



# 2002



**C-FAR**

Illinois Council on Food and Agricultural Research

— A Partnership for Illinois Food and Agriculture



## OUR MISSION

**The mission of the Illinois Council on Food and Agricultural Research (C-FAR) is to secure additional resources to adequately fund relevant and high-quality research and related outreach programs that lead to profitable, consumer-sensitive, and environmentally sound food and agricultural systems in Illinois and the nation.**

**C-FAR will foster public confidence in food and agricultural research through public participation in planning and evaluating the process and impact of research activities.**



# A PARTNERSHIP FOR ILLINOIS FOOD AND AGRICULTURE

**State of Illinois • Food and Agricultural Industry Leaders • Consumers •  
University of Illinois at Urbana-Champaign • Southern Illinois University at  
Carbondale • Illinois State University • Western Illinois University • Other  
Research Entities**

The Illinois Council on Food and Agricultural Research (C-FAR) is a statewide coalition organized to support relevant, high-quality research and related outreach programs for Illinois' food and agricultural systems. C-FAR was founded in December 1993 to address the critical need to increase levels of state funding for food and agricultural research and thus ensure the advancement and success of Illinois' number one industry. C-FAR membership has grown to 70 food, agriculture, consumer, environmental, and related organizations; 39 state and university entities; and a host of individuals who support the mission of C-FAR. C-FAR is structured around five working groups associated with critical areas of food and agricultural research: expanding agricultural markets, rural economic development, agricultural production systems, human nutrition and food safety, and natural resources. The working group design enables members to play a key role in determining the direction of C-FAR-funded research with the goal of maximizing benefits from the C-FAR investment.

C-FAR members look forward to working with Governor Blagojevich, the Illinois General Assembly, and Illinois' research community over the coming year to strengthen our state's food and agricultural research programs.



**State of Illinois  
Rod R. Blagojevich, Governor**

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# MESSAGE FROM C-FAR



Dear Friends,

We are proud to present this 2002 *Annual Report*. It represents the vitality of our organization and the *results* of the State of Illinois' investment in food and agricultural research. We encourage you to review its various sections.

2003 is a special year for C-FAR—it's our 10<sup>th</sup> anniversary. In December 1993, C-FAR was chartered as a nonprofit corporation in the State of Illinois. As we mark this milestone, we see a future filled with opportunities. This perspective stems from several developments.

First, our research capabilities are expanding because of a number of ongoing infrastructure improvements across our state, including the revamping of university-based research farms, the recruitment of key faculty with expertise in and appreciation for research that benefits end users, and the construction of new facilities that can propel research initiatives across many fronts. Second, during the past 10 years, C-FAR has built a remarkably vibrant and dedicated membership. Furthermore, C-FAR's unique partnership, in which members work side-by-side with representatives from Illinois' research community, has paid and will continue to pay dividends.

C-FAR's opportunities to advance Illinois' food and agricultural systems are literally endless. They include creating additional value for our agricultural products and, as a result, additional income for our producers; ensuring the safety of our foods; adopting economically viable alternative agricultural enterprises; reducing disease and insect threats to our crops and livestock; and protecting our natural resources—just to name a few.

While a strong foundation for research and an engaged private sector are critical to seizing these opportunities, an appropriate investment in food and agricultural research by the State of Illinois is equally important. The reduction of C-FAR's appropriation from \$15 million in fiscal year 2002 (FY02) to \$6.9 million in FY03 is widely, if not unanimously, considered only a *temporary* setback. Legislators, industry representatives, and consumers alike clearly understand the importance of adequately funding meaningful research to support Illinois' number one industry. As stated in C-FAR's enabling legislation, the Food and Agriculture Research Act, "Illinois should be among the top 10 agricultural states in State funding." Based on FY01 expenditures (the most recent data available), Illinois ranked 18<sup>th</sup> in funding for food and agricultural research. Reaching the goal of ranking in the top 10 is critical to the future success of Illinois' food and agricultural industry, and it will require unwavering determination and commitment by our membership, State of Illinois officials, and other dedicated individuals throughout Illinois.

Given the foundation we have laid in the past 10 years, we look forward to building upon and strengthening Illinois' existing research capabilities and the stakeholder–researcher partnerships established through C-FAR. Together, we can seize countless opportunities that will benefit not only our industry but also every Illinois citizen.

**Alan Puzey**  
Chairman of the Board

**Kraig A. Wagenecht**  
Executive Administrator

# C-FAR RESEARCH: BENEFITING ALL ILLINOIS CITIZENS

## C-FAR Research: Benefiting All Illinois Citizens

C-FAR research provides solutions and creates new opportunities in areas extending far beyond those associated with traditional agriculture, and these solutions and opportunities benefit all citizens of Illinois. C-FAR-funded research addresses such areas as

- food security
- natural resource protection
- crops and livestock production
- food safety and human nutrition
- information technologies
- rural community development
- value-added enterprises
- agritourism
- grape and wine production
- horticulture
- land-use and planning strategies
- watershed management

One example of how C-FAR-funded research benefits both Illinois producers and consumers is the ongoing development of networks between livestock producers and small to medium-sized processors, purveyors, and retailers. These partnerships make it possible to provide value-added meat products to currently underserved markets. For instance, research suggests that the Hispanic community in and around Chicago is a rapidly growing market for specialty pork products not currently available in larger grocery chains.

Another example of C-FAR's broad scope is the program "Food Safety: It's a Life Science," which the council supported in cooperation with the *Chicago Tribune*, Illinois Restaurant Association, GOJO Industries, Illinois State Board of Education, Illinois Department of Public Health, and Western Illinois University. This program educated more than 43,000 elementary students located in and around Chicago about the importance of food safety.

These and the many other traditional and nontraditional food and agricultural research initiatives supported by C-FAR result in a diversified portfolio for Illinois. Key stakeholder engagement ensures that this portfolio is targeted to concerns and opportunities specific to Illinois.

## C-FAR Dollars Leveraged to Benefit Illinois

Another significant benefit of the C-FAR appropriation is that it is leveraged to attract additional dollars into Illinois' state economy. C-FAR dollars are leveraged to obtain roughly *four times* the amount in additional funding to support high-impact research. The following examples demonstrate the critical role C-FAR's investment plays in generating significant outside funding:

- C-FAR-funded research on the health benefits of broccoli and other foods has allowed Illinois researchers to secure a \$2.5 million U.S. Department of Agriculture (USDA) grant.
- More than \$1.1 million in additional funds have been leveraged by C-FAR-funded researchers studying how atmospheric change affects agronomic and productivity traits of midwestern crops. This project, called "SoyFACE," uses free-air concentration enrichment (FACE) technology to find solutions for facilitating crop adaptation to the higher levels of carbon dioxide and ozone that are anticipated for the middle of this century. Located at the University of Illinois at Urbana-Champaign, this research facility is the largest open-air laboratory in the world for investigating how changes in atmospheric composition

# C-FAR DOLLARS LEVERAGED TO BENEFIT ILLINOIS

will affect crops. “The funding from C-FAR has provided the core on which we have been able to build and without which none of this would have been possible,” notes Dr. Stephen Long, principal investigator.

- C-FAR-funded researchers have obtained almost \$10 million in additional funding to investigate issues related to swine odor and manure management. Researchers are developing a variety of technologies designed to support an environmentally sustainable, socially acceptable, and economically viable swine industry within Illinois. This special initiative focuses on helping producers meet the guidelines set forth in the Livestock Management Facilities Act (510 ILCS 77/1 *et seq.*) and on providing solutions to address social concerns related to swine odor and waste.

- The Illinois Laboratory for Agricultural Remote Sensing (ILARS), established with C-FAR funds, has attracted more than \$1 million in outside funds, including research funding, equipment, sensor usage, and airplane flight service. The laboratory has also brought together many top scientists from the National Aeronautics and Space Administration (NASA), the National Center for Supercomputing Applications (NCSA), and the USDA. ILARS is expected to become a world center

**The National Research Council reports that the economic rate of return on public investment in food and agriculture research is 35 to 60% per year (March 2001). Additional studies indicate that each tax dollar invested in agricultural research ultimately returns more than \$8 in public benefits.**

for agricultural remote sensing research and development.

- Researchers have leveraged C-FAR dollars to obtain more than \$5.26 million in additional funds to boost rural development in Illinois. This rural community development research initiative has resulted in 64 agri-enterprise start-ups and expansions; 181 full-time jobs created or retained; \$4.28 million attributable sales increases; \$7.74 million new capital investments; and \$3.57 million in loan packages.

- C-FAR-funded beef research played an integral part in the successful development and funding of the Five State Beef Initiative (Illinois, Indiana, Ohio, Michigan, and Kentucky). This \$2.5 million, three-year program funded by the USDA aids the Eastern Corn Belt’s beef industry in producing and marketing high-quality beef products. Beef producers who apply program principles can expect to gain premiums ranging from \$50

to \$150 per animal, and consumers receive a higher quality, more consistent meat product at the grocery store.

- The C-FAR-funded water quality research team has secured more than \$2 million in additional funding to better understand water quality issues in Illinois. This multifaceted team works with state agencies so that regulators and lawmakers can use sound, scientific information to help establish policy. Researchers are identifying best management practices, studying the sources and movement of nutrients through Illinois watersheds, and developing and employing computer models to help predict consequences of alternative land management and agronomic practices on Illinois water quality.

These initiatives, and the millions of additional dollars secured for our state’s economy, would not have been possible without the C-FAR appropriation and the direction provided by C-FAR members.

# 2002 HIGHLIGHTS

## Membership Retreat and Annual Meeting

The C-FAR membership convened for a two-day retreat on February 13 and 14 in Findlay, Illinois. This special event, held once every three years, allows members to share their insights and experiences in order to identify priority research needs for the food and agriculture industry in Illinois. The C-FAR working groups used this opportunity to revise research focus areas and identify possible new strategic research initiatives to fund. In addition to setting new research priorities, the working groups elected chairs and vice chairs to serve in 2002.

Senator Duane Noland provided opening remarks at the retreat and received special recognition from C-FAR for his distinguished service in the Illinois General Assembly. Senator Noland, who retired in January 2003, spoke about the importance of C-FAR and how Illinois must “strategically plan what is ahead for us in agriculture.” Senator Noland played an instrumental role in passing the Food and Agriculture Research Act, C-FAR’s enabling legislation.

The C-FAR Annual Meeting was held on February 14, following the membership retreat. Terry Wolf (Homer) received special recognition for his service on the board of directors from 1996 to 2002 and as chairman from 1996 to 2001. Wolf currently serves as president of the National Coalition for Food and Agricultural Research.



**Nels Kasey, chair (standing), and Roger Hubele, John Huston, and Paul Gebhart (seated, left to right) assist in identifying research needs during the Expanding Agricultural Markets Working Group session at the 2002 Membership Retreat.**

## Semi-Annual Meeting

At the semi-annual meeting held on August 20 in Springfield, C-FAR members displayed their commitment to helping guide future research initiatives despite budget cuts to the C-FAR appropriation. C-FAR’s working groups dedicated most of the day to prioritizing research needs across the organization’s entire research portfolio. “Despite a temporary setback in this year’s appropriation, the membership’s near-record attendance at this meeting illustrates the food and agricultural industry’s commitment to a viable research program,” said Alan Puzey, C-FAR chairman.

During the meeting, C-FAR members unanimously endorsed a proposal to request a \$15 million appropriation in FY04. This funding level is necessary to reestablish research programs that had to be eliminated or reduced this fiscal year (FY03).

C-FAR members also made important structural decisions during the meeting. The membership decided to increase the number of elected directors on C-FAR’s board from six to seven. C-FAR’s board of directors currently has six elected directors and the past chair serves in an ex officio capacity. Members determined that adding another director to the board would provide for greater representation—an important consideration given the substantial increase in C-FAR’s membership during the past several years.

The membership also adopted a change to the organization’s bylaws that specifies additional qualifications for working group chairs and vice chairs. The new qualifications stipulate that working group chairs and vice chairs shall not receive (either directly or indirectly) C-FAR funds or be employed by an entity that receives C-FAR funding. (Note: These qualifications, and the same for the Board of Directors, will be reconsidered at the 2003 Annual Meeting.)



**Donald Ort, professor in the University of Illinois Department of Crop Sciences, explains the effects of carbon dioxide and ozone changes on soybean development at the SoyFACE research site during 2002 Agronomy Day.**

### **SoyFACE Featured at UIUC Agronomy Day**

C-FAR's SoyFACE project, funded through the University of Illinois at Urbana-Champaign's Sentinel Program, was featured at the university's 2002 Agronomy Day held on August 22. This research initiative exploits a new technology—free-air concentration enrichment (FACE)—to examine the effects of atmospheric changes, including increases in carbon dioxide and ozone, on crop production. This research will help producers better prepare for future environmental conditions. A special tour included stops at multiple field-research sites to allow participants to view ongoing experiments and visit with researchers firsthand. SoyFACE is situated on 80 acres at the southern edge of the University of Illinois' new South Farms. It is the largest open-air laboratory in the world for investigating how the atmosphere's changing composition will affect crops.

### **C-FAR Day at Southern Illinois University**

The second C-FAR Day was held on November 14 at Southern Illinois University in Carbondale. C-FAR members from across Illinois traveled to SIUC to tour research facilities and spend the day learning more about how our investments at the university are making progress in a wide range of areas, including value-added agriculture, biotechnology, nutrition and health, water quality, plant diseases, and agricultural waste management. Members enjoyed the special opportunity to visit with C-FAR-funded researchers and to see firsthand a sampling of new technologies and other advances in Illinois food and agriculture made possible through C-FAR.



**James Blackburn, professor of mechanical engineering and energy processes, explains his research on a new process for reducing odor and antibiotics in swine waste to C-FAR members during C-FAR Day at Southern Illinois University at Carbondale.**

# WHO'S WHO

Illinois Council on Food and Agricultural Research

## 2002 Board of Directors

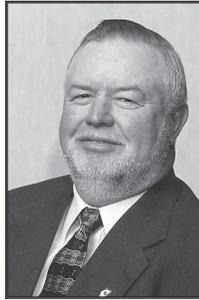
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**Alan Puzey**  
CHAIRMAN OF THE BOARD,  
FAIRMOUNT



**David Downs**  
VICE CHAIRMAN OF THE  
BOARD AND RESEARCH  
CHAIR, ALLERTON



**Fred Bradshaw**  
SECRETARY-TREASURER,  
GRIGGSVILLE



**Constance Locher  
Bussard, R.D.**  
LEGISLATIVE CHAIR,  
SPRINGFIELD



**Carol Keiser**  
MEMBERSHIP CHAIR,  
CHAMPAIGN



**Larry Fischer**  
RESEARCH VICE CHAIR,  
PITTSFIELD



**Jack Erisman**  
PAST CHAIR, PANA

## Staff



**Kraig A. Wagenecht**  
EXECUTIVE ADMINISTRATOR



**LeAnn M. Ormsby**  
COMMUNICATIONS DIRECTOR

## Additional C-FAR Staff

**Rhonda Hunter**  
ADMINISTRATIVE ASSISTANT

**Gloria Buhmester**  
SECRETARY

## 2002 Working Group Leadership

### Expanding Agricultural Markets



**Nels Kasey**

CHAIR, PARIS



**Phil Borgic**

VICE CHAIR, NOKOMIS

### Rural Economic Development



**A.J. Harland**

CHAIR, LAFAYETTE



**Karla Hart**

VICE CHAIR, SIMPSON

### Agricultural Production Systems



**Brent Bidner**

CHAIR, MONTICELLO



**Molly Ann Godar**

VICE CHAIR, ROCHESTER

### Human Nutrition and Food Safety



**Karen Little**

CHAIR,  
PLEASANT PLAINS



**Jeanne Harland**

VICE CHAIR, LAFAYETTE

### Natural Resources



**Susan Adams**

CHAIR, ATLANTA



**Byford Wood**

VICE CHAIR, BREESE

# 2002 C-FAR MEMBERS

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## ORGANIZATIONAL MEMBERS

Association of Illinois Soil and Water Conservation Districts

Audubon Council of Illinois

Champaign County Farm Bureau

Dairy Management, Inc.

DuPage County Farm Bureau

Environmental Law and Policy Center of the Midwest

Grain and Feed Association of Illinois

GROWMARK, Inc.

Hancock County Farm Bureau

Horsemen's Council of Illinois

Horseradish Growers of Illinois

Illinois Agri-Women

Illinois Aquaculture Industry Association

Illinois Association of Drainage Districts

Illinois Association of Meat Processors

Illinois Beef Association - Checkoff Division

Illinois Beef Association - Dues Division

Illinois Corn Growers Association

Illinois Corn Marketing Board

Illinois Dietetic Association

Illinois Farm Bureau

Illinois Farm Business Farm Management Association

Illinois Farm Credit Services

Illinois Farmers Union

Illinois Fertilizer and Chemical Association, Inc.

Illinois Forage and Grassland Council

Illinois Grape Growers & Vintners Association

Illinois Lamb and Wool Producers, Inc.

Illinois Landscape Contractors Association

Illinois Milk Producers' Association

Illinois Nurserymen's Association

Illinois Pork Producers Association

Illinois Pork Producers Association-Checkoff Division

Illinois Restaurant Association

Illinois Seed Trade Association, Inc.

Illinois Society of Professional Farm Managers & Rural Appraisers

Illinois Soil Testing Association

Illinois Soybean Association

Illinois Soybean Program Operating Board

Illinois Specialty Growers Association

Illinois State Beekeepers Association

Illinois State Grange

Illinois State Horticultural Society

Illinois State University Agriculture Alumni Association

Illinois State Veterinary Medical Association

Illinois Stewardship Alliance

Illinois Sustainable Agriculture Society

Illinois Thoroughbred Horsemen's Association

Illinois Turfgrass Foundation, Inc.

Illinois Wheat Association

Institute of Food Technologists, Chicago Section

Kane County Farm Bureau

Kankakee County Farm Bureau

Knox County Farm Bureau

Lake Vermilion Water Quality Coalition

Macoupin County Farm Bureau

Madison County Farm Bureau

Mason County Farm Bureau

Mercer County Farm Bureau

Midwest Dairy Association

Orr Agricultural Research Center

Rural Partners

Safer Pest Control Project

Southeastern Illinois Sustainable Agriculture Association

Southern Illinois University Agriculture Alumni Society

The Chicago Farmers

University of Illinois at Urbana-Champaign, College of Agricultural, Consumer and Environmental Sciences Alumni Association

University of Illinois at Urbana-Champaign, College of Veterinary Medicine Alumni Association

Warren-Henderson Farm Bureau

## **AFFILIATE MEMBERS**

**Central Illinois Agricultural Research Farms, Inc.**

**Greene Farm Management Services, Inc.**

**Illinois Crop Improvement Association, Inc.**

**Illinois Department of Natural Resources**

**Illinois Farm Development Authority**

**Illinois Forestry Development Council**

**Illinois Grape and Wine Resources Council**

**Illinois Institute for Rural Affairs**

**Illinois State Geological Survey**

**Illinois State University, Department of Agriculture**

**Illinois State Water Survey**

**National Center for Food Safety and Technology**

**Sangamon County Soil and Water Conservation District**

**Shawnee Community College**

**Southern Illinois University at Carbondale, Center of Excellence for Soybean Research, Teaching and Outreach**

**Southern Illinois University at Carbondale, College of Agriculture**

**Southern Illinois University at Carbondale, Department of Agribusiness Economics**

**Southern Illinois University at Carbondale, Department of Animal Science, Food and Nutrition**

**Southern Illinois University at Carbondale, Department of Forestry**

**Southern Illinois University at Carbondale, Department of Plant, Soil and General Agriculture**

**Southern Illinois University at Carbondale, Fisheries and Illinois Aquaculture Center**

**Southern Illinois University at Carbondale, Office of Economic and Regional Development**

**University of Illinois at Chicago, College of Pharmacy**

**University of Illinois at Springfield, Abraham Lincoln Presidential Center for Governmental Studies**

**University of Illinois at Urbana-Champaign, College of Agricultural, Consumer and Environmental Sciences**

**University of Illinois at Urbana-Champaign, College of ACES, Information Technology and Communication Services**

**University of Illinois at Urbana-Champaign, College of Veterinary Medicine**

**University of Illinois at Urbana-Champaign, Department of Agricultural and Consumer Economics**

**University of Illinois at Urbana-Champaign, Department of Agricultural Engineering**

**University of Illinois at Urbana-Champaign, Department of Animal Sciences**

**University of Illinois at Urbana-Champaign, Department of Crop Sciences**

**University of Illinois at Urbana-Champaign, Department of Food Science and Human Nutrition**

**University of Illinois at Urbana-Champaign, Department of Human and Community Development**

**University of Illinois at Urbana-Champaign, Department of Natural Resources and Environmental Sciences**

**University of Illinois at Urbana-Champaign, Department of Veterinary Biosciences**

**University of Illinois at Urbana-Champaign, Department of Veterinary Clinical Medicine**

**University of Illinois at Urbana-Champaign, Department of Veterinary Pathobiology**

**Western Illinois University, Department of Agriculture**

**Western Illinois University, Department of Family and Consumer Sciences**

## **INDIVIDUAL MEMBERS**

**In 2002, C-FAR had 138 individual members.**

# C-FAR COMMITTEES

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## ■ Research Committee

The purpose and charge of this committee is to

- inquire into and prepare reports on current and planned research in Illinois on food and agriculture
- seek recommendations on research needs from (a) research professionals currently conducting such research at Illinois universities or elsewhere, (b) interested persons and groups, and (c) the public
- identify research beneficiaries
- prepare recommendations regarding research needs, processes, and impacts, and pursue their implementation as authorized
- foster public confidence in ongoing food and agricultural research by engaging public participation in planning and evaluating the process and impact of research activities

### **Committee members:**

David Downs, chair; Larry Fischer, vice chair; Susan Adams; Brent Bidner; Bill Fisher; Jim Fraley; Cimeron Frost; Paul Gebhart; A.J. Harland; Karla Hart; Michael Herrin; Nels Kasey; Steve Kasten; Dan Kelley; Heather Hampton Knodle; John Little; Karen Little; John Quandt; Wendell Shauman; Walt Townsend; and Derek Winstanley. Ex officio members: George Fahey, Steven Pueppke, Danny Terry, Randy Winter, and Anthony Young.

