food supply in about 40 years with existing irrigated area and using less water per unit of area.

“In 2050, there will 2.2 billion more people than today and they will be much wealthier on average because of economic development, particularly in world’s most populous countries,” he said. “They will need more food, which will require more land and more water,” he added.

## Research and Technology Can Help

“Right now some people are working on enhancing productivity; others on enhancing water efficiency,” he said. The answer, according to Cassman, is going to be bringing those two efforts together.

The forefront here, he suggested, is to bring groups together within universities to have a tandem effort that seeks to increase both yields and water efficiency at the same time.

Cassman said science and technology in general comes up with new ways of growing food and producing goods and services.

Giving the example of Tri-Basin, one of the natural resource districts in south central Nebraska, he said, “they have challenges with water supply for irrigated agriculture.” Kansas sued Nebraska in 1998 for drawing more water from the Republican River than was allowed under a 65-year-old compact with Kansas and Colorado.

He said the NRD board, whose members are elected by the residents of that NRD, required all the farmers to install flow meters on irrigation wells. It also required farmers to report the amount of irrigation water applied to each irrigated field from each flow metered-well, he said.

“We used that data from nearly 800 individual fields to evaluate how well they are doing with regard to water productivity and nitrogen efficiency,” he said, “and found some amazing results statistically.”

Over three years — by using crop simulation models and



a geographic information system, data bases on soils and weather, Cassman and his team were able to re-create the entire water productivity of the system: the average, the ranges and the best farmers.

“We did statistical analysis to identify what management practices, if they were changed, could increase the productivity with which the water is used and at the same time increase yields,” he said.

The researchers found that they could actually put together a package of technologies, along with existing technologies, that would increase yields and reduce water use by about one-third in that NRD.

Cassman also suggested farmers can install sensors on their sprinklers so they don’t apply irrigation water if the soil is too wet because of the rain.

### Role of Education

“Every one of us is concerned with every drop of water and making sure that it is used wisely and properly,” Cassman said, “however, the biggest responsibility will be on the shoulders of people under 30 that are going to be the most effective.”

Cassman said this is a competitive world with limited resources and every country in the world wants to obtain the resources to maintain a standard of living and their economic growth rate.

“The only way to compete is to have an educated workforce, in science in particular, because it’s a world that’s becoming more complex,” he said.

Cassman said education is important even for understanding questions about what’s the best policy to ensure Nebraska uses its water wisely in the future for sustainable economic development and better quality of life.

He said it is important to have a society in which young people are interested in science and want to understand how things work and said it’s also important for the U.S. to keep up with other countries in educating its people. “If other countries are educating their kids, allocating resources and understanding how to solve these problems better than us, they will be taking showers and we won’t, they will be driving cars in the future and we will be walking.”

### Nebraska’s Position

“Since Nebraska is such a large producer of agricultural products, both livestock and crops,” he said, “we are now in a favorable position (compared with) other states in the country in terms of being able to maintain our economy and our standards of living.”

Cassman said Nebraskans can be proud that they have developed a political system called the NRD System. “The citizens in that district vote to elect a board, which has the authority to tax the residents of the NRD to initiate programs complying with over drafting of aquifers,” he said, adding that managing that resource is in the hands of every Nebraskan because they are the ones who use the water supply.

He said that the University of Nebraska’s Robert B. Daugherty Water for Food Institute is going to be one of the world’s leading centers in using all kinds of science and knowledge to help find solutions to some difficult questions. Also, he said, the research conducted at UNL can be applied in other parts of the world. “So the spin-off to the world is incredible.” ●



*Ken Cassman*



For more information visit [www.unl.edu/sdn/opportunities](http://www.unl.edu/sdn/opportunities)

# The Bread Basket of the World

By Gabriel Medina

The fertile soils of Nebraska and other Midwest states feed millions of Americans with different kind of crops, thanks to the water from the High Plains Aquifer. But University of Nebraska-Lincoln groundwater geologist Jesse Korus said that the region has a worldwide impact.

“We’ve heard of the High Plains region being called the bread basket of America,” Korus said, “but it is really the bread basket of the world in some respects. It overlies this major aquifer, which can help us to sustain irrigated agriculture. For that reason the High Plains Aquifer is probably one of the most important in the world.”

At least 20 percent of the total irrigated land in the United States overlies the High Plains Aquifer and 66 percent of it is under Nebraska, said UNL geologist Matt Joeckel.

A quadrillion gallons of water are contained in the High Plains Aquifer, which would be enough to fill Lake Huron. The Ogallala Aquifer is a major part of the High Plains Aquifer.

Even though Nebraska is fortunate to have this enormous quantity of water, there are some places where its levels are decreasing.

“Some estimates indicate that, at current pumping rates, there may be only between 25 and 50 years of use left in some parts of the High Plains Aquifer,” said Korus.

Joeckel, who is also the outreach coordinator of the Conservation and Survey Division of the UNL School of Natural Resources, pointed out that the term “sustainable” is not appropriate when referring to water use from The High Plains Aquifer. He explained that, according to some definitions, sustainability would mean that the water level declines stabilize. But because that is not happening, he prefers the term “wise-use.”

“I would certainly be concerned about places south of the

Platte River in Nebraska,” Joeckel said, “where water levels in the High Plains Aquifer have dropped significantly since development began around 1950.”

Joeckel added that water levels of this aquifer have also decreased in certain parts of Kansas, the Texas panhandle and the Oklahoma panhandle. These decreases of 100 feet or more in the water level worry Joeckel because it is possible there soon won’t be enough water for irrigation.

“Many people around the world derive some kind of indirect benefit from the use of waters from the High Plains Aquifer. So, in that sense we all bear some responsibility,” said Joeckel.

## Education

There are certain areas of the High Plains Aquifer near Nebraska’s Platte River Valley, as well as in Holt county of Nebraska that are polluted with fertilizers, according to Korus.

To stop, or at least decrease this pollution, the Natural Resources Districts of Nebraska as well as UNL’s Extension personnel are educating farmers about the proper use of agricultural chemicals.

“Generally, these producers want to be good stewards, they want to do the right thing,” Korus said.

Korus explained that the pollutant level in the High Plains Aquifer is being monitored by the Nebraska Department of Environmental Quality and the Natural Resources Districts.

## Misconceptions

Joeckel explained that people have certain misconceptions about the High Plains Aquifer. The most important one is that an aquifer is an underground lake, but in reality it is similar to a sponge made of sand and





*Jesse Korus*



*Matt Joeckel*

sedimentary rocks that are porous enough to hold water.

“An even better analogy would be filling up with sand a pint glass, and then running water into it until the sand was wet – but you could not see any liquid over the surface – and then putting a straw in and trying to suck the water out,” he said.

Another misconception is that the aquifer underlies all of Nebraska, but the truth is that it doesn’t underlie the southeastern corner of the state, where most of the population lives, Joeckel said.

Joeckel pointed out there are other misconceptions, like the fact that there is no relationship between underground water and surface water.

“There are certainly large stretches of major rivers in Nebraska that are gaining flow from groundwater,” he said. “The flow in many of Nebraska’s streams is related directly to the High Plains Aquifer, whether water is going into the aquifer or coming out of it.”

Joeckel also stressed that the High Plains Aquifer is the major source of fresh water in all of Nebraska, for drinking, agriculture and every other use.

### **Other World Aquifers**

With 3 billion acres of water, the High Plains Aquifer is not the biggest in the world, but it is very important because of its location. The Great Artesian Basin in Australia has 7 billion acre-feet of water and The Guarani Aquifer System located between Brazil and Argentina contains 24 billion acre-feet of water.

“There are much larger aquifers in the world than the High Plains Aquifer, but what makes the High Plains Aquifer so special is that it overlies a region of high agricultural productivity, of good soils and ideal climate for certain crops,” said Korus.

### **Taking Care of Water**

Korus explained that Nebraska is divided into 23 different Natural Resources Districts. Some of these districts regulate

how much water a particular farmer can use in any irrigation season.

Recently, Nebraska has been given the authority to stop additional development of groundwater supplies where it has impacted surface water supplies.

Korus said that there have also been disputes related to surface water supplies between states.

“Kansas has disputed Nebraska’s use of ground water because it reduces the amount of water flowing in the Republican River,” he said.

Korus explained that groundwater and surface water are interconnected, so if there is a surface water dispute and that surface water is connected to groundwater, then the dispute becomes a groundwater dispute.

“Part of my job here at the university is to help people to deal with ground water issues,” said Joeckel. “My personal interest lies along the lines of the materials that actually make up the aquifer, not the water, but the materials holding it, the sediments, particularly in the Ogallala formation.”

Joeckel said a drip irrigation system is a method that helps to conserve water. With this technique, water is applied slowly to the plant’s roots, so only about 10 percent of the water evaporates. If the water is sprinkled over all the plants through conventional irrigation systems, between 15 and 25 percent of the water is lost through evaporation.

“With strategies like this one, we get the most out of every drop of water,” Joeckel said. “We’ve not been very good to our aquifers on a global basis. So, we can learn a lot about how to use them better and make them last.”

Korus said he became interested in his job because water has helped Nebraska to develop and have an important economical growth.

“I’ve seen how irrigation has benefited this state in terms of its agriculture and because of that I want to make sure that I’m doing what I can to help protect those supplies for future generations.” ●

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# Water Monitoring Key to Competition

By Seanica Reineke

“In Nebraska, water is money.” Water issues are a growing source of conflict and competition in many areas of the world, including the Midwest. But technology, such as water monitoring technology, may help alleviate some of the problems associated with water conflict, according to David Admiraal, associate professor of civil engineering at the University of Nebraska-Lincoln.

