

Plant Sciences Institute UPDATE

Seeds of gold

It is often said that the development of hybrid corn may be one of this country's greatest achievements. One corn breeder, George F. Sprague, put Iowa on the map.

Sprague ran the Iowa State University-USDA corn breeding program from 1939 to 1958 and developed a unique population of corn that would forever change corn agriculture. The corn is Iowa Stiff Stalk Synthetic (BSSS). Historically, it has been used to develop U.S. commercial corn hybrids and today it is still one of the main gene pools for U.S. corn hybrids.

Prior to Sprague's time at Iowa State, Merrill Jenkins, who ran the maize breeding program from 1922 to 1934, recognized a problem in corn: lack of strength in the corn stalk. Back then, the corn didn't stand at attention like the rows of tall upright corn we see

today. If corn could stand straight up no matter what, be it rain or snow, yields could be

higher (corn on the ground could be missed or damaged during harvest). Jenkins also originated the idea that a population of corn with a lot of variabil-



George Sprague, one of the fathers of modern maize breeding.

ity would be a strong base from which to breed for various purposes.

Sprague's Stiff Stalk did all these things. And it turned out to be the beginning of legendary B lines from Iowa—inbred lines of corn that delivered high yields, strong roots and stalks, and were disease and insect resistant. United States corn yields have quadrupled since 1930; approximately 60 percent of that increase came on the coat-tails of the B lines. Almost half of today's U.S. corn hybrids can be traced back to the B lines.

BIOENERGY FOCUS

Agricultural transformation

As the nation gears up to make a tremendous increase in biofuel production, Iowa State scientists have a vision for farms of the future. Many of these farms will produce high yields of biomass for biofuels and industrial products. Not only that, they also will be energy efficient and good for the environment.

It's a vision professor of agronomy Matt Liebman has in mind as he tests two alternative cropping systems through research supported by a Plant Sciences Institute innovative grant.

"We're at a critical juncture in agricultural history where we have the opportunity to produce feedstocks for biofuels and industrial chemicals in a way that will enhance both society's need for energy sources and farmers' need for products that people would buy," Liebman said.

One cropping system includes four perennial species: switchgrass, Indiangrass, eastern gamagrass and big bluestem. The other is a double-cropping system—growing two crops in one year, rather than just corn or soybeans. One crop, triticale, would be grown during the cool season from October to June. During the warm season, crops including corn,

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Looking back— thinking ahead

Join us in celebrating Iowa State University's 150th anniversary! During the year-long celebration, we will reflect on the people and events that helped to make



Iowa State a premier university in the plant sciences. Iowa State has a proud tradition in agriculture and plant sciences, and we will highlight some significant happenings.

However, we must make the disclaimer upfront that the Plant Sciences Institute played no part in shaping that history. We are a new organization established just seven years ago. Yet the institute was built on the shoulders of these giants from the past.

In each newsletter for the next year, we will devote a column to reminisce about plant science luminaries and their legacies. We decided to spread out these columns over the year, because there is so much other exciting news about current happenings to cover—news about bioenergy, biofuels, plant and human health and so forth. So we will do both—look back and think ahead.

There have been many great plant scientists at Iowa State, some of whom we've heard much about—George Washington Carver, Ada Hayden, Louis Pammel, to name a few. We will top out our series with George Washington Carver, not just because he was a great plant scientist, but because his ideas translate so well into today's thinking about biorenewables and biobased products.

But we will also cover others who might be less obvious—not lesser lights, but less well-publicized. Our look back in this issue highlights George Sprague with mention of Merrill Jenkins. The two were pillars in maize breeding, and Sprague is credited as a discoverer of hybrid corn—a finding that forever changed agriculture in Iowa.

Stephen Howell
Director

Getting to the bottom of potato tuberization

How do plant leaves talk to roots and vice versa? Not a trivial question—it's a matter of how a plant coordinates what's happening above ground to what's happening underground. Plant leaves sense the environment and, having perceived appropriate conditions, transmit signals underground to roots, stolons and rhizomes.

Iowa State horticulture professor David Hannapel has found in his studies that the signal is an RNA, a messenger RNA. That would have been unheard of ten years ago. Messenger RNA was thought to stay within a cell slavishly carrying information from the nucleus to cytoplasm.