## ■ Nominating Committee

The purpose and charge for this committee includes soliciting and receiving nominations for the board of directors from organizational members and presenting a slate of candidates to be voted on by the C-FAR membership at the annual meeting.

### **Committee members:**

Jack Erisman, chair; Jeff Adkisson; Shannon Allen; Steve Calhoun; Kendall Cole; John Huston; William McCartney; and Bob Swires.

## ■ Rules and Procedures Committee

This committee, in consultation with the other committees, monitors C-FAR processes and develops proposals for improvements as needed.

### **Committee members:**

Norbert Soltwedel, chair; Rick Dean; Don Doehring; Pam Hansen; Dale Hedrick; Gary Heichel; Kent Krukewitt; and Dennis Thompson.

# RESEARCH PARTNERS

## University of Illinois at Urbana-Champaign

College of Agricultural, Consumer and Environmental Sciences



**Robert A. Easter,**  
Dean



**Steven G. Pueppke,**  
Associate Dean for  
Research



**George C. Fahey, Jr.,**  
Assistant Dean,  
Research Leadership-  
C-FAR

**The University of Illinois at Urbana-Champaign** carries out C-FAR-funded research in areas including

- agricultural and consumer economics
- agricultural engineering
- animal sciences
- crop sciences
- food science and human nutrition
- human and community development
- natural resources and environmental sciences
- specialty crops
- value-added agriculture
- veterinary medicine

## Southern Illinois University at Carbondale

College of Agricultural Sciences



**W. David Shoup,**  
Dean



**Anthony W. Young,**  
Associate Dean for  
Research

**Southern Illinois University at Carbondale** carries out C-FAR-funded research in areas including

- agribusiness economics
- animal sciences
- crop sciences
- food science and human nutrition
- forestry
- rural community development
- specialty crops
- water quality

## Illinois State University

Department of Agriculture



**J. Randy Winter,**  
Chair

**Illinois State University** carries out C-FAR-funded research in areas including

- animal sciences
- aquaculture
- crop sciences
- food safety
- horticulture
- rural economic development
- soil sciences
- water quality

## Western Illinois University

Department of Agriculture



**Danny E. Terry,**  
Chair

**Western Illinois University** carries out C-FAR-funded research in areas including

- alternative crops
- animal sciences
- crop sciences
- food safety education
- rural economic development
- sustainable agriculture
- value-added agriculture

# RESEARCH PROGRAMS

## FISCAL YEAR 2002

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In 1995, the Illinois General Assembly and then-Governor Jim Edgar passed the Food and Agriculture Research Act, the enabling legislation that provides the framework for C-FAR funding and research activity. In FY02, Governor George H. Ryan and the Illinois General Assembly appropriated \$15 million to C-FAR. (This appropriation was reduced midyear to \$14.7 million due to State of Illinois budget concerns.)

### **Funds are allocated to three C-FAR research programs:**

#### **Strategic Research Initiatives**

The Strategic Research Initiatives (SRIs) are team-based research efforts that provide a targeted, multidisciplinary, and multi-institutional approach for addressing major issues and concerns of the Illinois food and agricultural industry and consumers.

#### **University Internal Programs**

These programs are supported by funds for food and agricultural research allocated directly to the University of Illinois at Urbana-Champaign, Southern Illinois University at Carbondale, Illinois State University, and Western Illinois University. Each university sponsors an internal competitive grants program to solicit creative, innovative, high-quality research that addresses C-FAR priorities. In 1999, the University of Illinois initiated its C-FAR Sentinel Program as part of the university's internal research program. The Sentinel Program's purpose is to take advantage of opportunities for performing creative, problem-solving research.

#### **External Competitive Grants Program**

C-FAR's enabling legislation stipulates that a minimum of 15% of the total appropriation be allocated to an external competitive grants program open to qualified researchers at nonprofit institutions, organizations, or agencies in Illinois. The C-FAR working groups evaluate and select the proposals for funding. Proposal review follows a two-step process. The first step is a request for and review of pre-proposals. C-FAR working group members evaluate pre-proposals based on relevance to C-FAR research focus areas, potential outcomes and benefits to stakeholders, and dissemination plans. The second step involves inviting principal investigators of top-ranking pre-proposals to submit full proposals. Full proposals undergo scientific review and evaluation.

# STRATEGIC RESEARCH INITIATIVES

In 1998, the C-FAR membership established five Strategic Research Initiatives (SRIs) to implement a targeted, multidisciplinary, and multi-institutional approach to addressing major issues and concerns of the Illinois food and agriculture industry and consumers. The following research areas were identified:

- Information Systems and Technology
- Rural Community Development
- Swine Odor and Waste Management
- Food Safety
- Water Quality

The overall SRI effort received annual allocations of \$5 million from FY99 to FY02. In FY03, State of Illinois budget challenges resulted in a reduction of C-FAR's appropriation from \$15 million to \$6.968 million. As a result, the total SRI appropriation was reduced to \$2.75 million.

The SRI leaders have provided the following reports to C-FAR on the progress of their research and outreach efforts in FY02.



**Gary D. Schnitkey,**  
**SRI Leader, University**  
**of Illinois at Urbana-**  
**Champaign**

## INFORMATION SYSTEMS AND TECHNOLOGY

The goal of the Information Systems and Technology SRI (IT-SRI) is to aid decision making by increasing the availability and use of information in the global food and agricultural systems, with particular focus on Illinois agriculture. During FY02, IT-SRI projects yielded information and decision tools that help achieve this goal. Complete information on all projects is contained in progress reports on the IT-SRI website.

### **FARM.EDU**

During FY02, work began on FARM.EDU (see <http://www.farm.uiuc.edu>), a project that will eventually accumulate all information contained in individual IT-SRI projects. When completed, FARM.EDU will allow users to find all types of research-based information related to agriculture at one stop. The FARM.EDU website currently includes links to individual IT-SRI projects. Ultimately, users will be able to access information from multiple areas, including crops, pest management, animal systems, agricultural economics, and natural resources. Information will be customized to address the specific circumstances of individual users.

To be useful resources for participants in the agricultural sector, specific tools and information must be targeted at individual decision makers. During FY02, the IT-SRI completed development of many customized decision aids. The following sections briefly describe several specific examples.

## ■ Integrated Pest Management (IPM) Online

- The IPM Online project released European corn borer calculators. These calculators, along with corn borer information fact sheets, allow farmers and consultants to develop corn borer treatment plans specific to their own situations. Calculators estimate likely damage from first-generation corn borers and compare damage estimates to costs of treatment. These tools are available at <http://www.ipm.uiuc.edu/calculator/index.html>.
- A soybean aphid watch was added to the IPM Online site. Aphids pose an economic hazard to Illinois farmers and have been entering Illinois and surrounding states. Aphid watch information allows farmers and consultants to track known aphid infestations by Illinois counties, thereby identifying the most threatened areas. The aphid watch is available at <http://www.ipm.uiuc.edu/>.

## ■ Interactive Agronomy Handbook

- The Interactive Agronomy Handbook project released the new tool Soil Plan. Soil Plan allows users to enter soil-test data across multiple years. These data—along with soil type, location, and anticipated yield data—are used to develop customized fertilizer recommendations. Farmers and consultants can use this tool to base fertilizer use more systematically on soil type, nutrient test levels, location, previous crops, and previous fertilizer recommendations. This

resource helps them use commercial fertilizer more efficiently and reduce one of the largest direct costs of commercial crop production. Soil Plan is available at <http://www.aces.uiuc.edu/~longj/soilplan.php>.

- Another new tool available at the Interactive Agronomy Handbook site is the Nutrient Management Worksheet, which allows farmers and consultants to plan efficient livestock manure applications to farmland. This worksheet uses a database of nutrients contained in livestock manures as the basis for livestock manure application recommendations. When fully functional, this worksheet will allow any Illinois farmer to create nutrient management plans that satisfy new federal requirements. Following the worksheet's recommendations will result in more efficient manure applications, thereby lowering fertilizer costs and reducing the chances of nutrient runoff. This worksheet is available at <http://www.aces.uiuc.edu/~longj/nutrient.php>.

## ■ Illinois TRAILL

- Illinois TRAILL compiled and made available information that addressed diseases and other threats potentially devastating to Illinois livestock industries. These diseases include bovine spongiform encephalopathy (BSE), hoof-and-mouth disease, and anthrax as a biosecurity threat. This timely information allowed Illinois decision makers to assess these threats. The Illinois TRAILL website is at <http://il-traill.outreach.uiuc.edu/biosecurity/>.

- Illinois TRAILL released Illini PastureNet. This website provides up-to-date information on pasture management, an area that has seen a great deal of innovation in the past decade. Effective use of pastures presents a way to manage livestock enterprises to enhance both profit and environmental benefits. Illini PastureNet can be found at <http://il-traill.outreach.uiuc.edu/pasturenet/>.

## ■ Enhanced Farm Research Analyst (EFRA)

- The new tool EFRA, an extension to ArcView, helps researchers, consultants, and farmers develop on-farm research by designing research plots and performing statistics on geo-referenced data. This tool aids in conducting research that will tailor recommendations for very specific situations. For example, EFRA could be used to develop fertilizer recommendations pinpointed to soil types and locations within fields. EFRA is available at <http://www.farmresearch.com/efra/>.

## ■ ProStar

- ProStar is a Web-enabled interactive management simulation of farm supply firms. This program

allows users to work through a multitude of management and competitive market scenarios and evaluate the operational and financial performance of their own business as they implement alternative strategies. The ProStar simulation allows users to experiment with alternative strategies before trying them in real agribusinesses, thereby learning to identify and eliminate nonprofitable strategies from consideration. During 2001 and 2002, ProStar has been beta-tested in an asynchronous mode by several university-level agribusiness management classes and in a synchronous mode by Evergreen FS and GROWMARK personnel. The ProStar website is <http://www.prostar.ilstu.edu>.

### Farm.doc

- An Ifarm Premium Calculator, which provides costs that farmers pay for alternative multi-peril crop insurance products, was released on farm.doc in January 2001. The initial Premium Calculator covered only Illinois, but federal funding allowed expansion of the database to cover 12 states in January 2002. This calculator allows farmers to compare the costs of alternative insurance products more easily, and it was partially responsible for the more

diverse choice in crop insurance products made by farmers during 2002. The Premium Calculator is at <http://www.farmdoc.uiuc.edu/cropins/index.html>.

- Farm.doc released the Illinois Basis tool, which allows users to access historical cash prices and basis data for different locations in Illinois. This information is a key consideration when making marketing decisions, and this tool allows users to obtain up-to-date data tailored to individual locations in Illinois. The Illinois Basis tool can be accessed at <http://www.farmdoc.uiuc.edu/marketing/basis/index.asp>.

### Illinois Watershed Management Clearinghouse

- The Illinois Watershed Management Clearinghouse was the first decision-support system developed and customized for use by local communities. During 2002, this project partnered with the Illinois Water Resources Center and became part of their watershed workshop series, which is used to help watershed committees write and implement plans. In addition, several classes used the site to learn more about the role of geographic information systems (GIS) in watershed management.

The Illinois Watershed Management Clearinghouse is at <http://web.aces.uiuc.edu/watershed/>.

### Illinois Land-Use Clearinghouse

- The Illinois Land-Use Clearinghouse informs and educates the farm community and the general public about important agricultural issues. In the past year, the staff updated the links to agricultural, conservation, and land-use contacts and organizations as well as the county-specific links to pertinent land-use, planning, and development departments and local ordinances; reported results from the national public opinion poll conducted by American Farmland Trust (AFT); added AFT's grass-based farming systems program (<http://grassfarmer.com/>); and developed Illinois-specific GIS maps based on the 1997 Agricultural Census data (farmer operator age, housing density by county) and the 1992 and 1997 Natural Resource Inventories. The Clearinghouse can be accessed at <http://www.farmlandinfo.org/fic/states/illinois.html>.

*The researchers in the IT-SRI work closely with members of C-FAR's Expanding Agricultural Markets Working Group.*

*Please visit <http://web.aces.uiuc.edu/sriit> to learn more about the IT-SRI program.*

# RURAL COMMUNITY DEVELOPMENT



**Raymond C. Lenzi, SRI  
Leader, Southern Illinois  
University at Carbondale**

The Rural Community Development SRI (RCD-SRI), also known as I-FARRM (Illinois Farming Alternatives and Rural Revitalization Methods), has continued to record outstanding research outputs, engage in active and cutting-edge outreach, and post demonstrable and significant economic impacts in FY02.

In the area of research, I-FARRM researchers completed and published 40 business plans, feasibility studies, marketing plans, and related studies; completed 31 monographs or fact sheets; and published 3 books and 2 manuals. In the area of outreach, researchers made 2,395 direct client contacts; disseminated 85,835 research pieces; and held 306 conferences, workshops, meetings, and presentations, with a total of 8,301 attendees. In the area of economic impact, I-FARRM assisted with 35 agri-enterprise start-ups and expansions; created or retained 125 jobs, representing \$2,560,000 in annual payroll; attracted \$5,690,000 in new capital investment; and leveraged \$1,884,532 in project dollars.

The following are some of the more specific FY02 highlights and accomplishments by category.

## Research

- The READI (Rural Enterprise and Alternative Agriculture Development Initiative) project completed publication of the *Fish Farming Business Plan Workbook*, which is being printed and distributed with support from C-FAR and the North Central Regional Aquaculture Center (NCRAC).
- READI produced 15 feasibility studies, business plans, and marketing or case studies for grape/wine, aquaculture, and value-added grain enterprises. The I-FARRM project as a whole produced 40 of these studies.
- READI produced six value-added alternative fact sheets on topics ranging from aquaculture methods to value-added opportunities for the small farmer. Three fact sheets address various aspects of the corn-based ethanol industry.
- The RDO (Rural Development Opportunities) project collaborated with the READI project to use GIS methods and research to locate potential aquaculture sites relative to soil types, topography, and drainage systems.
- Researchers with the RDO project completed a publication quantifying the economic contribution of the agricultural sector to the overall Illinois economy. This publication demonstrates and reinforces the continued importance of the agricultural sector generally and the family farm in particular.

- The RDO project completed three agritourism business plans or feasibility studies.
- The RDO project continued research on software for its GIS Enterprise Siting Model programs.
- Researchers with the VALUE (Improving Farm Income and Rural Communities through Value-Added Commodities) project completed two edited books: *Issues Facing the Rural Midwest* and an updated *Cooperative Approach to Local Economic Development*. The VALUE project also produced 37 refereed journal publications or book chapters.
- VALUE researchers completed four rural development case studies and a 2002 Specialty Grain Elevator Survey.
- VALUE researchers developed six additional fact sheets on topics related to value-added opportunities and opportunity gaps.

## Outreach and Economic Impact

- The VALUE project organized three new producer groups around value-added opportunities for niche/specialty grains: (1) the ILLI-MEX Alliance in Christian County, (2) the Livestock Economic Development Group in Gallatin/Saline counties, and (3) the Illinois Valley Alliance in Bureau County.
- The VALUE Project provided technical assistance with two major ethanol plant initiatives: (1) the Agricultural Development Association project in Crawford County and (2) the Fulton County ethanol plant planned by Prairie Premium Ag Coalition and Central Illinois Ag Coalition (now merged). While these two projects have not yet broken ground, they have already raised \$38 million in capital.
- With ongoing research and outreach assistance from the READI project, the Illinois Fish Farmers Cooperative is up and running. The cooperative now has 20 employees, and it processed its one-millionth pound of fish at the end of FY02.
- READI and the Illinois Cooperative Center assisted eight agricultural enterprise cooperative ventures in FY02 with business planning and implementation.
- I-FARRM provided technical assistance outreach to support start-up or expansion of 32 new agri-enterprises.
- Southern Illinois hosted six new prawn/shrimp agritourism-related festivals, attracting thousands of participants and providing a successful premium sales venue for most of the new shrimp farms.
- The RDO project assisted with agritourism start-up enterprises, which yielded new jobs and income for farmer clients.
- The RDO project initiated and assisted the Southern Illinois Community Foundation, organized and held several public fund-raising events (with hundreds of attendees), and raised funds that served as bridge financing to retain the Franklin County Hospital.
- The VALUE project hosted two large regional conferences on value-added and niche market opportunities relative to specialty crops.
- The VALUE project provided technical assistance to five agricultural producer groups regarding planning and development of value-added enterprises and networks.

**The researchers in the RCD-SRI work closely with members of C-FAR's Rural Economic Development Working Group.**

**Please visit <http://www.siu.edu/~ifarrm> to learn more about the RCD-SRI program.**



**Michael Ellis, SRI Leader,  
University of Illinois at  
Urbana-Champaign**

## SWINE ODOR AND WASTE MANAGEMENT

The Swine Odor and Waste Management SRI (SOWM-SRI) has emphasized two major issues: (1) phosphorus output in manure and (2) gaseous and particulate emissions from facilities. The SOWM-SRI has focused on establishing the equipment, facilities, and methodologies necessary for odor sampling and analysis. In FY02, researchers completed development of olfactometry facilities and equipment for subjective odor evaluation by trained panelists, analytical equipment for chemical determination of odorous compounds, equipment to collect samples of gaseous emissions, and the Odor and Nutrient Proving Center (at the University of Illinois at Urbana-Champaign) for initial on-farm technology evaluation. These major accomplishments, together with a team of scientists with comprehensive expertise, place the SOWM-SRI at the forefront of research to solve manure odor problems.

## Progress in Research and Technology Development and Evaluation

When the SOWM-SRI was initiated, there were no proven, economically feasible approaches to solving swine-manure problems, particularly to reducing odor. C-FAR has supported research to develop a range of new and unique technologies. Generally, a three-stage approach to technology development has been followed:

1. Initial concept development, laboratory-scale evaluation, and process optimization
2. Construction of pilot-scale equipment and testing on research farms (such as the Odor and Nutrient Proving Center)—this step is often repeated to optimize design and operation
3. Full-scale commercial application and testing

The SOWM-SRI currently has projects at all three of these development stages, and in the past year, the SOWM-SRI has continued progress toward the ultimate goal of developing appropriate technologies to the point of readiness for commercial application.

## Stage 1 Projects: Laboratory-Based Development and Evaluation

- *Thermochemical Conversion (TCC)*: Laboratory-scale TCC equipment converts swine manure into a valuable product (crude oil) at high-energy conversion efficiency. Researchers are currently working to develop a continuous process for pilot testing.
- *Gravity Liquid-Solid Separation*: A potentially low-cost, low-input system to separate liquid swine slurry from solid has been tested at laboratory scale.
- *Odor Analysis*: Researchers have made progress in developing instrumentation for rapid on-site measurement of odors. Such an instrument has important applications in many situations (such as research, monitoring commercial barns, and assessing regulatory compliance).
- *Chimney-Stack Exhaust*: Researchers have designed a simple, inexpensive stack that will emit exhaust air from farms high enough in the atmosphere to minimize odors at ground level.

## Stage 2 Projects: Pilot-Scale Equipment at Research Farms

- *Dust- and Odor-Reduction Technologies*: Novel technologies initially developed by SOWM-SRI researchers (including an aerodynamic deduster, wet scrubber, and catalytic converter) are undergoing prototype testing. These technologies are potentially complementary, relatively inexpensive approaches to reducing dust and odor emissions in exhaust air. Other technologies under evaluation include lagoon covers, ozonation, and facility cleanliness.
- *Aerobic Thermophilic Swine Waste Treatment*: Researchers have developed a novel waste-processing technology from laboratory-scale concept to 1,000-gallon pilot system. During pilot testing, this system yielded significant energy and low levels of odor and pathogens in products used as fertilizer. Farm-scale testing is currently under way.
- *Variable-Rate Slurry Application*: A unique concept for controlling slurry application rate relative to soil needs has been developed. Initial field testing of prototype equipment and associated computer hardware and software is in progress.
- *Catalytic Converters*: Researchers have developed an innovative approach that uses the same technology as in car exhausts to remove odors from swine facilities. Catalytic converters are undergoing initial field testing.

## Stage 3 Projects: Full-Scale Application and Testing

- *Composting*: An innovative approach has been taken to adapting traditional composting technology for application, and composting sites on three commercial swine units have been established. This research will establish optimal practical approaches for liquid–solid separation and composting.
- *Nutritional Approaches to Minimizing Phosphorus Output*: The results of this research project provide the basis for current industry recommendations regarding phosphorus output. Researchers have explored methods for improving phosphorus and other mineral utilization and minimizing excretions. Such methods include using phytase and organic acids to increase phosphorus availability in corn–soy diets and by-products (such as corn gluten meal) and establishing nutritional characteristics of improved corn varieties (such as low phytate).
- *Anaerobic Sequencing Batch Reactor*: A collaborative effort has advanced research from laboratory-scale reactor to commercial-size system on an Iowa farm. Commercial-scale testing continues with a focus on process optimization.
- *On-Farm Odor Characterization*: A comprehensive survey of odor levels in commercial finishing barns was completed. Researchers sampled 26 barns on Illinois operations with deep or shallow pits over time and characterized odor levels. The key odor factors identified through this

study will help target future research efforts.

- *Dispersion Modeling*: Researchers have developed models that predict dispersion of odors and particulate emissions around swine units. These models are being used to design emission-control equipment (such as chimney-stack exhausts) and to predict how application of odor-control technology will affect swine units. These models can be used to help with siting decisions for new facilities or expansion of existing operations.

## Other Areas

- *Community Concerns*: Researchers have conducted surveys and developed a comprehensive series of fact sheets addressing major issues related to siting of swine facilities.
- *Legal Issues*: A comprehensive review and analysis of legal and regulatory aspects of swine odor and waste in Illinois has been completed and is available via the SOWM-SRI website.
- *Communications and Outreach Activity*: Researchers have continued their efforts to develop a system for delivering research results to the industry. This system includes a comprehensive website (<http://sowm.outreach.uiuc.edu>) where all SRI materials are posted and a monthly newsletter circulated to update stakeholders on SOWM-

SRI progress and activities. The SRI has also been promoted at many industry events, including the Illinois Pork Expo and various Extension meetings. Workshops on SRI results have been conducted, including a Swine Field Day jointly organized with the Illinois Pork Producers Association to showcase the SRI to the industry.