“Water itself is, of course, one of the most important things for human life and for life in general,” Admiraal said. Requirements for accurate water quality and quantity measurements have gone up throughout the past four decades, he added, because both quality and quantity have decreased. Also, he said accuracy is more important now because of the emphasis placed on the environment and on health.

Health is a main reason why people should care about water monitoring, he added, because everyone uses water and is affected by the quantity and quality of water available. People are concerned about developing cures for cancer and other diseases, but Admiraal believes it is better to never have a disease than to have a cure for it.

“Having access to clean, healthy water prevents the spread of diseases that were at one time a far greater risk than cancer,” Admiraal said.

“Whether it is water that we directly drink, water that we play in or water that our kids stomp through that flows in the gutters of our streets, I think most of us would agree that if possible, we prefer it to be free of unhealthy bacteria, viruses and chemicals.”

People have realized that discharging polluted water into streams and rivers is not acceptable from a health standpoint, Admiraal said, because any non-natural chemical or substance has the potential to negatively impact the quality of life. He said water regulation in the United States has “vastly improved the health of the population by preventing the spread of potentially deadly diseases like cholera and other diseases that spread through human waste.”

This also includes monitoring stormwater runoff, which requires programs to prevent contamination of water by oils, pesticides and fertilizers along with structural changes to water networks to help remove contaminants that impact the quality of life and the environment. Admiraal works with

stormwater in his water quality projects with the city of Lincoln, sampling the water to monitor the levels of a variety of pollutants with the goal of developing better strategies for water quality improvement in streams.

Water is needed for various reasons: to fuel agriculture, for household uses, to produce economically feasible electricity and also for recreational purposes, Admiraal said. He added that water has helped develop Nebraska’s strong agricultural economy. However, with increasing pressures on water usage, water monitoring is becoming a necessity.

“The science that studies contaminants and related issues is rapidly changing, but it will always be important for us to be able to quantify the extent of the problem,” Admiraal said, “and this quantification will require that we know not only how much of any given substance is in the water, but also the quantity of water that is being affected.” He added that knowing the amount of water available makes it easier to decide how much water users, such as irrigators, ethanol plants and recreational users, receive. Not knowing makes it easy to misallocate that amount of water, which is already a limited resource, going to each user.



David Admiraal

## Water Monitoring – Measuring Quality, Quantity

Water monitoring measures the quality of water, including the water temperature, the chemicals – and the amount of chemicals – in the water. Monitoring also measures water quantity, which is the depth and flow rate – or gallons per minute – of the water. There are various ways to monitor water with different technologies.

Emerging technologies and techniques measure various features of water quality and quantity, but the accuracy of many of the economical devices is limited. Currently, some aspects of water quality can be measured instantaneously with electronic sensors, but few low-cost devices are available. Water monitoring relies heavily on laboratory analysis of samples to determine specific quantities of chemicals and constituents in the flow that cannot be measured accurately with electronic devices, he said. Based on his work, Admiraal believes cost-effective sensors that can directly and accurately measure specific chemicals in streams are “a long way down the road.”

He said the most common way to measure water quantity is with a weir – a concrete structure, like a dam, that is



installed to back up flow in a canal or river to form a reservoir, divert water into a side channel or purely for the purpose of measuring flow. Weirs cost anywhere between \$1,000 and \$100,000, depending on size, and can be placed in different types of channels– from small ditches to large canals.

There also are some newer technologies being used, though Admiraal said it is still sometimes difficult to get trustworthy measurements with them. One new technique is measuring surface velocities of rivers with radar, microwave and imaging techniques. Another technique is with hydroacoustic devices, which can measure velocities throughout the water column, which is the water flowing in a river between the surface and the bed. Admiraal said these technologies hold promise for: improving measurement accuracy; making measurements in a short time; reducing the need for a skilled operator for long periods of time; and measuring flow rates in places too dangerous for an operator to go.

### Future Improvements and Developments Necessary

Currently, typical water quantity measurements are 10 percent accurate, which Admiraal said leaves plenty of room for improvement. He said new technologies, such as those with remote sensing capabilities without structures and without on-site operators, are needed. He said those technologies currently are being developed. Typical water quality measurements are even less accurate and more difficult to obtain than water quantity measurements. “We need devices that can not only identify the quantity of a contaminant, but what contaminants are present, and that’s a pretty complex thing to do.”

Admiraal said scientists and engineers need to produce devices or improve existing devices that measure flow from a distance over a wide area, allowing for better estimates of the total water budget across Nebraska and the United States. He said these devices would ensure more accurate allocations as a result of more accurate measurements. “Competition for water will grow independent of water measurement,” said Admiraal. “Knowing the amount of water won’t affect how people try to get their hands on it, but it does allow us to determine if it is being distributed correctly. Accurate measurements make sure what was promised and delivered are the same.”

Already, Admiraal said, “big strides have been made” in thermal measurements by using thermal cameras to measure water surface temperatures from a distance. He described how a number of researchers have used thermal imaging to measure temperatures near power plants because they use water as a coolant. “I would expect to see not just thermal imaging, but other technologies pop up in the future that are going to help us come up with better flow measurements, better water quality measurements,” Admiraal said. “It’s an emerging technology, and just like any emerging technology, you find new uses for it and it becomes less expensive as they find new ways of using it or developing that technology.”

However, he said there are tradeoffs between accuracy, cost and where each method can be used effectively. ●

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*Urban water monitoring technology equipment*

# Maximizing the Value of Water

By Christine Hunt

“Irrigation contributes billions of dollars a year to Nebraska’s economy. And that’s just looking at how much grain is produced and sold, and how much diesel fuel and other inputs are used. Irrigation manufacturing provides additional benefits to the state. If you look at the multipliers of how that works through local communities, it adds to the value of irrigation. I think many of our rural communities realize that irrigated agriculture is important to their sustainability,” said Derrel Martin, professor of irrigation and water resource engineering in the Department of Biological Systems Engineering at the University of Nebraska-Lincoln. “I think people across the state are interested in how we utilize and value our water resource,” he said.

## Nebraska’s Water Resources

“There is a finite supply of water,” said Martin. “In Nebraska, the state receive, on average, about 22 and a half inches of precipitation a year. That’s the average across the state. That’s our main source of water year in and year out.” Nebraska does have the High Plains (Ogallala) Aquifer that stores a vast volume of water; however, according to Martin, the issues arising today are really related to the flow of water in streams, not the volume of water in the aquifer.

## Demands on Nebraska’s Water

Groundwater feeds many streams in Nebraska. As groundwater is pumped for irrigation, the water elevation may drop over time and can affect stream flow, said Martin.

With more irrigated land than any other state, Nebraska is facing issues with maintaining stream flow; for example, in the Republican and Platte River Basins, said Martin. “That’s what’s driving a lot of water policy and water management issues at the resource level, not at the farm level necessarily, but at the watershed or Natural Resource District level,” he said. “Not just in Nebraska, but all across the western United States.”

Almost 94 percent of the land in Nebraska is owned by a private entity, someone trying to make a living, said Martin. “What can be done that enhances their opportunities while not being at odds with managing the watershed. I think that’s where we’ve evolved to today,” said Martin. “We’re taking a bigger, more holistic picture of looking at the water resources that we have and trying to ascertain where the water goes and where it come from. In the end we have to decide how much water is available to use and how to manage the water. How can Nebraska’s water use be sustainable?”

## Managing Water While Protecting the Watershed

UNL’s Department of Biological Systems Engineering, along with graduate students and extension educators, form

a team that takes a dual view of managing water, said Martin. The team looks at water management at the farm level so farmers can be profitable and efficient, but also studies how that water use impacts the watershed, he said.

There are times it might be best for the farmer to be as efficient as possible and use every drop of pumped water for crop use, said Martin, “That doesn’t necessarily enhance the watershed. You have to look at where the water goes that we pump from groundwater or that we divert from streams. When you pump water from groundwater and it goes to your center pivot, how much of that water might evaporate into the air? How does water evaporate off the canopy. When you use surface irrigation, does the water soak into the soil or run off the field?” he said.

Through years of research and the use of computer modeling and simulation programs, Martin and his colleagues answer these questions, as well as many others. Research enables the team to make predictions and look at how management strategies or new designs might affect water balances, Martin said.

## The Water Optimizer -- Value from Each Drop

Martin and the team, along with UNL Professor of Agricultural Economics Ray Supalla, created the Water Optimizer though 25 years of research. The Water Optimizer is a computer program developed to help producers and water policy analysts maximize the value from the limited water available for irrigation, said Martin.

A significant portion of Western Nebraska is affected by water allocation programs, which means a producer is given a set volume of water to use, either annually or on a multi-year basis, he said. As a result, producers must look at which strategies to use in terms of what crops to plant and how much water to allocate to each crop. Decisions become more complex when producers have more than one irrigated field if they are able to move water back and forth between those fields, he said.

The Water Optimizer program allows producers to enter the raw production costs, commodity values and their own production goals. The program then determines the alternatives that produce the maximum net return for the producers. Martin went on to explain if an agricultural producer wants to use half of the field for corn or soybeans in a rotation, the program is designed to allow for that.

## Growth in Technology

Technology is rapidly becoming available to producers that will allow them to better monitor soil and crop conditions in the field, “I think we are really on the cusp of that,” said Martin. As farms increase in size, producers don’t have time to find the sensor in the field and read it

by hand, he explained. Today, equipment installed in the field can send messages by satellite or wireless networks to a producer's computer or phone. Cell phones can also be used to remotely turn a center pivot on and off, monitor what the pivot is doing and even get warning signals if a pivot has a problem, he said.

