

Sustaining agriculture

Sustainable agriculture and agriculture biotechnology seldom are portrayed as allies. But they should be, because biotechnology can be an important asset to



sustainable agriculture, which seeks to promote environmental health, economic profitability and social and economic equity.

Herbicide-resistant soybeans already have

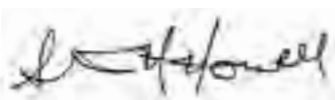
contributed to the health of the environment by encouraging farmers to adopt low- or no-till farming practices. Insect-resistant plants developed through biotechnology have helped lighten the environmental load of pesticides, particularly in pesticide-intensive crops like cotton.

On the horizon are new biotech-developed agronomic traits that may confer drought resistance and more efficient water use. The development of crops that conserve water will be important to maintain aquifers and reduce consumption of water by agriculture, the largest water-using industry in the United States. Drought-resistant plants will offer farmers greater security from losses caused by occasional droughts.

Biotechnology also is taking aim at fertilizer usage. Researchers are developing crops that utilize nitrogen more efficiently and may require less fertilizer.

As for social and economic equity, some blame biotechnology for being in bed with corporate America. It is true that huge capital investments are required to introduce new transgenic crops. The regulatory environment is so strict it may cost \$80 million or more to launch a single transgenic variety. Yet new biotech crops require fewer farming inputs and can translate into higher profits for small or large farmers.

Isn't it time for the sustainable agriculture and agriculture biotechnology communities to join forces and see the virtue in each other's ways?



Stephen Howell
Director

Research puts soybeans under pressure

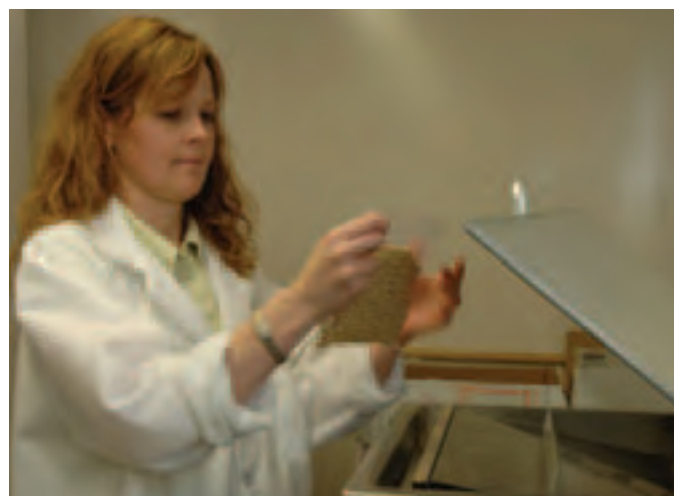
Three lab coats hang in Stephanie Jung's office at Iowa State's Food Sciences Building. The one for regular lab work is a pristine white. She wears the other two, sporting brown blotches and stains, to work on her research subject: high hydrostatic pressure processing (HHPP).

The processors use tanks of water at high pressure to eliminate microbes, making food safer and longer lasting. Jung's experiments use pressure as high as 900 megapascals—90 times that generated by a typical pressure washer. But as the coats show, equipment doesn't always cooperate.

"I've learned a lot about tubing and piping," said Jung, an assistant professor of food science and human nutrition.

Jung, an affiliate of the Center for Crops Utilization Research, studies how HHPP affects food components like proteins and enzymes. HHPP is used to preserve meats, seafood and other foods, but little is known about how it affects some nutrients.

HHPP could be useful for soybeans, which must be thermally processed to inactivate trypsin inhibitor, which limits soy nutrition, and lipoxygenase, an enzyme responsible for undesirable



Stephanie Jung did her doctoral research in France on high-pressure processing, then worked in other areas before returning to her "first love" at Iowa State.

flavor change. But thermal processing also cuts available soy protein and beneficial chemicals.

Jung is testing whether HHPP can make soy products with inactivated enzymes and more protein, plant chemicals and vitamins. She's also experimenting with HHPP parameters, like pressure level, duration and temperature.

"What is unique with the equipment at Iowa State is we can study the impact of rate of pressurization and depressurization," Jung said.

A native of France, Jung also is studying enzymes to improve soy-based industrial products. She and center director Lawrence Johnson are researching ways to use water and enzymes to separate soy oil and eliminate the use of hexane, a flammable, pollution-prone chemical.

