

Plant Sciences Institute UPDATE

Integrating food, feed and fuels



Senior Associate Dean Joe Colletti and Wendy Wintersteen, dean of the College of Agriculture and Life Sciences, champions of the New Century Farm.

Iowa State University's New Century Farm is no longer just an idea on paper. At this writing, ground has been broken, earth moved and footings placed.

Bioenergy candidate crops are in the ground already on this 1,000-acre farm due west of Ames, and research on biomass harvesting, transportation, storage and processing can begin in 2009 with the completion of the first buildings. These include the "hanger," where harvesting equipment can be put through its paces year-round, and a 23,000-square-foot bioprocessing facility.

Informally called "the kitchen," the bioprocessing facility will accommodate scalable pilot-plant trains of biochemical and thermochemical conversion technologies for making biofuels and industrial chemicals. In addition, scientifically workable amounts of commercially important value-added, non-petroleum-based compounds and biobased products will be captured throughout these processes, so their market potential can be evaluated.

This is not the same old snapshot of bio-fuel breadth—corn to motor fuel. "Here we

A passion for practical perennials

Emily Heaton may best be known for holding the measuring stick in the popular photo of giant *Miscanthus*. But she is also a key addition to Iowa State University's efforts to build the new practical farm.

Following two years with the young energy crop seed company Ceres, Inc., in Thousand Oaks, California, Heaton, now an assistant professor in the Department of Agronomy, will be working to answer the tough questions about how energy crops should be implemented on the landscape.

"Companies are looking to the land-grant institutions for guiding principles of energy crop production that can only come from large-scale and long-term environmental research about the issues surrounding water, carbon, soil and species invasibility," says Heaton. "The industry knows perennials can be good from the water and carbon standpoint, but documenting this is beyond their scope right now."

Understanding the agronomic and environmental impact of new energy crops and their place in the landscape, as well as supporting marker-assisted breeding of energy crops, will be key components to Heaton's research. "I believe farms will be more intensively managed in the future, because to meet food and fuel demands, we'll have

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Growing up

It's not easy growing up. That's as true for plants as it is for animals. Passing through the transitions in life is as important for plants as it is for humans.

You may have taken life transitions in plants for granted. When you drive by a cornfield in late summer, you can often see tassels beginning to emerge—all in unison. It can be quite a sight, because they can emerge by the millions in a single field. What is happening is that the plants are all undergoing a life transition—from the adult vegetative phase to the reproductive phase of growth.

Corn plants undergo another transition that is less noticeable—from juvenile to adult vegetative phase—much like the transition from teenager to adult in humans. These transitions are critical to plant development and crop production because they are responsible for many of the architectural features of plants and their timing is important for the adaptation of crop plants to seasonal cycles.

What is fascinating about these transitions is that they are controlled by small RNAs. Small RNAs are little pieces of RNA (the copies of DNA) that don't code for proteins, but regulate the expression of other genes. Scott Poethig at the University of Pennsylvania recently discovered that the juvenile to adult transition in corn is controlled by two small RNAs or "micro RNAs." These micro RNAs act like gatekeepers to prevent the juvenile to adult transition. But when they decline in abundance, the transition occurs.

All of this serves to remind us of the importance of basic science in revealing to us the mechanisms behind the seemingly simple, but most important things in life—like growing up.



Stephen Howell
Director



Integrating food, feed and fuels/CONTINUED

will further the science of biofuels and contribute to the economic development of Iowa," says Lawrence Johnson, director of the Center for Crops Utilization Research (CCUR) and professor in the Department of Food Science and Human Nutrition. "This facility represents a change in mindset," where all eyes are upon sustainability. "Petroleum will never be sustainable, but biofuels have the potential, if we do it the right way."

The farm will accommodate academic research projects and corporate ventures, addressing food and fuel strategies through integrating production with processing and utilization. Johnson's CCUR staff is working to design a plant management system and securing equipment to create a flexible and user-friendly facility that provides for propri-

etary projects, joint partnerships with Iowa State faculty, start-ups and typical grant contract work.

Here plant sciences and industrial use interface. The New Century Farm is where "basic science linked to use-inspired discovery can flourish," says Joe Colletti, senior associate dean for the College of Agriculture and Life Sciences.

Sustainability for profit demands a broad suite of crops creating opportunities for plant scientists to identify new varieties suitable for optimal lignocellulosic ethanol conversion and full-season cropping systems.

A lot of universities focus on discovery. But "ISU is also applying the land-grant principles very well," says Johnson, "by providing the means to take discoveries down the long path to commercialization."