Today they're developing irrigation systems that allow the producer to divide the center pivot field into different sectors, said Martin, applying a different amount of water to each sector. It's another way producers can get more value out of their water, he added.

Martin believes the use of electronic technology in farm fields will be more common in the next decade. The researchers' challenge is to make the technology effective and reliable, as well as measure and monitor conditions at a cost that is reasonable to producers, he said.

### **Making Research Relevant**

Sometimes in research settings, we're reluctant to step forward until we think we know everything about the problem, said Martin, comparing research to peeling back the layers of an onion. "Every time one layer is peeled back, there's another layer. You're smarter. You learned something, but you are not done" he said.

"We're often not willing to say that we already know a lot. We need to get reliable information utilized now rather than waiting until we've got all the way to the core of the onion," said Martin. The public can't wait until we get to the core. We'll never be there."

"I think we need to make sure that what we do is relevant to stakeholders and not just those in Nebraska but across the Great Plains Region," said Martin. "We try to ensure that what we do matters to people."

### **The Need for Sociological Research**

Research is needed to find out what matters to producers and communities, Martin said – not just the hard sciences, but also the social sciences. We need to learn how producers think, what kind of information delivery they want, who they trust. "I think we need to do more, to really understand our stakeholders and clients," he added.

Past research shows that when people are not limited to how much water they can pump and they all raise the same crop in the same county, there will be a wide range in the amount of water applied, said Martin. It's the same weather, the same crop, the same county, the same soil, but there is a huge variation in how much water people apply, he said. Researchers are interested in the reasons for that, what tools producers are using for their decision-making and what barriers they wish to avoid. "I think we need to do more to understand these issues," he said. ●



*Derrel Martin*

# Improving Water Quality Starts with Conservation Techniques

By William Whited

While places like Nebraska maintain high quality standards for water used for drinking, agriculture and wildlife, changes in one water supply can also affect another supply, said Tom Franti, associate professor of biological systems engineering for the University of Nebraska-Lincoln Water Center.

Franti said the need to conserve limited freshwater supplies rises with the world's growing population. But, he said, crop chemicals like atrazine may make that task more difficult. Unlike municipal drinking water standards, the standards for agriculture water are less strict and pose a greater vulnerability for waste to leach into natural habitats. According to Franti, federal law regulates different standards for safe water depending on its use.

"You want to have water that's going to be healthy for everyone who consumes it," Franti said. "You can't just say, 'well, our drinking water is one thing and our ag water is another thing,' because ultimately they're part of one whole system," he said, adding that nature's water system is tightly connected, with storm water runoff often draining through agricultural lands to replenish the reservoirs used for drinking water.

Not only are people affected from the farm to the city, but wildlife too may suffer if contaminants are not kept under a certain maximum, he said.

"They (animals) don't have the ability to change their water quality like we do before we consume it," Franti said. "They are subject to whatever water that they receive through the ecosystem, and they have to live with that. So if that water is very poor quality, it can threaten their whole life cycle."

## Different Standards and Regulations for Different Uses

"Every industrial water treatment system has a permit that allows them to discharge water at a certain standard level," Franti said. "So if there's a contaminant in industrial water, they have to clean it up to a certain level." Unlike standards for municipal and industrial wastewater, agricultural runoff water remains unregulated at its source. "It's a non-point source, which means water in agriculture comes from all the fields, all the operations, streams, lakes and reservoirs," Franti said. "There are standards for the quality of that water when it's consumed, or where it's used. But where the water comes from there's no enforced standards," he said.

Federally mandated contamination levels, or the highest levels of lead, arsenic, mercury and hundreds of

other hazardous materials in treated water deemed safe for human consumption, vary by use and source, Franti said. Unlike high water standards for treated water in municipal supplies, rural areas have no quality guarantee if drawn directly from aquifers, and require extra environmental safeguarding to limit the spread of pollution, he said.

"One difference in rural areas is that homes that are on wells don't necessarily have water treatment. Most of them might have a water softener," he said. While treating rural water may improve the quality of life, sometimes natural contaminants like iron-rich soil and leaked oil can heavily pollute critical sources such as wells.

Many rural residents have wells that supply their water and Franti said the well's quality may determine whether residents can live on the land and support livestock and crops. "If they have high nitrates, they might have a distillation system to clean out some of that for personal use. But if they have poor water quality in their aquifer through their well, there's not a lot they can do about it, except go to a different source," he said.

"That's another reason we want to keep our agricultural water quality high, so that those groundwater systems don't get so contaminated that rural homeowners can no longer use that well water," Franti said. He said one key to combating water pollution is to use technology such as conservation buffers, which use a systematic arrangement of trees, shrubs and grasses that doubles as wildlife habitat.

## Preserving Water Quality, Investing in the Future

He said conservation buffers consist of planting vegetation along waterways, such as streams, to limit harmful materials from getting into the water.

Coupled with good farm management practices like limiting fertilizer and pesticide use, Franti said, these vegetation barriers can help preserve water quality downstream, and also the habitat for wildlife. But, he said, both urban and rural residents need to have a permanent commitment to good practices in preserving water quality for the future.

"Supporting things like bonding to pay for replacement of treatment plants in order to have high quality water will be important," Franti said. "There are potentially ways to look at some new solutions as well," he said, including UNL's continued water research using equipment like the rainwater runoff simulator machine. This scaled machine simulates rainstorms to measure how different kinds of vegetation filter water over long periods of time. Unlike real world rainfall, the machine allows control of the amount of water,





*Tom Franti*

In addition to cooperative work with Nebraska's Department of Environmental Quality, Franti said UNL will continue looking for grant support from federal agencies, such as the United States Department of Agriculture, for rural and agricultural research. He said supporting elements of water, agriculture and overall livelihood in places like Nebraska remain interconnected in many ways, economically, socially and academically.

"If you cut agricultural research dollars, we won't have a lot of the things available to do our research," Franti said. Water quality also determines the success of our neighbors, especially crop-producing states, he said.

"I'm involved with a regional project on water and water quality that includes Kansas, Missouri, Iowa, and Nebraska," Franti said. This research collaboration started in the early 2000s with watersheds and streams flowing from Nebraska into Kansas.

By partnering with neighboring states and environmental agencies, Franti said he hopes to continue the positive experience he's had working on water quality projects. With each project, people nationwide are better served.

"Nebraska has a very good reputation with other states as being very proactive doing education and watershed-based outreach," Franti said. "So we get a lot of positive feedback from our partners out there when we work with them." The goal, Franti said, is to put all communities on the same map with the attitude that water quality affects everyone's lives.

"You have to avoid this us-versus-them problem to talk about how we can make a solution happen," he said. ●

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soil and contaminants in testing the filtering effectiveness of experimental buffers.

According to Franti, water quality issues also affect urban areas. Pollutants such as car exhaust, leaked oil, tire rubber residue, lawn fertilizer and other materials wash into storm drains, then flow out to lakes and streams. This is because paved landscapes like streets and driveways don't filter or absorb water to improve its quality. Because of pavement, urban areas actually produce 4 to 5 times more runoff water per area than in rural regions.

With little soil to absorb water, urban areas also experience more flooding problems, Franti said.

### **Water Research and Consumption**

"Using less water means you have to treat less water, which saves money at the end," Franti said, adding that populations need extension outreach. Through outreach, Nebraskans and populations worldwide can change their water use habits to better prepare for increased future needs.

A growing trend to communicate outreach for farmers to use fewer chemicals involves incentive programs. The programs, provided by Nebraska Natural Resource Districts or federal agencies, such as the Department of Agriculture's Natural Resources Conservation Service, reward farmers with payments over time for practicing safer farming methods such as no-till farming, Franti said.

# Water Law Regulates Usage

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By Tim Duey

The University of Nebraska-Lincoln's David Aiken has been observing Nebraska water policy debates for over 30 years, witnessing a historic policy change in 2004.

"Things have quieted down a lot in terms of water law," Aiken said. "We passed legislation in 2004 which gives the state the authority to close areas of the state to new high-capacity wells, and that has gone a long ways in terms of keeping us from developing water problems in the future."

According to Aiken, Texas did not make the same prudent decisions that Nebraska did in 2004 and now Texas has lost over 2.5 million acres to groundwater depletion. Aiken believes that the 2004 law is progressive enough to overcome past shortcomings in Nebraska's water resources management. In the early 2000s, Kansas and Nebraska were locked in a contentious legal battle over the right to water from the Republican River. The case, *Kansas v. Nebraska*, was eventually settled out of court, but subsequent enforcement actions led to a ruling that Nebraska had used significantly more water in dry years than it was entitled to and would have to cut back.

Aiken said things are better today than they were 30 years ago. In his opinion, after a long period of inaction by

Nebraska's Natural Resource Districts, or NRDs, the state has finally gotten things right, and, if the state follows through with its plans to reduce the amount of water it uses from the Republican River to levels similar to those of the mid-90s, Nebraska should finally achieve water harmony with Kansas. As a result of the 2004 legislation, the state closed off the Republican River to new wells. Now, most of western Nebraska is also closed to new drilling, and Aiken says that has had a major impact in helping Nebraska better manage its water resources.

"The reason the legislature did that is that the legislature realized that groundwater feeds the streams," Aiken said. "and that if you pump enough of the groundwater out then the streams are going to dry up ... not many states do that, not many states say that you can't get a well because it could hurt the stream, and so it was a very progressive piece of legislation. I was astounded when the legislature passed it because it was such a good idea. It kind of blew me away."

But although Aiken thinks Nebraska's progressive water management legislation is a good idea, he also recognizes that not everyone is going to be affected positively by it. Instead of drilling new wells, people who want to start



farming in much of Nebraska will have to buy existing wells. This could negatively impact the rural economy, Aiken said, because when a farmer has a grown child who wants to begin farming, it's often a tradition for the parent to drill a new well or two for that new farmer to use. That's not going to be an option anymore in much of Nebraska.

