IOWA STATE UNIVERSITY

Plant Sciences Institute UPDATE

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Board biz

R. Kyle Phillips, Plant Sciences Institute Board member and past chair of the Iowa Corn Promotion Board, shares some thoughts on what his organization would like to see coming from the institute in the future.

Ray Kyle Phillips has been involved in the institute since its inception, initially as a member of the Iowa Corn Growers Board. He saw the need to establish the institute because "Iowa farmers needed a champion in the biotech arena and Iowa State could be that champion," says Phillips.

Now, nearly a decade later, Phillips says he would like to see a bit more autonomy for the organization. "Maybe a new way of doing things that would allow the Institute to operate more independently."

"The number one challenge right now for the Iowa corn farmer is future profitability," says Phillips, who along with his wife Sue has been farming in Iowa since 1974. "It's the dynamic nature of the business now where we can no longer predict prices and profit projections and input prices are changing so rapidly."

Phillips holds an agricultural business degree from Iowa State. Though his first love is agronomy, he is quick to credit his education in the economic and business aspects of agriculture for

Kyle Phillips

keeping him in operation through the agricultural economic downturn in Iowa during the 1980s.

Now firmly focused on production and profit projections for the upcoming year, Phillips notes that within 2008 land rents increased close to 10 percent, seed corn prices increased more than 20 percent and phosphorus and potassium fertilizer costs went up 150 percent, from around $73 an acre to $182 an acre. Ammonia costs "skyrocketed."

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Seeds of change

What genes and molecular mechanisms pilot plant cells along paths to become either starchy endosperm, transfer layer or aleurone is something Philip Becraft, associate professor in the Departments of Genetics, Development and Cell Biology and Agronomy wants to know.

Cell fate determination is an important area of study in all organisms, but understanding these pathways at the molecular level for seed development could help researchers boost the production of beneficial compounds naturally produced in grains, alter phosphorous content in animal manure to reduce negative environmental impacts (aleuronic mineral storage capacity includes phosphorus which finds its way from feed to manure to waterways) or even help the brewmeister brew better beer.

"Every developmental event is regulated by a specific mechanism," says Becraft. "Some dictated by positive regulators and others by negative regulators."

In corn, starch grains and protein bodies accumulate in mature starchy endosperm cells of the growing kernel. The transfer layer pumps maternal solutes into the endosperm. The aleurone, a single layer of cells surrounding the endosperm has a mineral storage function and "serves as a

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Stimulus package

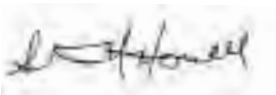
It is hoped the president's $787 billion stimulus package will help the nation out of its worst recession since the Great Depression. The purpose of the package is to create jobs and put Americans back to work. Iowa is expected to receive $1.9 billion, which will go a long way toward easing the state's budget problems.

But as the largest appropriations bill in the country's history, the stimulus package is the opportunity of a lifetime

to do something truly transformative—to modernize our transportation, communications, education and health care systems. As it works out, we will probably shell out nickels, dimes and dollars to patch up bridges and leaky roofs on schools—all of which are good causes, but not transformative.

A small fraction, yet a sizeable chunk of the stimulus package will go to science—$10.4 billion to the National Institutes of Health, $3 billion to the National Science Foundation, and $5 billion to the Department of Energy. Many thanks go to some members of the Iowa congressional delegation for their support of this important investment in science. The scientific establishment employs people to do science, and so this is a good investment to create jobs.

But it is also the opportunity to do great things in science. Iowa is at the cusp of exciting new developments in alternative energy—particularly in the areas of biofuel and wind energy—that could help to make this country more energy independent and put us firmly on the road to prosperity. Three or four years from now, we will look back on these moments and ask whether we spent the funds well. So, let us use the stimulus package to transform Iowa and the nation!



Stephen Howell
Director

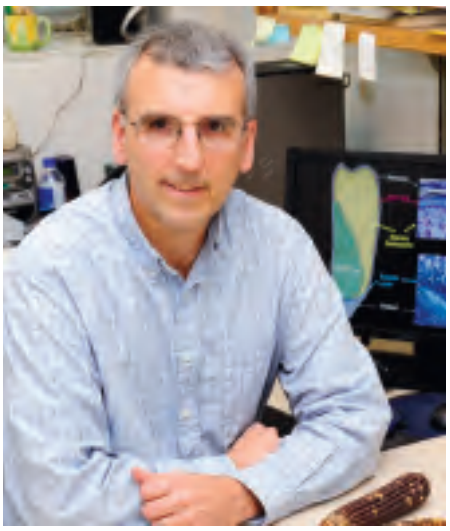
Board biz/CONTINUED

"These high-dollar inputs without high dollar projected sales are simply not sustainable," says Phillips. "Wild fluctuations are the worst thing for agriculture—we need a little stability—live and let live." According to Phillips, a little more competition in the marketplace could help even out prices.