- *Leveraged Funding*: Leveraged funding to the SOWM-SRI currently is approaching \$10 million, an impressive index of SRI success in generating additional research funding in this area.

**The researchers in the SOWM-SRI work closely with members of C-FAR's Agricultural Production Systems Working Group.**

**Please visit <http://sowm.outreach.uiuc.edu> to learn more about the SOWM-SRI program.**



## FOOD SAFETY

**Jeannette M. Endres,  
SRI Leader, Southern  
Illinois University at  
Carbondale**

The constituency groups for the Food Safety SRI (FS-SRI) include all those involved with food production, handling, and preparation, from the producers on the farm through to the family who consumes food. Other key constituency groups include physicians, who diagnose foodborne illnesses, and educators and other researchers, who work to identify the behavior of organisms and educate the consumers about how to avoid foodborne illnesses. Because of this broad scope, the research projects and outreach efforts of the FS-SRI are targeted to specific constituency groups.

## Producers

- In an attempt to develop a relatively low-risk fertilizer for fruits and vegetables, researchers applied a thermal treatment to swine waste to reduce pathogens. Six bacterial pathogens were found to be substantially reduced at the swine waste reactor conditions in both laboratory-scale (3 liter) and pilot-scale (1,000 gallon) systems. Most organisms were reduced from between 104 and 107 cell-forming units per milliliter to detection levels (that is, 1 cell-forming unit per milliliter). There were two exceptions: *Clostridium perfringens*, a spore-forming bacterium, and enterococci. These organisms were reduced from 1,000-fold to 100,000-fold, but they were still present at low levels in the treated product.
- Risk-assessment methodology was applied to evaluate the use of feed-grade antibiotics in pork production. An integrated economic framework that will evaluate risks to human health as well as the economic impact on pork production is currently being developed. To date, researchers have determined that
  - eliminating the use of subtherapeutic antibiotics in the grower-finisher unit pigs appears to have a relatively small impact on productivity, but antibiotic use for growth promotion does improve profits.

- increasing the number of different rations fed to grower-finisher pigs generally improves the feed conversion ratio (FCR) and average daily gain (ADG), but antibiotics reduce FCR when the number of rations is increased.
- FCR and ADG improve as the average number of days that growth-promoting antibiotics are used increases.
- Poultry producers using alternative methods of production have no more and, in some cases, significantly less salmonella infestation compared with those using traditional methods for raising poultry.
- FS-SRI on-farm strategies for detecting and controlling salmonella were developed collaboratively by veterinary clinical medicine researchers and producers, demonstrating C-FAR's unique philosophy in practice.

## Consumers

- Studies demonstrate that a commercially produced wash and water are equally effective in reducing *S. boydii* 18 on parsley; however, neither product completely removes pathogens. These research findings demonstrate the need for vegetables and fruits to be washed and refrigerated promptly.
- Consumers of varying age groups will receive meals from the food

service establishments participating in the implementation of the model Hazard Analysis Critical Control Point (HACCP) project. These food service establishments include day care centers, school meal programs, university dining services, long-term care facilities, hospitals, restaurants, catering services, deli operations, and correctional systems.

- Illinois residents are using the FS-SRI's award-winning educational interactive program. This program is now available for commercial distribution on CD-ROM and through programs offered by University of Illinois Extension.
- The Food Safety Kiosk, the *Mysterious Food Safety Caper*, continues to receive recognition, recently winning a 2001 Global Award. The Global Awards honor the best health care communications worldwide, and the 2001 awards program attracted 1,361 entries from every corner of the world. Award winners were showcased in a comprehensive editorial in *Medical Marketing and Media* magazine.

- More than 1,000 individuals took the BAR B Q Food Safe Quiz on the Food Safety Kiosk displayed at the 2002 Illinois State Fair. The FS-SRI was featured at an August 2002 press conference, held at the Illinois State Fair, to kick off National Food Safety Month.
- One season of crop production using genetically modified organism (GMO) and non-GMO products showed mixed results for the parameters evaluated. No statement can be made about the safety of GMO crops at this time. It appears that growing conditions and location may be the most significant factors determining a crop's nutritional profile, regardless of genetic modification. Researchers are conducting studies using larger sample sizes and feeding whole crops in FY03. Findings from these studies will allow more definitive analysis of the safety of specific GMO crops. Results thus far suggest that large-scale GMO and non-GMO crop studies are warranted.

### Food Service and Retail Markets

- Researchers completed model HACCP plans for food service facilities and evaluated plan effectiveness in 24 participating food service establishments. After researchers completed initial site interviews, individual HACCP plans were designed, managers trained, and plans implemented. The extent of implementation and success varied depending on the type of facility and the commitment of staff, especially the manager in charge or the owner.
  - Researchers investigated the effect of job environment on HACCP training in a study of 86 university food service employees at SIU Dining Services. The results indicated that the workers satisfied with the training retained more than the workers not satisfied with the training.
  - Model HACCP plans for retail meat stores were written for five stores. HACCP plans varied significantly depending on the types of products handled in the store.

### Educators and Physicians

- Educational programs targeting medical students and physicians include videos developed by the SIU medical school in conjunction with the Springfield Department of Public Health. Researchers will assess the effectiveness of the videos in building skills and knowledge during the 2002–03 school year. The mnemonic slogan “It’s what you do AFTER that counts!” has been incorporated to reinforce the main educational points. AFTER represents the following:
  - A—ask about alimentation
  - F—perform a fecal exam and ask about family
  - T—treat the symptoms
  - E—educate the patient
  - R—report to local public health authorities
- Based on data accrued to date, researchers are developing a formal problem-based learning module (PBLM) case that covers foodborne illness surveillance and epidemiology. The goal of this effort is to highlight the concepts that enable health care providers to differentiate infectious processes from intoxications and to emphasize the appropriate medical interventions for specific foodborne illness conditions.
- Educational efforts geared to youth groups include
  - a survey of 74 teenagers employed in fast-food operations and 450 junior high students regarding food safety knowledge and practices.

- a food safety curriculum developed for grades 7–12 using data gathered from research studies of safe food handling knowledge and practices among youths, the State of Illinois Learning Standards, and the State of Illinois Food Code.
- completion of six public service announcements and production of five additional public service announcements associated with the 7–12-grade curriculum.
- a food safety curriculum developed for K–3 and 4–6 grades, which was reviewed by the National Environmental Health Association, is recommended by the Illinois State Board of Education (ISBE) and is available through the ISBE Curriculum Publishing Clearinghouse.
- The third annual State Food Safety Symposium, jointly sponsored by the Illinois Departments of Public Health and Agriculture, the Illinois Restaurant Association, and the Food Safety SRI, featured FS-SRI research.
- After working with the SIU medical school and the FS-SRI on food safety videos, the Springfield Department of Public Health has created a new position, Food Safety

Educator. The Food Safety Educator is responsible for developing and providing education to ensure safety in the handling, preparation, and storage of foods.

- Researchers have completed a survey of the diagnostic and treatment behaviors of physicians treating foodborne illness in Springfield emergency rooms and urgent care centers. From more than 2,500 emergency and urgent care records of possible foodborne illness (obtained via the use of select ICD-9 codes), only 16% indicated that a sample or specimen was taken for laboratory analysis. Furthermore, while almost 21% of the records indicated that patients were asked if a food might have been the cause of the illness, less than 5% indicated that the physician gave the patient foodborne infection education. These findings demonstrate the need for medical school instruction and physician education regarding foodborne illnesses and food safety.
- A Food Safety Summit related to the HACCP effort was held on October 28, 2002. Invited participants included food managers, restaurant owners, and members of the Food Stakeholder Advisory Committee as well as interested members of the community.

*The researchers in the FS-SRI work closely with members of C-FAR's Human Nutrition and Food Safety Working Group.*

*Please visit <http://www.siu.edu/~foodsafe> to learn more about the FS-SRI program.*



**George F. Czapar, SRI Leader,  
University of Illinois Extension,  
Springfield Center**

## WATER QUALITY

The Water Quality SRI (WQ-SRI) is organized into four integrated components. The Best Management Practices (BMP) group seeks to identify practices that reduce nutrients in water resources and to evaluate these practices from agronomic, economic, and environmental perspectives. The Mass Balance group works to understand the sources and movement of nutrients through Illinois watersheds. The Modeling group is developing and employing computer models at the state level, watershed level, and field scale that may help predict consequences of alternative land management and agronomic practices.

A fourth component, Outreach, is intended to make research results readily available to stakeholders and to provide policy makers, the agriculture community, and Illinois citizens with information about possible solutions to water quality concerns in Illinois. The WQ-SRI's comprehensive website details individual projects, budgets, progress reports, and outcomes of this initiative. In FY02, 24 integrated projects were funded. The following four projects are examples from each of the WQ-SRI components.

## ■ **BMP: Evaluation of Nitrogen Management Practices on Corn Yield and the Environmental Fate of Nitrogen**

Tile-line monitors were installed on 54 tile lines contained in two fields in Douglas County, Illinois. During the spring of 2002, excessive rainfall raised questions about the extent of nitrogen fertilizer loss and how much additional nitrogen would be needed. The nitrate ( $\text{NO}_3\text{N}$ ) concentrations obtained from samples taken between the fall nitrogen application and early April were used to develop news releases to inform the public, particularly producers, of the potential for loss from nitrogen applied in the fall of 2001. See *Nitrogen Loss for 2002*, available at <http://www.ag.uiuc.edu/cespubs/pest/articles/200206m.html>; also see *Plant, Then Sidedress*, available at <http://www.ag.uiuc.edu/cespubs/pest/articles/200206n.html>.

## ■ **Mass Balance: Long-Term Changes in Agricultural Soil Nitrogen and Carbon Pools**

Researchers used a mass-balance approach and literature data to estimate long-term nitrogen loss from Illinois agricultural soils. Their findings indicate that the loss of nitrogen from initial plowing and draining of Illinois soils probably caused nitrogen losses comparable to those experienced during the past 20 years and that human-related nitrogen inputs were probably even higher than they are today.

Researchers also estimated that changes in soil nitrogen pools during the past 50 years were probably small. A second study will compare soil samples collected from fields around 1902 or in the late 1950s with current samples to examine long-term changes in organic matter pools caused by agricultural production. Excellent records document where and when the fields were sampled (by Cyril Hopkins as part of the initial soil survey work in Illinois or by the Soil Conservation Service in the 1950s) as well as the total carbon and nitrogen concentrations by soil depth. By next year, research data documenting long-term changes in soil organic matter pools should be available.

## ■ **Modeling: Understanding and Modeling the Hydrology of Tile-Drained Watersheds**

The overall objective of this study is to investigate the basic factors governing the hydrologic processes unique to tile-drained watersheds and to improve a watershed water quality model's simulation of those basic processes. Researchers have monitored surface runoff, tile drainage, and river flow at several locations and have collected water samples for water quality analysis. Flow-measuring weirs have been installed at locations upstream and downstream of a selected section of the stream to continuously monitor inflow and outflow.

Researchers working on this project successfully competed for an external grant to expand the scope of the project. They received a \$290,000 grant from the U.S. Department of Agriculture's Natural Research Initiative. As a result of their WQ-SRI project, researchers were able to secure additional funds approximately six times greater than their total FY02 allocation.

### ■ Outreach: Conceptual Model of Nitrogen Cycling

WQ-SRI researchers developed this website to provide the public with information about nitrogen cycling in the form of conceptual models. The website (<http://www.sws.uiuc.edu/nitro>) starts with fairly simple concepts related to biogeochemical cycling and works toward more detailed descriptions of nitrogen cycling. These materials will help provide a framework for the subsequent development of improved mathematical models of nitrogen dynamics and nitrogen mass-balance studies in Illinois watersheds.

During the past 12 months, this website was accessed 493,000 times. It is intended as an educational tool; reviewer comments and suggestions for improving the model or modifying the website are encouraged.

### ■ Future Considerations

Water quality continues to be one of the biggest challenges facing agriculture. Specifically, concerns that excess nutrients and sediment are damaging rivers, streams, and lakes remain priority issues. The mission of the WQ-SRI is to identify cost-effective approaches for improving Illinois' water quality. The Natural Resources Working Group has recommended that the SRI be continued for three more years but with a slightly different focus. Primary goals are to include

1. *Help improve the scientific basis for developing water quality standards.* This effort will require close collaboration with regulatory agencies in Illinois. These agencies are all concerned with protecting water from nutrient over-enrichment without pursuing standards that are overly restrictive or unachievable.
2. *Determine whether models used for total maximum daily load (TMDL) calculations are appropriate.* Similarly, if these models use default values, identify the correct values for a particular watershed. A primary concern that has been identified is that water quality data are limited and recommended models must be functional using the data currently available.

3. *Establish realistic endpoints for water protection efforts, and identify cause-and-effect relationships for changes in land practices and water quality indicators.* This goal will require evaluating whether biological indicators are a better estimate of overall water quality than chemical concentrations data collected on a fixed sampling schedule.

■ *The researchers in the WQ-SRI work closely with members of C-FAR's Natural Resources Working Group.*

*Please visit <http://web.aces.uiuc.edu/sriwq> to learn more about the WQ-SRI program.*



# C-FAR SENTINEL PROGRAM



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lege of Agricultural,  
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Introduced in 1999, the C-FAR Sentinel Program at the University of Illinois at Urbana-Champaign was initiated to take advantage of windows of opportunity to do research focused on C-FAR priorities. Sentinel projects are multi-investigator and multidepartmental, with most crossing college boundaries and bringing together investigators from a variety of disciplines. In 2002, this program comprised nine creative, problem-solving research initiatives.

“Sometimes you have to push the ball up a little hill so that it has a free path to begin rolling down the big hill under its own power. Research works the same way. The Sentinel Program has helped us to get over some of those first little impediments so that we can create marvelous research programs to meet long-term Illinois needs,” says Steven Pueppke, associate dean for research at the College of Agricultural, Consumer and Environmental Sciences (ACES).

The Sentinel Program is the fourth component of the University of Illinois’ C-FAR research portfolio. It complements and extends the research efforts of the other components: the university’s Internal Competitive Grants Program, External Competitive Grants Program projects, and the Strategic Research Initiatives (SRIs).



## CROP ROTATION COLLAPSES AS A PEST MANAGEMENT TOOL FOR WESTERN CORN ROOTWORMS: IN SEARCH OF A SOLUTION

### Principal Investigators

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This research effort focuses on solving a new threat posed by the western corn rootworm: loss of crop rotation as a pest management strategy. Since the mid-1990s, a variant of the western corn rootworm has compromised the utility of crop rotation as an important management tactic for this perennial pest of corn. The variant plagues producers throughout east-central Illinois, and they have responded by significantly increasing their use of soil insecticides on rotated corn acres. In recent years, the problem has been spreading. Researchers monitored western corn rootworm abundance in nearly 500 different soybean fields from 101 Illinois counties during the summer of 2002 and found evidence that the variant western corn rootworm is slowly moving to the north (north-east and northwest). Maps and more complete analyses of these data are available at the project website, <http://www.staff.uiuc.edu/~s-isard/Cornrootworm/>.

Through laboratory behavioral (egg-laying and feeding) comparisons of adult western corn rootworms collected from Warren County (which is not yet colonized by the variant) and Champaign County (which is colonized by variant western corn rootworm), researchers determined that adults from east-central Illinois are no more likely to tolerate or thrive on soybean foliage than adults collected in northwestern counties of the state. In fact, a diet of soybean foliage is very stressful for adults from both regions. On the other hand, exposure of western corn rootworm adults to soybean foliage does stimulate rapid egg-laying. Presumably, stressed adult females attempt to void themselves of eggs as quickly as possible. Beetles that consumed mixed diets of corn and soybean tissue produced as many eggs as insects that fed only on corn tissues. This finding indicates that consuming both corn and soybean may prevent vigor reductions associated with an exclusive soybean diet.

A common misconception is that western corn rootworms have abandoned corn in east-central Illinois as an ovipositional site, but this research has shown that both corn and soybean fields serve as suitable egg-laying sites for the western corn rootworm variant in this region. In fact, late-planted corn and soybean fields both appear to compete for western corn rootworm eggs. To date, pest management recommendations have primarily relied on the use of Pherocon AM traps in soybean fields. Many producers in infested areas have significantly increased their use of soil insecticides on rotated corn acres. Project researchers have determined that broadcast treatment to soybeans to prevent egg-laying is ineffective. Because egg-laying in soybeans takes place over a protracted period of time, broadcast insecticide applications are futile.

Researchers have created a set of simple meteorological and behavioral models to predict the spread of the western corn rootworm variant throughout the Corn Belt. Using data collected in Illinois, Indiana, Michigan, and Ohio, researchers created western corn rootworm density maps. Densities above a threshold represented populations searching for plants other than corn and likely adapted to the



corn and soybean rotation. Landscape diversity was represented by the proportion of noncorn, nonsoybean vegetation on farmland in each county. Based on these models, researchers hypothesize that, as the proportion of noncorn, nonsoybean vegetation in a region increases, the short-term spread of the variant western corn rootworm decreases.

Researchers have almost completed the expressed sequence tag database and have begun preliminary microarray hybridization assays. Sequencing of the cDNA library has been completed. A total of 20,736 reactions have resulted in 16,797 sequences. Following trimming and filtering, 16,172 sequences were further analyzed, and researchers estimate that 7,000 unique sequences will result from this project. Through this study, researchers hope to identify differences in gene expression in the brain tissue of variant western corn rootworm adults (collected in east-central Illinois) compared with nonvariant adults (collected from northwestern region of Illinois).

## SOYFACE: RESEARCH AND DISCOVERY PROGRAM TO ABATE THE THREATS AND HARNESS THE POTENTIAL OF ATMOSPHERE CHANGE TO BENEFIT ILLINOIS AGRICULTURE

### Principal Investigators

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With assistance from 16 investigators representing the Departments of Animal Sciences, Crop Sciences, Food Science and Human Nutrition, and Natural Resources and Environmental Sciences as well as the Illinois State Water Survey and USDA-ARS

The SoyFACE project uses an open-air field laboratory to simulate future atmospheric conditions and, thus, explore how changes in the atmosphere will affect major crops. The ultimate goal of this project is to use this information to

prepare our crops and crop systems for the future as well as for changes in the atmosphere that have already occurred. The 2002 SoyFACE experiment on the laboratory's 80-acre site was about three times the size of last year's experiment. Four FACE (free-air concentration enrichment) rings, each 70 feet in diameter, and four control rings were built in each of the soybean fields and cornfields comprising the site. The carbon dioxide (CO<sub>2</sub>) concentration within the FACE rings was elevated to that anticipated for the year 2050—that is, about 50% higher than today's concentration. Four other rings that elevated the ozone level to about 20% higher than today's level were added to the soybean field. The facility successfully maintained these elevations from crop emergence to harvest.

Results from the 2001 and 2002 experiments showed that the higher CO<sub>2</sub> levels increased soybean yield by 15 to 18% but also delayed crop maturation by several days, exposing the crop to the risk of an early frost. Soybeans grown in the elevated CO<sub>2</sub> environment suffered double the insect damage found in plants grown at current CO<sub>2</sub> levels. Despite the yield increases observed, the harvest index was significantly reduced, showing that there is potential to increase yield further. Elevated CO<sub>2</sub> did not alter protein or oil content of the grain, but it did significantly increase isoflavanoid content. Researchers also noted an increase in yield in three of the four corn hybrids grown in elevated CO<sub>2</sub> in 2002. These plants grew much faster during June (when there was no rainfall), they formed a larger leaf area, and initial sampling suggests that yield was increased by more than 10%.

Beyond yield results, the 2002 crop has yet to be fully analyzed. Researchers have determined that the 20% increase in the ozone level decreased yield by 15%. Since the ozone level has been rising rapidly in our region, this loss could



develop relatively soon. Ozone also accelerated crop senescence by about one week, and the plants showed more insect damage than control plants. Significant differences in response among the germplasm suggest, however, that breeding could reduce susceptibility to ozone in a relatively short period. The U.S. Department of Agriculture and Environmental Protection Agency estimate that our current ozone levels are already depressing soybean yields in Illinois by more than 15%. Therefore, increasing resistance of the crop to ozone would help growers today as well as those in the future.

SoyFACE research and outreach efforts have increased the visibility and the international reach of this project. In 2002, more than 500 individuals visited the SoyFACE facility, including growers from the United States and Brazil, consumer groups from Japan and the United States, and high school teachers from around the world. Researchers from 40 universities and research organizations in 12 different countries visited the site to discuss potential research collaborations. This widespread interest represents potential opportunities to leverage external expertise. Furthermore, groups from five universities in the Midwest took part in the SoyFACE 2002 experiment. Researchers also substantially revised the project website (<http://www.soyface.uiuc.edu>) to include many views of the 2002 experiment.

In 2002, SoyFACE also leveraged additional external funds to expand the project, including the following support: Archer Daniels Midland provided carbon dioxide; Pioneer Hi-Bred provided seed; the Argonne National Laboratory and USDA-ARS contributed additional equipment; and the USDA National Research Initiative and International Arid Lands Consortium awarded the Illinois Laboratory for Agricultural Remote Sensing two major competitive federal research grants. The estimated value of these leveraged funds is approximately \$360,400.

## DEVELOPING AN AGRICULTURAL REMOTE SENSING PROGRAM AT UNIVERSITY OF ILLINOIS

### Principal Investigators

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Donald G. Bullock, Department of Crop Sciences

The Illinois Laboratory for Agricultural Remote Sensing (ILARS) supports the collection and processing of data gathered on the ground and from aircraft to assist with research on precision agriculture, watersheds, and Illinois crop yields. The ultimate goal of the project is to develop real-world applications for remote sensing technologies that will improve farm management. In 2002, researchers focused on several individual projects sponsored by federal and private agencies in order to develop the extensive database necessary to support a remote sensing-based precision farming system.

Experiments have been conducted on commercial and university research farms to demonstrate new remote sensing-based field operations. Researchers working on an AG 20/20 initiative project funded by NASA and the United Soybean Board have been using the laboratory to study uses of remote sensing-based herbicide application. AG 20/20 is a partnership between industry and government organized to develop and disseminate simple, innovative information tools that increase production efficiency, reduce the economic risks, and diminish environmental impacts associated with farming. Researchers from other departments and institutions are working on ILARS projects, and ILARS researchers have submitted several major cooperative proposals to federal agencies. In 2002, the laboratory received more than \$250,000 in external funding.