Another part of the new legislation is that the NRDs will buy back wells from farmers so that the state can eventually reduce its overall water use in problem areas, such as the Platte and Republican basins. But grain prices and land prices both are very high right now, which makes the business of buying back wells that much more expensive. "This started out as a 20- or 30-year program, but if prices stay high it's going to be a 50-year program," Aiken said. "Because with prices this good, farmers say 'well, if you want me to quit irrigating, you're going to have to pay more.' And it's going to be a lot."

According to Aiken, the NRDs can impose a tax of up to \$10 per irrigated acre on Nebraska farm land to fund the well purchases. There is a legal challenge to the tax right now, so NRDs are either not collecting the money or not spending it at this point.

Aiken also believes it's time to start working more closely with Kansas to avoid paying penalties for overuse of water during dry years. ●

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*David Aiken*



# Nebraska's Water Resources, Management Offer Global Learning Opportunity

By Seanica Reineke

"Nebraska has a lot to offer in terms of not only our water resources, but also the variety of different things that you can see across the state in terms of institutions, laws, integrated management, crop production methods and irrigation methods," said Anthony Schutz, assistant professor in the University of Nebraska College of Law, "which is important in growing more food with less water."

Without water laws, there's no "particular right to use water, and because water's so necessary, you have to have protection of the rights you do have in order to fulfill your needs," said Schutz. Since Nebraska is a state that relies heavily on water for agricultural irrigation, Schutz said many Nebraska lawyers spend time dealing with water law, and it is something Nebraskans especially should care about. "Without water law, there's nothing that ensures the presence of that water. If you don't have that, then it's hard to care about much else," Schutz said.

Schutz said Nebraska's water situation is unique for a couple of reasons. One, it overlies the Ogallala Aquifer. People continually learn more about the aquifer, including management techniques related to both the groundwater and stream flow. He said the aquifer is a dynamic system that changes across the state. It is a porous structure with water flowing in and out naturally, Schutz said, adding that water also is withdrawn, primarily for agricultural irrigation, but also for other purposes.

"There are areas where we've used water in storage in the aquifer and haven't replaced it," Schutz said. "It's in the western regions of the state you can look at groundwater depletion maps, or things along those lines, that give an indication of how much the static water level has dropped over time. In other parts of the state, though, we've drastically increased the amount of water in storage." He said one area where aquifer water storage has increased is the groundwater mound under the Central Nebraska Public Power and Irrigation District's facility near Holdrege.

Nebraska is unique, too, because of the wide fluctuation in rainfall from the East to the West, according to Schutz. The eastern region gets around 30 inches of rainfall annually and the western region around 10 inches annually. Schutz said there's as much variability in rainfall across the state of Nebraska as there is from Omaha to Washington D.C. For these reasons, Schutz added, water law is necessary to protect the limited resource, foster investment and resolve conflicts.

## What is Water Law?

Water law is regulation by the local, state and federal governments and encompasses protection of water

quality, protection of water quantity and resolution of conflicts. Nebraska's first water law was adopted in the 1880s, and by 1894, the state adopted the Irrigation Act. At that time, Schutz said, there wasn't much groundwater use compared to the usage today. He also said it was harder to tell how much groundwater was available than it was to determine the amount of surface water available. It was important to learn how the resource behaved and how to manage it, Schutz said.

At that time, Nebraskans were just beginning to understand how that aquifer water was distributed, stored and moved underground. "The combination of a huge supply, as well as the uncertainty associated with how that supply behaved, led to significant delays in adopting water laws," Schutz said, "and ultimately led to the adoption of markedly different regimes for surface and groundwater."

## Local, State and Federal Laws

Local, state and federal government departments and divisions regulate various measures of water law. One main law today is the Clean Water Act, which establishes the structure for regulating discharges of pollutants into United States waters and regulates the quality of surface waters. The Department of Environmental Quality (DEQ), Department of Natural Resources (DNR) and Natural Resources Districts (NRD) – which are state agencies – all have particular measures to regulate. The DEQ enforces state and federal quality protection measures, dealing with both surface and groundwater. The DNR regulates surface water quantity and NRDs regulate groundwater quantity, to ensure an adequate supply of water is allocated among its users.

"Given the vast landscape that we're talking about, it makes sense that [water law] would involve governments," Schutz said, "and that local governments, like NRDs, deal with at least some of the issues associated with water use because, realistically speaking, that's one of the best ways to ensure accountability and actual effectiveness as opposed to just what's on paper. Nebraska's an example of that; it's an example that other states, or perhaps people in other countries, could learn from."

The primary role of water law is to assure that people will have water, making sure it's a reliable resource for everyone. For example, if a river has multiple appropriations, the law sets rules to resolve conflicts and makes sure people have a predictable supply of water in certain situations, called prior appropriation. "If they have that reliable source of water, then they're apt to make investments, for example, in developing agricultural lands," said Schutz.



## Water Law's Impact on Nebraska Agricultural Production

Near Nebraska's Blue River Basin and Platte River Basin, there are regulations specifying when fertilizers can be applied because of groundwater quality concerns. Schutz said agriculture generally has relatively few point sources of water pollution. Point sources, such as concentrated animal feeding operations, are required to have a permit, Schutz added, but crop production doesn't include point sources. He said non-point source pollution is the most difficult problem facing water quality today. Non-point source pollution is defined as pollution that comes from a variety of sources, both rural and urban, but may be as a result of runoff from agricultural lands, such as nitrogen and phosphorus.

"The Gulf hypoxic zone is primarily due to agricultural production in the United States," said Schutz. The hypoxic zone is an area along the coast of Louisiana and Texas in which water at the bottom of the Gulf of Mexico holds less than two parts per million of dissolved oxygen, which causes hypoxia. Hypoxia causes fish to leave the area, but also causes stress or death to organisms at the bottom of the Gulf that can't leave the zone.

That is why Schutz believes fertilizer and pesticide applications are going to come under closer scrutiny in the future. He said devising ways to deal with those problems will be difficult because of the large numbers of operators involved. "Permits and regulations are not easy, but they're at least feasible in many cases," Schutz said. "But when we have a million farmers in April applying fertilizer or in the fall applying fertilizer, that's a little different to watch and regulate."

Water scarcity is primarily a problem for agricultural production in Nebraska, Schutz said. In Nebraska, irrigation in the western part of the state is a competitive component of a scarce resource. With water law in regard to

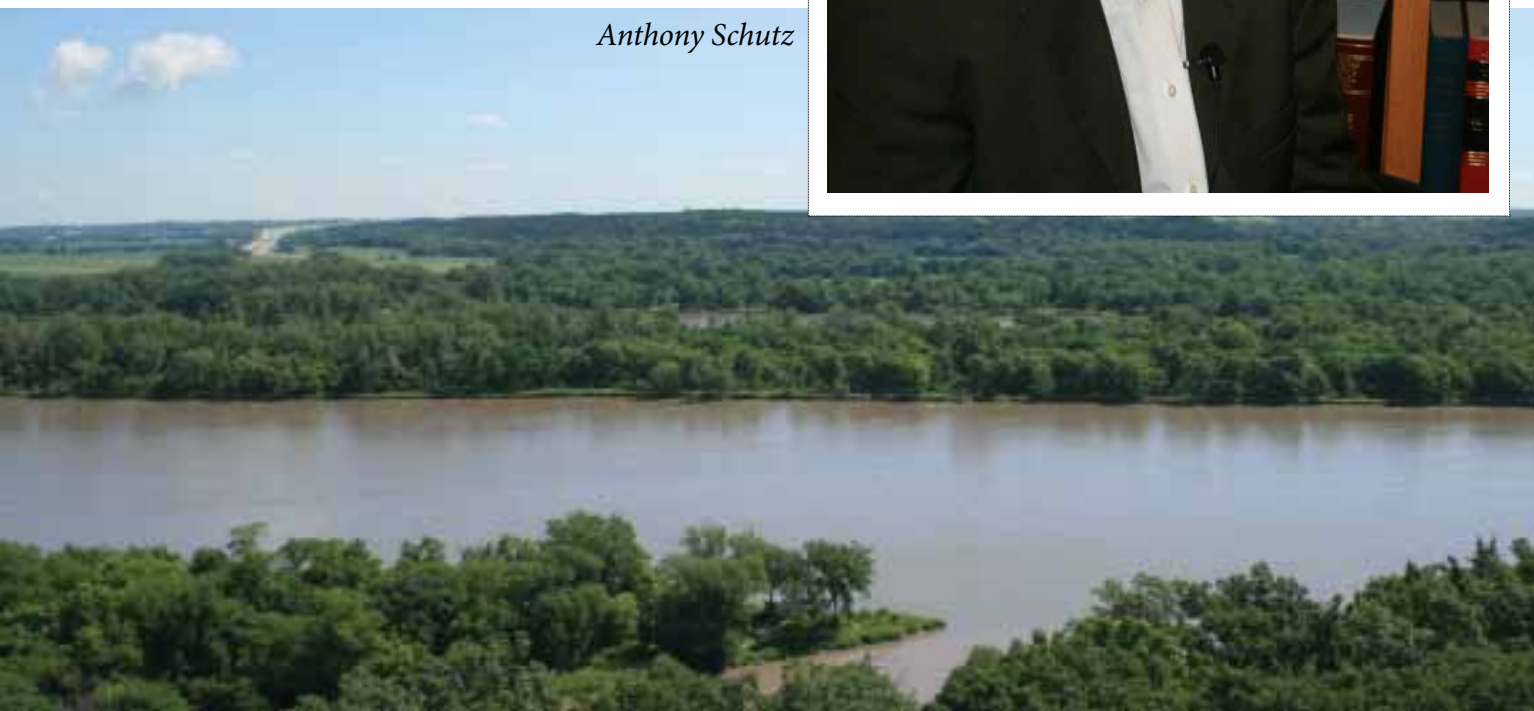
groundwater use, Schutz said, it allows people to use water as a supplemental irrigation supply in times when rainfall isn't enough. However, he said that could result in exhaustion of the resource if the supply doesn't meet the demand. Water law was developed to deal with these situations.