A passion for practical perennials/CONTINUED



on modeled and actual biomass production of *Miscanthus* and switchgrass.

In California, Heaton worked to develop an agronomic program for energy crops Ceres planned to commercialize. Her responsibilities included evaluating the market potential of a variety of bioenergy crop candidates, the likelihood of success for those species over a large geographical area, length of time to develop the crop from seed and if the species could be implemented as a commercial product within a reasonable time frame.

With her corporate job, came a shift in focus to a global commercial perspective rather than her local academic viewpoint developed in Illinois, where Heaton grew up. "I learned a lot," says Heaton. "The world is not going to be saved by good intentions—it has to be profitable."

A look at the Alaska pipeline and offshore drilling rigs makes it clear oil companies are undaunted by technological barriers. But what they must know is that there is enough oil or carbon to make the drilling worth their while—enough product and a steady supply. "Can plant biomass supply them enough carbon molecules year round, every year—that's what remains to be demonstrated," says Heaton.

to make Mother Nature work year round," says Heaton.

"The oil companies say, get me carbon molecules year round, every year," explains Heaton. "The sustainable agriculture people say get me ground cover, carbon sequestration, watershed protection and wildlife habitat year round, every year. It's all the same in what I view as the practical farm—just different crop components, and we need to learn to plug and play."

In 2006, Heaton graduated with a degree in crop science from the University of Illinois at Urbana-Champaign, where she studied the interactions between atmospheric greenhouse gases and photosynthesis, while completing her doctorate

Is food the new crude?



Dermot Hayes addresses how bidding for acres pits fuel growers against food growers.

In October 2006, the world suddenly recognized the energy value of grains,” says Dermot Hayes, leader of the Plant Sciences Institute’s Public Policy Task Force, Pioneer Hi-Bred Chair of Agribusiness and professor in the Departments of Economics and Finance. Now, along with an enormous surge in ethanol-producing capacity, a tug-of-war between fuel and food markets (which includes animal feed) has begun.

This change came about following a summer of high crude oil prices and corn prices hovering below two dollars a bushel, creating an enormous incentive to build corn ethanol plants.

Ethanol plants were initially profitable, turning two dollars worth of corn into eight dollars worth of ethanol, and speculators quickly realized this expansion would continue until corn was priced so high that this arbitrage possibility was eliminated, explains Hayes, whose economic analyses have put him at the center of the food-fuel debate.

The surge in corn grain ethanol production gives corn producers another customer, and farmers recognize that under current conditions, the fuel value can often be higher than the food or feed value.

According to Hayes, approximately

half the price increase for a bushel of corn, wheat and soybeans is due to bad weather, continuing population growth and panic reactions from the governments of Argentina, China, India, Russia and the Ukraine, where various forms of crop export restrictions have been imposed. The other half is due to increased use of crops for biofuel.

Food importing countries are also responding. Historically these governments protect their farmers from cheap food imports but now are protecting consumers from expensive food by keeping more of it at home and encouraging imports.

High global demand for corn to make ethanol motivates farmers to plant more acres to corn. Other grain crop market prices must then rise or they will be displaced by corn and cause shortages.

But high prices bring new opportunities. Crops loaded with specific traits become economically feasible to produce and innovative crop and cropping designs—like customizing crops to specific types of soil and topography—become financially worth their while, “creating a golden age for plant scientists,” says Hayes.

Iowa corn growers replanted drowned out areas this year. When corn was selling at two dollars per bushel or less, this would not have happened, says Hayes. “In ten years, we’ll see people using technologies we didn’t even think about with two dollar a bushel corn.”

June 2008 board meeting

Plant Sciences Institute welcomed new board members Michael Lassner, vice president, Trait Discovery for Pioneer Hi-Bred International, and Theodore Crosbie, vice president of Global Plant Breeding for Monsanto Company, at the June 18, 2008, board meeting. Pictured on left, top to bottom: Stephen Howell, Wendy Wintersteen, John Greaves, Steven Briggs and Michael Lassner. On right, top to bottom: Charlotte Bronson, Patrick Schnable, Thomas Steen, Virginia Walbot and Craig Hill.



Recent research grants

The following 22 new grants totaling \$7.1 million were awarded recently to plant science researchers at Iowa State.