Another important function of ILARS is its support of graduate education and training. In FY02, five graduate students in the College of ACES were supported by ILARS remote sensing projects, and one Ph.D. student and one M.S. student completed their degrees. Labora-

tory facilities were also used in various courses that teach students remote sensing techniques, providing invaluable hands-on experience working with airborne and ground-based remote sensing data.

Through its outreach efforts, ILARS has become increasingly well known. Researchers from ILARS have presented papers and held displays at national and international conferences. The laboratory has also provided the foundation for a variety of collaborative relationships. ILARS researchers are working closely with similar research laboratories at other universities and with government agencies, such as NASA and the USDA. Working with NASA contractors, the laboratory has provided remote sensing data-collection and data-processing services to the local agricultural industry. One major seed company has donated their research database, patents, and funding to support ILARS research projects. In addition, ILARS has developed a good cooperative relationship with other research institutes and private companies in Asia, Europe, and South America.

## TRANSGENIC SWINE PROGRAM

### Principal Investigators

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**Sharon M. Donovan, Department of Food Science and Human Nutrition**

**Walter L. Hurley, Department of Animal Sciences**

The Transgenic Swine Program has three objectives. The first is to translate the existing lines of hemizygous alpha-lactalbumin ( $\alpha$ -LA) and insulin-like growth factor-I (IGF-I) transgenic swine into commercially viable, federally approved food sources for human consumption. To this end, researchers are continuing to work with the Food and Drug Administration (FDA) to address FDA-approval requirements.

The program's second objective is to develop accurate and precise analytical techniques for measuring milk production and for testing safety. In collaboration with James Pettigrew,



professor in the Department of Animal Sciences, project researchers have begun to develop and validate the isotope dilution technique as an alternative to the weigh-suckle-weigh method for measuring milk production of  $\alpha$ -LA swine.

The Transgenic Swine Program's final objective is to develop additional lines of transgenic swine with agriculturally beneficial characteristics. Researchers have a patent pending for the IGF-I transgenic swine. In addition, researchers are continuing to characterize the lactational performance of the homozygous  $\alpha$ -LA and  $\alpha$ -LA/IGF-I transgenic swine. In collaboration with Jonathan Beever, professor in the Department of Animal Sciences, researchers have isolated clones of porcine sucrase-isomaltase (SI), amylase, and intestinal fatty acid binding protein to use as promoters driving the expression of transgenes in the pig intestine. This study is currently focused on sequencing and characterizing the promoter region of the porcine SI gene.

Several specific studies focus on supporting the program's objectives. For example, in an effort to further characterize the  $\alpha$ -LA line, researchers have determined that milk produced by  $\alpha$ -LA transgenic sows contains higher concentrations of oligosaccharides and sialyl-lactose than that produced by nontransgenic sows. Data in the literature suggest that oligosaccharides may protect the neonate from pathogenic infection by inhibiting the attachment of enteropathogens to the intestinal lining, by reducing colonic pH, and by serving as a prebiotic for bifidobacteria. Researchers are currently continuing this line of investigation. Another study is designed to assess whether the improved preweaning growth of piglets suckling  $\alpha$ -LA sows is maintained through the grower and finisher stages of production. Researchers have measured carcass composition and meat quality at slaughter in these pigs. Analysis of their findings is ongoing.



## ILLINOIS CENTER FOR SOY FOODS

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### Principal Investigators

**Barbara P. Klein, Department of Food Science and Human Nutrition**

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The goal of the Illinois Center for Soy Foods (ICSF) is to promote consumption of soy foods, thereby providing benefits to growers, processors, and consumers in Illinois. To achieve this goal, the ICSF has initiated several research, training, and outreach projects.

The center has developed prototype soy-fortified bakery products well suited to American diets. ICSF products were showcased at several public events in 2002, including the Salute to Agriculture Day at the University of Illinois' Memorial Stadium; the College of ACES Open House; and the USDA and USAID Conferences on Food Aid. ICSF has also opened Soy Source, a retail store located in Bevier Hall at the University of Illinois at Urbana-Champaign, to feature and test-market new soy foods and has developed a cookbook series on how soy products can easily be used in the American kitchen. The first two books in this series, *Tofu in the American Kitchen* and *Textured Soy Protein in the American Kitchen*, were published in 2002.

The center has made educational and outreach efforts a high priority. ICSF staff organized short courses on various topics, including sensory and flavor issues related to soy (Soy Flavor Workshop: Sensory and Instrumental Methods), the value of soy foods for management of certain diseases (Soy in Dietetics Practice), application of soy as an ingredient (Application of Soy in Meat Products), the use of soy in recipes suited for dietary management (Soy in the Kitchen: Hands-On Learning for Dietitians), and the nutritional benefits of soy (U.S. Private Voluntary Organizations Training). The center also presented field training to international audiences (in Botswana, Kenya, Tanzania, Uganda, and Zimbabwe) about how to add

soy to local diets. ICSF staff designed and conducted two hands-on training activities: one focused on development of soy-enhanced biscuits for school lunch programs in Bangladesh, and the second on the use of soy flour in flat breads for Central and South Asia. The World Food Programme and other private voluntary organizations can use these training activities in their large-scale feeding programs.

In 2002, the center initiated a seed-grant competition targeted at research issues facing soy consumption, and six awards were awarded in 2002–2003 for research in the areas of soy functionality, flavor, processing, allergens, and marketing soy foods. ICSF has also provided several companies with research and technical services to address problems related to extrusion and dairy analogues. ICSF researchers participated in a number of major national and international conferences in 2002. Finally, the center has developed a website, <http://www.soyfoodsillinois.uiuc.edu>, as a consumer resource for learning more about cooking with soy.

ICSF's value has been affirmed by the soybean industry's strong support, including donations of soybean processing equipment and research grants worth more than \$200,000.

## ILLINOIS GENETIC MARKER CENTER

### Principal Investigators

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**Randall L. Nelson, Department of Crop Sciences and USDA-ARS**

**Torbert R. Rocheford and Fred Kolb, Department of Crop Sciences**

**John A. Juvik, Natural Resources and Environmental Sciences**

**Robert Elshire, Department of Crop Sciences and IGMC Manager**

The Illinois Genetic Marker Center (IGMC) is a biotechnology laboratory focused on identifying the genetic basis of economically important traits in Illinois crops. The center will allow researchers to develop new germplasm and varieties with traits that add value. The center, which began limited operation in October 2001, became fully operational in January 2002. IGMC staff have developed a website (<http://genotyping.uiuc.edu>) to provide information about the work being done at the center, to help answer questions about molecular markers and how they are used, and to serve as an entry point to user services and manuals.

Since January 2002, several significant research projects have been conducted in the center. Some examples include a study on the genetic basis of glucosinolate (antioxidant compounds linked to reduced cancer risk) production in broccoli, an analysis of the control of protein concentration and resistance to soybean cyst nematodes in soybean, and a survey of soybean lines to assay genetic diversity. In addition, Jon Beever, professor in the Department of Animal Sciences, plans to use the facility for an extensive study on meat quality in pork.

IGMC use is increasing as more researchers learn about the center. In the spring of 2002, the center held an open house to promote awareness of the IGMC and the services it offers. This event generated interest among researchers from several departments in the University of Illinois' College of ACES and School of Life Sciences. Other promotional activities planned include publishing articles about the center in departmental newsletters, offering class tours of the facilities, and possibly organizing another open house. As researchers receive approval for grants written this year, the center's user base will continue to grow.

IGMC staff have taken several steps to accommodate the anticipated increase in center usage: (1) development of an online scheduling system that allows users to check for equipment availability and sign up from any computer with a web browser; (2) installation of a key-card lock system, which allows controlled access to the center in the evenings and on weekends; and (3) purchase of a Hydra-96 precision liquid handling machine, which increases worker efficiency and reduces supply use. Researchers are also evaluating strategies for increasing the rate of throughput in order to expand the center's capacity without requiring additional equipment.

With its growing user base and continued efforts to increase efficiency, IGMC is on track to be completely self-sufficient by FY04.

## ILLINOIS AGRICULTURAL POLICY CENTER

### Principal Investigators

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The Illinois Agricultural Policy Center's primary purpose is to evaluate policy implications of the new farm bill and

to inform agricultural leaders regarding these implications. The center's ultimate goal is to help create a farm bill that meets the needs of Illinois. The center was created in the spring of 2001, and work during FY01 focused mostly on gathering data and on updating and implementing the Illinois Resource Agricultural Model (IRAM) as well as other farm-program simulation models. During 2002, the center staff made progress on the following projects:

- Researchers completed simulation analyses of four alternative farm bill proposals developed by the U.S. House of Representatives Agricultural Committee. The results focused on how government payment and income affect Illinois producers.
- Center staff gave many presentations to producers, farm organizations, lenders, and others on the farm bill proposals as well as on implementation of the bill that ultimately passed.
- Researchers developed a decision tool, made available to producers through the farm.doc website (<http://www.farmdoc.uiuc.edu>), that helps producers make the base acre and program-yield decisions called for by the 2002 farm bill. A policy section was also added to farm.doc.
- Researchers made progress in their effort to internationalize the IRAM model, with a focus on the soybean sector. Researchers have gathered land, production, and price data for South America, and they are currently collaborating with experts from other universities, including members of the Sao Paulo University agribusiness faculty, in this effort.
- The center began to develop and distribute a quarterly newsletter, *Illinois Rural Policy Digest*. The first issue of the newsletter was published in July 2002. Each issue contains three to four articles focusing on policy issues related to Illinois agriculture and/or rural communities.

## MANAGING THE SOYBEAN APHID

### Principal Investigators

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Scott A. Isard, Department of Geography

Philip L. Orwick, National Soybean Research Laboratory

John T. Shaw, Leellen F. Solter, and David J. Voegtlin, Illinois Natural History Survey

Additional project team members: Annalisa Ariatti, John Ebinger, Ron Estes, and Curt Hill

The soybean aphid, *Aphis glycines*, has clearly shown that it will remain a pest in Illinois. The goal of this project is to provide Illinois farmers with the information necessary to continue to raise soybeans profitably within the constraints imposed on them by the soybean aphid.

Based on observations in 2002, project researchers believe that the aphid is likely to increase its distribution and abundance during the next several years. In Illinois in 2001, the aphid infested most fields in the northern counties, with damaging densities observed primarily in counties along the Wisconsin border and along the Illinois River/Interstate 80 corridor. Cash receipts for soybean in northeast and north-central Illinois total more than \$300 million annually. Even if only 10% of fields in this region suffered a 10% loss on average, the economic loss caused by soybean aphids would be approximately \$3 million in 2001.

In FY02, researchers for this project conducted numerous studies designed to determine behavioral patterns of this insect pest and to assess the threat it poses. Some of the key research findings and project developments during the past year include the following:

- Researchers installed a network of eight suction traps to monitor movement of the soybean aphid throughout Illinois. Traps at Freeport, DeKalb, Monmouth, Perry, Brownstown, Dixon Springs, Joliet, and Champaign were monitored on a weekly basis.
- Researchers studied the host range of the soybean aphid among various legumes, conducting tests on 4 randomized blocks of 48 lines encompassing 20 legume species. Researchers observed that *Glycine* species were the most compatible with the soybean aphid, while *Pisum sativum* was least compatible. Researchers also identified economic legume species other than soybean that were able to support aphid multiplication. These species included *Trifolium* spp., *Medicago sativa*, and *Phaseolus vulgaris*.
- Researchers screened 798 current MG II and III commercial soybean cultivars for resistance to aphid infestation. Four weeks after infestation, 18 cultivars demonstrated a higher resistance to aphid infestation, and resistance in 4 of these cultivars was confirmed in a subsequent replicated test. About 75% of the cultivars screened demonstrated low resistance to aphid infestation.
- In laboratory tests, researchers have demonstrated the potential for soybean aphids to transmit such viruses as soybean dwarf virus and soybean mosaic virus. Transmission in the field has not been observed during extensive monitoring.
- Researchers performed additional analysis of the importance of planting time in aphid infestation. In Illinois, evidence suggests that the aphid successfully overwinters in areas where late-planted soybean crops are near buckthorn, such as river bottomlands and suburban/urban lands being developed for buildings. Late-planted soybean crops in these areas provide a temporal bridge for winged aphids to develop. These aphids can then fly to buckthorn, which supports them through the winter.
- Researchers expanded the Soybean Aphid Internet Reporting and Mapping System (SAIRMS), a tool designed to provide stakeholders and researchers with a standardized sampling protocol and a convenient, Internet-based procedure for reporting soybean aphid observations. SAIRMS data are posted on the Soybean Aphid Watch



website (<http://www.pmcenters.org/northcentral/saphid/>), which monitors spread of this pest. In 2002, researchers revised the sampling protocol, Internet reporting form, and the presentation of the maps on the website.

- In April 2002, project researchers prepared and disseminated a two-page fact sheet concerning aphid biology and management.

## MANIPULATION OF PHOTOPERIOD TO ENHANCE THE SUSTAINABILITY OF ILLINOIS DAIRY FARMS

### Principal Investigators

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Extension

Gary D. Schnitkey, Department of Agricultural and Consumer  
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Management of photoperiod (the duration of a cow's exposure to light each day) in dairy cattle can be a profitable tool for producers. Properly implemented, photoperiod technology leads to immediate milk production responses, requires little capital investment, and has a quick asset turnover. These features make photoperiod management particularly attractive as a method for helping producers meet current challenges and improve long-term viability of the Illinois dairy industry. This project emphasizes a combination of outreach education and applied research to demonstrate, optimize, and develop novel photoperiod management techniques and thereby facilitate widespread awareness and adoption of these techniques on dairy farms in Illinois.

The outreach activity of project researchers in 2002 was impressive. Researchers presented at several Four-State Dairy Management seminars, reaching at least 450 dairy producers and allied industry representatives in the Illinois-Iowa-Minnesota-Wisconsin region; at four regional Extension meetings in New York attended by more than 300 producers; and at the annual meeting of the Dairy Farmers of Nova Scotia attended by 250 producers. Project researchers also delivered an invited presentation at the Sixth International Workshop on the Biology of Lactation

in Farm Animals, cosponsored by the American Society of Animal Science and the European Association of Animal Production. In addition to those presentations, researchers published one review article and four symposium proceedings articles. Researchers have also disseminated information on photoperiod management through the revised photoperiod website, <http://il-traill.outreach.uiuc.edu/photoperiod/>. The site includes data summaries, installation instructions, and worksheets for estimating installation costs and economic benefits.

Results from a recent survey published in *Hoard's Dairyman* provide some indication of general stakeholder interest in photoperiod management research. Survey participants were asked, "Do you use supplemental (photoperiod) lighting to extend day length for your milking herd?" Of the 367 survey respondents, 32.4% answered "yes" while 67.6% answered "no." This was the first national survey to include queries regarding the use of photoperiod manipulation, and the results indicate that dairy producers are using the technology and suggest that new findings in this area would be of interest.

Researchers also made progress with regard to the project's applied research objectives. The first field study testing the viability of photoperiod management in Illinois began on October 1, 2001. This study involves pairs of farms with similar production and management levels. Within each pair, one farm has installed lighting and is applying long-day treatment to the lactating herd, while the other farm serves as a control and provides no photoperiod treatments to the herd. Milk production, herd health, and implementation costs were followed for six months, and researchers are now summarizing the results. Farms are currently being enrolled for a second year of this study.



These models will eventually be used to input results from the animal feeding trials and evaluate the economic outcome for the livestock producer of feeding special “species specific” soybean meal-based diets. Research findings of this project are anticipated to be useful in creating niche markets for added-value soy products produced by small-to-medium size soybean producers.

## CREATING NICHE MARKET OPPORTUNITIES IN ANIMAL FEEDING FOR SMALL FARMERS WITH SOYBEANS

### Principal Investigators

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Marilyn L. Nash, National Soybean Research Laboratory

Rodney L. Frazier, Frazier Barnes and Associates

This multiyear project is designed to identify soybean meal processing techniques that will add value to soybeans as a feedstuff for poultry and swine. Animal scientists at the University of Illinois are identifying soybean meal processing conditions with the goal being to increase soybean meal amino acid digestibility and/or minimize meal phytate phosphorus content. The former result would allow for more nutrient-efficient diet formulations for pigs and poultry. The latter would free up phosphorus already present in soybean meal but presently unavailable for digestion. This would require less feed supplementation and result in less phosphorus excretion by the animal to the environment. By developing soybean meal with benefits specific to swine and/or poultry feeding, it is anticipated that increased opportunities will arise for processing plants to furnish “species specific” meal.

Researchers are working with meal samples processed under tightly controlled conditions at Texas A&M University under the guidance of Frazier Barnes and Associates, an agricultural consulting company. The first soybean meal samples to be analyzed are from beans processed with varying residence times during the desolventizing/toasting stage, to determine if protein quality and growth and performance in pigs will be affected. The samples for examining phytate phosphorus variation were manufactured by varying extractor residence time and will be analyzed for composition and quality. Researchers are also developing sophisticated swine and poultry farm production models.

## PLANT DISEASE MOLECULAR DIAGNOSTIC INITIATIVE

### Principal Investigators

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This project provided funds to purchase equipment that would aid in the rapid detection of plant pathogens. Researchers have obtained a Zeiss microscope that can automatically count soybean cyst nematodes, a microplate reader that can perform high-throughput immunological assays on plant pathogens, and an ABI 7900HT sequence detection system that can quickly quantify pathogen DNA.

The counting microscope from Zeiss is in the process of becoming operational. The high-speed microplate reader has been used to process over 10,000 immunological assays that detect fungal toxins in plant tissues. The ABI 7900HT sequence detection system, which performs real-time polymerase chain reaction (PCR) assays, is also operational and has been used to detect fungal and nematode DNA in plant tissues. This instrument has greatly improved the sensitivity and speed of DNA-based pathogen assays. Researchers have converted several conventional PCR assays that detect plant pathogens into real-time PCR assays, called TaqMan assays, and have found the new assays are 100 times more sensitive. Due to this success, researchers are currently converting all of their conventional PCR assays to TaqMan assays. The real-time PCR machine has also greatly improved research on detecting virulent soybean cyst nematodes (SCN) (nematodes capable of infecting resistant soybean plants). In these experiments, TaqMan assays have been used to detect a nematode virulence gene. Researchers now have the ability to determine the frequency of this gene in SCN field populations, which should allow them to rapidly predict SCN virulence to some resistant soybean varieties. The ability to quickly predict SCN virulence will allow researchers to advise growers on which SCN-resistant soybean varieties to grow that will best control their field populations of nematodes. This initiative is already showing benefits to farmers, plant breeders, and researchers studying plant pathogens.

# INTERNAL AND EXTERNAL RESEARCH PROJECTS

In accordance with the Food and Agriculture Research Act (C-FAR's enabling legislation), the majority of research funds are allocated on a percentage basis to Illinois' four food and agriculture research universities: University of Illinois at Urbana-Champaign (82%), Southern Illinois University at Carbondale (11%), Illinois State University (4%), and Western Illinois University (3%). Each university solicits requests for proposals (RFPs) as part of an internal competitive grants program to select innovative, high-quality research that addresses the needs of the Illinois food and agriculture community and consumers as defined by the C-FAR membership.

C-FAR's External Competitive Grants Program is designed to encourage and support research efforts from state agencies and organizations outside of the four universities. The program solicits RFPs from nonprofit research entities within the state. By legislation, a minimum of 15% of the C-FAR allocation is dedicated to support these research projects. Working group members review and select proposals submitted to this program.

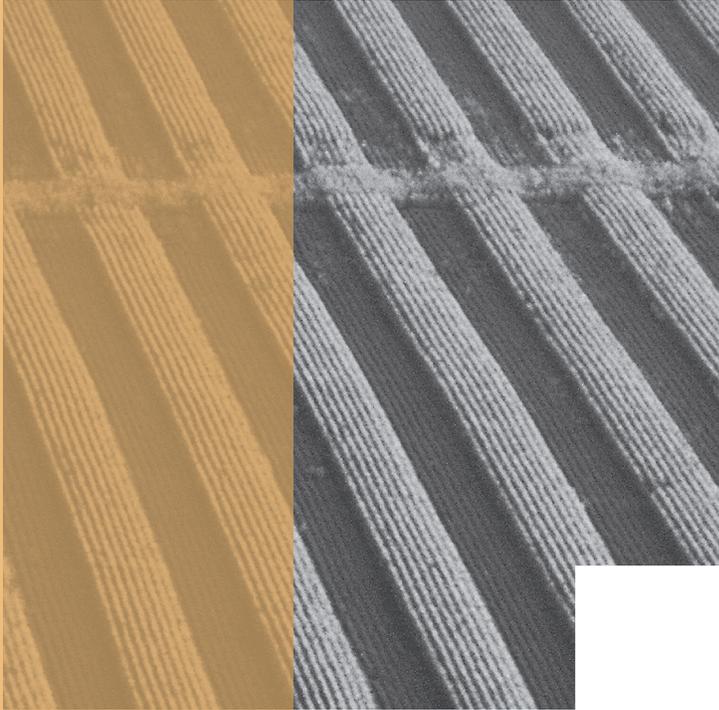
Projects supported through the university internal programs and the External Competitive Grants Program are typically funded for one or two years. Funding can be extended based on need. Support is provided on a fiscal year that runs from July 1 through June 30. The following sections provide a report on the internal and external research projects that were completed in 2002 as well as a listing of the research projects that were funded in FY03.

PLEASE VISIT THE  
C-FAR WEBSITE AT  
[HTTP://WEB.ACES.UIUC.EDU/  
C-FAR/CFARREPORTING/  
PUBLIC.CFM](http://web.aces.uiuc.edu/c-far/cfarreporting/public.cfm) FOR MORE  
INFORMATION ABOUT THESE  
PROJECTS.

# CROPS



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## Application of Extractable Starch Corn Calibration in Illinois Country Elevators

The ultimate goal of the project was to evaluate the potential of near-infrared transmission (NIT) technology for predicting starch yields. Researchers estimate that an increase of one percentage point in extractable starch is worth \$0.04 to \$0.06 per bushel, and it appears that, in most situations, an increase of 2 to 3% is possible. If 17% of Illinois' 1.47 billion bushels were affected, this improvement would have a value of \$20 to \$45 million per year. This project focused on developing a method for identifying and capturing this value for corn growers, merchants, and processors.