Water law imposes restrictions on people's use of water to help preserve and sustain the water supply over time. Also, the legislature provides funding for the DNR and even for university researchers, which develop information upon which decisions about restrictions, conservation and sustainability efforts can be made. Schutz said water law also creates reservoir systems—like those in the Republican River Basin—to integrate irrigation with flood management. Reservoirs hold back flood waters, releasing the water over time so huge flows don't destroy tens of thousands of acres of farmland or developed land. Schutz said these reservoirs also help ensure users receive an adequate water supply in dry times.

Schutz said water law has changed a lot within the last 130 years, but there's always more to learn and ways to adapt. "We have to be nimble, always operating in the present, learning from the past and thinking about the future. And because we will make mistakes, we have to make sure we don't make mistakes that can't be undone. But the hope is, over time, we'll get better." ●



*Anthony Schutz*



# Water Center Focuses on Water Quality, Sustainability

By Farooq Baloch and William Whited

The University of Nebraska-Lincoln Water Center is part of a national network of Water Resources Research Institutes that serve Nebraska, in addition to the rest of the U.S. Supported by local, state and federal funding, the Water Center implements and facilitates the land-grant mission of research, extension and teaching.

“We need to develop new, more efficient technologies for everything from irrigation to treating wastewater, to cleaning up contaminated water supplies,” said Bruce Dvorak, interim director of the Water Center.

Dvorak said researchers – assisted by the Water Center – can get people to adopt some of the new technologies or modify existing technologies so they will be adopted.

The Water Center focuses on facilitating necessary research and on aiding new scientists with funding and with help, as well as assisting undergraduate and graduate-level water science students.

Dvorak, who has a doctorate in environmental engineering and is a licensed professional engineer, is also a UNL professor who teaches students and supervises students in their research. He said one of the big challenges facing the world is that there are many technologies that work very well in the lab, but are challenging to put into practice.

This is typically where the Water Center’s outreach functions

come into play – getting the results of the research to water managers and to the public so they can use it. “Problem-solving is what we like to do,” he said.

Dvorak said it’s necessary to understand the science of water so people can set priorities about the use of water. To help people understand that science, the Water Center works with not only the general public, but also government agencies, non-governmental organizations, agricultural producers and other partners to educate people about water issues.

## The Role of the Water Center

The UNL Water Center was established by Congressional mandate in 1964 as one of 54 Water Resources Research Institutes at universities across the country and in U.S. territories. It operates as part of UNL’s Institute of Agriculture and Natural Resources, is a part of the UNL School of Natural Resources and is affiliated with the Robert B. Daugherty Water for Food Institute.

The UNL Water Sciences Laboratory is part of the Water Center, Dvorak said. “It aids the entry of new scientists into the water resource field, trains future water scientists and engineers and develops new methodologies for detecting contaminants in water,” he added.

The Water Center, according to Dvorak, has served as facilitator of interdisciplinary faculty discussions of water-



*Rachael Herpel, water specialist with the Water Center demonstrates groundwater flow at a “Sunday with a Scientist” at Morrill Hall, UNL. Courtesy UNL Water Center*



*Bruce Dvorak*



*Lorrie Benson*

related graduate and undergraduate curricula. It transfers the results of sponsored research to water managers and to the public through conferences, workshops, lectures, publications, news releases, the center's website and individual contacts.

"I anticipate the Water Center is going to continue to serve that state function of serving our clientele, providing science-based information and working with our faculty on a broad range of water issues," Dvorak said, "everything from ecosystems to municipal water systems, to wildlife issues, as well as agricultural water management."

Lorrie Benson, assistant director of the Water Center, said the Water Center is, in many ways, the entry point on water issues for the university. "We get lots of calls from the media, from water community members who are looking for research," she said.

Benson said they also receive calls from individuals. For example, she said, a landowner called her to obtain some information about drainage tiles on his farm. In another call, a Nebraska congressional representative needed information about irrigation in Saudi Arabia.

## Water Center and Partners

Dvorak said the Water Center works with a wide variety of local, state and federal agencies such as the U.S. Geological Survey, with which they co-sponsor conferences. He said they also work with the Nebraska Department of Natural Resources on educational sessions for staff around the state and around water modeling.

Other partners include school groups, where the Water Center assists in arranging the right extension educators and faculty to educate students about water issues.

"As far as drinking water goes, the Nebraska Department of Health and Human Services System, as well as the university, has an ongoing campaign to work with water utilities to help educate clientele so they understand what are the risks associated with their drinking water," Dvorak said.

The Nebraska Department of Environmental Quality regulates water quality and UNL Extension often partners with them in joint educational campaigns.

## Challenges and Concerns

Aging water pipelines and increasing levels of contaminants in groundwater are two of the major issues in Nebraska, according to Benson. Many small communities in Nebraska have aging pipes and plumbing, but don't have the financial resources to replace that infrastructure. However, tap water is extensively tested for contaminants and is less expensive than bottled water.

## Research and Technologies

The Water Center also collaborates with UNL faculty in water-related research, which has helped farmers move to more efficient irrigation techniques that save water and reduce inputs of fertilizers and pesticides and as a result, save dollars. Benson said many irrigators have moved to water-efficient irrigation systems. "There's some interesting research in the area, and UNL faculty has been involved with that," she said. "We've done things through education that help with initiatives like lowering the spray nozzles on the irrigation equipment so that they are closer to the ground – so less is lost to evaporation," she added.

Research and technology are important to solve water-related issues and save water but pricing water could be one solution.

Dvorak was a Fulbright scholar in the Czech Republic during the fall of 2010, researching the country's water system. The faculty of Czech University provided science-based guidance on water issues to industry, producers and regulators, which the water center facilitates in Nebraska. The Czech Republic formerly was a socialist country and under socialism, utilities could use piped and treated water for little or no cost and so had no incentive to conserve the resource.

"When they went over after socialism to charging market rates," he said, "the total amount of water taken from the environment was cut in half. So right off, just putting a market-based pricing on is one solution." ●







## Education

*UNL Professor Ellen Paparozzi instructs students in a greenhouse setting*

# Water for Food Institute a Global Leader in Water, Food Research

By Jaclyn Tan

The Robert B. Daugherty Water for Food Institute at the University of Nebraska is preparing to attract the world's brightest minds to Nebraska to meet the challenge of producing more food with less water, said University of Nebraska President James B. Milliken.

"We hope that by providing a focus in Nebraska," Milliken said, "by providing an institute that is addressing a problem that is faced all over the world, we will be a talent magnet here."

Milliken said by 2012, the university hopes to have hired an executive director and key people to lead the research, policy development and educational efforts, as is the mission of the institute. He said he also hopes to recruit people from various areas – agriculture, water, government and policy circles – to serve on advisory boards at NU to help shape the institute's agenda.

In early 2010, NU received \$50 million from the Robert B. Daugherty Charitable Foundation to provide seed money for a global water institute. Daugherty founded Valmont Industries in Omaha, one of the largest center pivot irrigation systems firms in the world.

"We were delighted to be able to name the institute for him," Milliken said. "I think it's a fitting tribute to a man whose life's work has been devoted to the agricultural use of water, and that's what the institute is dedicated to."

## Nebraska Makes Sense

Using water efficiently in agriculture is critical to feeding the world, Milliken said. By 2050, the population of the world will increase from about 6.5 billion to more than 9 billion, he said, requiring food production to double to meet this need. "That has to happen with the same amount of water or even less water," he said, "because as the population grows, urban centers require more water for sanitation, safe drinking, industrial uses."

So why put this global institute in Nebraska?

"There are a lot of reasons why Nebraska makes sense," Milliken said. Water is fundamentally important to agriculture, he said. Nebraska is the most irrigated state in the U.S. and also sits on top of the Ogallala Aquifer, the largest freshwater resource in North America. In addition, the institute will build on the strength of the UNL Water Center, which has been around for more than 60 years and involves about 100 faculty members from many parts of the university, Milliken said.

## Building Global Partnerships Toward Solutions

In the challenge to find solutions to water problems, the institute continues to build partnerships with institutions on a global level, Milliken said. "The potential partners for this work are spread across the world," he added. "Those

solutions may be different in Nebraska than they are in South Asia, for instance. But, we believe that there are commonalities, that there are some policy issues, that there are some basic research issues that are important to both [areas].”

In March 2011, he attended a conference in Chennai, India, which was hosted by a joint entity of the U.S. and Indian governments, the Indo-US Science and Technology Forum. In the several-day conference, faculty from the University of Nebraska, Michigan State University and Iowa State University, along with their counterparts in India, talked about common issues in agriculture use of water.

Milliken said that NU also has been working with the United Nations’ International Hydrological Program, which according to its website, is “an intergovernmental program devoted to water research, water resources management, and education and capacity building,” and Delft University in the Netherlands, which is a UNESCO-sponsored university and the largest university in the world dedicated to water research and education. “It’s the kind of institutional partnership that we’re looking for to help leverage our work,” Milliken said, “and I think they look at it the same way.”

