Recent research grants

The following 24 new grants totaling $5.48 million were awarded recently to plant science researchers at Iowa State.

Regulation of Chloroplast Biogenesis: The Immutans Mutant of Arabidopsis
Department of Energy—$110,000
(S. Rodermel, genetics, development and cell biology)

Translational Genomics to Decipher Resistance Signaling Pathways
USDA—$72,000
(S. Whitham, plant pathology)

Database of Maize Genome Information
USDA—$60,000
(V. Brendel, genetics, development and cell biology)

Engineering Carbohydrate Polymers for Value-Added Products from Agricultural Feedstocks
Petroleum Research Fund, American Chemical Society—$40,000
(N. Pohl, chemistry)

Research in Corn Breeding and Genetics
Nidera S.A.—$38,250
(M. Lee, agronomy)

Metabolomics: A Functional Genomics Tool for Deciphering Functions of Arabidopsis Genes in the Context of Metabolic and Regulatory Networks
National Science Foundation—$1,000,000
(B. Nikolau, biochemistry, biophysics, and molecular biology)

Arabidopsis Systems Biology Computational Software
National Science Foundation—$969,634
(E. Wurtele, genetics, development and cell biology)

Enzyme-Assisted Aqueous Processing of Soybeans (Year 2)
USDA—$750,977
(L. Johnson, food science and human nutrition)

Bone Response to Soy Isoflavones in Women
National Institutes of Health—$668,946
(D. L. Alekel, food science and human nutrition)

Food Chain Economic Analysis, Part III
USDA—$387,988
(C. Hurburgh, agricultural and biosystems engineering)

Soy Components and Colon Cancer
USDA—$142,664
(R. MacDonald, food science and human nutrition)

Development of Maturity I-IV Varieties for the Better Bean Initiative
United Soybean Board—$125,300
(W. Fehr, agronomy)

Relational Legume Genome Database: The Breeder's Toolbox
USDA, ARS—$64,194
(V. Brendel, genetics, development and cell biology)

Integrating New Fiber Utilization Technologies in Biorefinery
Department of Energy—$50,000
(B. Shanks, chemical and biological engineering)

CREST: Center of Research Excellence in Bioinformatics and Computational Biology
National Science Foundation—$44,583
(S. Aluru, electrical and computer engineering)

Genetic Transformation of Maize (zea Mays L.) for the Production of Maize Lines with Enhanced Tolerance to Environmental Stress Conditions
USDA—$28,483
(K. Wang, agronomy)

Functional Analyses of Genes Involved in Leaf Initiation
National Science Foundation—$284,240
(P. Schnable, agronomy)

Regulation of Starch Synthesis in Maize Kernels: Function of Starch Synthase III
Department of Energy—$120,000
(M. James, biochemistry, biophysics and molecular biology)

Regulation of Inflorescence Architecture in Maize
National Science Foundation—$95,360
(V. Brendel, genetics, development and cell biology)

Uniformity in Near Infrared Measurements of Soybean Quality
American Oil Chemists Society—$54,647
(C. Hurburgh, agricultural and biosystems engineering)

Catalytic and Binding Domains of Maize Starch Synthases
Exseed Genetics L.L.C.—$39,215
(A. Myers, biochemistry, biophysics and molecular biology)

Application of Biotechnology to Control Soybean Death Syndrome
Southern Illinois University–Carbondale—$25,400
(M. Bhattacharyya, agronomy)

Identifying Seed Shatter and Ather Dehiscence Genes that Predict Ecological Fitness
Environmental Protection Agency—$197,817
(C. Lashbrook, horticulture)

Practical Biodiversity: Keeping Oats on Farms by Helping Farmers Enhance Disease Resistance
University of Nebraska—$111,548
(J.-L. Jannink, agronomy)

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, 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.

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Plant Sciences Institute
1060 Roy J. Carver Co-Laboratory
Ames, Iowa 50011-3650

IOWA STATE UNIVERSITY

Plant Sciences Institute UPDATE

SPECIAL REPORT Biorenewables

April 2006, Volume 6, Number 3

Iowa State puts together powerful bioenergy team

Excitement about Iowa's emerging role in bioenergy is sweeping across the state. Iowa State is taking a strong leadership role in research into biorenewable fuels and products by combining the efforts of powerful research units on campus. Robert Brown, head of the Office of Biorenewables Programs, has been a broker or matchmaker in building campus coalitions and helping to put Iowa State at the center of the nation's bioenergy map.

Robert Brown, director of the Office of Biorenewables Programs, in a field of switchgrass, a biomass crop.

Brown said the Office of Biorenewables Programs helps campus units—and others—communicate and coordinate biorenewables research. The office helps researchers seek grants and bridges diverse areas to enhance collaboration.

"The research that's identified ends up being done in places like the Plant Sciences Institute and other university units," said Brown, a mechanical engineering professor.