Using the potato as a model, Hannapel has shown that shorter days cue leaves to export RNA down the vascular system of the plant, signaling stolons to tuberize. The results of this study are described in *The Plant Cell*, "Dynamics of a Mobile RNA of Potato Involved in a Long-Distance Signaling Pathway," December 22, 2006.

Hannapel's study showed that a particular RNA that encodes a protein called BEL 5 is signaled to move by short days. This was demonstrated by growing plants under both long-day and short-day conditions and measuring the accumulation of BEL 5 throughout the plant. Under short days, higher levels of BEL 5 RNA were found at base than at the top of the plant, and concentrations increased

through the stem to the stolon tip indicating that the BEL 5 RNA had traveled. The concentration levels were the reverse for plants grown under long-day conditions.

Experiments also showed that untranslated ends of the BEL 5 RNAs contain the travel information. What Hannapel calls "chaperone" proteins bind to untranslated regions of the RNA and carry it to other regions of the plant.

"When we looked at plants with just the coding sequence, the BEL 5 RNA wouldn't move in response to short days. But when we looked at them with the untranslated regions, it did move in response to short days," Hannapel said. He added that the photoperiod seems to regulate the process.

Increased movements of BEL 5 RNA toward the bottom of the plant were correlated with enhanced tuber production—overexpression of BEL 5 consistently resulted in shorter growing periods and higher yields. A higher yielding potato could be a future application of this work and would be particularly useful in developing countries. In the meantime, Hannapel said, this model system will help scientists to better understand the process of tuberization and the role of mobile RNAs in development. Hannapel's research has been supported by the Plant Sciences Institute and the National Science Foundation.



CCUR Advisory Board members attending February 23, 2007, meeting (from left): Grant Kimberley, Dick Vegors, Jim Foster, Renay Robison-Scheer, Larry Johnson, Frank Barresi, Jeff Stroburg, Andy McPherson, Julius Schaaf.

Seeds of gold/CONTINUED

Sprague had good foresight of how the corn industry would develop—he knew the commercial industry would play a prominent role. He also believed in merging the basic research with application. He worked closely with Raymond F Baker, plant breeder at Pioneer Hi-Bred International. Baker had been a student of Jenkins. Like others, the first hybrids Pioneer produced in the early 1930s had a strong influence from Iowa State.

Recurrent selection, recycling the best of the crop from each cycle over and over, was how Sprague developed such great corn lines. The improvement is incremental from year to year, cycle to cycle. And he released the lines he developed freely. He never patented or assumed ownership of them.

Arnel Hallauer, Sprague's successor at Iowa State said, "He was the most non-territorial sort of fellow you'd want to meet. He was so outstanding himself, he didn't have to worry about it. Everybody knew the contributions he made were great."

George F. Sprague spent his life and career breeding corn. He was known to have high standards and to be diligent in his work. During his 47 years at the USDA and 20 at the University of Illinois, he published throughout. While at Iowa State, he had 32 graduate students. From May to November, he could often be found wearing his work clothes, out in the corn fields.

Epistasis is symposium topic

Epistasis plays critical roles in processes important to livestock and crop improvement and to evolution in natural populations. It is the topic for the 9th Annual Plant Sciences Institute Symposium, "Epistasis: Predicting Phenotypes and Evolutionary Trajectories" to be held May 31–June 3 in the Scheman Building in Ames.

For more information, go to www.bb.iastate.edu/~gfst/phomepg.html.



State representative Lisa Heddens, D-District 46, Ames, and institute associate director Patrick Schnable, at the January 18, 2007, legislative event hosted by the Plant Sciences Institute.

BIOENERGYFOCUS

Agricultural transformation/CONTINUED

sorghum and crotalaria, a legume, would be grown.

The two systems offer ongoing ground coverage and working root systems that will prevent soil erosion and nitrogen leaching. Less run-off and less leaching lead to better water quality, said Liebman.

"You want deep-rooted plants that are actively taking up nutrients for as much of the growing season as possible," he said. "You want to make sure that the root zone is fully occupied to maximize nutrient capture efficiency."

More plant coverage for more time, as the two cropping systems offer, also allows the collection of more carbon, taking it out of the air and storing it.

"One of the interesting things about biofuels and other industrial chemicals is that they are essentially materials with carbon bonds. You don't need the nitrogen, phosphorus, potassium and other elements that livestock and humans require for their nutrition," Liebman said.

After converting the plant materials

to bioindustrial products, these elements can be recaptured in ash and gaseous emissions from the biorefinery, taken back into the field and applied to the crops. The end result should be less energy used to make fertilizer and a

reduction in farmers' fertilizer costs.

