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U of I Selected to Lead National Study of the Soybean Genome

The University of Illinois was recently selected as the lead institution for a $4.4 million, four-year study of the soybean genome as part of the National Science Foundation's Plant Genome Program.

Entitled "A Functional Genomics Program for Soybean," the project is aimed at generating baseline gene expression data for at least 30,000 unique DNA sequences in the soybean genome that will serve as a major boost for public and private research addressing fundamental problems in soybean biotechnology.

This multi-university effort is headed by Lila Vodkin, professor of soybean genetics in the Department of Crop Sciences at the U of I. Co-principal investigators for the project are Randy Shoemaker, USDA Agricultural Research Service at Iowa State University, Paul Keim, Northern Arizona University, Joseph Polacco, University of Missouri, and Nevin Young and Ernest Retzel, University of Minnesota.

"This NSF program represents a major collaborative effort that will provide the scientific knowledge base needed for rapid expansion of both basic and applied research on soybean genetics," Vodkin says. "Public distribution of the data and analytic tools generated from this project should be a major benefit for the entire community of soybean researchers."

She points out that there are 80,000 to 100,000 different genes in the soybean plant. Until recently, most researchers were limited to studying these genes one at a time rather than looking at many sequences. That approach has changed significantly due to the techniques developed from the $3 billion effort to map the entire human genome.

Lila Vodkin (center), professor of soybean genetics at the U of I, instructs research assistants Rose Gregoire (left) and Jennifer Tarter in the proper techniques for creating a radioactive probe to track soybean DNA. Advanced techniques such as this will play a key role in a new four-year study of the soybean genome funded by the National Science Foundation.

The goal is to speed technology development for this economically important crop

"The human genome project has definitely changed a lot of the ways research is done," Vodkin says. "It is now possible to work on thousands of genes at a time. Once you have the DNA sequence information, computers and other technologies can be used to begin to get a handle on the function of the genes."

The new project will focus on determining the expression of thousands of gene sequences in the soybean plant. These sequences then can offer clues to how the genes function in the plant. Ultimately, this information could be used to produce new soybean varieties with increased yields or new disease resistance or to develop new transgenic plants.

"Obviously we are not going to determine the function of all the genes in the soybean plant," she says. "But, what we are providing is a set of information that will be extremely useful to other soybean researchers. The goal is to speed technology development for this economically important crop."

Vodkin emphasizes that the U of I and the College of Agricultural, Consumer and Environ-mental Sciences are especially well positioned for this state-of-the-art research on the soybean genome.

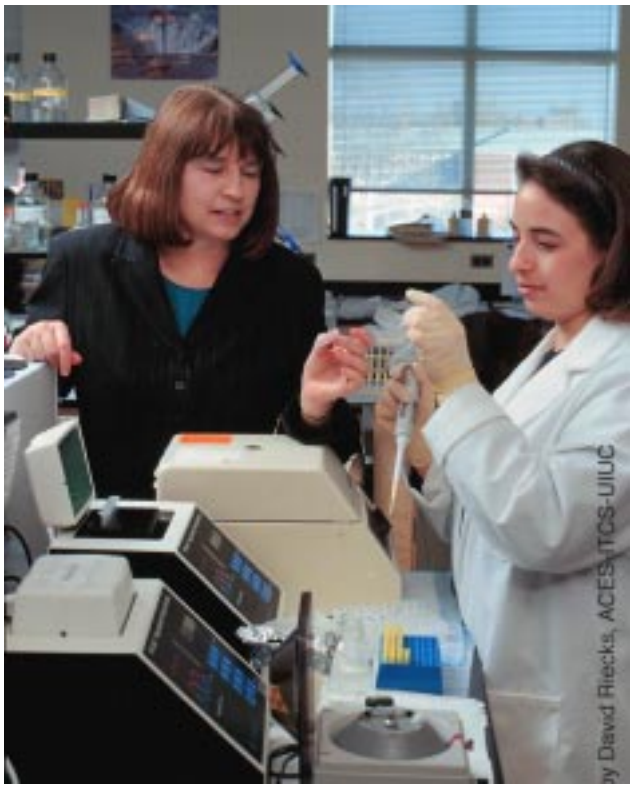
"This campus is home to an impressive array of facilities dedicated to advanced biotechnology research," Vodkin says. "These facilities include the Biotechnology Center, the Keck Center for Functional and Comparative Genomics, and the National Computational Science Alliance."