The office also works with Jill Euken, an Extension field specialist for biobased products. "The role I play is outreach—hooking industry into university faculty and

CONTINUED ON PAGE 3

Spinning cornstalks into bioenergy gold

There's a tremendous bioenergy resource in the stalks and leaves left in cornfields, but it will be tricky to capture it and maintain soil quality, agronomy professor Ken Moore says.

Kenneth Moore

Moore is studying the use of corn crop residues for bioenergy production with associate agricultural and biosystems engineering professor Rob Anex, interim agronomy chair Kendall Lamkey, and Jeremy Singer of the U.S. Department of Agriculture Soil Tilth Laboratory at Iowa State. They want to maximize biomass production, but minimize the impact of removing crop residues, such as corn stover, from fields, where it usually decays and controls soil erosion.

Studies predict it will take big increases in crop biomass to make conversion into fuels economical—and because of that, protection of soil quality is an issue. Ways also must be found to remove crop residues without significant investments of work and energy. And its bulk could make it expensive to transport. Most processors will have to be small and local—possibly boosting rural economic development.

Moore also is studying treating harvested cornstalks and leaves with enzymes or acids to help preserve it during storage and begin converting it to sugars for fermentation into ethanol.

Anex, an affiliate of the Center for Crops Utilization Research, will analyze the economics of new systems. Lamkey, director of the Raymond F. Baker Center for Plant Breeding, will develop corn hybrids for optimal grain and biomass. Singer, a USDA-Agricultural Research Service agronomist, will study planting corn with ground cover—one method for sustaining soil quality.

"We want to develop a system where we understand the interactions and anticipate problems," Moore said.

They just don't get it

When I was young, I thought Iowans were smarter than the rest. Now that I'm older, I'm convinced—particularly when it comes to biorenewable resources.

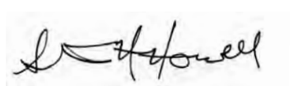
A case in point is the *Wall Street Journal*'s editorial campaign to malign bioenergy. They are convinced ethanol is pork for the Midwest and renewable fuels are a government boondoggle promoted by every administration since the Arab oil crisis of the 1970s.

A major theme in the journal's arguments is that we cannot wean ourselves from fossil fuels to biorenewable resources because "all sources of 'renewable energy' combined supply just 3.3 percent of U.S. energy needs." Their editorials also say the administration "is now lecturing the nation that it's 'addicted to oil' and extolling the merits of cellulosic biomass, aka wood chips." (*WSJ*, 2/2/06).

They claim, rightly so, that our major energy sources are not from OPEC countries, but from domestic sources, Canada and Mexico. However, what they do not emphasize is that 60 percent of our oil in 2005 was imported—regardless of the source. What the *WSJ* isn't telling readers is that the situation is unsustainable, creating huge trade deficits and badly affecting our environment.

In reality, biorenewable fuels have the capacity to offset much of our current consumption of transportation fuels. It has been estimated that if we could convert 50 percent of the Midwest's corn stover to ethanol, we could supply 40 percent of the nation's transportation fuel.

Iowa is rapidly becoming the bioenergy capital of the world, but to develop further we must educate the nation on the importance of bioenergy and biobased products. That education must start at home.



Stephen Howell
Director

Better bean oil for biolubricants

Two food science researchers are collaborating with a mechanical engineering professor to understand the properties of biobased lubricants.

Earl Hammond, emeritus university professor, and Tong Wang, an associate professor, both in food science and human nutrition, are collaborating with Sriram Sundararajan, assistant professor of mechanical engineering.

Linxing Yao, Tong Wang, Earl Hammond, and Sriram Sundararajan review products of their biobased lubricant research.

"The ultimate goal is to modify soy oils to introduce new molecular structures that can be used as lubricants," Wang said. "We're using model systems to find molecules that work best." The research will help biologists modify plants to make oils with desirable structures and properties.

Researchers want a biobased lubricant with a low melting point; low oxidation, comparable to petroleum-based motor oil; and the right viscosity. Low oxidation and melting point are important to keep the oil from gelling or freezing, respectively. The right viscosity lets oil cling to parts without excessively increasing the resistance to flow.

Most oil molecules are straight-chain fatty acids—carbon atoms linked in a line, Sundararajan said. Hammond and Wang, both affiliates of the centers for Designing Foods to Improve Nutrition and Crops Utilization Research, want to see if adding a branch, altering chain length or introducing unsaturation (so carbon atoms are linked by double bonds) in fatty acids creates favorable qualities.

Hammond recently found that branched fatty acids from lanolin have a relatively low melting point. He and Wang also are testing oleate esters—fatty acids that have reacted with alcohols—that could be used for lubricants or biodiesel.

Wang and Hammond synthesize the model oils and Sundararajan uses a device called a microtribometer to test them. The instrument has a sphere that slides against a flat surface under a controlled load in the presence of test lubricants. Engineers check the components for wear and monitor friction during experiments.

The research is making progress, Hammond said. "I think we can tell them that branched-chain fatty acids are capable of solving the melting point problem.

New faculty to focus on biorenewables

Two prospective faculty positions will add power to biorenewables research at Iowa State.