Phillips would like to see research dollars and effort bear some fruit that could be directly attributed to the institute. This includes preservation of intellectual property rights in such a way that benefits would go to the university and indirectly to Iowa farmers. These successes would better enable the institute to get more funding from the legislature.

Phillips has confidence in the Plant Sciences Institute scientists solving some of the big basic research challenges for developing better crops, challenges that range from lowering necessary inputs to yield improvements for biomass and grain. "We are constantly searching for better ways to provide for the growing world," says Phillips.

Seeds of change/CONTINUED



Philip Becraft

digestive tissue in the germinating seed to feed the growing seedling," says Becraft.

To map out events determining cell fate, Becraft exploits a genetic marker for anthocyanin, a purple pigment localized to the aleurone layer. By looking for mutations that disrupt or change the pigmentation of a corn kernel, Becraft is finding his way to specific genes that are controlling normal aleurone differentiation.

In a related project, Becraft and his colleagues have developed a high-throughput PCR (polymerase chain reaction) based method to rapidly screen mutations in genes essential for grain development.

Focusing on a class of genes called *dek* (for defective kernel)/*emp* (for empty pericarp), the team is amplifying insertion site DNA from a mutant corn line highly riddled with natural genetic elements called transposons—recognizable mobile genetic elements that randomly hop around the genome and can cause mutations when they insert into specific genes.

Characteristic sequence bits from the transposable elements are amplified along with small segments from the corn genes into which they have inserted. "If one of the inserts is responsible for the phenotype then we see it in all the mutant samples but not in the wild type," says Becraft, comparing wild type corn plant DNA with mutant siblings.

Using this method, Becraft expects to identify and determine the function of some 250-400 mutant genes within five years. "These belong to a class of some 350 to 900 essential genes," says Becraft, that are identified as a class of mutants causing lethal abortion events in seed development—another visually identifiable phenotype.

After determining the predicted biochemical function of the genes identified, "we look to see what is modified. Are the activities of these genes or gene products altered in any of the mutants?" These essential genes identify crucial steps in various cellular, developmental and metabolic processes and represent likely targets for manipulating seed properties.

Becraft's high-throughput methodology will appear in an upcoming issue of *The Plant Journal*.

Sorghum solution

By introducing sorghum, Maria Salas-Fernandez, assistant professor in the Department of Agronomy, is bringing new depth to Iowa State's burgeoning breeding program in forages and biofuel feedstocks.

Salas-Fernandez will blend traditional breeding strategies with her molecular biology and genomics expertise.

"Sorghum has so many different types that can contribute to different production systems," says Salas-Fernandez, including a grain composition similar to corn, a sugar-rich stalk in sweet sorghums and the lignocellulosic biomass component.

The Buenos Aires native who recently completed her doctoral degree at Cornell University in New York is gathering germplasm from publically available sources, collaborators and breeders both nationally and internationally for planting come spring. Types include traditional grain sorghum, photoperiod sensitive types (that do not flower in temperate climates), sudangrasses and sweet sorghums.

Maria Salas-Fernandez

"Breeding is a game of numbers—you need genetic variation to make any progress at all," says Salas-Fernandez.

The program she is establishing will primarily involve sorghum, but will eventually include other crops. Salas-Fernandez will study plant height, flowering time and cellulose/hemicelluloses/lignin composition, as it relates to biomass. She will make use of sorghum's completed genome sequence, genetic maps, established molecular markers and expressed sequence tags (ESTs).

"I don't think one crop will cover all the needs for biofuel production," says Salas-Fernandez, "that would be naive."

Among the advantages of sorghum is the fact that it is adapted to marginal lands, so its cultivation will not displace food crops. It could also be included in a rotation, as compared to corn it uses roughly 30 percent less water, 20-25 percent less nitrogen, and planting costs are significantly lower.

Building character

Academic alchemist Catherine Brewer is blending study disciplines to create her own unique niche. The Washington state native now in her second year as a doctoral student at Iowa State, morphed an interest in English to chemistry into her current passion, chemical engineering.

As an undergraduate, Brewer developed an interest in green chemistry, using biocatalysts—enzymes, rather than metal catalysts to promote chemical reactions.

"An enzyme does the same thing as a catalyst at ridiculously low temperatures," explains Brewer, "with a high amount of selectivity and without creating as many harmful wastes." The challenge, though, is how to get the biological processes to produce the higher product concentrations desired for industrial use.

For her doctoral research, Brewer chose to study mechanisms of fast pyrolysis, a process used in feedstock conversion to biofuels, with Robert Brown, Bioeconomy Institute director, Hoover Chair and professor of mechanical engineering.

But while attending the 2007 "Growing the Bioeconomy Conference," Brewer's focus shifted following Cornell University Professor Johannes Lehmann's presentation about biochar and its fertility-conferring effects observed in anthropological sites in the Amazon jungle.