The U of I also is home to unique facilities dedicated to soybean research, such as the National Soybean Research Laboratory and the USDA Soybean Germplasm Collection, which consists of more than 16,000 plant introductions and soybean varieties from around the world.

"The USDA collection is affiliated with the NSRL, which serves as a focal point for more than 50 soybean research programs on campus," Vodkin says. "Taken together, the U of I's strengths in both biotechnology and soybean research provide a solid base for this new research effort."

She further notes that one of the keys for making this effort possible was the support from the Soybean Checkoff system for an earlier collaborative soybean genome program headed by USDA Agricultural Research Service scientists at Iowa State University. Primary funding for the project came from the United Soybean Board and the North Central Soybean Research Program, representing growers from the 10 leading soybean producing states in the country.

"The fact that the soybean growers through the Checkoff system were willing to invest more than $4 million in the companion and foundation project led by USDA researcher Randy Shoemaker at Iowa State was an extremely positive factor in receiving support for this new project from the NSF," Vodkin says. "The database of 200,000 to 300,000 partial sequences that will be generated from that earlier project have proved vital for our taking this next giant step forward in functional genomics research sponsored by the NSF."



Professor Lila Vodkin (left) assists senior Jennifer Tarter in preparing a sample of soybean DNA for amplification by polymerase chain reaction. One of the keys for making this new study possible was support from the Soybean Checkoff system.

Research Could Hold Key to Preserving Brown Stem Rot Resistance in Soybeans

Although resistance to the disease brown stem rot (BSR) has been incorporated into many soybean varieties, concern is increasing about how long these resistant varieties will maintain their effectiveness.

"The fungus *Phialophora gregata*, which causes BSR, can colonize resistant soybean lines, although this occurs to a lesser degree than in susceptible lines,' says A. Lane Rayburn, associate professor of cytogenetics in the Department of Crop Sciences at the University of Illinois. "In fact, researchers already have reported vascular browning from BSR in one of the major resistant lines. All indications are that resistance seems to be breaking down in certain areas."

Rayburn notes that the break-down in resistance can occur from selection pressures as more and more resistant varieties are grown in a given area. These concerns are similar to those raised about the potential for resistance in genetically engineered Bt-corn.

"In the case of the fungus that causes BSR, the problem is aggravated by changes in tillage systems," Rayburn says. "In no-till cropping systems, BSR appears to occur more frequently than with conventional tillage systems. This change in practices could have a serious negative effect on the continued effectiveness of the genes now used in resistant varieties."

He adds that additional concerns have resulted from the recent discovery of different isolate of the fungus and of two types of the fungus that cause different symptoms of BSR in soybeans.

"The variation of disease symptoms and the potential speed by which more virulent isolates could evolve give great cause for concern," Rayburn says. "This makes it imperative to find ways to quickly assess genetic variability in the disease causing fungus. It also is important to assess this variability in isolates from soybean fields in production. That is the only way to get a true measure of the problem farmers face."

As a result, Rayburn is collaborating with USDA plant pathologist Lynn Gray on solutions that apply modern molecular techniques to unraveling the variability of the fungus that causes BSR. Support for this preliminary research was provided by the U of I Research Board.

"To date, a technique known as flow cytometric analysis has shown the most success," Rayburn says. "It appears to have excellent potential for furthering our knowledge of genetic variability in the fungus and will allow the application of other exciting techniques for solving this puzzle."

He notes that analysis has revealed up to 30 percent variation in the DNA content of the fungus. Ongoing studies of samples from two fields in Champaign County have provided further evidence that DNA variation does exist in farmer's fields.

"The major cause of DNA variation in fungi appears to be chromosome length polymorphisms (CLPs), which are the result of chromosome rearrangements," Rayburn says. "This is probably true for the BSR fungus. And the DNA variability in the fungus may well also indicate differences in the symptoms and virulence of the disease."