### 2011 Water for Food Conference

Milliken said the 2011 Water for Food Conference in Nebraska, held in May 2011, brought to Lincoln global leaders in water research. More importantly, the conference spread the word about the institute. “We’ve had people from

China, India, Africa, Europe, South America, come to our conferences and we expect that to continue,” he said. “In fact, we expect interest to grow.”

### Opportunities for Nebraska

While the institute still needs to secure key leadership personnel, the University of Nebraska is building on its strengths in water research, Milliken said. “I think the impact of the work of our faculty is already being felt,” he said. “I met with some university officials in China recently who told me that the work of our faculty at the University of Nebraska has helped significantly expand the yield of corn there, with less water and less fertilizer.”

Because of NU’s strong background in water research and previous successes, Milliken is confident the university will obtain additional funding for the institute. “It’s generated a tremendous amount of excitement around the world,” he said, “and I think we’ll have no trouble attracting other resources to support the work.”

Through the global water conference, partnerships and private and public funding, Milliken said the institute will bring in global talent to Nebraska, which will benefit the state. “Talent doesn’t stop at the Nebraska boundaries,” Milliken said. “It doesn’t stop at the U.S. boundaries. It’s distributed around the world. And the more that we can do to attract that talent to Nebraska [and] to have our students and faculty collaborate with people elsewhere— [that] will really leverage what we have in Nebraska.” ●

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# IANR Progress in Science, Technology Moves U.S. Forward

By Farooq Baloch

One of the most critical issues facing America is to regain its dominance in the world of science and technology, a position it has been losing, according to *Rising Above the Gathering Storm*, a 2005 report by the National Academies. In its report, the Academies – an organization of science and technology experts who advise government and public on critical national issues – cautioned that America was losing the edge in science and technology. A follow-up report in 2010 reported that the situation had become worse – that addressing the competitiveness challenge could take years.

However, the University of Nebraska-Lincoln Institute of Agriculture and Natural Resources (IANR) has already made notable progress in the areas of science and technology. “Our scientists are among the top quoted scientists in the world in the field of agriculture,” said Ronnie Green, NU vice president and Harlan UNL vice chancellor for the Institute of Agriculture and Natural Resources. He added that Nebraska is well-positioned to be a world leader in the areas of science, technology, engineering and mathematics, known as STEM areas.

Green said due to the importance of its agriculture, its food system and its natural resources, Nebraska is capable of dealing with scientific challenges such as producing enough food for the world long-term and sustaining natural resources, as well as the energy required to produce that food. He said agriculture and natural resources, which are the fields in which many IANR scientists are researching, are heavily based in biology, biochemistry, chemistry and engineering while mathematics and statistics also are involved in these STEM fields. The IANR also is forming a more cohesive life science curriculum to ensure that students acquire greater skills and understand how science will be applied and used around the world for innovations.

According to a study performed by Battelle, an independent research and development organization, the IANR was returning \$15 on every state tax dollar invested with IANR. Green expects that return on investment will increase by 20 to 30 percent in the next five years because of the importance of the STEM areas and the research conducted in these areas.







Green, who joined the university in 2010 as vice chancellor, earned his Ph.D. in animal science from UNL. He described his return to the university as a great opportunity and a great challenge — in terms of world food security, in terms of world energy security and natural resource sustainability.

### Nebraska's Progress

One of the conclusions of Rising Above the Gathering Storm was that America needed to invest more heavily in educators in STEM areas. Green said the U.S. needed to have more science, mathematics and technology areas in the secondary school system and invest heavily in education in those areas.

"I do think we have made some progress during the last five or six years in emphasizing the STEM areas, in particular," he said.

Green said the statewide 4-H curriculum has moved to a STEM emphasis, and has been a national leader in creating a robotics program in which young people build and program robots as a way of learning about science, engineering and technology. Additionally, he said, the IANR faculty is working in Lincoln schools and has achieved some early success in a variety of areas. Faculty from entomology and crop science teach fourth-graders in the Lincoln Public Schools about growing soybean plants. Green explained that students get to touch, feel, see and understand that there's science involved in that, and that science is translated into a food product. The students are then able to connect that process to something that's in their daily lives. "So I think we have made progress," he said.

Progress has been made, too, in student enrollment. The CASNR had a seven percent growth in the number of students last year, making for seven consecutive years of growth, and a near all-time high enrollment in the college over the entire history of the university.

Green said the institute has added new major areas of study, but there has been huge growth in existing majors, such as natural resources, citing fisheries and wildlife as an area that has rapidly expanded. He said the animal science program has also expanded and experienced increased enrollment during the last several years.

### Goal: to be the Top Ag Institute in the World

Green said the IANR was selected to be the site of the first Fulbright symposium on food and agriculture in 2010. He added that the University of Nebraska was chosen as the site because of its history of attracting science students from all over the world.

In another example, Green said he recently led an IANR delegation to UNESCO-IHE, an international center on water education in Delft, Netherlands. The IANR and UNESCO-IHE will form a partnership in which they will jointly have graduate students from all over the world. Green said participating students would spend a year in Nebraska and be part of the university's global program.

Green said it is the quality of the IANR faculty's understanding of the issues around the world which helps them to be able to export knowledge around the world. At a recent trip to India for a workshop with the Indo-US Science and Technology Forum, there were discussions about how their joint technical expertise can help Indians with agricultural water use.

Green said he believes IANR is one of the strongest research institutions in the country, particularly in agriculture, and added the goal of IANR is to be considered the top agriculture institute in the world.

Green said he sees opportunities for America to be the innovation engine of the world in terms of exporting technological knowledge to other regions of the world. Nebraska has expertise and resources, Green said, and added there are applications for UNL research to regions all over the world. ●

# Addressing the Need: Planning the Future of Science Research

By Jaclyn Tan

Even as the population of the world increases, globalization has made the world a smaller place.

“You know, it’s fascinating to me when I look at the exports and I think about where so many of our commodities from Nebraska go to,” said Susan Fritz, Associate Vice Chancellor in the Institute of Agriculture and Natural Resources (IANR). “Many of them go outside of the country. And they end up in places that are heavily dependent on those exports, so that there are food choices and there’s actually food to feed people. And if that isn’t interconnectedness, I don’t know what is.”

But while the Earth is not growing in size, research shows that the global population will increase from 6.5 billion people now to more than 9 billion by 2050. And in order to feed those people, global food production must double between now and then.

## Planning to Meet the Global Food Need

In Nebraska, where one-third of the jobs are tied to agriculture or agribusiness, the University of Nebraska-Lincoln Institute of Agriculture and Natural Resources has set tangible goals to meet this global food need in its vision statement, “Innovating Agriculture and Natural Resources to 2025,” which was unveiled in January 2011.

Fritz said the vision is just a “new way of framing” the research. “The reality is that we’ve been on this trajectory for a number of years,” Fritz said.

The vision statement, as presented by NU Vice President and IANR Harlan Vice Chancellor Ronnie Green, highlights Nebraska as an “epicenter for global food production” because of its rich natural resources and strong economy. Fritz said the vision statement sets forth concrete and measurable goals for advancing the IANR research being conducted at the University of Nebraska-Lincoln. For example, one goal for the IANR is to increase production efficiency of Nebraska agriculture by 25 percent by 2025. Another goal is to decrease the median age of rural Nebraska residents by 2.5 percent.

Ultimately, the IANR can demonstrate how it is meeting these goals by increasing the IANR’s return on the state taxpayer’s dollar, which Fritz said is currently a return of \$15 for every dollar invested in the institution.

“I don’t think there’s one of us who wouldn’t like to get a return like that,” she said. “And my goal is that some day that return will be even higher.”



*Susan Fritz*

## Meeting the Goals Through Science and Management

To meet the 2025 vision, Fritz said the IANR can employ two kinds of strategies: one related to scientific research and one related to management aspects.

An example of a science-related strategy is Innovation Campus, Fritz said, which is being built just north of the University of Nebraska-Lincoln and will become a private and public sustainable research campus.

Innovation Campus gives UNL the opportunity to center research around agriculture and natural resources, Fritz said. One way to advance science on campus is to transfer the science out of the lab and into businesses, she said, thereby strengthening Nebraska’s economy. Attracting top researchers to Innovation Campus will create jobs in Nebraska and strengthen not only the state’s economy, but also the regional and national economy, she added.

On the other hand, Fritz said, an example of a managerial, or operational strategy, is one that calls for figuring out more efficient ways of gathering not just the university’s existing research talent, but also outside research talent, so that these scientists can work to solve problems.

“And so that means, in some cases, we need to figure out how we can leverage the talent in life sciences across this campus – and maybe other campuses in the university system and beyond – so that we can start to look at solutions that are so complex that they are beyond the time and the talent of any one scientist,” she said. “But if we brought the talents and the disciplines together on a problem, we might achieve the solution in a much quicker manner.”

## Combining the Strategies to Ensure Sustainability

The combination of technology and management strategies is also crucial in finding solutions to sustainable agriculture and increased food production, Fritz said.

“The challenge 20 or 30 years ago was to feed a hungry world, and to take agriculture production to the next level,” she said. “Now today, as we look at feeding a hungry world, we think of maybe a broader set of solutions.”

For example, Fritz said, scientists today study how water can effectively be used to maximize crop yield. “Thirty years ago, it may have been more about controlling man’s environment,” Fritz said, “and today it’s about sustaining that environment and exploiting it a bit to feed the world, but at the same time looking at leaving the world in a condition to continue to feed the world.”

## Working for Nebraska

As a Nebraskan who grew up on a farm, and, up until

recently, lived on one, Fritz is proud to be a part of the team that will take the state and the university to newer heights. She remembers how the research at UNL affected her father, who was a farmer.