The Raymond F. Baker Center for Plant Breeding and Department of Agronomy are searching for their first researcher specializing in developing crops as biorenewable resources, said Kendall Lamkey, interim chair. The researcher will "develop crops and modify plant characteristics that will help make Iowa and the United States less dependent on non-renewable materials," said Lamkey, who also directs the Baker Center.

Meanwhile, the departments of Agricultural and Biosystems Engineering and Natural Resource Ecology and Management are adding a joint position in biomaterials, biomass processing and biofuels. This faculty member will conduct research in the Center for Crops Utilization Research and work closely with the university's bioeconomy initiative, agricultural and biosystems engineering chair Ramesh Kanwar said. The faculty member also will teach classes in a newly proposed biosystems engineering major.

Soy-based adhesive readied for market

Deland Myers

Deland Myers pops out of his chair in his Food Sciences Building office. He dives into boxes, finding fiberboard samples for visitors.

They're made with soy-based adhesives that Myers, a food science and human nutrition associate professor, has spent years researching. Now he believes they're ready for commercialization.

Several factors favor Myers' assertion. Prices are rising and supplies are falling for petroleum, the source of most wood adhesives. Most also contain a type of formaldehyde—a possible cancer-causing chemical.

Soy protein, the part left when soybeans are crushed for the oil used in biodiesel fuel, usually goes in animal feed and foods. As biodiesel production increases, however, more soy meal and flour will be for sale.

Adhesives are a potential market for those products, said Myers, an affiliate of the centers for Designing Foods to Improve Nutrition and Crops Utilization Research.

West Central Cooperative of Ralston, the country's largest biodiesel marketer, is working with Myers. "I don't know that we're in danger of having excess soy meal," research and development manager Larry Breeding said. "However, you want to always take a look at different uses for a product."

Myers believes soy adhesives can supplement existing adhesives. "We think by adding soy, we can make a product that's more appealing … and may have some performance aspects others lack," he said. Myers is seeking companies interested in using soy protein in their adhesive formulations and in making wood and fiber composite boards with soy adhesives for testing.

Years ago, he told his research group, "We're on the side of right. If we can keep going, the time will come when companies seek alternatives.

"Now," he said, "I think we're at that point."

Students study biorenewables abroad

An exchange program isn't just creating future biorenewables leaders. It's also creating advocates for Iowa State, said Lawrence Johnson, director of the Center for Crops Utilization Research (CCUR).

Belgium exchange students Elke Vermoesen, Miet De Baer and Dirk Aerts were treated to a tractor ride on the farm of Doug and Linda Svendsen near Marshalltown.

"It's getting us visibility we didn't have on an international level," Johnson said. "European students who studied in Ames are telling others this is the place for biorenewables," he added

The European Union/United States Curriculum on Renewable Resources and Clean Technology is a cooperative venture of CCUR, the Office of Biorenewables Programs and the Plant Sciences Institute. The universities of Arkansas and Washington also participate with the universities of Graz in Austria and Ghent in Belgium, and the Polytechnic Institute of Toulouse, France. It's financed with a grant from the U.S. Department of Education and the European Union Directorate for Education and Culture.

The three-year program includes an annual two-week European intensive course. Five or six Iowa State graduate students participate and four or five Iowa State faculty join other international leaders to teach the sessions. The third is scheduled for summer 2007 in Graz. "The seminars let Iowa State faculty forge ties with the best people in Europe," Johnson said. "My vision is that there will be long-lasting relationships that result in projects."

Up to three graduate students from each institution cross the ocean every four to six months to study and conduct research. Scott Bents, an Iowa State engineering student, currently is studying life-cycle analysis of biobased products in Graz.

Three Belgian students at Iowa State in Fall 2005 worked with Basil Nikolau, professor of biochemistry, biophysics and molecular biology and director of the Center for Designer Crops; Eve Wurtele, professor of genetics, development and cell biology; and Tim Ellis, associate professor of civil, construction and environmental engineering.

The students also had several experiences—including riding a combine during harvest. "These three students—they're just like family to us now," Johnson said.

Iowa State puts together powerful bioenergy team/CONTINUED

vice versa," Euken said. She also educates Iowans on the potential of a biorenewables-based economy.

That collaboration is necessary to advance four thrust areas the U.S. Department of Energy identified for biorenewables research: plant science, production, processing and utilization. The Plant Sciences Institute largely focuses on the first two, while other campus research centers study the other areas.

Steve Fales, the Office of Biorenewables Programs' associate director, said the office is integrating research into all four areas by encouraging research with a "systems approach"—considering the entire impact and life cycle of a product or process.

"We need to bring the fundamental plant sciences—genomics and molecular biology—to bear on these practical problems and solutions," said Fales, former chair of the agronomy department, who joined the office this past winter. "Engaging the plant scientists with the engineers is something this office can facilitate."

Fales took his own advice by reading Brown's biorenewables textbook. Brown has picked up several plant biology books.

Until now, Brown said, "My world has been the mechanical engineering department. Now sometimes I think I'm confused for an agronomist, I'm over there so much."