Meristems meeting gets global audience



Thomas Laux of Freiburg University in Germany was the keynote speaker at "Meristems 2005," this year's Plant Sciences Institute symposium, June 2-5 in Ames. Laux spoke on establishing the stem cell population in meristems, believed by some to be the plant equivalent of animal stem cells. Many international researchers were among the 147 people who attended.

Grants add power to research initiatives/CONTINUED

our body's digestive enzymes, so it could release glucose slowly or pass into the large intestine undigested.

The researchers believe LCAPS could help prevent obesity by cutting calories available to the body. The starch also could lower the glycemic index—a measure of how much glucose is digested over time, said co-investigator Paul Flakoll, a professor of food science and human nutrition and of animal science. A low-glycemic index diet has been found to cut the risk of Type 2 diabetes.

The researchers will feed LCAPS noodles to humans and test whether the rates of glucose release are reduced.

The grant creates “a totally new collaboration,” said Flakoll, co-leader of the nutrition initiative. “It's not something we're used to doing together. We're tying plant biochemistry and molecular biology with something that happens in humans.” The grant also will help develop additional slow-release starches.

Charles Brummer, associate professor of agronomy, will join forces with the plant genomics initiative. His grant will bring genomics tools to bear on improving alfalfa, an animal feed and a potential feedstock for bioenergy and industrial products.

Brummer has mostly used conventional plant breeding to develop qualities such as winter hardiness and late-season production in alfalfa. The grant will let him identify alfalfa genes contributing to heterosis—the quality that makes hybrid plants more productive than their parents. Brummer will use an alfalfa GeneChip, capable of testing for the expression of about 60,000 genes, to compare hybrids producing heterosis with plants that don't show heterosis.

“There's no doubt yield is very complex and every plant has different genes,” Brummer said. “We'll only be able to identify some of the genes involved in some germplasm.”

Agronomy professor Pat Schnable, leader of the genomics initiative, said Brummer's proposal has implications for heterosis in hybrid corn. By studying a different species, “We will be able to find additional mechanisms and more fully understand this complex process,” he added.

Color clarifies gene regulation in corn

Red corn has given Feng Zhang some unusual insights into the molecular control of gene expression in plants—and into corn's role in American folklore.

The corn he studies is derived from Indian corn, which Native Americans believe is a gift from God.

“Only in the dance of the red corn will the children prosper and be happy upon the earth,” says one Indian story that Zhang, a doctoral student, found on the Internet.

In a paper published in the March issue of *The Plant Cell*, Zhang uses red corn to demonstrate how gene expression can be altered by subtle chromosomal reorganization.

Working under Thomas Peterson, a professor of genetics, development and cell biology and of agronomy, Zhang focused on two corn lines with red kernels and white cobs, designated *rw*. Zhang analyzed a gene, designated *p1*, that controls kernel pigmentation.

“We found a deletion in the regulatory region that determines when a gene is turned on,” Feng said. The difference between an *rw* variety and an *rr* (red kernels and red cob) or *wr* (white kernels and red cob) doesn't lie in *p1* itself, he said, but in the code that regulates the expression of *p1*.

That shows the importance of gene regulation, said Peterson, who is affiliated with the Laurence H. Baker Center for Bioinformatics and Biological Statistics, the Center for Plant Transformation and the Center for Plant Genomics.



Thomas Peterson, left, and Feng Zhang say their work on how genes controlling corn color are regulated show the importance of “control before power” in gene expression.

“It's like having an orchestra with thousands of instruments,” he said. “They need to be regulated or conducted.”

The paper also describes how the regulatory region of the gene was altered by recombination with *p2*, a closely linked gene.

“Feng's work shows how new genes can arise by combining parts of old genes in new ways,” Peterson said.

The *p1* gene also governs production of maysin, a chemical in red corn silk that is poisonous to corn earworms. Missouri researchers are transferring the gene to sweet corn in an attempt to make naturally earworm-resistant varieties.

The Plant Sciences Institute and Iowa State's biotechnology program supported Zhang's research. He'll go on to a postdoctoral fellowship at the University of Georgia.



Clinic advances feedstock studies

Stanford University's Chris Somerville discusses altering plant cell walls so they can be more easily converted to biofuels at “Tailoring Lignocellulosic Feedstocks for Bioenergy and Bioproducts,” a May 16 workshop at Iowa State. The workshop, sponsored by the Plant Sciences Institute and Iowa State's BioEconomy Initiative, drew 115 participants.