“Many of the choices he made that ultimately led to his operation being more successful, had to do with the information that was provided by the University,” she said. That’s a part of the mission of UNL as a land grant university: to do research that will better the industry, to educate the next generation of researchers, and to ensure that this research gets out to the producers and consumers who need it. And Fritz said she is excited about her role in this “transformational time.”

“I’m just very honored to be here to do the kinds of things that I do,” Fritz said, “that hopefully some day, either in the short- or the long-term, make a difference in people’s lives.” ●

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# Ag Science = Exciting Opportunities

By Seanica Reineke

By 2050, it is projected that more than 9 billion people will inhabit the planet, according to the University of Nebraska-Lincoln's College of Agricultural Sciences and Natural Resources (CASNR) Dean Steven Waller, who said the job of feeding those 9 billion will be on the shoulders of the global community.

Right now, nearly 6.9 billion people live on Earth. In order to feed an extra 2 billion people, Waller said "we will have to become more efficient and more productive in what we do," which will mean looking to the STEM disciplines – Science, Technology, Engineering and Mathematics.

Waller said an appreciation of science is needed to encourage Americans to seek careers in the STEM areas, and that begins with the youth. "The young scientists that are going to feed the world are here already, if you think about them being 1, 2, 3 or 4 years old," said Waller. "We just need to be sure that all of those students that have an interest...have every opportunity to be exposed to science, to get excited about science and to learn from scientists."

Getting young people interested in science is a lifelong process that begins with passion: passion for science and passion for asking questions. That is what Waller wants from CASNR faculty, and he hopes to see that in all elementary and secondary educators, as well as in parents. He believes asking questions and learning about science can be a joint learning venture. Waller said it's important for parents and children to ask questions together – and find answers.

## Programs Engaging Students and Teachers

The CASNR faculty works with fourth graders in Lincoln Public Schools (LPS) by embedding the science curriculum into everyday school activities and blending it with the schools' standards. Waller said it is both exciting and a bit challenging to provide a curriculum that fulfills the expectations of the school system and, at the same time, exposes young people to science as it relates to agriculture and natural resources. In LPS math classes, elementary students are using agricultural examples, such as converting square feet into acres. Waller said the students begin to connect what they learn in the classroom to what they see in the world. Even more exciting to Waller is the fact that they can relate their school lessons to the food they eat.

Students are not the only ones learning from using

agriculture in the classroom. Teachers are, too. Waller said as time goes by, it becomes less likely that educators have been on a farm or really understand agriculture, which is why UNL has a program called NU-Teach. One of the only collaborations of its kind, NU-Teach is a partnership between the UNL Colleges of Arts and Sciences, Education and Human Sciences and CASNR. It was created by UNL faculty and administrators with the goal of developing a stronger academic program to prepare future teachers.

"We need role models in the STEM fields," Waller said. "We've got to be able to convince students of any background, of any gender, of any cultural upbringing that they can be scientists."

## Paying it Forward

Part of CASNR's agenda is to provide an agricultural education to a variety of students who may not have been exposed to agriculture otherwise.

"My goal is to get the right faculty in place, and get out of their way, and let them do what they need to do," Waller said. "If we've matched them with students that have a passion and an interest and a capacity to do great things, then our role...in the college administration is just to make sure that there are no obstacles for them to be successful."

One way CASNR is providing this education to a diverse group of students is through the Engler Agribusiness

Entrepreneurship program, which includes student scholarships, support for classes, lectures, entrepreneurship training, internship placement and student travel. CASNR received this \$20 million donation from Paul Engler, a native Nebraskan and NU alum, in March of 2010. The donation is the largest monetary gift the college has ever received.

Waller said the Engler program models the college's philosophy about lifelong learning, going from childhood to adulthood. More importantly, he said, it has elevated the conversation around agriculture in Nebraska because people viewed that as a significant benchmark of excellence.

After six consecutive years of growth, Waller said parents and students see CASNR as a destination, not an alternative. The college saw an increase of 7.1 percent in enrollment during the fall, 2010 semester, making total college enrollment 1,882 students. That is an all-time high for CASNR, and Waller said it's a "validation of the importance of what we do," but also a reflection of the diversification that has taken place.







*Steven Waller*

Eighty-eight percent of students enrolled in CASNR come from Nebraska, and Waller relates that to stakeholders around the state being optimistic and talking about their excitement for the college and agriculture's future. The college offers a range of degree programs, both traditional and non-traditional. Waller said a lot of the growth has been in non-traditional areas, such as golf management, but traditional degree programs, such as animal science, have grown, too.

Waller said students have a responsibility to give back to the community once they graduate. In his eyes, that is when true growth of the college happens because it magnifies the college multiple times over. "I want to be seen as a college that cares for its students, one student at a time, that every student has value, to make sure that every student has achieved hopefully more than they thought they could have when they came; that they contribute over time; that they're part of the ongoing conversation about their future and their children's future; that they're engaged citizens; and that they have a sense of service," he said.

### **Broadening the University's Reach**

Some of the most fascinating things happening in the United States and the world, according to Waller, have grown out of agriculture. One example is Global Positioning System (GPS). Even advances in genetics have grown out of agriculture, he said. Now is the time when everything is lining up for great advancements in agriculture, according to Waller, who said CASNR is positioned to be part of those advances.

UNL as a whole is prepared for those advances, too. As UNL joins the Big Ten, it will become part of a conference

with 12 universities, eight of those being land-grant universities – which are institutions designated by their state legislatures to receive benefits of the 1862 and 1890 Morrill Acts. Those acts were provided for people in the working class to learn about agriculture, among other subjects, and gain an education they could use. According to Waller, the Big Ten is a core of universities in the United States that effectively define the agricultural research, education and extension programs nationally, and Nebraska now will be part of it.

### **Opportunities**

In Waller's opinion, the future of science and agriculture is one of rapid change embedded in science that will make educational institutions, especially universities, focus on preparing students for work in a continuously changing environment. He said there will be new discoveries that no one can anticipate right now, so students need to learn how to think, solve problems, interact with others and serve others.

These changes will come at a fast pace, which will influence advances in science and agriculture that will create solutions for feeding the world. Waller said these advances will be accomplished by people from all areas and different approaches, including those from humanities, arts, sciences, business and agriculture.

Currently, other parts of the world have more sustainable agriculture because they have found practices over thousands of years that make them sustainable, but on a small scale. Waller calls it "subsistence farming to provide food and fiber for a family, not hundreds of people or more." Nutrient value, nutrient efficiency of plants, water use and water efficiency are all important factors when looking at the responsibility of feeding 2 billion more people in the coming years, according to Waller. This is a global challenge, and he said it will not be solved by growing more in the United States, but by finding a "global solution to a global problem."

What can influence this change? Waller believes behavioral changes will have to occur in regard to the way people view their food, what they eat and what their children will eat, and it is going to take time. "Agriculture has to be more of an area of excitement than one that people assume is at the grocery store," said Waller. This will happen through conversations. "Strategic discussions are critical, not only for those of us that are trying to provide opportunities for our students, but it's equally important for our students to have their own conversations about what they envision the future to be." ●

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# Planning For the Future: A Look at the Evolving Scientific Workforce

By Patrick Radigan

One weekend a year, the Strategic Air and Space Museum near Ashland, Neb., comes alive with the passion and excitement of competition and fun.

This year, 59 teams from Nebraska and Iowa traveled to the museum to take part in the Nebraska Robotics Expo 2011, an event where youth create and operate Lego™ robots to navigate a course while earning points in the process.

Although only 18 teams walked away with awards, one University of Nebraska-Lincoln administrator said events like the Robotics Expo benefit all parties involved.

“We use robotics as a tool and as a curriculum to help young people get excited and have enthusiasm about studying science and studying math,” said Beth Birnstihl, associate dean of UNL Extension. “Maybe they could even explore a potential career in science.”

With the growing need for scientists in the state of Nebraska and nationwide, Birnstihl said the development of youth over the next five to 10 years could be paramount to how society is able to handle global issues. According to Birnstihl, the solution to issues like water conservation and finding renewable fuels start with inspiring youth to explore the science world.

“If you think about today, you’ve got an iPad, an iPhone, you can Tweet, you’ve got Facebook, there are lots of opportunities to explore,” Birnstihl said. “What we want them to explore are those fields around science, so that in the long run they can use that information to decide what they want to be as an adult.”

## Help Wanted: Science, Technology, Engineering and Math (STEM)

Amid all the issues facing the scientific community over the next 10 years, Birnstihl said perhaps the most important issue is the depletion of the scientific job force.

“Nebraska doesn’t have enough individuals in our work base to fill the scientific need we have, nor does the United States,” Birnstihl said. “We have to step up to the plate as a country and as a state so that we can maintain our job force and supply the businesses in the communities with workers.”

One way the university is trying to address this issue is by getting youth involved in specific scientific fields through 4-H and other UNL sponsored camps and conferences, Birnstihl said.

Through these hands-on learning programs, young people in Nebraska and surrounding states have a chance to be involved with something that gives them the belief they can be successful in a Science, Technology, Engineering, or Math (STEM) field.

*Beth Birnstihl*

“We have to help young people be confident and say ‘yes, I can do this,’ and that ‘there is a job for me that is exciting,’” Birnstihl said.

“We don’t know what jobs are going to be created in the next five years, we don’t even know what jobs are going to be created in the next two or three,” she said, “but we are confident that technology and all the basics around STEM are going to be key for those jobs.”