The objective of this project was to install the calibration for extractable starch for corn on NIT instruments at collaborating country elevators, to monitor and assist with use of the calibration, and to update the calibration annually. The calibration was installed on nine instruments at country elevators in Illinois. Initial data obtained from the elevators were sparse due to several factors. The primary reason is that the market for high-extractable starch (HES) corn has not developed at the local elevator level. The market for HES corn is driven by merchants who have access to corn wet millers willing to pay a premium for identity preservation of HES corn. At this point, the greatest demand for HES corn is for export to Japan rather than from domestic millers. Other factors impeding data collection include the following: decreased use of NIT instruments by local elevators, increased costs associated with growing high-oil corn (HOC), and decreased premiums paid for HOC. As the once widespread markets for HOC have diminished, many country elevators have discontinued participation in HOC programs, shelving or selling their

NIT units. These factors led researchers to remove certain elevators from the project while adding new elevators that serve the export markets and had previously established or were in the process of establishing HES programs.

Demand by merchants for data about HES content in particular hybrids or lots of corn has greatly increased over the two years of this project. That trend does not appear to be slowing, but the market will continue to be driven by processors and larger terminals rather than by country elevators.

### A C-FAR External Competitive Grants project

**Dennis R. Thompson, John McKinney, Steve Mbuvi, Illinois Crop Improvement Association**

**Marvin R. Paulsen, Mukti Singh, Agricultural Engineering  
College of Agricultural, Consumer and Environmental Sciences  
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## Development of Added-Value Low-Phytate, High-Oil Corn Hybrids

Management of phosphorus (P) in swine and poultry operations is becoming a serious environmental problem. A 150-bushel per acre corn crop produces about 58 pounds per ton of total P and about 50 pounds per ton of phytic acid P (phytate). Nonruminants cannot digest phytate, so the phytate contained in feed ends up in manure. Application of this type of manure to soils increases P content of soil to excessive levels, thus endangering the water quality of streams, lakes, and drinking water. Transfer of low-phytate corn gene(s) into corn

hybrids would significantly reduce this problem. Researchers have identified corn genes that reduce phytate levels in corn grains by 50%. The P level in animal feces can be reduced even further by adding the enzyme phytase to feed rations. The goal of this research was to develop high-oil, low-phytate corn hybrids that would enhance feed efficiency (as a result of the higher oil levels) and improve P management in swine and poultry operations.

Researchers transferred a recessive corn gene that lowers phytate levels in corn grain by 50% into about 20 corn inbreds. They then developed about 26 high-oil, low-phytate hybrids from these lines. During testing in 2001 and 2002, the new hybrids were found to yield an average of 10 to 15% less grain than four commercial hybrids used as controls. In addition, the lower phytate levels of the grain appeared to reduce germination and stand establishment. Researchers' preliminary conclusions are that the high-oil genes reduce grain yields and the low-phytate gene reduces germination. Victor Raboy of the USDA developed the low-phytate gene using a mutagen that may have affected closely linked genes, thus contributing to poor performance. Correcting this problem could require considerable breeding effort.

Preliminary research findings indicate that low-phytate corn hybrids produce lower grain yields than commercial

hybrids. Using a single-kernel assay for inorganic P in corn kernels, researchers have partially assayed the large collection of University of Illinois germplasm. They found a correlated effect between low phytate and increased levels of inorganic P, but total P was not changed. This finding provides a quick assay for possible low-phytate genes. In the past year, researchers assayed about 5,000 kernels and found nine corn lines that appear to have low phytate levels. Crosses have been made with known low-phytate genes to determine if they are the same or different. These lines also need to be assayed for phytate to determine their level. If any of these nine corn lines are found to be low in phytate, researchers can use them to produce low-phytate corn hybrids that, as a result of their better agronomic genes, are competitive with commercial hybrids in terms of grain yield.

### A C-FAR External Competitive Grants project

Robert J. Lambert, Crop Sciences

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### Evaluating Corn GMOs for Safety, Equivalence, and Environmental Impact

The purpose of this research was to compare genetically modified organism (GMO) corn to non-GMO corn relative to consumer safety, equivalence, and environmental

impact. Specific objectives were to (1) combine genomic analysis with physiological studies to determine how the expression of foreign genes in GMO corn affects equivalence to non-GMO corn (in terms of herbicide metabolism, nitrogen uptake, assimilation and partitioning into different nitrogen pools, and alteration of the expression of endogenous genes); (2) sequence analyze cDNA generated from subtraction experiments on maize; and (3) study the steady-state mRNA abundance of a large number of GMO crop genes concurrently by using high-density arrays of partially sequenced cDNA (ESTs). Through these studies, researchers will be able to catalog gene clusters differentially affected in their expression rate in the organs of transgenic plants and at different stages of development important to the yield.

To date, research findings indicate that most GMO corn is not significantly altered relative to non-GMO controls. Some GMOs did have dramatically altered metabolism and, thus, would not be considered equivalent to non-GMO corn. Results related to specific research objectives were as follows:

- *Objective 1:* The whole-plant tolerance to glufosinate of GDH (glutamic dehydrogenase) plants, a GMO hybrid, was greater than that of an equivalent Liberty Link hybrid, another GMO plant with a gene used for the commercial tolerance to glufosinate. Research on tobacco has verified that the *gdhA* gene does not significantly alter plant tolerance to various other herbicides encompassing several different modes of action. Researchers also found that the relative incorporation of radio-labeled nitrogen (<sup>15</sup>N) into amino acids was increased by 20 to 25%. Furthermore, the overall metabolite profile, determined by gas chromatography mass spectrometer analysis, showed that 176 metabolites in roots and 93 metabolites in leaves more than

doubled in GDH plants, but few metabolites were altered in other GMOs (0% from 20 tested by spectro-photometer). Finally, researchers confirmed that water-deficit tolerance in *gdhA* transgenic plants plays a role in the increased yield or yield stability of this corn.

- *Objective 2:* Researchers tested thousands of genes and found none are altered in the GMOs tested. This finding supports equivalence of GMO and non-GMO corn. GDH corn served as a positive control, but even in this case, researchers did not find widespread changes in gene expression. Therefore, researchers expect that alterations in genes expression are rare (that is, affecting less than 10% of the genes).

- *Objective 3:* Researchers prepared planted plants, harvested samples, and made RNA for use differential hybridization of probes derived from GMO corn (Liberty Link, Roundup Ready, Bt, GDH) compared to microarrays of corn ESTs. Researchers used metabolites to help choose the genes arrayed. No changes were noted in relation to natural variation. This observation will promote GMO licensing in the future.

The practical outcome of continuing this research to completion will be increased acceptance of GMO products as safe and environmentally desirable by consumers worldwide.

### A C-FAR External Competitive Grants project

David Lightfoot, Bryan Young, Plant, Soil and General Agriculture

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## ■ Identification of Human-Food Corn Hybrids with Low Levels of Fumonisin

The mycotoxin fumonisin has been implicated as a causal agent of human esophageal cancer and neural tube birth defects. It is produced by *Fusarium verticillioides* and *F. proliferatum*, which cause Fusarium ear rot of corn, the most frequently occurring ear rot disease in Illinois. The disease causes only a few rotted kernels on the ear, and fumonisin is often present in corn grain that has no visible symptoms of rot. The purpose of this project was to evaluate 70 white, yellow, or blue food-grade dent corn hybrids and 30 fresh market or processing sweet corn hybrids for susceptibility to Fusarium ear rot and the production of fumonisin in grain. The goal was to identify the most susceptible hybrids so that the food processing industry could avoid using these.

In laboratory tests, researchers found that white and yellow hybrids inoculated with *F. verticillioides* or *F. proliferatum* had from 4 to 250 parts per million (ppm) fumonisin in grain and blue hybrids had from 29 to 162 ppm fumonisin in grain. Sweet corn hybrids generally had low levels of fumonisin in ears because they were harvested shortly after inoculation. Several white and yellow food-grade hybrids had a level of resistance to Fusarium ear rot that would allow for acceptable corn grain in most Illinois environments.

In 2001, 12 food-grade hybrids were field tested in three Illinois locations without inoculation. Hybrids grown near Brownstown, Illinois, had less than 1 ppm fumonisin in grain. Food-grade hybrids grown near Carbondale, Illinois, which were identified as susceptible in researchers' inoculation tests, had between 1.4 and 3.7 ppm fumonisin. Hybrids grown near Dwight, Illinois, had much higher levels of fumonisin in grain, with an average of

3.6 ppm in both resistant and susceptible hybrids. The six most susceptible of these hybrids had more than 4 ppm fumonisin in grain, exceeding the Food and Drug Administration's current guidance level of 2 to 4 ppm for corn to be used as human food. Preliminary indications are that fumonisin levels in corn grain are much higher in 2002. These research findings ultimately will help corn producers select optimal hybrids for food-grade corn.

### A C-FAR External Competitive Grants project

Donald G. White, Jerald K. Pataky, Crop Sciences

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## ■ Influence of Corn Hybrid on Dry-Milling and Extrusion-Product Performance

With a stronger understanding of how using various commercial hybrids affects corn meal performance and quality, processors, millers, and producers could increase the quality and value of extruded corn snacks. This project aimed to measure the variability present in extruded corn snacks caused by corn hybrid characteristics. Corn meal is a low-valued coproduct from the dry-milling process. Variation in corn meal characteristics often does not reveal itself until the meal is being processed. Understanding variation caused by corn hybrid will show the value that corn producers can provide by marketing corn hybrids with similar characteristics for extrusion processing.

Researchers found that the source of corn meal influences the characteristics of extruded corn snacks.

Textural attributes of the selected hybrids differed significantly. Four commercial hybrids grown on research plots were dry milled in batches of 50 kilograms and blocked according to hybrid. Batches of whole corn were tempered and degerminated to obtain "throughs" and "tails," and these samples were separately roller milled, aspirated, and sieved to obtain through meal and tail meal. Tail meal was blended with through meal to obtain a standardized fat content (greater than 1%) in sufficient quantity for pilot-scale extrusion. Batches (of approximately 8 kilograms each) were extruded using a co-rotating twin screw extruder. Extrusion parameters included a screw length:diameter ratio of 87:7, screw speed of 250 rpm, feed rate of 30 pounds per hour, and moisture content of 22%. Researchers collected samples of puffed-corn products and data on extruded performances. Dry-milling yields were measured, and samples of meal were tested for fat content, particle size, rapid viscoanalysis (RVA) characteristics, and color. The extruded puffed-corn products were tested for similar parameters as well as textural attributes of the puff. In addition, data on extrusion performance were collected. Through analysis of these data, researchers found that hybrid influenced parameters such as

dry-milling performance and yields, particle size distribution of corn meal, and RVA characteristics. RVA profiles also indicated functional differences between through and tail meal fractions.

#### **A C-FAR External Competitive Grants project**

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#### **Sources of Genetic Resistance to Reduce Fumonisin in Corn-Based Food**

Fumonisin is a mycotoxin that has been implicated as a cause of human neural tube birth defects in China and south Texas and as a cause of human esophageal cancer in several countries. It also causes numerous problems to animals that consume it. Fumonisin is produced by *Fusarium verticillioides* and *F. proliferatum* in corn grain. These two species cause Fusarium ear rot, the most common ear rot disease of corn in Illinois. Fumonisin is found in grain with few or no symptoms of rot, mak-

ing it difficult to detect. Every year in Illinois a certain amount of food-grade corn contains fumonisin levels that exceed the level allowed according to FDA guidance levels. If the FDA changes its fumonisin recommendations from “Guidance Level” to “Action Level,” the marketing of Illinois corn grain outside the state will be greatly disrupted. The goal of this research is to identify sources of resistance to Fusarium ear rot and to begin incorporating resistance into commercially usable inbreds and hybrids.

Researchers have identified sources with high levels of resistance to Fusarium ear rot and the production of fumonisin. When incorporated into corn hybrids grown commercially in Illinois, these resistance sources will protect Illinois corn growers from future regulation of fumonisin in corn grain. Furthermore, control of fumonisin benefits the general public by reducing the risk of neural tube birth defects and cancer associated with the consumption of corn-based food products contaminated with fumonisin.

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#### **Effects of Tillage, Plant Nutrition, and Seed Treatment on Reduction of Soybean Sudden Death Syndrome (SDS)**

Soybean sudden death syndrome (SDS) is caused by the soilborne pathogen *Fusarium solani* f. sp. *glycines* (FSG). According to a statewide survey in 1998, SDS appeared in 91 out of 102 Illinois counties, causing an estimated loss of \$60 million. In 2000, 95 Illinois counties detected SDS and, as a result, sustained losses estimated at

\$400 million. This research focused on developing a management method to reduce soybean root infection caused by the SDS pathogen. Researchers hypothesized that increasing the soil’s macroporosity would enhance profile drainage and thus reduce root infection by FSG and subsequent development of SDS. The main objective was to evaluate how deep-till treatment affected root infection by the SDS pathogen, subsequent foliar symptom severity, and soybean yield.

Two 3-acre areas in Jackson County, Illinois, were selected for this study. Researchers used two areas so that they could establish a corn–soybean rotation. In 1999, the areas were divided into 12 strips, each 30 feet wide, and these were alternately treated with no-till and deep-till. Each strip was divided into 10 equal sections, or subplots. Within these subplots, researchers measured physical and biological properties of the soil as well as its moisture content. Physical properties included bulk density and porosity, whereas biological properties included initial and final populations of soybean cyst nematode (*Heterodera glycines*) as well as soybean root colonization by FSG. Plots were rated for SDS incidence and severity at the R5 growth stage in 1999 and at four separate times, beginning at the R5 stage, in 2000 and 2001. Researchers calculated foliar disease indices (DX) as the product of disease incidence and severity for each subplot. Yields were measured at maturity.

Results indicated that deep-till, or subsoiled, plots had lower bulk density, greater porosity, and lower soil moisture than did no-till. Soil bulk density correlated positively with root infection by FSG as well as SDS foliar index. Soil moisture correlated positively with foliar DX and negatively with soil bulk density. Subsoiling reduced foliar DX by 61% in 1999 and by

39% in 2000; however, two years after subsoiling, the foliar DX was only 21% lower than that of no-till plots. This finding shows that the benefit of deep tillage dissipated with time, probably due to reconsolidation of the soil. The soil changes brought about by deep tillage were degraded. Researchers also found that, for every 10% increase in the foliar DX, there was a 7% decrease in soybean yield.

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**Samuel J. Indorante, USDA-NRCS, Plant, Soil and General Agriculture**

**College of Agricultural Sciences  
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### ■ Improving Phytoestrogen Content in Soybeans: A Non-GMO Approach

Foods containing bioactive components are receiving increased attention due to their functionality in disease prevention and treatment. Soy phytoestrogens are being implicated in a reduced risk of breast and prostate cancer, cardiovascular disease, and osteoporosis. Additionally, phytoestrogens have been shown to have positive and negative effects on animal reproduction and growth. The biological effects of these isoflavones appear to be species-, dose-, and age-dependent. Soybean phytoestrogens may exhibit their cardio-protective effects independent of the estrogenic pathways. Soy phytoestrogens have also been shown to improve coronary arterial reactivity and to exert antioxidant effects beneficial to reducing heart disease. The amount of phytoestrogens in soybean seed can vary by a factor of five. Furthermore, phytoestrogen content and profile can vary by year, environment, and genotype. Hence, genetic markers closely linked to genes controlling these soy phytoestrogens



may be used to indirectly select for favorable alleles more efficiently than direct phenotype selection, as has been the case with other traits of agronomic importance. The purpose of this study was to determine the heritabilities of daidzein, genistein, and glycitein and to identify genetic markers linked to loci that condition variation in phytoestrogen production by different soybean varieties. Researchers can then use this genetic information to develop a soybean variety that has a high and consistent concentration of a beneficial phytoestrogen.

The study involved 100 recombinant inbred lines (RIL) from Essex X Forrest soybeans. Isoflavone content of seeds from each RIL was determined by high-performance liquid chromatography (HPLC). Isoflavone content of soybean seeds was compared against 150 polymorphic DNA markers in a one-way analysis of variance. Researchers identified four genomic regions that are significantly associated with soybean seeds' isoflavone content. Molecular linkage group B1 contained a major quantitative trait locus (QTL) underlying glycitein content ( $P = 0.0001$ ,  $R^2 = 50.2\%$ ), linkage group N contained a QTL for glycitein ( $P = 0.0033$ ,  $R^2 = 11.1\%$ ) and a QTL for daidzein ( $P = 0.0023$ ,  $R^2 = 10.3\%$ ), and linkage group A1 contained a QTL for daidzein ( $P = 0.0081$ ,  $R^2 = 9.6\%$ ). Selection for these chromosomal regions in a marker-assisted selection program will allow researchers to manipulate amounts of isoflavones (genistein, daidzein, and glycitein) in soybean seeds. In addition, researchers can use tightly linked markers in map-based cloning of genes associated with isoflavone content.

### A C-FAR External Competitive Grants project

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**David Lightfoot, Khalid Meksem, Victor Njiti, Michael Schmidt, Plant, Soil and General Agriculture**

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### ■ Molecular Markers for Parasitic Ability of Soybean Cyst Nematode

Since the development of the first cultivars resistant to *Heterodera glycines*, or soybean cyst nematode (SCN), nematologists have sought ways to identify the parasitic abilities (virulence) of field populations. At present, this identification is based on a soybean host differential test, which is labor-intensive, requires large greenhouse space, and requires a minimum of one month to complete (assuming there are sufficient numbers of nematodes in the submitted soil sample). The purpose of this research was to develop molecular markers for a rapid and reliable identification of field populations of *H. glycines*.

Using repeated selection on several sources of SCN-resistant soybean, researchers identified nine amplified fragment length polymorphism (AFLP) markers that provide varying degrees of specificity to 48 popula-

tions of SCN races 1 through 6, 9, and 14. The nine AFLP markers were cloned and their DNA nucleotide sequence determined before they were used to design oligonucleotide primers for PCR-amplification of genomic DNA from the original unselected field populations. Researchers then developed sequence tag site (STS) primers that are specific for races 1 through 6, 9, and 14 of *H. glycines*. For example, one of the primer combinations resulted in specific amplification of a 251-bp fragment found only in race 5. A second primer combination produced two discrete fragments (500- and 990-bp long, respectively) that were specific for race 2. Populations of race 2 and race 5 are difficult to control because they overcome the most common source of resistance used in Illinois and the rest of the Midwest. However, populations of races 2 and 5 are uncommon in Illinois. Another primer combination could identify races 1 and 3, the most common races in Illinois and the Midwest. Researchers are currently conducting tests on SCN populations from various locations to validate these results. When this research is completed, diagnosis of *H. glycines* virulence should be possible by means of PCR reactions (probes) involving the STS markers identified in this study.

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## Variety Evaluation and Nitrogen Management of Wheat Types in Illinois

The number of acres planted with soft red winter wheat (SRW) in Illinois has declined steadily from a high of just over two million acres in 1990 to under one million acres in 2000. This decline has continued despite the fact that wheat yields have increased by an average of 0.6 bushel per acre each year since 1950. Even with lower acreages planted, wheat prices have spiraled downward from a high of \$4 per bushel in 1996 to just over \$2 per bushel in 2000. Two factors explain this price decline: (1) decreased demand for SRW by world markets and (2) diminished quality of Illinois wheat the last few years due to weather, diseases, and other complications. Other wheat types, such as soft white winter wheat (SWW) and hard red winter wheat (HRW), have proven to be leaders in world demand and have a favorable price advantage over SRW. The goal of this research was to determine if other wheat types could be grown in Illinois and compete favorably (in terms of grain yield, milling quality, and baking quality) with wheat grown in other production regions. A second objective of this study was to determine the effects of nitrogen management on these various wheat types.

When averaged over six locations across Illinois during the three-year period from 2000 through 2002, SWW varieties grown in Illinois out-yielded the most popular SRW varieties by nearly 5 bushels per acre with nearly equal test weights. However, growing SWW did raise a few concerns, such as sprouting in the head when harvest is delayed. Furthermore,

milling and baking quality tests have indicated that flour quality may not meet all requirements in some situations. HRW and hard white winter wheat (HWW) varieties did not perform well in Illinois growing conditions, consistently yielding more than 10 bushels per acre less than SRW varieties even though test weights were slightly higher. Researchers also evaluated how different nitrogen sources (such as ammonium nitrate, ammonium sulfate, and liquid urea-ammonium nitrate solutions) and application timing (spring-split timing of nitrogen application) affected performance. They found that these factors had no significant effect on yield or test weight of these wheat types. Farmers wishing to grow SWW should contact a local miller or elevator to determine the demand for this product in their area. Researchers recommend that producers enter this market slowly and probably on a contract basis until more information is obtained on quality standards and marketability of Illinois-grown SWW.

### A C-FAR External Competitive Grants project

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## Wheat Scab Resistance: Breeding and Research on Molecular Markers

Scab, or Fusarium head blight (FHB), is a severe disease of wheat in Illinois as well as many other states. Scab causes significant reductions in grain yield, test weight, grain quality, and milling yield. The fungus also produces mycotoxins that are detrimental to both humans and livestock. The long-term objectives of this project are (1) to develop soft red winter wheat varieties with excellent resistance to scab (as well as other diseases), high yield potential, acceptable milling and baking quality, and acceptable winter hardiness; and (2) to develop molecular markers associated with genes for scab resistance and use these markers for marker-assisted selection.

Substantial progress has been made in both areas of emphasis for this research project. Researchers have established effective phenotypic evaluation techniques for use in the greenhouse and the field, made many (a few hundred) crosses with scab resistance sources, evaluated many breeding lines, and identified a number of scab-resistant breeding lines. Researchers have also made progress in developing molecular markers for scab resistance genes. Molecular markers associated with three genes for scab resistance have been identified, and one of these genes has been located on a specific region of the short arm of chromosome 3B. Molecular markers (SSRs) flanking that gene have been identified. Furthermore, researchers have developed genetic materials that will enable them to conduct additional research on scab resistance. Currently, researchers are

working to validate SSRs in additional populations and to apply marker-assisted selection for scab resistance.