Research planned for the 1999 growing season will focus on documenting the DNA variation in Illinois soybean fields and associating specific CLPs with changes in the disease symptoms.

"That will require collecting isolates from production fields in the state," Rayburn says. "Those isolates of the fungus that vary the most will be used to inoculate soybean lines with different levels of BSR resistance. The isolates can then be rated on the types of symptoms produced and the severity of the disease."

He notes that these results may help answer some of the remaining questions, such as what causes the DNA variation and what effect the variation has on the virulence of the fungal pathogen.

Rayburn emphasizes that this field testing is essential for keeping the research effort focused on isolates of the fungus that occur in farmer's fields rather than just in greenhouse or laboratory settings.

"One of the major keys for success is the cooperation of the farmers in this research," he says. "Their help is absolutely essential for ensuring that our techniques will actually benefit producers. That is the ultimate goal for all the work on brown stem rot that we are undertaking in the laboratory."

Research Aims to Keep Soy On Top As Protein Source in Swine Diets

Soybean meal has emerged in the last five decades as the supplemental protein source of choice in swine diets around the world. Yet, from a swine nutrition perspective, the soybean meal marketed today differs very little from that manufactured 50 years ago. The result is an increasing threat from other oilseed meals to the dominance of soybean meal in swine diets.

"A number of factors are eroding the competitive position of soybeans as a component in swine diets," says Bob Easter, head of the Department of Animal Sciences at the University of Illinois. "One major factor is the explosive growth in industrial capacity to produce key amino acids such as lysine, tryptophane, and threonine. This has allowed easy amino acid supplementation of cotton, sunflower, peanut, and other competing oilseed meals, thereby substantially improving their nutritional worth in comparison to soybean meal."

To help meet this challenge, the U of I has launched a comprehensive research program aimed at developing a long-term strategy for improving the fundamental nature of the soybean meal used in swine diets.

Along with Easter, Steve Sonka, director of the National Soybean Research Laboratory, will serve as co-leader of the project. Primary support for this effort is being provided by the Illinois Soybean Checkoff Board.

"The goal of this project is to insure that soybean meal from the U.S. will remain the favored protein source in swine feed formulas, both domestically and globally," Easter says. "We plan to carry this out by building on existing knowledge through five interrelated lines of investigation. This work will provide guidance for work in other research areas and can be used to establish future priorities."

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The first line of investigation will focus on the factors that cause variability and limit utilization of protein and minerals in soybean meal. The research specifically will focus on identifying the indigenous and processing factors that contribute to incomplete digestion of nutrients. Don Mahan of Ohio State University will serve as team leader for this part of the project.

"In this first phase, soybean meal from well-defined points of origin, such as the U.S., Brazil, Argentina, China, and India, and produced under a variety of climatic conditions will be fed to pigs," Easter says. "Digestion measurements will be used to correlate variations in digestibility with changes in the components of the meal. Subsequently, selected components such as oil, hulls, and processing factors will be evaluated to precisely determine their effect on digestibility."

The second closely related area of research will focus on carbohydrates in the soybean. Many of the complex carbohydrate molecules are indigestible and may have negative nutritional value.