Recent research grants

The following 26 new grants totaling \$3.8 million were awarded recently to plant science researchers at Iowa State.

Food Chain Economic Analysis, Part II

USDA—\$334,308

(C. Hurburgh, agricultural and biosystems engineering)

Acetyl-CoA: The Precursor for High-Energy Phytochemicals

Department of Energy—\$260,000

(B. Nikolau, biochemistry, biophysics and molecular biology)

Synthesis of Catechin Trimers

Polyphenol Technologies Corporation—\$186,865

(G. Kraus, chemistry)

Research Experience in Molecular Biotechnology and Genomics

National Science Foundation—\$70,000

(D. Oliver, genetics, development and cell biology)

Technology Transfer and Commercialization of Soy Protein Adhesives for Bemis Manufacturing of Molded Wood Products

Iowa Soybean Promotion Board—\$36,800

(D. Myers, food science and human nutrition)

Iowa Grain Quality Initiative

Iowa Soybean Promotion Board—\$25,000

(C. Hurburgh, agricultural and biosystems engineering)

Genetic Transformation of Maize Inbred Lines

Crop Design N.V.—\$22,785

(K. Wang, agronomy)

Comparative Evolutionary Genomics of Cotton

National Science Foundation—\$87,175

(J. Wendel, ecology, evolution and organismal biology)

Development of Soy/Corn Oil Plastic Composites

USDA—\$70,000

(R. Larock, chemistry)

ASTA/APSA Workshops to Harmonize Phytosanitary Regulations for Seed Trade in Asia-Pacific

USDA—\$66,153

(J. Cortes, Seed Science Center)

Ionic Liquid Efficient and Recyclable Catalyst Systems for Making Biodiesel

United Soybean Board—\$52,170

(J. Verhade, chemistry)

Processing High B-glucan Oat Varieties to Optimize Sensory and Physicochemical Properties of Oat Products

USDA—\$40,000

(P. White, food science and human nutrition)

Functional Analysis of Soybean Genes through Transposon Mutagenesis

University of Minnesota—\$25,225

(K. Wang, agronomy)

Establishment of Robust Maize Transformation Systems for the Public

National Science Foundation—\$892,561

(K. Wang, agronomy)

Solid-State NMR Studies of Antimicrobial Peptides

National Institutes of Health—\$223,786

(M. Hong, chemistry)

Collaborative Research: Comprehensive Molecular, Genetic and Cytogenetic Analysis of Transposon-Induced Chromosomal Rearrangements in Maize

National Science Foundation—\$188,483

(T. Peterson, genetics, development and cell biology)

Genetic and Biochemical Basis for the Transformation of Energetic Materials (RDX, TNT, DNTs) in Plants

Department of Army, Corps of Engineers—\$145,684

(J. Shanks, chemical engineering)

Integrating New Fiber Utilization Technologies in Biorefinery

Department of Energy—\$112,000

(B. Shanks, chemical engineering)

Establishment of Robust Maize Transformation Systems for the Public Sector

National Science Foundation—\$97,982

(K. Wang, agronomy)

Perturbation of Methyl Group Metabolism by Diabetes and Retinoid Compounds

American Diabetes Association—\$96,812

(K. Schalinske, food science and human nutrition)

Structural Studies of a T cell Specific Tyrosine Kinase

National Institutes of Health—\$323,880

(A. Andreotti, biochemistry, biophysics and molecular biology)

High Beta-Carotene Maize to Alleviate Vitamin A Deficiency in Sub-Saharan Africa

International Center for Tropical Agriculture (CIAT)—\$138,840

(S. Rodermeil, genetics, development and cell biology)

Regulation of Shoot Development in Arabidopsis

National Science Foundation—\$131,946

(S. Howell, genetics, development and cell biology)

High Beta-Carotene Maize to Alleviate Vitamin A Deficiency in Sub-Saharan Africa

International Center for Tropical Agriculture (CIAT)—\$102,363

(W. White, food science and human nutrition)

Identification of Genes for Key Agronomic Traits in Maize

Iowa Corn Promotion Board—\$34,934

(P. Schnable, agronomy)

Rice Consumption in the United States: Recent Evidence from Food Consumption Surveys and Trends

USA Rice Federation—\$30,000

(H. Jensen, economics)

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.

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



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