**Frederic L. Kolb, Leslie L. Domier, Wenchun Zhou, Larry K. Boze, Crop Sciences**  
**College of Agricultural, Consumer and Environmental Sciences**  
**University of Illinois at Urbana-Champaign**

## Identification of Potential Alternative Crops for Illinois

Continued economic pressures and changing government policies related to growing Illinois' main crops (corn, soybean, and wheat) will require farmers to produce alternative crops to remain profitable. The goal of this project was to develop crop suitability maps for existing and potential alternative crops in Illinois so that producers can evaluate which world crops are most suitable for Illinois growing conditions and, in particular, the conditions in their own location.

Researchers for this project identified 986 world economic crops and created overall suitability maps for 414 of these. The suitability of Illinois conditions was determined using air temperature, precipitation, winter minimum temperature, growing days, soil texture, soil drainage, soil pH, and estimates of the crop's requirements. The maps are available on the Alternative Crops Suitability Maps website at <http://www.sws.uiuc.edu/data/altcrops>. The website is interactive and allows users to identify a specific location in the state, select the suit-



ability classes (highly suitable, suitable, moderately suitable, slightly suitable, and/or unsuitable) from which to identify crops, select a crop from the crop list, and view the overall suitability map as well as individual suitability maps for each of the climate and soil variables.

## A C-FAR External Competitive Grants project

**Steven E. Hollinger, Illinois State Water Survey**  
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## The Economics of Pesticide-Free Organic Row Crop Production

The goal of this research was to assess the economic risks and returns associated with an organic row crop rotation. The researcher surveyed organic corn and soybean producers and handlers to identify the agronomic practices and handling procedures that influence the quality of the commodity. The survey data were then combined with field data and cost-and-return budgets.

Forty-three percent of the survey respondents are strictly organic farm-



ers. More than half of the respondents listed concern for the environment as their top reason for switching to organic production. Other factors cited include organic premiums, farm diversification, and lower input costs. The researcher found that organic producers had yield reductions ranging from 0 to 20 bushels per acre for soybeans and 10 to 45 bushels per acre for corn. Numerous factors, including weather, location, plant variety, tillage practices, soil fertility, and weed management techniques, affected yields. Major price discounts for organic producers include the costs associated with clean out for split seeds, stained seeds, and foreign material. To reduce the risks of organic farming, almost half of the survey respondents had an off-farm source of income. More than half of the respondents use forward contracting, or hedging, to sell their product, and almost 75% of the respondents use crop insurance even though they are able to insure their crop only at conventional price levels. Survey respondents also identified the additional challenges of organic row crop production, the costs of production, and the need for additional research to aid organic row crop producers. Researchers are combining these results with the budget estimates to assess the economics of organic row crop production.

**Rick Hirschi, Agriculture**  
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## Evaluating Consumer Acceptance of Genetically Modified Organisms

This project examines public sentiments about agrobiotechnology. Specific research goals were to (1) identify factors driving public acceptance of or resistance to agrobiotechnology and (2) assess willingness to pay for non-biotech foods as a measure of behavioral intention when consumers have the option to choose between biotech and nonbiotech foods. Primary results of this research indicate the following:

- Consumer perceptions about negative and positive attributes (that is, risk and benefit perceptions) are the most important factors determining public attitudes toward agrobiotechnology, and risk perceptions have a greater effect on public acceptance than do benefit perceptions.
- The favorable effect of positive attributes was statistically significant in explaining public acceptance of agrobiotechnology, indicating that promoting beneficial aspects of agrobiotech may be a viable strategy for reducing public rejection of biotech foods.
- Trust, awareness, and sense of outrage play an important role in shaping public attitudes toward agrobiotechnology, largely through their relation to risk perceptions. Furthermore, trust and outrage have a more significant effect on risk perceptions than awareness does.
- Factors such as attitudes, risk and benefit perceptions, and willingness to pay a premium for nonbiotech foods indicate that U.S. consumers are more ambivalent about agrobiotechnology than are UK consumers.

- U.S. consumers were willing to pay 10 to 12% more on average to avoid biotech breakfast cereals; UK consumers were willing to pay 19 to 35% more.

This research showed that consumers' distrust of regulatory agencies, coupled with the sense of outrage due to the lack of a labeling system, is the most important factor causing consumers to perceive risks from agrobiotechnology. In addition, awareness/knowledge of agrobiotechnology issues had a statistically significant effect on attitudes, but the effect of distrust/outrage was substantially greater. This finding clearly indicates that restoring consumer confidence in regulatory agencies and allowing consumers to make informed choices would be the most effective strategies for alleviating risk perceptions and, thereby, improving overall acceptance of biotech foods. Unless these two factors are addressed, educating consumers and increasing their awareness of agrobiotech issues are not likely to be effective. Another key finding of this research is the greater willingness of UK consumers to pay higher prices for nonbiotech foods compared to U.S. consumers. This finding indicates that a voluntary labeling system is an appropriate strategy for meeting the demand for informed choices in the U.S. market; however, to the extent that UK consumers represent its population, the European Union's position on mandatory labeling seems justified. While there has been some speculation that the EU's tough regulations regarding biotech foods are political moves to increase trade barriers between the European Union and United States, this research suggests that EU policies instead result from heightened consumer concerns.

**Wanki Moon, Agribusiness Economics**  
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## ■ **Extent, Characteristics, and Management of ALS-Resistant Nightshade**

Two biotypes of eastern black nightshade that are resistant to acetolactate synthase (ALS)-inhibiting herbicides have recently been identified in Illinois and Indiana. Since these ALS-resistant and -tolerant nightshade biotypes have just been identified, there is an urgent need to understand the inheritance, genetics, and mechanism(s) of resistance; ascertain the severity of the problem in Illinois; and identify alternative management practices for ALS-resistant nightshade in order to prevent this weed from becoming a more widespread problem in the future. Studies were designed to meet the following objectives: (1) investigate the genetics and inheritance of resistance to ALS-inhibiting herbicides in eastern black nightshade; (2) determine if enhanced metabolism plays a role in resistance, in addition to site-of-action-based resistance; and (3) continue to provide Illinois growers with a screening service for herbicide-resistant nightshade.

Researchers have collected seed from more than 70 eastern black nightshade accessions from 35 Illinois counties and have found that 14% of these demonstrate tolerance to five times the application rate of the imidazolinone herbicide Raptor (an ALS inhibitor). The remaining 86% of these accessions were dead within 14 days after application. This finding suggests that differential tolerance to imidazolinone herbicides exists among eastern black nightshade populations and, further, that resistance or tolerance to imidazolinone herbicides in eastern black nightshade in Illinois is more extensive than previously thought. This problem may lead to more frequent reports of control failures following imidazolinone applications in the field. Researchers found that two biotypes

were highly resistant to the imidazolinone herbicides imazamox (Raptor) and imazethapyr (Pursuit), but these biotypes are not cross-resistant to the sulfonylurea herbicide primisulfuron-methyl (Beacon). Although both biotypes were highly resistant to the imidazolinone herbicides examined, the biotype from north-central Illinois was about one and one-half times more resistant than the biotype from southern Indiana. ALS genes were sequenced in the two resistant biotypes and a control (susceptible) biotype from Urbana to determine if a mutation had occurred in their ALS genes' coding regions. Both resistant biotypes had the same point mutation in the ALS coding region, and this mutation has previously been documented as the cause of imidazolinone-specific resistance in other weed species. Despite having the same mutation, ALS enzymes from these two biotypes did not show the same level of herbicide insensitivity during *in vitro* ALS enzyme assays. ALS activity of the Illinois biotype was about eight times less sensitive than that of the Indiana biotype, suggesting that other genetic factors and resistance mechanisms may be involved. The results from ALS enzyme assays, coupled with the difference in whole-plant tolerance to imidazolinone herbicides, suggest that enhanced metabolism could be a secondary mechanism of resistance in these eastern black nightshade biotypes.

### **A C-FAR External Competitive Grants project**

**F. William Simmons, Natural Resources and Environmental Sciences**

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**College of Agricultural, Consumer and Environmental Sciences**

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## ■ **Mechanisms and Evolution of a Novel Example of Herbicide Resistance**

Herbicides remain the most widely used and cost-effective strategy for controlling weeds in Illinois cropping systems. However, the development of herbicide resistance in weed populations threatens the continued effectiveness of herbicides and, thus, the ability of Illinois and U.S. crop producers to remain competitive in the global market. Among the most widely used herbicides are those that target acetolactate synthase (ALS). Due to their very low use rates and low mammalian toxicities, these herbicides are relatively benign in terms of environmental ef-

fects. Unfortunately, numerous weed populations have evolved resistance to these herbicides. Cloransulam-methyl, a new ALS-inhibiting herbicide, was commercialized in 1998. Unlike many other ALS inhibitors, cloransulam-methyl provides effective control of common and giant ragweed. However, after the first year of commercial use of cloransulam-methyl, resistance was identified in ragweed populations from more than 30 sites throughout the Midwest. Such a rapid occurrence of herbicide resistance did not fit the model for resistance development and, therefore, presented a unique opportunity to investigate mechanisms and evolution of herbicide resistance. The primary goal of this research was to determine why resistance to cloransulam-methyl evolved so quickly in these populations.

Researchers identified the mechanism of cloransulam-methyl resistance in common ragweed and giant ragweed. As has been observed in other weed biotypes with resistance to ALS inhibitors, resistance in biotypes of both common and giant ragweed resulted from a single nucleotide change in the ALS gene. Based on sequence analysis of the ALS gene from several plants, researchers obtained evidence confirming the hypothesis that resistance evolved from previous selection with other ALS inhibitors. Results from DNA sequence analysis also indicated that the ALS gene in both ragweed species is highly variable. In fact, although several biotypes of

both ragweed species contained the same resistance-conferring point mutation in the ALS gene, a few biotypes of both species contained different resistance-conferring ALS point mutations. This finding led researchers to hypothesize that the high variability of the ALS gene in both ragweed species enabled them to rapidly evolve resistance to ALS inhibitors. Researchers compared variability of the ALS gene among different weed species to test their hypothesis and determined that the ALS gene in common ragweed is more variable than is the same gene in common cocklebur, smooth pigweed, and common waterhemp. The unusually high variability of the ALS gene in ragweed species is an important contributing factor to the rapid evolution of cloransulam resistance in these species. Furthermore, if the high variability of the ALS gene in these two species is indicative of high variability in other genes, it is predicted that the ragweed species are likely to rapidly evolve resistance to other herbicides.

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### **Internet-Based Management Tools for Evaluation of Precision-Farming Practices for Farm Supply Dealerships: Phase II**

This project covers the development, beta testing, and eventual distribution of Internet-based management tools for farm supply business management. The overall objectives of this study were to (1) assist cooperative, corporate, and proprietary farm supply dealers in estimating the cost of delivering select precision-farming services; (2) evaluate alternative pricing policies for those services; and (3) evaluate the impact on business profitability

based on their own decisions and various adoption rates by their farm customers. Specific research objectives included beta testing and publishing a Variable Rate Technology (VRT) Cost Estimator and also Breakeven Analysis and Profitability Analyzer Calculators on the ProStar Internet site (<http://www.ProStar.ilstu.edu>).

The beta-test model of the VRT Cost Estimator, in spreadsheet format, is currently on the ProStar website. For access information, e-mail the principal investigator at [porourke@ilstu.edu](mailto:porourke@ilstu.edu). The Internet-based active server pages (ASP) version of the cost estimator is being tested at Illinois State University. Additional work is proceeding and additional funding will be sought to achieve all the project's objectives after the C-FAR funding of this project has ended. Researchers anticipate that the VRT Cost Estimator will be ready for release within 12 months. The Internet-based decision support management tools developed through this project may help farm supply dealers make decisions about whether to adopt and how to price precision services. Business decisions are generally better, both in terms of economic and social concerns, when made with good analytical tools and accurate data. Additional benefits may arise from use of these tools in college or high school agribusiness courses, both in the classroom and over the Internet.

**Patrick D. O'Rourke, Jeffrey A. Wood, Agriculture**

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## 100 Generations of Selection—What Happened? The Next Step

Selection for oil and protein in corn was initiated in the Burr's White variety in 1896 at the University of Illinois. One hundred generations of selection have now been completed. The objective of this project was to evaluate progress of selection for oil or protein in generations 65 through 100 of the following corn strains: Illinois High Oil (IHO), Illinois High Protein (IHP), Switchback High Oil (SHO), Reverse High Oil (RHO), Reverse High Protein (RHP), Reverse Low Protein (RLP), and Reverse Low Protein (2) (RLP2). Evaluation trials were grown in the summer of 2000 and again in the summer of 2001. Specific objectives of this project were to determine (1) direct and correlated response to selection for oil or protein percentage in IHO, RHO, SHO, RLO, IHP, RHP, and RLP during the past 35 years; (2) whether selection limits have been reached; (3) whether reverse selection can be effective in a strain (ILP) that has reached a selection limit; (4) whether selection in the reverse strains (RHO, RLO, RHP, RLP), started after 48 generations of forward selection, can reach the protein or oil levels being achieved by the original forward selection; and (5) whether genetic variance has changed in the past 35 generations of selection in IHP, IHO, and SHO. Based on these findings, researchers attempted to predict limits of selection effectiveness and to understand genetic control of progress.

Evaluation trial data and estimates of genetic variance indicate that an upper limit has not been reached for IHO, SHO, or RLP. For IHP, the results are not clear—although no significant increase in protein occurred after generation 88, there was significant genetic variance in generation 98, suggesting progress should be possible. RLP2 was evaluated to test the hypothesis that, even though progress had stopped in ILP, residual genetic variability might allow effective reverse selection. Results from the evaluation trials suggest that progress is being made, but the data from individual years do not. For RHP, the mean reached the level of ILP, at which point progress stopped. The evaluation trials did not indicate any further progress during the past 35 years. The long-continued progress in the IHO and IHP strains is unique in plant breeding. Genetic evaluation of the results suggests that all the progress could result from a relatively large number of genes segregating in the original Burr's White with a relatively low average frequency of favorable alleles.

Measurement of continued progress from selection after 100 generations provided unique information on limits to selection for protein and oil, two key components of the corn kernel. This information will allow design of corn hybrids with specific levels of oil and protein, thus enhancing the value of the corn crop. The results also

have implications for selection limits in other crops and in animals. For example, if as much progress could be made for grain yield in corn as has been made for oil and protein in IHO and IHP, then corn grain yields of 700 bushels per acre should be possible. This selection program and research related to it will continue, providing further valuable information about the potential for long-term selection. The availability of this germplasm has resulted in research funding agreements with plant breeding companies, and this research may lead to commercialization of hybrids containing genes for high oil or protein from these materials.

**John W. Dudley, Robert J. Lambert, Crop Sciences**  
**College of Agricultural, Consumer and Environmental Sciences**  
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### ■ Conference on Long-Term Selection

This project was designed to support an international conference on long-term selection. Because the University of Illinois is the site of the longest continuous directed-selection experiment (that is, the long-term selection experiment for oil and protein in the corn kernel), it was a logical site for the conference. The objectives of the conference were to bring together experts on long-term selection in order to (1) showcase the results of the long-term selection experiment for oil and protein in maize and C-FAR's contribution to it; (2) explore potential limits to selection in both plants and animals; and (3) evaluate the future for long-term selection and the kinds of experiments needed to generate additional information necessary to understand limits to selection in plants and animals (in other words, how high can corn yields be in 50 years or how much faster can chickens grow?).

The symposium was held June 17–19, 2002, at the Holiday Inn in Urbana, Illinois. Approximately 165 scientists from around the world attended. Twenty-two speakers from five countries (including two researchers from the National Academy of Sci-

ences) presented the latest findings on long-term selection and the genetic control of progress from selection. The speakers presented research on organisms ranging from bacteria to sand fleas to *Drosophila* to mice to corn. It is difficult to measure the impact of a conference such as this; however, it is the first time scientists working on such a diverse set of organisms have exchanged ideas and results in a symposium setting. This experience will certainly affect the research of the participants and, through publication of the conference proceedings, the research of many other scientists as well. The kind of information exchanged in this symposium is likely to be the basis of applied research projects that can improve crop and animal production in Illinois in the future. The comments of conference attendees were uniformly favorable.

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# ANIMALS



## Improving Illinois Beef Quality Through a Heifer AI and Development Program

The goals of this project were to (1) research methods for improving estrus synchronization of beef heifers to allow for insemination at a predetermined time and (2) develop and implement a heifer development program focused on producing high-quality replacement beef heifers and creating marketing opportunities for value-added heifers. Researchers conducted a field study that included 1,468 beef heifers from 32 herds throughout Illinois. Heifers in this study were synchronized using the melengestrol acetate/prostaglandin (MGA/PGF) synchronization protocol, and then they were bred at estrus, at 72 hours post-PGF, or at 60 hours post-PGF. The heifers bred at 60 hours post-PGF also concurrently received an injection of gonadotropin-releasing hormone (GnRH). Pregnancy was subsequently determined. This research yielded a comprehensive set of guidelines for developing beef replacement heifers, which has subsequently been implemented in herds throughout the state. Diverse collaborators created and implemented a comprehensive, coordinated program designed to teach producers how to raise value-added replacement heifers and, thus, compete more effectively in the global



marketplace. Results of the study demonstrate that heifers treated with the MGA/PGF estrus synchronization procedure and bred at a predetermined time have higher pregnancy rates than those bred based on estrus detection. This technique significantly reduces the time and labor required for breeding and facilitates implementation of artificial insemination (AI) as well as the use of bulls with acceptable estimated progeny differences (EPDs). Researchers also found that GnRH applications did not further improve pregnancy rates. Therefore, GnRH application can be dropped from the protocol, making this technique more cost-effective for small producers. Overall, 55% of the heifers synchronized with the MGA/PGF protocol and bred at 72 hours post-PGF became pregnant. The protocol developed through this research will enable more producers to improve the profitability of their cattle enterprises and the quality of the replacement heifers they retained in their herds.

### A C-FAR External Competitive Grants project

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## Gene Expression in Cloned Bovine Fetuses

Nuclear transfer (NT) is a technique for replicating genetically identical offspring through the fusion of enucleated eggs with cells from the animal to be replicated. The procedure, though thoroughly documented, leads to erratic outcomes, including early embryonic mortality, high incidence of regressed fetuses, low birth rates, and high morbidity and mortality rates after birth. The goal of this experiment was to document inconsistencies between NT fetal development and control fetal development. This project has provided evidence that suggests differences in gene expression may occur in genetically identical cloned cattle.

Researchers for this project produced cloned fetuses of one genotype and compared their liver gene expression profiles to the liver gene expression profile of the original (control) fetus. In comparing the clonal livers with the control liver, researchers observed 32 expressed gene sequences of known and unknown identities that had differing gene expression patterns. Researchers were unable to confirm these observations after their initial screening. Researchers also observed inconsistencies in the messenger ribonucleic acid (mRNA) gene products. All the mRNAs in the liver samples were amplified, and those mRNAs that were either present or absent in the cloned fetal liver versus the control fetal liver were sequenced and identified. Ultimately, scientists will be able to use this information to modify protocols and, thus, correct the abnormalities observed in the gene expression of cloned cattle.

Researchers had expected differences in mitochondrial gene expression and had hoped that the majority of gene expression differences could be linked to mitochondrial rather than nuclear genomes. Mitochondria and their genes are transferred with the egg cytoplasm and thus are passed to offspring solely from the dam. Nuclear DNA is passed to offspring from both sires and dams. In NT, the objective is to pass the nuclear DNA to the clonal offspring. While researchers for this project detected differences in mitochondrial gene expression, they also observed differences in nuclear genome sequences, suggesting other factors contribute to the differences in gene expression.

These research findings support recent evidence indicating that individual clonal offspring express genes from within identical genotypes differently. The mechanisms that control gene expression clearly need further investigation. Elucidating these mechanisms will expand our basic understanding of biological processes and could benefit many biomedical applications, such as transgenesis and disease research. In addition, if the benefits of cloning elite cattle to produce known/repeatable phenotypes are to be realized, then it is necessary to understand these differences in gene expression.

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## **Dairy Herd Expansion and the Stockperson–Animal Relationship**

During the past decade, the dairy industry has undergone significant restructuring as producers pursue herd expansion opportunities in order to realize economies of scale and adopt emerging technologies. The increased mechanization found in larger dairies undoubtedly influences the amount of time and labor that the producers have available to spend with their animals. While the subject of herd expansion has been the focus of many public discussions, very little effort has been made to systematically examine how dairy herd expansion affects the stockperson–animal relationship. The primary goals of this study were to explore the nature of the stockperson–dairy cow relationship and to characterize dairy producers’ perceptions concerning the impact of herd expansion on stockperson–animal interactions.

Ethnographic content analysis was used to record specific information concerning the nature of stockperson–animal relationships and the impact of herd expansion. The researcher analyzed archival data from producer interviews, discussions in public forums, and postings to Internet discussion groups concerning dairy herd expansion to develop this qualitative characterization. Using an a priori coding scheme, the researcher reviewed producer responses for the occurrence of words or phrases. Responses were subsequently classified into one of the following types of stockperson–animal relationship: ownership, partnership, or stewardship. More than 80% of the responses analyzed fit in the “partnership” or “stewardship” categories. Furthermore, the sources analyzed consistently cited human interaction as important to the welfare of a dairy cow. Concern for

“cow comfort” surfaced as a recurring theme and was often cited as an important provision that the stockperson contributes to his or her cattle. In this sense, the relationship was characterized by a sense of stewardship. At the same time, producers were very cognizant of the link between cow comfort and milk yield, suggesting interdependency or a partnership between the cow and producer. Responses classified under ownership primarily consisted of references to animals as capital or as resources requiring maintenance.

Ultimately, the evidence from this project suggests that the stockperson–dairy cow relationship contains elements that are consistent with all three types of human–animal relationship, and herd expansion did not appear to alter perceptions. For example, one common post-expansion challenge reported by producers was their inability to hire and retain qualified personnel. Producers indicated that cow comfort depends on stockpeople who are competent at working with cattle and recognizing signs of reduced welfare. This finding suggests that, as producers expand their herds, it may be important to implement employee training programs in the area of dairy husbandry and handling.