## Solving Tomorrow's Problems Through Science

In addition to efforts being made with local youth, other efforts focus on getting college students to work in science-related fields once they graduate. With the rising demand for workers in STEM fields, UNL Associate Professor of Chemistry Mark Griep said the ability of students to step into the workforce will be critical to the sustainability of both Nebraska and the country as a whole. According to Griep, who also serves as the vice chair of the chemistry department, there are serious implications associated with maintaining an advanced, scientific workforce.

"I truly do believe that we need to focus on the STEM disciplines," he said, "so that we can make those discoveries and we translate them into products and economic benefits. We can't just exist in a culture of celebrity and phone apps. It's not enough."

More specifically, Griep said the ability to fill the needs of future STEM fields will be important in handling local environmental and sustainability issues, such as energy production and water conservation. Looking at the current market for scientific discovery and advancement, Griep said the ability of college students to move into STEM fields in the next few years will be important in being able to handle pressing scientific issues and problems.

With the rapid growth and development of populations all over the world, Griep said meeting the needs of the scientific workforce goes hand-in-hand with addressing issues related to the future of modern society.

"We live in cities and they do create waste, so what do we do with that waste? Nobody really thought that through," Griep said. "We've never been this dense before. These issues are only coming up because we are maturing as a culture."

To address sustainability, Griep said it's important to have a workforce devoted to understanding and discussing the situation, rather than relying on the activism of everyday citizens. For Griep, sustainability isn't just about large scale reforms and policy, it's about people understanding the best way to be productive members of an environmentally efficient society.

"The sustainable discussion is actually fairly new," he said, "Certainly people have been talking about it for a while, but I think in terms of citizens thinking about it they aren't anywhere near thinking about sustainability. That's a whole other way of thinking."

## Changing Today to Prepare for Tomorrow

In addition to trying to predict and adapt to future issues, Birnstihl also said work being done in STEM areas today could have a significant impact on the future.

National campaigns like Time Warner Cable's "Connect a Million Minds," an effort to get more youth involved in science and math, and other similar projects have the

potential to start a movement within the today's younger populations, Birnstihl said.

"We have to work together. 4-H can't do it alone, Time Warner can't do it alone," she said. "When we work together and emphasize the same key points, then the young people begin to hear it over and over."

Through these coalitions and educational programs, Birnstihl said it could be possible to help students learn tools and methods that they can then share with family and friends in their own community.

"As young people return to the farm, and return to the ranch after college, they're going to bring some of those tools with them," she said. "We never stand still, we keep moving forward in terms of the tools we use."



Mark Griep

## Taking a Universal Approach

According to Griep, both STEM and unrelated fields can benefit from having workers with scientific knowledge. With the complex workings of farms, factories and other processing facilities, there are a number of people involved in the workforce that aren't in science-specific jobs.

However, Griep said, that doesn't mean they can't benefit from having knowledge of what they are dealing with in their background.

"I think that the more people know, the better – I do believe that," Griep said. "If someone is an accountant, I do believe it helps them to know some of the

chemistry that goes on in a corn ethanol plant.

"The accountant is responsible (for) tracking whether things are done correctly and the money is spent correctly. How can they do that if they really don't know what the chemicals are?"

Another reason Griep said it is important for all students to have scientific knowledge is because it helps encourage involvement, especially on Nebraska-related issues. Griep said he has found that students tend to have a greater willingness to learn the theories and ideas they are discussing in class when there is a practical, local example to discuss. Especially on issues like high arsenic in water, which is a natural occurring pollutant that affects a number of Nebraska communities, Griep said personal involvement creates a more passionate interest in the students in his class.

"I think it truly personalizes the chemistry for the students," he said. "They do have to think, 'how does this affect me?' In a classroom of, say, 180 students, I've always found one of the students is usually from one of the communities that has these high arsenic levels and they can actually testify what did their community do, so that really does make it real." ●

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# Educating Future Science Communicators

By Gabriel Medina

Curiosity is one of the intrinsic characteristics of children, but before they become adults a considerable amount of them lose their sense of wonder and their interest in studying or learning more about science.

Nebraska's children are also less interested in science today than in the past, but it is important for society to educate more scientists as well as science communicators, according to Mark Balschweid, head of the Department of Agricultural Leadership, Education, and Communication (ALEC) at the University of Nebraska-Lincoln.

"If you look at data on elementary students, there's a certain natural curiosity in them...a natural fascination with science and the wonders of science," he said. And then we get to a point where it becomes not nearly as interesting, not nearly as exciting, he added. "There's a great cooling-off period that's being documented. And if you look at the forefront of where research and science education is, it's really about inquiry-based learning and that inquiry-based learning says let's return to that period of wonder in young people and let's let them follow their natural curiosities." Balschweid explained that due to children's loss of interest, it becomes a difficult task to convince them to study science as a major in college.

"One of the primary missions that we have as educators," Balschweid said, "is to make sure that we have an informed citizenry for generations to come. And in order to be an informed individual, that means that they must be able to have access to clear, understandable facts, a truth if you will, about the science that affects their lives on a daily basis." According to Balschweid, Nebraskans should have basic scientific information. If they are informed, they can make better decisions related to where their food comes from and how to manage use of water and energy.

## The Importance of Small Communities

Balschweid pointed out that Nebraska is mostly comprised of small communities, not of big cities, and these communities need specific kinds of well-trained leaders. "I remind people that this great nation that we live in," said Balschweid, "this great state that we are a part of, is really made up of small communities. Those small communities really weave together to form the fabric of who we are. If we

don't have strong, vibrant small communities, then Nebraska suffers as a whole. There are hundreds of small communities that need community leaders, they need people that have vision, they need people who can communicate and who are committed to education of the children in their schools." Balschweid also explained that one of his main goals is to educate young people in agriculture and industrial technology with the hope that they will stay in those communities, or at least in Nebraska.

Nebraska's demographics have dramatically changed over

the years, so the ALEC department is doing research in cross-cultural leadership and cross-cultural communications. The goal is for small communities to have capable leaders who are able to communicate with people from different backgrounds.

Even though the university has tremendous programs in science and outstanding programs in communications, he said, education in communicating science is needed. "We hope to be able to provide some information and some other programming essential for that," he said.

"I think the most difficult challenges for communicating science in the 21st century are that science has exploded in terms of the technology, discovery and application," he said. "It's

*Mark Balschweid*

really easy to get overwhelmed by the tide of information. So the challenge is how we take that information that can be very complex and present it in such a way that is more easily understood. And so it's my belief that we will always need people who specialize in science communication specifically," he added.

"I think it's really important that we teach science in a context people understand," he said. "That we teach science not in a sterile lab-based setting, where we have canned experiments, but we utilize the context that they can understand. Certainly for a state like Nebraska that is so heavily dependent on agriculture, we can teach science in the context of animal and food production, so students can relate."

UNL's Department of Agricultural Leadership, Education, and Communication receives funds from federal agencies like the U.S. Department of Agriculture and U.S. Department of Education, as well as state funds in the form of grant dollars. ●

*For more information visit [www.unl.edu/sdn/opportunities](http://www.unl.edu/sdn/opportunities)*





# Donor Funding Makes Projects Come to Life

For Ann Bruntz, a director of development at the University of Nebraska Foundation, the phrase “there is no place like Nebraska” is not just the first line in Nebraska’s fight song. It’s her reality, every day.

For one thing, in her job as an NU Foundation liaison between the University’s Institute of Agriculture and Natural Resources (IANR) and people who want to contribute to IANR’s and Nebraska’s work and future, she travels the state a great deal.

“We’re 500 miles wide,” she said, a state with great agricultural, topographic and environmental diversity. Four major ecoregions exist in Nebraska, and those diverse four are similar to many areas across North America and in many developed and developing countries worldwide.

“Production agriculture is number one in Nebraska,” Bruntz said, and agriculture is her passion. She and her husband are farmers and cattle feeders and part of one of Nebraska’s small-town communities.

Food, energy, water and other natural resources, and people are IANR’s focus, and those are key to both present and future, Bruntz noted.

“There’s going to be, by 2050, 9 billion people on this planet, and they need to eat,” she said; IANR’s research, teaching and extension education help Nebraskans and the world move forward to help feed this growing population.

The Robert B. Daugherty Water for Food Institute, founded with a \$50 million gift from the Robert B. Daugherty Charitable Foundation, is committed to helping the world use its limited freshwater resources efficiently, and focuses on ensuring the world’s food supply for current and future generations. That’s a great example of how donors’ thoughtful and generous contributions make a difference for Nebraska and the world, Bruntz said.

Another is a \$20 million gift from the Paul F. and Virginia J. Engler Foundation to establish a permanently endowed fund to support the Paul F. Engler Agribusiness Entrepreneurship Program.

“When Paul set up this gift, his passion was to light a fire in the belly of students for entrepreneurship, and especially agribusiness entrepreneurship,” Bruntz said.

Engler, who grew up in Nebraska and now lives in Texas, also cited his concern for the health of Nebraska’s rural



*Ann Bruntz*

communities, a concern shared by IANR and many Nebraskans.

Funding makes projects come to life whether it’s funding from a number of \$25 gifts or those that are larger, Bruntz said.

“When it comes from the heart,” she said, “it’s important.”

Bruntz said her passion for fundraising comes from her love of Nebraska, and she sees a passion to give back, to pay it forward, in every contributor.

In this part of the country’s heartland, she said, it’s the people she works with who supply the heart.

“I’ve worked at the University of Nebraska Foundation for six years,” Bruntz said. “The motivation to get up and drive and do what I do is the joy and the passion I see from the alumni and the constituents.” ●

*This story is based on an interview conducted with Ann Bruntz by William Whited*

**Funding makes projects come to life whether it’s funding from a number of \$25 gifts or those that are larger.**





# STRATEGIC DISCUSSIONS FOR **nebraska**

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