Perhaps a crucial aspect of the future farm vision is that crops would be linked to biorefineries through a decentralized network throughout the state, providing jobs across Iowa.

"We have a big demand for liquid fuels and industrial chemicals. That's probably not going to go away," said Liebman. "My end goal is to develop profitable, environmentally

desirable cropping systems for Iowa farmers that can help them meet national energy goals, water quality goals and contribute to rural development."

Liebman and co-workers Rob Anex, Ken Moore and Andrew Heggenstaller are in year two of the field experiments supported by the Plant Sciences Institute.



Agronomy professor Matt Liebman is testing alternative crops for future biofuel production.

Recent research grants

The following 23 new grants totaling \$4.85 million were awarded recently to plant science researchers at Iowa State.

Transcriptional Control of the Maize Vp1 Gene, A Key Regulator of Seed Maturation

USDA—\$324,400

(P. Becraft, genetics, development and cell biology)

Control of Cap-Independent Translation by a Viral 3' UTR

National Institutes of Health—\$211,425

(W. A. Miller, plant pathology)

GEPR: Functional Genomics of Bud Endodormancy Induction in Grapevine

National Science Foundation—\$207,352

(J. Dickerson, electrical and computer engineering)

Bioinformatics and Computational Systems Biology Summer Institute at Iowa State University

National Science Foundation—\$150,000

(R. Jernigan, biochemistry, biophysics and molecular biology)

Robust and Reliable Infrastructure Networks: Identifying Research Priorities

National Science Foundation—\$66,246

(R. Anex, agricultural and biosystems engineering)

Genome Evolution in Diploid and Polyploid Cotton

National Science Foundation—\$816,319

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

Mesoporous Silica-Supported Metal Oxide-Promoted RH Nanocatalysts for Selective Production of Ethanol from Syngas

Department of Energy—\$600,000

(G. Kraus, chemistry)

Risk and Benefit Analysis for Genetically Modified Agricultural Products

USDA, APHIS—\$326,063

(M. Misra, agricultural and biosystems engineering)

Genetic Mechanisms Regulating Inflorescence Architecture in Maize and Related Cereals

National Science Foundation—\$212,457

(E. Vollbrecht, genetics, development and cell biology)

Functional Genomics of the Biotin Metabolic Network of Arabidopsis

National Science Foundation—\$205,000

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

Development of Maturity I-IV Varieties for the Better Bean Initiative

United Soybean Board—\$131,600

(W. Fehr, agronomy)

Incorporation of Field-Scale Risk Assessment Tools into I-Farm for Use by Consultants and Producers

USDA—\$88,000

(R. Anex, agricultural and biosystems engineering)

VCA-PGR: Functional Analyses of Genes Involved in Meristem Organization and Leaf Initiation

National Science Foundation—\$567,924

(P. Schnable, agronomy)

Plant Resistance to Insect Pests Mediated by a Protease

Consortium For Plant Biotechnology Research, Inc.—\$143,750

(B. Bonning, entomology)

Seed Production of Soybean Varieties with Mid-Oleic and 1% Linolenic Acids

United Soybean Board—\$40,000

(W. Fehr, agronomy)

Application of Biotechnology to Control of the Soybean Cyst Nematode: SCN Parasitism Genes

United Soybean Board—\$219,500

(T. Baum, plant pathology)

Functional Analysis of Soybean Genes Through Transposon Mutagenesis

University of Nebraska-Lincoln—\$55,000

(K. Wang, agronomy)

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

Centro Internacional De Agricultura Tropical—\$45,000

(W. White, food science and human nutrition)

Seed Commercialization Project

International Crops Research Institute for the Semi-Arid Tropics—\$193,200

(J. Cortes, Seed Science Center)

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

Centro Internacional De Agricultura Tropical—\$112,000

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

Conjugated Soybean Oil for Use as Ink and Alkyd Resin Drying

United Soybean Board—\$68,300

(J. Verkade, chemistry)

Purchase of Gas Chromatographs with Which to Conduct Fatty Acid Analyses for the Soybean Breeding Program

Iowa Soybean Association—\$44,325

(W. Fehr, agronomy)

Harmonization of USB Soybean NIR Efforts: Whole Grain Instruments

United Soybean Board—\$24,949

(C. Hurlbush, agricultural and biosystems 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, 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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