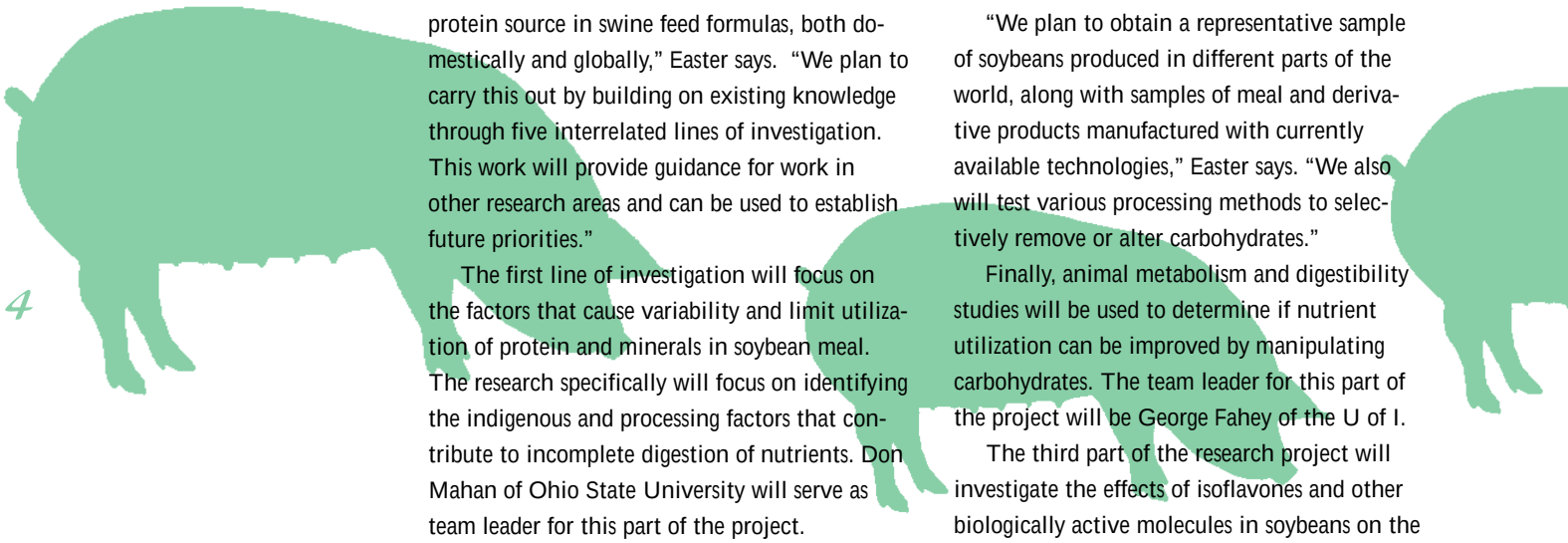
"These indigestible carbohydrates contribute fermentable carbon, which can lead to odor production," Easter says. "They also result in undigested residues, which increase the mass of waste from a livestock operation. To our knowledge, the nature of these carbohydrates have not been comprehensively defined, nor have new techniques such as enzyme processing been explored as methods for improving their utilization."

The first phase of this effort will consist of a detailed literature review of known factors affecting the nutrient composition of soybeans and soybean meal. From that base, decisions will be made on what analytical chemistries to use for the next phase of the work.

"We plan to obtain a representative sample of soybeans produced in different parts of the world, along with samples of meal and derivative products manufactured with currently available technologies," Easter says. "We also will test various processing methods to selectively remove or alter carbohydrates."

Finally, animal metabolism and digestibility studies will be used to determine if nutrient utilization can be improved by manipulating carbohydrates. The team leader for this part of the project will be George Fahey of the U of I.

The third part of the research project will investigate the effects of isoflavones and other biologically active molecules in soybeans on the



George Fahey (left) and Bob Easter of the Department of Animal Sciences at the U of I check results from high-pressure liquid chromatography as part of a new program aimed at maintaining the position of soy meal as the primary protein source in swine diets around the world. Primary Funding for the program is provided by the Illinois Soybean Checkoff Board.

We expect to include top-notch scientists from a number of other universities as partners

reproduction rate and carcass composition of pigs. Plans call for feeding soybean meals with both high and low levels of these compounds to pigs and examining the effects on sow reproduction and on muscle growth and composition.

Todd Winters of Southern Illinois University and Tim Stahly of Iowa State University will serve as co-leaders of this phase of the project.

Another major effort will compare the effects of feeding soybean meal and other proteins on the taste and quality characteristics of pork. Research will include a series of feeding trials using soybean meal and other oilseed proteins, followed by sensory evaluation of the resulting pork. The project leaders for this effort will be Floyd McKeith and Mike Ellis of the U of I.

"This a totally unexplored area of research," Easter says. "If the results are favorable, it could create the opportunity for consumers to specifically seek soy-fed pork products."