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### Comparison of Two Protein Binders in the Manufacture of a Value-Added, Ready-to-Eat Pork Product

The Illinois swine industry has experienced sharp declines in prices in recent years. Pork product consumption has been steady at 50 pounds per capita for approximately 30 years. Improvements in swine production technology and expansion of swine breeding herds, especially on large corporate farms, have dramatically increased the volume of pork available to the food market. The price declines caused by increased production have been offset to a modest degree by increased pork exports from the United States. However, there are still significant inventories of domestic pork, and little effort has been made to expand the market for pork by developing convenient, value-added fresh pork products. The objective of this research was to work with a small pork processing plant to develop and market a novel, restructured, value-added pork product. To meet this objective, researchers evaluated two nonmeat protein binding systems (Fibrimex™ and Activa™) in developing a restructured, fully cooked pork roast.

In evaluating Fibrimex™ and Activa™, two commercially available nonmeat protein binding systems, researchers found that both would effectively bind the restructured pork product that was developed. Neither system had a distinct advantage in improving product appearance, sensory attributes, or textural properties of the pork roast product. While this novel, restructured pork roast was successfully developed, the small meat processing plant that researchers worked with was unable to incorporate the roast in their current product line. There were two reasons for this result, with the first being related to the cost of production for the pork roast product. The base meat product was pork shoulder, which historically has lesser value compared to other fresh pork cuts (\$0.55 per pound versus \$1.40 per pound for pork loin or \$1.00 per pound for fresh ham on a wholesale basis). However, the addition of the protein binders and the additional labor required for processing made the product expensive for consumers. To realize profit from the product, this small plant would have to produce much larger quantities of the value-added roast. Increasing production was not an option because the plant was already running at capacity. The second reason the plant has not added the roast to its product line is that, given its current labor and processing arrangement, the plant would have to delete a value-added product currently sold in order to accommodate the new product.

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### Economic Optimization of Wean-to-Finish Pork Production Systems

Arguably, the wean-to-finish production system has been the major technical development in swine production in Illinois during recent years. In this system, piglets are weaned into a single building where they remain until they are removed for slaughter. Traditional approaches involve weaning piglets into nurseries and then moving them into growing-finishing accommodations. Wean-to-finish production is being widely used in the swine industry in Illinois because of its practical and economic advantages. When this research was initiated, little objective, research-based information was available for establishing optimal design and management approaches to maximize the output and profitability of wean-to-finish systems. Because of the dramatic differences between wean-to-finish and conventional approaches, historical data from traditional systems could not be used as the basis for advocating optimal management strategies. To address these issues, researchers from the University of Illinois collaborated with commercial producers, who, as well as providing facilities for the research studies, were intimately involved in setting the objectives and designing the studies carried out in this project. The specific project objectives were to develop (1) facility design and management approaches for wean-to-finish production systems that maximize the output from each facility and (2) an economic computer simulation model that allows producers to determine optimal design and management strategies for their facilities at any point in time.

This research project involved a total of 17 experiments (with more than

15,000 pigs) that were carried out on three different commercial wean-to-finish systems. Important outcomes and impacts for the Illinois swine industry include the following:

- Swine producers are applying these research findings to make critical management decisions regarding their management of wean-to-finish systems. Specific areas impacted include the use of double-stocking buildings, housing pigs in large groups (that is, 100 pigs per pen), optimizing floor- and feeder-space allowances, minimizing body weight variation, improving post-weaning performance through feeding and management, and optimizing pig removal strategies at market.
- This project formed a group of collaborators, including producers, associated industry personnel, and researchers, that combines research expertise with production facilities, extensive experience, and practical expertise. This group has continued to function beyond this specific research project, focusing on facility design and management issues impacting the future competitiveness of Illinois swine production.

#### **A C-FAR External Competitive Grants project**

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**Gary D. Schnitkey, Agriculture and Consumer Economics**

**Gerald L. Riskowski, Agricultural Engineering**

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### **Fate of Antibiotics and Antibiotic Resistance Genes in Feed, Feces, and Treated Waste from Pigs**

The long-term objective of this research is to evaluate and quantify how feeding growth-promoting levels of antibiotics to swine affects the overall gene pool and dissemination of antibiotic resistance genes in feed, feces, and waste. The specific objectives were to evaluate the fate of tetracycline (the most widely used growth-promoting antibiotic) resistance genes in the feed and feces of swine fed growth-promoting levels of this antibiotic.

A comprehensive survey of eight pig production facilities was undertaken from late fall 2001 through early winter 2002. The survey compiled a complete record of production system, antibiotic use and records (both current and for the past 10 to 20 years), and waste treatment systems. Five of these sites were selected for inclusion in this study based on a combination of reliability of records kept and data reported, antibiotic use, waste system being used, and sample accessibility. Researchers collected feed, fecal, waste, and environmental samples from each facility from December 2001 through January 2002 (n = 82). Total DNA was extracted from feed, fecal, waste, and soil samples, and genomic DNA was subjected to polymerase chain reaction (PCR) analysis to detect the presence of the tetracycline resistance genes. The following are research conclusions based on the survey of tetracycline resistance genes:

- Feed on all five farms examined, including the organic farm, was genetically contaminated with diverse tetracycline resistance genes.



- The containment buildings and waste handling facilities on the four conventional swine farms consistently produced a strong PCR signal, confirming the presence of a wide variety of both ribosomal protein and efflux pump tetracycline antibiotic resistance genes.
- Results of this study demonstrated that land application of swine waste reduced the diversity of tetracycline resistance genes on three of the commercial farms evaluated.
- Regardless of antibiotic use, tetracycline resistance genes were found to be widely distributed in the confinement buildings and waste handling system. This finding was consistent for all the farms evaluated except the organic farm.
- No evidence was found to indicate that the waste handling system used reduced the diversity of tetracycline resistance genes.

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**Joanne C. Chee-Sanford, USDA-ARS, Natural Resources and Environmental Sciences**

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**Lutgarde Raskin, Civil and Environmental Engineering**

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## Identification of Genes Influencing Pork Quality

To ensure long-term demand for their products, animal producers must provide consumers with a high-quality, nutritious product. Recently, consumers have become much more vocal in demanding meat of the highest quality, a trend that is likely to continue. To meet this demand, producers must understand the factors that influence meat quality. Researchers for this project have implemented a study to evaluate the contribution of genetics to pork quality. Using the recently developed genetic map of the swine genome and a three-generation resource population, researchers are seeking to identify genomic regions harboring genes that affect economically important traits, also known as economic trait loci (ETL). A panel of highly polymorphic DNA-based genetic markers will be used to scan the genome of pigs that were produced by mating swine breeds genetically divergent for their production characteristics, specifically meat quality. Researchers will perform statistical analyses to identify regions of the

genome that segregate with variation in about 36 different phenotypic measurements.

Successful identification of regions that influence economically important traits will facilitate the development of breeding programs that use molecular tools in their animal selection process (for example, via marker-assisted selection). Using such tools, producers will be able to predict animal performance more accurately. Furthermore, identification of these regions will provide a foundation for determining how specific genes influence production traits and for understanding the biological mechanism underlying their influence. This understanding can then be used to modify current production systems so that they accommodate the precise physiology of the animal and thus increase production efficiency.

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## Improving the Reproductive Efficiency of the Swine Breeding Herd Through Precision of Mating and Accurate Diagnosis of Reproductive Status

The purpose of this research was to help pork producers improve reproductive performance and identify limits to reproduction in pigs. Of all sows mated, only 69% actually produce a litter of pigs, and the ensuing loss of economic opportunity can exceed \$500 per sow each year. Previous studies have reported that the number of sows that establish pregnancy, farrow, and produce large litters is highly related to whether the sows are inseminated within 24 hours before ovulation. Producers must be able to determine the onset of estrus accurately if they are to inseminate their sows during this optimal time. One goal of this project was to evaluate whether improved reproductive performance would justify the increased labor necessary for accurately determining onset of estrus and improving optimal time of mating. Researchers measured how different rates of estrus detection (once, twice, or three times daily) as well as different mating times affected various reproductive measures, including percentage of weaned sows expressing estrus following weaning, interval from weaning to estrus, time of ovulation after onset of estrus, percentage and timing of inseminations relative to ovulation, and farrowing and litter traits following mating. The second part of this project focused on diagnosis of pregnancy and failure of sows to produce a litter. In this experiment, researchers used real-time

ultrasound to investigate the optimal time to diagnose pregnancy in swine and mechanisms for pregnancy loss.

In the first experiment, researchers determined that increasing efforts to detect estrus did not translate into improved timing for inseminations and did not improve either pregnancy rates or litter size. It is important to note, however, that systems with more frequent estrus detection had numerically higher farrowing rates and litter sizes. Still, these research findings suggest that, except on very large operations, the extra labor associated with more frequent estrus detection may not be economically feasible. Researchers also gathered new information indicating that, in double insemination systems, the first artificial insemination typically does not occur within 24 hours of ovulation. Further, they found additional evidence demonstrating that the interval from weaning to estrus significantly influences the time of ovulation and the duration of estrus. These findings will help producers implement effective management strategies designed to optimize their breeding labor and timing insemination schedules.

In the second experiment, researchers demonstrated that transrectal real-time ultrasound (TRE) can diagnose pregnancy earlier and more accurately before 24 days than transabdominal real-time ultrasound (TAB). However, the advantage in accuracy does not appear to justify the additional difficulty or time associated with the TRE technique—at least not for use in routine pregnancy diagnosis. The TRE technique does provide an effective method for diagnosing the causes of reproductive failure and for assessing status of both ovaries and uterus. These



studies also indicated that pregnancy loss after establishment occurs very infrequently in pigs. Finally, researchers found that some females with healthy embryos failed to establish pregnancy or established a pregnancy but failed to maintain it. These problems appear to be related to early progesterone values.

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### ■ **Oligosaccharide Effects on Swine-Gut Microbial Populations and Immunity**

A popular trend in animal diets is using prebiotics, probiotics, and synbiotics to enhance nutrition and improve health. A probiotic is a live microbial food supplement that beneficially affects the host by improving its intestinal microbial balance. The most common probiotics used are *Lactobacillus* and *Bifidobacterium* species. In contrast, a prebiotic is a nondigestible food ingredient that beneficially affects the host by selectively stimulating growth and/or activity of one or a limited number of bacteria in the colon. Two common prebiotics are fructooligosaccharides (FOS) and mannanoligosaccharides (MOS). Synbiotics, the combination of a probiotic and a prebiotic, potentially improve gut health by directly providing beneficial microbes while promoting growth of endogenous beneficial bacterial species. Although limited

research has been conducted on the effects of prebiotic oligosaccharides on livestock performance, few animal or human studies have evaluated how these oligosaccharides affect gut health. The goal of these experiments was to determine the effects of prebiotic oligosaccharides, used alone or in combination with probiotics, on nutrition and health.

High in vitro fermentation rates indicated that many oligosaccharides serve as colonic foods for swine. Nursery pigs supplemented with inulin performed similarly to those given dietary antibiotics, demonstrating that inulin supplementation is a viable alternative to subtherapeutic use of antibiotics. Researchers also observed that supplementing the diets of ileal-cannulated growing pigs with galactooligosaccharides reduced the digestibility of certain nutrients but increased fecal concentrations of beneficial bacteria and ileal short-chain fatty acid concentrations. In this model, galactooligosaccharides functioned as a readily fermentable prebiotic. In another experiment, researchers evaluated the effects of the prebiotic oligosaccharide FOS, the probiotic *Lactobacillus acidophilus*, and synbiotic combinations in humans and dogs. In humans, FOS and *L. acidophilus* modified several metabolites associated with gut health, with FOS tending to be beneficial

(decreasing fecal protein catabolite concentrations) and *L. acidophilus* being negative (increasing fecal protein catabolite concentrations). In dogs, FOS enhanced indices of gut health by positively altering gut microbial ecology and fecal protein catabolites, while *L. acidophilus* was more effective when fed in combination with FOS. Researchers also examined the effects of FOS and MOS, both alone and in combination, on indices of gut health in dogs. They found increased levels of beneficial colonic bacteria, increased local and systemic immune indices, and reduced fecal protein catabolite concentrations, suggesting that supplementing diets with FOS and MOS may benefit the colonic health and immune status of dogs. Results of these experiments demonstrate that oligosaccharide supplementation has the potential to enhance nutritional responses and gut health. Benefits of these results may be realized in the swine industry, where antibiotic use is coming under increased scrutiny, and in the companion animal and human food industries.

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Champaign

### ■ Soy Isoflavones: A Value-Added Nutraceutical on Swine Reproduction

Soybeans and soy feed ingredients contain bioactive compounds that affect the physiology and metabolism of animals and humans that ingest these products. The most thoroughly studied of these compounds are the isoflavones (commonly called phytoestrogens). These compounds have been shown to affect, both positively and negatively, reproductive function in animals. In addition to the isoflavones, other compounds found in soybeans may be estrogenic and therefore considered “phytoestrogens.” These include the phytosterols, steroidal saponins, and other nonisoflavone phenolic acids. The overall objective of this study was to determine if soy phytoestrogens affect factors that would lead to increased swine reproductive prolificacy. Researchers sought to examine how phytoestrogens affect the swine estrous cycle and how the isoflavones are metabolized. Specific research objectives were to determine (1) how soy phytoestrogens affect the endocrinology of the swine estrous cycle and the ovulatory capacity of the porcine ovary and (2) how soy phytoestrogens are digested and metabolized by the gilt’s body.

In their evaluation of how soy isoflavones affect the swine estrous cycle as it relates to ovarian function (especially ovulation propensity), researchers observed that soy isoflavones do not negatively influence biological events

that affect ovulation rate. In fact, many experiments demonstrated that soy isoflavones actually decrease events that lead to natural ovarian follicle death and, thus, potentially increase the number of follicles that have the propensity to ovulate. An increase in ovulation, coupled with embryonic survival, would increase litter size, thereby enhancing the profitability of the swine operation. To further support these findings, preliminary studies indicate that gilts fed a soy diet high in isoflavones may have larger litters than those fed a soy diet devoid of isoflavones. Researchers have completed three trials examining how a low versus a normal soy isoflavone diet affects the endocrinology of the estrous cycle. Progesterone analysis has determined that, although the estrous cycles of the gilts were synchronized via moving and boar exposure, the surgery to place jugular cannulas appeared to cause luteolysis again. As a result, the timing of frequent blood sampling during the estrous cycle was shifted, and researchers missed a good window of blood sampling for the follicular phase of the estrous cycle. However, they did obtain samples for the early (metestrus) and late luteal (late diestrus) phases. No obvious differences have been observed in progesterone or estrogen profiles during the estrous cycle between treatment groups. This finding suggests a soy diet has no effect during the luteal phase of the gilt’s estrous cycle. In another experiment, researchers have finished collecting samples for their metabolism study to determine how soy phytoestrogens are

digested, metabolized, and utilized by the gilt's body. Samples are currently being analyzed by high-performance liquid chromatography (HPLC).

### **A C-FAR External Competitive Grants project**

**Todd A. Winters, Gary A. Apgar, William J. Banz, Nicole Hoefling, Michael Bonkowski, Sarah Perkins, Angie Sellitto, Animal Science, Food and Nutrition**  
**College of Agricultural Sciences**  
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### **Validation of Dynamic Ideal Protein for Lactating Sows**

The objective of this project was to test the hypothesis of Dynamic Ideal Protein for the lactating sow. The hypothesis suggests that the limiting order of amino acids in lactation diets changes with varying degrees of body protein loss. Lactating sows mobilize body protein when dietary intake does not meet amino acid requirements for milk production. Considering that the profile of amino acids in body tissue differs from the profile of amino acids in a corn-soybean meal lactation diet, it is logical to believe that the limiting order of amino acids in the diet will change as the supply of amino acids from mobilized body protein increases relative to the supply of amino acids from dietary intake. Lysine, threonine, and valine are the three most limiting amino acids in corn-soybean meal diets fed to lactating sows, and calculations indicate that threonine is more limiting than valine in the diets of sows that mobilize significant amounts of body protein, whereas valine is more limiting in the diets of sows that mobilize a minimal amount of body

protein. Because there is currently conflicting evidence regarding the amino acid composition of mobilized body protein, this study was conducted to verify whether threonine or valine is more limiting in diets of sows with either a significant or minimal rate of body protein loss during lactation. This information is needed for formulation of lactation diets that more closely meet the lactating sow's amino acid requirements. It will assist in balancing dietary amino acid intake with the supply of amino acids mobilized by the sow's body tissues.

The results of this research indicate that threonine is more limiting than valine in the corn-soybean meal diets of lactating sows with a high rate of body protein loss in lactation. Furthermore, research data disprove the primary assumption that valine is the second limiting amino acid for lactating sows, regardless of body protein loss. However, researchers were unable to determine whether valine or threonine is more limiting in diets of sows with a minimal rate of body protein loss. These findings clearly demonstrate that further research is needed to refine amino acid requirements of lactating sows, particularly in regard to the contribution of amino acids from the sow's body. The results of this research ultimately will help establish specific amino acid requirements for lactating sows that take into account the rate of body protein loss expected during lactation.

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### **Rotational Grazing for Sheep**

The purpose of this trial was to evaluate the advantages or disadvantages of rotational grazing for lambs and ewes. Researchers evaluated the differences in lambs based on average daily gain during the grazing period, while they evaluated differences in ewes based on body condition scores. The results of this trial will help sheep producers ascertain whether they benefit most by rotationally grazing their pastures or continuously grazing one large pasture.

This trial included a total of 60 lambs and 44 ewes, and it was conducted in two separate years, 2000 and 2001. During the trial, two lambs died due to causes not related to the experiment. Starting weight of the lambs was not significantly different between the rotationally grazed group and the continuously grazed group. Lambs that were rotationally grazed gained weight at a significantly faster rate than those that were continuously grazed (with an average difference of 0.08 pound per day). In the ewe trial, there was no significant difference in body scores at the beginning of the trial. During

the course of the grazing season, continuously grazed ewes dropped in average condition score by 0.159, while the rotational group increased their average score by 0.432, which was a significant difference.

**John P. Carlson, Agriculture**

College of Business and Technology  
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**Roger Staff, Natural Resources Conservation Service**

**Dean R. Oswald, University of Illinois Extension, Macomb Center**

**Norbert Pohlman, Illinois Lamb and Wool Producers**

**Premiere Sheep Supply, Washington, Iowa**

## Improving Dietary Phosphorus Utilization and Decreasing Phosphorus Excretion by Poultry and Swine

Improving phosphorus (P) utilization in cereal-soy-based diets would have tremendous economic and environmental impact on the livestock industry. Roughly \$1 billion is spent annually for inorganic P supplementation of animal diets. Due to its low availability in plant ingredients, a large amount of P is excreted in the

feces of swine and poultry. When the feces are applied to soil, much of the P enters and pollutes ground and surface water. This is a concern in the United States as well as in other countries where the negative impact of animal husbandry on the environment has already led to legislation to limit application of animal manure on land. The three objectives of this research were to (1) determine whether using low-phytate corn in diets of laying hens and early/late finishing pigs effectively reduces P excretion; (2) determine if the dietary P requirement of poultry is increased by stressors, such as heat stress and induced molting; and (3) define the effectiveness of combinations of citric acid,  $1\alpha$ -OH- $D_3$ , and phytase for chicks and laying hens.

Results showed that the use of low-phytate corn in laying hen and early/late finishing pig diets greatly increased P utilization and reduced P excretion. There was little or no need for P supplementation in diets using low-phytate corn. Furthermore, researchers determined that citric acid,  $1\alpha$ -OH- $D_3$ , and phytase each individually increased P utilization in chick diets and their effects were generally additive when used in combination. In contrast,  $1\alpha$ -OH- $D_3$  had no effect on P utilization in the diets of laying hens. Researchers found that the dietary available-P requirement of first-cycle laying hens was only about 0.18%, which is much lower than the 0.40 to 0.45% levels commonly fed by industry. Interestingly, researchers also found that the available-P requirement of second-cycle molted laying hens is higher than that of first-cycle nonmolted hens. In other experiments, researchers determined that elevated environmental temperature or heat

stress had no effect on the available-P requirement of laying hens; however, heat stress did increase the mortality rate in 3-week-old broiler chicks fed a low-P diet (0.10% available P, which is much lower than the levels fed by industry). Researchers observed no increased heat stress in chicks fed levels of P similar to or moderately below industry levels.

These results indicate that producers can reduce P excretion by at least 50% through feeding poultry and swine low-phytate corn or through feeding citric acid,  $1\alpha$ -OH- $D_3$ , and phytase. Such a reduction would greatly reduce environmental problems associated with P excretion on large poultry and swine farms. In addition, the use of low-phytate corn in laying hen diets virtually eliminates the need for P supplementation, thus decreasing feed costs by more than \$3 per ton. Finally, researchers demonstrated that laying hens require less P than previously thought. Therefore, by simply feeding laying hens the lower P levels required, producers can reduce P excretion by at least 30%.

**Carl M. Parsons, David H. Baker, Animal Sciences**

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## Conference on New and Re-emerging Infectious Diseases

The primary goal of this series of conferences is to promote (1) a lively discussion of controversial issues and (2) collegial interchange of ideas for developing new interdisciplinary interactions and strategies for the global control of infectious diseases. The fourth and fifth Conferences on New and Re-emerging Infectious Diseases at the University of Illinois at Urbana-Champaign were supported

by C-FAR and were held April 19–20, 2001, and April 18–19, 2002. The conferences generated much interest from campus participants as well as those coming from regional institutions. More than 100 registrants attended each conference. Furthermore, at both conferences, graduate students received awards for outstanding poster presentations. The College of Veterinary Medicine and the Department of Veterinary Pathobiology displayed impressive exhibits that highlighted the national and international activities in the College and the characteristics of the graduate program in veterinary pathobiology. Based on the response of the participants, the conferences were extremely successful. Comments about the conferences appeared in the international journals *Emerging Infectious Diseases*, *Trends in Parasitology*, and *Acta Tropica*.

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## ■ Recycling Livestock and Urban Wastes as Value-Added Coproducts

A major problem facing the Illinois livestock industry is disposal of manure, and a major waste problem facing municipalities is disposal of landscape waste. Composting provides a solution to both disposal problems. To take advantage of this solution, it is necessary to make livestock producers aware of composting's potential and to develop methods for accessing the value-added compost market. Accordingly, the objectives of this project were to (1) develop and refine management strategies for using landscape waste to compost livestock manure,

(2) transfer composting technology to Illinois farmers at on-farm composting demonstration sites, and (3) commercialize a brand-name compost concept (product) that can be accessed by any Illinois composter or that can serve as a model for private-sector entrepreneurs.