Soil Science student collaborator Rachel Unger with Brewer working to recreate Iowa's richest dark soils that are naturally endowed with biochar from years of prairie wildfires.

"In all thermochemical processes we make biochar," says Brewer. "And charcoal is one of the most stable forms of organic carbon in soil."

Her interest was kindled with disposing of a "waste" product, sequestering carbon and improving soil health in one swath. Now exclusively focused on biochar, Brewer is collaborating with soil scientists in the Departments of Agronomy and Horticulture, comparing the soil response to chars made from a variety of feedstocks including switchgrass and corn stover.

Brewer is currently analyzing physical and chemical properties of biochar samples for mineral content, surface area, carbon structure composition and presence of functional groups to determine which type of char is best suited to particular soil types.

The same char will not be suitable for all soil types Brewer points out. "It will depend on what one is trying to grow, the type of tillage and how these factors come together."

PSI Fellowships are a valuable recruiting tool, attracting top doctoral candidates. After one year as a PSI Fellow, Catherine Brewer was awarded a prestigious National Science Foundation Graduate Research Fellowship.

Recent research grants

The following 22 new grants totaling $4.7 million were awarded recently to plant science researchers at Iowa State.

VCA: A Two-Component AC/DS Platform for Reverse and Forward Genetic Analysis in Maize
National Science Foundation—$592,302
(E. Vollbrecht, genetics, development and cell biology)

A Modular Approach for Combinatorial Biosynthesis of Functionalized Terpenoids
National Institutes of Health—$582,002
(R. Peters, biochemistry, biophysics and molecular biology)

Mycotoxin Risks Associated with Ethanol Co-Products from Conventional vs Biotechnology-Derived Corn Grain
USDA, CSREES—$378,000
(G. Munkvold, plant pathology)

Meta!blast: A Cell and Metabolic Biology Interactive Learning Environment for High School Students
National Institutes of Health—$252,013
(E. Wurtele, genetics, development and cell biology)

Environmental Fate and Effects Assessment for a Genetically Engineered Bioenergy Feedstock Crop
USDA, CSREES—$207,556
(J. Wolt, agronomy)

Exploring New Resistance Resources for Threatening Soybean Diseases
Iowa Soybean Association—$200,724
(J. Hill, plant pathology)

Breeding General Use and Specialty Soybean Varieties for Iowa
Iowa Soybean Association—$193,900
(W. Fehr, agronomy)

Sudden Death Syndrome (SDS) in Soybean
Syngenta Seeds, Inc.—$168,822
(M. Bhattacharyya, agronomy)

Phase II Introgression of Novel Genes Conferring Resistance to SCN in Soybean Germplasm of Early Maturity Groups
Iowa Soybean Association—$159,730
(S. Cianzio, agronomy)

TRPGR: Cyber Infrastructure for (Comparative) Plant Genome Research Through Plant GDB
National Science Foundation—$146,678
(V. Brendel, genetics, development and cell biology)

Fusarium Species Infecting Soybean Roots: Risks and Management Tools
Iowa Soybean Association—$117,000
(G. Munkvold, plant pathology)

Determining the Impact of Multiple Pests on Soybean Yield and Grain Composition
Iowa Soybean Association—$102,347
(G. MacIntosh, biochemistry, biophysics and molecular biology)

Genome Fluidity and Allele-Switching Frequency in Soybean: Impact on Seed Quality and Vigor
American Seed Research Foundation—$90,000
(A. Goggi, agronomy)

Characterization of the Soybean Rust Infection Process in Susceptible and Resistant Soybean Interactions
Iowa Soybean Association—$75,654
(S. Whitham, plant pathology)

Bone Response to Soy Isoflavones in Women
National Institutes of Health—$60,144
(D. Alekel, food science and human nutrition)

Genomics of Wood Formation and Cellulosic Biomass Traits in Sunflower
Department of Energy—$50,000
(K. Lamkey, agronomy)

Application of Biotechnology to Control the Soybean Cyst Nematode: SCN Parasitism Genes
United Soybean Board—$317,745
(T. Baum, plant pathology)

Phage Display Technology for Small Molecules
Archer Daniels Midland Company—$252,625
(A. Rao, biochemistry, biophysics and molecular biology)

Modeling Ribosomal Control, Function and Assembly
National Institutes of Health—$250,841
(R. Jernigan, biochemistry, biophysics and molecular biology)

Breeding Soybean for Disease, Pest, and Abiotic Stress Factors Resistance
Iowa Soybean Association—$196,771
(S. Cianzio, agronomy)

Biofuels Research Program (2008)
ConocoPhillips Company—$181,000
(R. Brown, mechanical engineering)

Functional Genomics of Maize Gametophytes
National Science Foundation—$124,746
(E. Vollbrecht, genetics, development and cell biology)

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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