In the final phase of the project, Kelly Zearing of North Carolina State University will head up an economic analysis of selected scenarios for the evolution of U.S. soybean production, processing, and demand for the next decade.

The overall program is expected to continue for a minimum of three years. Participants are encouraged to participate and share preliminary results as part of the Soy and Animal Nutrition Symposium at the 1999 Global Soy Forum in Chicago.

"This project represents an attempt to bring together the best talent available in swine nutrition to comprehensively investigate the optimization of soybean meal as a component in swine diets," Easter says. "We expect to include top-notch scientists from a number of other universities as partners in each of the five major areas of our study."

U of I Joins in World Class Plant Science Research Center

A partnership in a $146.4 million plant science center to be built in St. Louis offers University of Illinois scientists new opportunities to use innovative technology to increase yields, improve nutritional components of grain and address other crop productivity problems.

The U of I joined the Missouri Botanical Garden, Monsanto Company, University of Missouri-Columbia and Washington University in St. Louis in planning the Donald Danforth Plant Science Center, a not-for-profit research facility scheduled to open in 2000.

With state-of-the-art laboratories on the blueprint, the Danforth Center is expected to become a landmark plant biotechnology research facility in the Heartland and one of the top plant research facilities in the world. Research will focus on developing environmentally sound solutions to problems of providing food and plant-related products worldwide.

"It makes sense to have this facility in the major agricultural region of the country and cen-tral to established plant science research programs that already are addressing the broad, complex challenge of feeding the world," says Steven G. Pueppke, associate dean for research at the U of I College of Agricultural, Consumer and Environmental Sciences.

"We see great advantages for our scientists and students to be able to drive a couple of hours and find the latest equipment and technologies for research, participate in new developments and explore new ideas," he says. "At the same time, the U of I has an excellent, integrated system that spans basic research to delivery of research benefits to growers. We expect the Danforth Center researchers will want to come to campus to work with our faculty and facilities."

Partnership in the new plant science center carries no financial cost for the U of I and will not prevent U of I scientists from continuing to collaborate with researchers at other institutions, Pueppke noted. A U of I representative will sit on the board of directors.

"We hope this partnership will facilitate collaborative, innovative thinking among scientists," he says. "The result could be drought-resistant plants, a more nutritious corn kernel, high-oil grains, edible plant vaccines and other goals yet to be imagined, he says.

The Danforth Center was founded with donations, including a $60 million pledge from the Dan-forth Foundation and an $81.4 million pledge of funds and land from the Monsanto Fund. The center will be built on 40 acres north of Olive Street, east of Lindbergh Boulevard and west of Warson Road in St. Louis. Plans include laboratories, greenhouses, a library and meeting facilities.

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New Service Matches Soybean Buyers And Sellers

Soybean buyers and sellers from around the world can make business connections through a new Internet bulletin board. A Buy/Sell Page for trade queries is the newest service on StratSoy, a Web-based information and communication system for the soybean industry (http://www.ag.uiuc.edu/~stratsoy/).

StratSoy was developed at the University of Illi-nois College of Agricultural, Consumer and Environmental Sciences. The project is funded with farmer checkoff dollars from the United Soybean Board.

The StratSoy Buy/Sell Page is the first Web-based bulletin board dedicated exclusively to the soybean industry trade needs, according to Pradeep Khanna, StratSoy project manager. The StratSoy team developed the service in response to e-mail inquiries which showed both a growing demand for U.S. soybeans and products in world markets and a need to better service that demand.

The electronic bulletin board is free, although users must register online with StratSoy to post trade queries. Online forms allow users to post and search trade queries instantaneously. Users can view posted information and respond directly to the person or business listed as a contact.

"StratSoy receives a large number of soybean related trade queries, many of them from overseas buyers who want to buy less than a shipload of U.S. soybeans or soybean derivatives, such as oil and meal," Khanna says. "Similar requests are also received from sellers. Before the Buy/Sell Page, there was no efficient mechanism to disseminate information about these queries."