Biofuels Research Program (2008)

ConocoPhillips Company—\$2,560,779
(R. Brown, mechanical engineering)

Advanced Biorefinery Feedstocks

MetaboliX, Inc.—\$108,000
(E. Wurtele, genetics, development and cell biology)

High Expression of Proteins in Plant Cells by Maximizing Plant Virus Translation Efficiency

Dow Agosciences, LLC—\$100,974
(W. A. Miller, plant pathology)

Fusarium Species Infecting Soybean Roots: Risks and Management Tools

Iowa Soybean Association—\$30,000
(G. Munkvold, plant pathology)

Development of a Soybean Aphid Early Warning System to Predict Aphid Outbreaks and Provide Valuable Information on Aphid Management to Soybean Producers

Iowa Soybean Association—\$30,000
(J. Coats, entomology)

Non-Host Resistance for Creating Broad-Spectrum Disease Resistance in Soybean

Iowa Soybean Association—\$30,000
(M. Bhattacharyya, agronomy)

Evaluating Food Safety of GM Crops—Opportunities for India Borlaug Fellow at Iowa State University

USDA, FAS—\$24,156
(J. Wolt, agronomy)

Development of High-Dimensional Data Analysis Methods for the Identification of Differentially Expressed Gene Sets

National Science Foundation—\$184,740
(D. Nettleton, statistics)

Impact, Interactions, and Management of the Fusarium Root Rot Complex in Soybeans

USDA, CSREES—\$94,999
(G. Munkvold, plant pathology)

Regional Biomass Feedstock Partnership-Biomass Residue Removal

U.S. Department of Energy—\$86,999
(R. Anex, agricultural and biosystems engineering)

Regional Biomass Feedstock Partnership-Herbaceous Bioenergy Crop Field Trials Project

U.S. Department of Energy—\$25,000
(K. Moore, agronomy)

Center for Research on Botanical Dietary Supplements

National Institutes of Health—\$1,420,261
(D. Birt, food science and human nutrition)

ISGA: Functional Genomics of Plant Disease Defense Pathways

National Science Foundation—\$526,623
(R. Wise, plant pathology)

Modular Assembly of Synthetic Cellulosesomes

USDA—\$471,751
(M. Hargrove, biochemistry, biophysics and molecular biology)

VCA: A Two-Component AC/DS Platform for Reverse and Forward Genetic Analysis in Maize

Boyce Thompson Institute for Plant Research, Inc.—\$410,183
(E. Vollbrecht, genetics, development and cell biology)

Role of Lipopolysaccharide O-Chain in Type III Effector Delivery and Role of Type III Effector Delivery in Inhibition of Host Defense in Bacterial Leaf Streak of Rice

USDA, CSREES—\$399,490
(A. Bogdanove, plant pathology)

PLEXdb: Plant Expression Database

National Science Foundation—\$384,601
(J. Dickerson, electrical and computer engineering)

West Africa Seed Alliance

International Crops Research Institute for the Semi-Tropics—\$358,754
(J. Cortes, Seed Science Center)

CYP701A: A Family of Multifunctional Cytochromes P450 in Terpenoid Biosynthesis

National Science Foundation—\$170,919
(R. Peters, biochemistry, biophysics and molecular biology)

Bio-Fuels Unit Operations Course Development

USDA, CSREES—\$140,435
(D. Grewell, agricultural and biosystems engineering)

Oil Production of Soybean Varieties with Mid-Oleic and 1% Linolenic Acids for Industry Testing

United Soybean Board—\$100,000
(W. Fehr, agronomy)

Barley Coordinated Agricultural Project: Leveraging Genomics, Genetics, and Breeding for Gene Discovery

USDA—\$97,852
(J. Dickerson, electrical and computer engineering)

Plant Sciences Institute UPDATE

The Plant Sciences Institute Update is published four times each year by the Plant Sciences Institute at Iowa State University, 1060 Roy J. Carver Co-Laboratory, Ames, Iowa 50011-3650; phone 515 294-5255.

The Plant Sciences Institute at Iowa State University is dedicated to becoming one of the world's leading plant science research institutes. More than 200 faculty from the College of Agriculture and Life Sciences, the College of Liberal Arts and Sciences, the College of Human Sciences, and the College of Engineering conduct research in nine centers of the institute. They seek fundamental knowledge about plant systems to help feed the growing world population, strengthen human health and nutrition, improve crop quality and yield, foster environmental sustainability and expand the uses of plants for biobased products and bioenergy. The Plant Sciences Institute supports the training of students for exciting career opportunities and promotes new technologies to aid in the economic development of agriculture and industry throughout the state. The institute is supported through public and private funding.

To be added to our mail list, e-mail psidir@iastate.edu.

On the Web at <http://www.plantsciences.iastate.edu/>



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