This is the first Web-based bulletin board dedicated exclusively to the soybean industry trade needs

The StratSoy project will monitor the service only to ensure postings are related to soybean trade. Users are responsible for verifying information they find on the Buy/Sell Page.

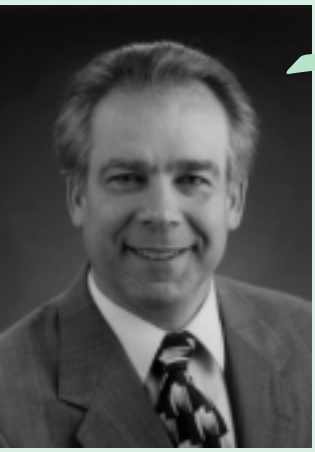
Past e-mail messages to StratSoy suggest that China, Japan and other Asian companies looking for U.S. soybeans will be heavy users of the Buy/Sell Page, Khanna said. He also expects buyers in Mexico and the Caribbean to use the service. Sellers are likely to be small- to medium-size U.S. processors looking for international business opportunities.

"The system will directly benefit the U.S. soybean industry," Khanna says. "The international buyers who send their trade queries to StratSoy may not always know of currently available sources for U.S. soybeans in their country or region. This system creates an excellent mechanism for matching demand with supply and an opportunity to increase sales of U.S. soybeans."

The Buy/Sell Page is one of several new services on StratSoy, which already offers an extensive list of soybean-related resource links and an Ask an Expert service. Other interactive tools introduced recently include the Expected Processing Value (EPV) calculator and the StratSoy Basis Service.

The EPV calculator can be used to figure soybean value on the basis of oil and protein content. The StratSoy Basis Service can help producers determine the most profitable time to market corn and soybeans.

"The StratSoy goal is to increase the profitability of the U.S. soybean industry worldwide," Khanna says. "Working on phase II now, the StratSoy team is looking for ways to enrich the StratSoy Web site so that it improves as a user-friendly, comprehensive source of information for the U.S. soybean industry. We expect more interactive decision-making tools will be created and made accessible on StratSoy."



From the Director's Desk

This issue of the NSRL Bulletin high lights important research efforts addressing key challenges. Issues such as gene sequencing, development of new products, and strategic change are of considerable interest throughout the global soybean sector. These, and issues of similar importance and scope, will be addressed during the upcoming Global Soy Forum. This event, which includes the Sixth World Soybean Research Conference, will be held in Chicago, August 4-7, 1999. (More specific information about this unparalleled event can be found at http://www.gsf99.uiuc.edu or by contacting me at the NSRL address included in this newsletter.)

In this note, I'd like to focus on the word "global" as it applies to today's soybean sector and the Global Soy Forum. Most of us are comfortable with the geographic dimensions of the word "global." Geographically, soybean production is concentrated in the Americas, China and India. Soybean consumption, however, extends to nearly all reaches of the world.

But, there is another key aspect of the global soybean sector that we, as researchers, must increasingly be aware of. That dimension relates to the soybean value chain, which extends from genetics and breeding to production and business management to utilization and consumer behavior.

In business today, firms know that their individual performance affects and is affected by the entire value chain in which they operate. Further, companies in the 1990's learned that enhancing the performance of the entire chain could lead to greater levels of success for the individual firms as well. To accomplish these goals, firms need to consider each decision, not just in terms of the direct effects within the firm, but also relative to the firm's suppliers and customers.

As researchers, the issues we address increasingly have implications at more than one level of the soybean value chain. For example, genetic implications that alter the output traits of soybeans will require adaptations throughout the production and marketing system. Clearly sound science must continue to be the cornerstone of our efforts. However, if we are to most effectively advance social well-being, we need to understand how our scientific advances will alter the entire soybean value chain.

One of the organizing principles of the Global Soy Forum is that it will involve participants (researchers, producers, agribusiness and policy managers) from throughout the soybean value chain. Participants at the Forum will have an exciting opportunity to examine and evaluate key issues that will define the future of the sector. This opportunity will be uniquely enhanced because of the contributions of a truly global collection of speakers and participants—a collection that is global, both geographically and from the perspective of the entire soybean value chain.

Steven Sonka
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