Four farmers have developed demonstration compost sites in cooperation with the livestock and urban waste research team. These compost sites are located in different geographic areas to increase visibility. The compost cooperators are Dumoulin Farms (Hampshire), Alan Dale Farms (New Bedford), Q W Farms (Edgewood), and Merna Farms (Merna). The farmers managing these compost sites use livestock manure as a nitrogen source and urban wastes (including landscape waste and sawdust) as carbon sources. These cooperator sites provide compost workshops that target livestock operators, public works staff, and Illinois Environmental Protection Agency (IEPA) officials. Five compost workshops have been provided during the past two years. In addition, two focus-group sessions were held for compost end users (horticulture proprietorships). The goal of these sessions was to identify and establish compost characteristics desired by potential marketers. A name-brand compost product, called Sweet Earth, has been developed, and the IEPA has approved this product for sale. Compost must meet specific standards to be marketed

as Sweet Earth compost. Sweet Earth is being promoted as a brand-name, value-added product. Producers who can provide appropriate documentation (laboratory analyses) verifying that their compost meets Sweet Earth's standards can market compost with this name, which should provide added value for their compost.

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College of Applied Science and Technology  
Illinois State University  
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# FOODS

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## Control of the Growth of the Foodborne Pathogen *Listeria monocytogenes*

*Listeria monocytogenes* is the causal agent of the severe and life-threatening infection known as listeriosis. In the United States, approximately 2,500 individuals become seriously ill with listeriosis each year, and approximately 500 of these patients die. A critical factor underlying the threat posed by this foodborne pathogen is its ability to grow at refrigeration temperatures. The population of *L. monocytogenes* can increase to dangerous levels due to the organism's ability to continue growing and multiplying in refrigerated foods. The goals of this research were to (1) provide a better understanding of the mechanisms of growth of *L. monocytogenes* at low temperatures and (2) develop inhibitors to *L. monocytogenes* growth, particularly at low temperatures, that can provide additional antimicrobial barrier protection.

Researchers believe that a considerable number of genes and proteins are expressed in greater amounts when *L. monocytogenes* is growing at low temperatures and that this increased expression is part of the mechanism enabling the organism to adapt to these conditions. A novel method was used to identify bacterial RNAs with increased expression in bacteria grown at 10°C versus 37°C. Researchers found 24 genes showing increased expression, including genes involved in stress responses, regulatory responses, and amino acid metabolism. This finding is important because genes showing increased expression at low temperatures are potential targets for antimicrobial substances. Previous

research has shown that the membrane lipid fatty acid anteiso C15:0 plays a major role in *L. monocytogenes* growth at low temperatures. Researchers have demonstrated that anteiso C15:0 influences growth at low temperatures through its effect on the bacterium's long-range membrane fluidity.

In an effort to use these previous findings to develop a method for controlling *L. monocytogenes* growth, researchers have studied how temperature influences antilisterial activity in a variety of compounds. They have focused their studies on compounds that target fatty acid biosynthesis or the listerial cytoplasmic membrane (given the critical role membrane fluidity plays in low-temperature growth), such as inhibitors of fatty acid biosynthesis, lipid antimicrobials, parabens, plant-derived compounds, surfactants, and antimicrobial peptides. Researchers found that temperature did not have a major impact on antimicrobial activity in any of these compounds. Researchers did note, however, that some inhibitors of fatty acid biosynthesis were also potent growth inhibitors, suggesting they might have potential application for controlling the growth of *L. monocytogenes*.

### A C-FAR External Competitive Grants project

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## *Mycobacterium paratuberculosis* Thermal Inactivation and Incidence in Fluid Milk

The primary objectives of this research project were to (1) collect information on the prevalence and concentrations of *Mycobacterium paratuberculosis* (MpT) present in the raw milk delivered to Illinois milk processors and (2) develop unequivocal data on the heat resistance/susceptibility of MpT to the time-temperature conditions characteristic of commercial pasteurization techniques. MpT, an obligate intracellular pathogen, is the causal agent of paratuberculosis, or Johne's disease, which occurs primarily in cattle and other ruminants. As infection progresses, the ruminants excrete MpT in feces and milk. Paratuberculosis is one of the most widespread bacterial diseases of domestic animals throughout the world, and it is estimated that the disease causes more than \$1.5 billion in annual losses for the U.S. cattle industry alone.

The clinical picture of Johne's disease in cattle is remarkably similar to that of Crohn's disease in humans. Crohn's disease is a chronic inflammatory, granulomatous, and ulcerative process that occurs in the deep layers of the

small and sometimes large intestines. Mounting evidence seems to support the conclusion that MpT plays a role in at least a proportion (estimated as approximately 50%) of Crohn's disease cases. Current data concerning the ability of MpT to survive commercial milk pasteurization are mixed and inconclusive. Studies have reported that MpT can survive pasteurization if present in sufficient numbers in the initial milk sample, and it has been suggested that milk may be a vehicle of MpT transmission to humans. To date, project researchers have focused on determining the prevalence and concentrations of MpT (initial bioburden) in raw milk. This information is necessary to evaluate accurately the effectiveness of pasteurization.

Researchers evaluated samples from commercial raw milk tankers received by Illinois milk processors for MpT. They examined MpT concentrations by culture on Harrold's egg-yolk medium (HEYM) and in BACTEC 12B radiometric medium. A double decontamination procedure was used during the isolation of MpT. Decontamination was necessary because no selective media are available for MpT. MpT is nutritionally fastidious and requires rich media, and MpT cultures are easily overgrown by the mixed population of competing microorganisms found in milk. Results for analyses performed on a total of 143 tanker raw milk samples (collected from January through April 2002) are currently available. Of the 143 samples, 13 (9.1%) tested positive for MpT concentrations by either of the

two culture methods. Positive cultures on HEYM showed visible colonies after approximately 3 to 4 months of incubation. The recovered numbers of MpT in positive samples ranged from 1 to approximately 40 colony-forming units (CFUs) per 50 milliliters (ml). The HEYM positive sample recoveries are based on colony counts, while the BACTEC positive sample recoveries are based on the radiometric growth index. The maximum concentration of MpT observed in this study was less than 1 CFU/ml (0.8 CFU/ml).

Researchers also conducted tests to evaluate how the decontamination procedure affected recovery of *M. paratuberculosis* ATCC 19698. The results show a loss of approximately 46% in recovery of MpT from the decontaminated samples and confirm that minimum detection limits are only lower than those using samples not processed by decontamination. This finding helps explain the prevalence and concentrations of MpT (initial bioburden) found in raw milk. Research for this project will continue, with the goal of developing unequivocal data on the heat resistance and susceptibility of MpT to the time and temperature treatments used in commercial pasteurization. Thermal inactivation kinetics will be determined using MpT inoculated into ultra-high temperature (UHT) sterile milk.

#### **A C-FAR External Competitive Grants project**

**Joseph Dunn, National Center for Food Safety and Technology  
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### **Trust, Credibility, and Other Social Variables in Communicating Food Safety**

The goal of this research was to document empirical baseline information regarding public perceptions and value judgments about sources of information on food safety issues. This information can be used by communicators in agricultural businesses and outreach organizations to develop strategies and guidelines for public communication and education efforts.

It is critical to be familiar with public perceptions of risks to food and agriculture posed by chemicals in food, food irradiation, food biotechnologies, and other new modes of agricultural production and food processing. Whether these risks are real or imagined, consumer concerns significantly affect behavior in the marketplace. This research contributes to understanding the nature and scope of public concerns and perceptions relating to the safety of the food supply. By documenting baseline information through a survey of consumers, this research can help agricultural businesses and outreach organizations develop strategies for public education and communication that address these concerns. The researcher is currently processing initial survey data and analyzing them in comparison with international data from Asia and Europe. The researcher is also preparing research articles for publication based on survey results. Finally, several public presentations of this research have been made to members of the Illinois mass media, U of I Extension, the National Agricultural

Biotechnology Council, University of Illinois ACES faculty, UIUC student organizations, and international conferences in Europe and Asia.

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## Can Soy Components Prevent Prostate Enlargement and Mammary Cancer in High-Risk Individuals?

The objectives of this research were (1) to determine whether diets containing soy protein and a low or a high amount of soy isoflavones affect the life span in mutant and gene knockout mice, which are genetically predisposed to reduced incidence of cancer, delayed aging, and very long life, as well as in transgenic mice, which are cancer-prone, short-lived, and exhibit symptoms of premature aging; and (2) to examine the effects of soy-derived diets on learning and memory as indicators of cognitive aging in long-lived, short-lived, and normal mice.

In this study, researchers bred and evaluated long-lived Ames dwarf (Prop1<sup>df</sup>) and growth hormone receptor knockout (GHR-KO) mice, short-lived transgenic mice that overexpress human GH (Mt-hGH and PEPCK-hGH), and normal animals from each of the four lines. Two weeks after weaning, the animals were assigned to one of the following three diets: (1) the control diet with casein as the only source of protein, (2) a diet containing soy protein and a low level (0.2 milligram per gram of protein) of soy isoflavones, or (3) a diet containing soy protein and a high level (5.7 milligrams per gram of protein) of soy isoflavones. Researchers analyzed life span data for the effects

of diet, genotype, and interaction. The expected genotype effects on longevity were statistically significant in each of the four stocks. The effects of the diet were significant in two of the four stocks (Ames dwarf and Mt-hGH transgenic), and no significant interaction was detected. Compared to the casein diet, the soy diet with low isoflavones extended life in normal, Ames dwarf, and Mt-hGH mice, while the soy diet with high isoflavones did *not* affect longevity. Researchers also observed that the effect of diet on longevity in normal mice was strain-dependent and, in the strain tested, also sex-dependent. In mice fed the low-isoflavone soy diet, memory retention after 24 hours appeared to be better than in animals fed the casein diet in each of the four groups tested, and memory retention after seven days was similarly improved in three of four groups. In most groups, these apparent effects reached statistical significance. The high-isoflavone soy diet had no consistent effect on memory retention.

These research findings indicate that, in comparison to a casein-based diet, a soy-derived diet can extend life span in both normal mice and genetically long-lived Ames dwarf mice. An unexpected finding was that short-lived GH-transgenic mice and long-lived GHR-KO mice did not benefit from the same diet. The finding that Ames dwarf mice demonstrated an extended life span with a soy-derived diet while the GHR-KO mice did not is surprising since these animals have similar life spans and share many phenotypic characteristics. The ability of a diet rich in soy components to increase longevity in this species was not previously reported. Increased life span of Ames dwarf mice consuming a soy-derived diet is of particular interest since these animals are remarkably long-lived without any dietary interventions. Results also indicate

that a low-isoflavone soy diet can help maintain mental function during aging in long-lived, short-lived, and normal mice. This finding indicates that soy-derived dietary components can improve mental function and may delay cognitive aging. If this diet produced similar effects in human beings, it would represent a major improvement in the functionality and quality of life of the elderly. Another unexpected finding of this research was the high-isoflavone soy diet's failure to produce beneficial effects on survival and/or cognitive function. This failure was surprising because the effects of soy-derived diets are often ascribed to the hormonal activity of phytoestrogens. This finding may suggest that the effects of soy phytoestrogens on aging are biphasic, with low levels being beneficial and high levels ineffective or perhaps detrimental. Currently, researchers are conducting a histological examination of cancer and non-neoplastic lesions in the animals used for this study.

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**William J. Banz, Todd A. Winters, Animal Science, Food and Nutrition**

**College of Agricultural Sciences**  
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## ■ Dietary Protein and Exercise Are Keys to Body Weight, Fat, and Blood Lipids

This research addresses the nutrition and public health problem of obesity. Obesity is the number one public health problem in the United States, with more than 65% of the adult population classified as overweight and more than 100 million Americans considered obese and at high risk for chronic adult diseases. This problem has led to a vast number of fad weight-loss diets as well as confusion among the general public about the roles of protein and carbohydrates in our diet. A primary concern of this research is that public confusion regarding dietary needs results in a loss of confidence in the research community and may have a negative impact on the agricultural community, particularly producers of high-quality proteins, including animal proteins from beef, pork, and dairy.

This research project was one component of a systematic program designed to evaluate the potential for diets with reduced carbohydrates and increased high-quality protein to help adults achieve ideal body

weight, lose body fat, improve blood lipids, and improve the regulation of blood sugar (glucose and insulin). The design of this research was important because (1) this study provided a highly controlled comparison between the currently recommended high-carbohydrate diet (with a carbohydrate-to-protein ratio of 3.5) and a reduced-carbohydrate, increased-protein diet (with a carbohydrate-to-protein ratio of 1.5); (2) the diets compared had levels of protein and carbohydrate considered safe and within the acceptable macronutrient distribution range; (3) the study controlled for equal amounts of calories and dietary fat in both diet groups; and (4) both of the diets met current standards for all known nutritional requirements. This research is the first test of the researcher's hypothesis, which provides a new definition of optimal dietary protein levels for adults.

Research shows that an adult diet with moderately reduced carbohydrates (170 grams per day) and moderately increased protein (125 grams per day) is effective for adult weight loss and improvement in body composition. Adults lose 10 to 20% more weight when consuming diets with the increased protein levels recommended, and 90% of the weight lost is derived from body fat. The increased-protein diet is two to four times more effective than high-carbohydrate diets in targeting loss of body fat while maintaining

body muscle. These changes in body composition are critically important because it is excess body fat that causes increased health risks and maintaining muscle mass ultimately improves long-term health. Researchers observed that the increased-protein diet also produced greater improvements in blood lipids. Both diet groups reduced blood cholesterol levels by 10% (primarily as a result of weight loss). However, subjects consuming the higher protein diet had increases in the HDL ("good cholesterol") component of the blood lipids and a dramatic decrease in total blood lipids (triglycerides); the group consuming the high-carbohydrate diet, on the other hand, decreased HDL with no improvement in triglycerides. The higher protein diet also improved adult health by reducing blood insulin levels and stabilizing blood glucose. The impact of this research stems from its importance to both consumers and producers of dietary protein. This research provides important new information about the potential use of increased dietary protein to combat the increasing tide of obesity. The research also establishes a fundamentally new concept for evaluating adult dietary protein needs based on the metabolic use of the branched-chain amino acids.

### A C-FAR External Competitive Grants project

Donald K. Layman, Food Science and Human Nutrition  
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## ■ Effects of Dietary Soy Isoflavones on Rejection of Organ Transplants

Organ transplantation is a life-saving treatment for persons afflicted with many diseases. However, preventing rejection of the organ requires that transplant recipients regularly use immunosuppressive drugs, which are both expensive (\$12,000 per year) and have numerous adverse effects. The role diet plays in the success of organ transplants is unclear, and researchers for this project were interested in evaluating whether soy in the diet could possibly improve transplant outcomes and decrease the amount of antirejection drugs needed. Soybeans contain isoflavones, micronutrients that have a number of biological effects as well as other bioactive phytochemicals. In a previous study, researchers found that the soy isoflavone genistein, when given intravenously, delayed rejection of organ transplants in rats. In this project, researchers sought to (1) determine if a soy protein diet containing isoflavones could inhibit (delay) rejection of heart transplants or affect autoimmune lupus in rats and (2) examine the effects of a high-isoflavone diet on immune function.

Organ transplant rejection was significantly delayed in animals fed a diet containing soy protein naturally high in isoflavones compared to those fed a control diet of casein protein. Researchers used a rat heart-transplant model to evaluate the diet and have confirmed this finding in several strain combinations. A diet of soy low in isoflavones did not confer a benefit. Interestingly, isoflavones given without soy protein did not delay rejection. Researchers also noted that the soy isoflavone genistein inhibited interferon- $\gamma$  in stimulated lymphocytes of treated animals, thus demonstrating that the soy isoflavone genistein has

in vivo immunosuppressive activity. To further study the immune effects of soy, researchers tested mouse strains that develop lupus, an autoimmune disease. Mrl/lpr mice fed a high-isoflavone soy diet had lower IgG antibody levels than mice fed either a casein protein or low-isoflavone soy diet. This finding indicates that the high-isoflavone soy diet has an immune effect. Ultimately, this research showed, for the first time, that a high-isoflavone soy diet has a beneficial effect on organ transplant rejection and autoimmune disease in rodent models.

### A C-FAR External Competitive Grants project

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## ■ Effects of Soy and Genistein on Estrogen Receptor-Beta Signaling

The goal of this research was to determine if the phytoestrogen genistein could signal through estrogen receptor-beta (ERb) in uterine tissue. It is well known that genistein binds to and acts through estrogen receptor-alpha (ERa), but there was no information on whether ERb can mediate the physiological effects of genistein on reproductive organs or other tissues. Researchers recently described the first known reproductive tract effect to be mediated by ERb: the expression of the progesterone receptor in uterine stromal tissue is at least



partially mediated via estrogen receptor-beta. The present study sought to establish (1) whether the estrogenic effects of genistein can be mediated via ERb and (2) the ability of genistein to compete with estradiol for binding to ERb and to act as a functional E2 antagonist. These questions are important because increasing quantities of soy and genistein are being consumed by humans and animals, and it is critical to understand the physiological actions induced by bioactive compounds such as genistein in soy.

Researchers obtained extensive immunohistochemical data confirming that genistein can work through ERb to increase progesterone receptor in the stroma (connective tissue) uterus. They also determined that other environmental estrogens (PCBs, methoxychlor, and the like) can signal through ERb. Thus, genistein and other phytoestrogens have a clear stimulatory effect on progesterone receptor expression through ERb, though this effect appears to be confined to the subepithelial stroma. This research is the first to document that an environmental estrogen such as genistein can signal through ERb and, thus, adds a new dimension to the understanding of how genistein can work as an estrogen.

Researchers originally obtained immunohistochemical data showing that genistein could induce effects on progesterone receptor. They subse-

quently attempted to corroborate that immunohistochemical finding by using the Northern blotting technique to try to establish that the increase in progesterone receptor in the stroma was accompanied by an increase in the mRNA for this protein. Researchers observed that the effect of progesterone receptor is confined to a narrow band of subepithelial stroma; the rest of the stroma does not show changes in progesterone expression in response to genistein. Therefore, when researchers examined progesterone receptor mRNA expression in response to genistein, they could detect no difference. It is believed that this finding is due to the fact that the changes are happening in a subpopulation of stromal cells rather than in all stromal cells. Researchers also used real-time polymerase chain reaction (PCR) to examine progesterone receptor mRNA expression, and they were again unable to demonstrate a genistein effect. They are now in the process of looking at progesterone receptor mRNA expression via in situ hybridization, and they are hopeful that this procedure will provide data corroborating the immunohistochemical data.

**Paul S. Cooke, Veterinary Biosciences**  
**College of Veterinary Medicine**  
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**Gerald Cunha, Anatomy**  
**University of California at San Francisco**

## ■ Effects of Soy Protein Feeding on Diabetic Nephropathy

Type 2 diabetes mellitus is rapidly reaching epidemic proportions in the United States and other countries with westernized lifestyles. It is now estimated that at least 16 million Americans have diabetes, with approximately 90 to 95% suffering from Type 2 diabetes mellitus. Among the numerous complications associated with this disease, diabetic nephropathy (kidney disease) accounts for approximately 35.8% of all new cases of end-stage kidney disease. Therefore, it is necessary to develop effective therapies for preventing or treating diabetic nephropathy. In patients with diabetes, elevations in urinary albumin excretion (UAE) indicate morphological and functional anomalies in the kidney. Therefore, UAE is commonly measured to aid diagnosis and to monitor progression of diabetic nephropathy. Dietary protein restriction has long been known to reduce UAE and has been the conventional treatment for diabetic nephropathy. Recently, researchers have shown increased interest in manipulating dietary protein quality, specifically by replacing animal protein with soy protein, to reduce UAE. The aim of this study was to determine the qualitative and quantitative effects of dietary protein on the progression of diabetic nephropathy in a Type 2 diabetes mellitus animal model (BKS.cg-m+/+Leprdb mice).

Twenty-four diabetic (+Leprdb/+Leprdb) and 24 control (m+/m+) mice were fed ad libitum one of four different diets: 20% casein, 20% soy protein, 12% casein, or 12% soy protein. In diabetic mice, a 20% casein diet was found to increase urinary albumin excretion to macroalbuminuric levels, while a 20% soy protein diet led to no major changes in urinary albumin excretion. Low-protein diets

(12%), independent of protein type, decreased urinary albumin excretion to low microalbuminuric levels. Based on these data, researchers concluded that diets rich in soy protein prevent an increase in UAE, suggesting slower development of diabetic nephropathy. Thus, replacing casein with soy protein, especially for higher protein intake, may offer a new treatment option for the prevention of diabetic nephropathy. Researchers noted that, at low protein intake levels, replacing casein with soy protein did not lead to any significant benefit beyond the protective kidney effect seen with protein reduction. Protein reduction is often not a practical solution, however, due to poor compliance and the risk of malnutrition. Thus, using higher intake levels of soy protein may offer a more viable alternative.

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## ■ Innovative Nonsolvent Process for Textured Soy Protein

*No final report submitted for this project.*

### A C-FAR External Competitive Grants project

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## ■ Soy Phytoestrogens: Nutraceuticals for Our Most Deadly Ailments?

Researchers have hypothesized that soy compounds, especially isoflavones (phytoestrogens), mimic the beneficial health properties observed in estrogen. Research performed over many years has documented that estrogens, including the phytoestrogens, influence cardiovascular health, usually in a positive manner. Estrogens have also been reported to improve skeletal muscle membrane integrity (decreasing energy loss) and, in some cases, to stimulate skeletal muscle cell proliferation. The phytoestrogens daidzein and genistein have also been reported to inhibit smooth muscle cells in vitro; however, more conclusive studies are needed to confirm these reports. The focus of this research study, therefore, was to assess the effect of soy phytoestrogens on cell proliferation, protein degradation, and protein synthesis in A7r5 vascular smooth muscle cells and L6 skeletal muscle cells.

The researchers used tritiated thymidine incorporation assays to determine cell proliferation. For A7r5 cultures, phytoestrogen concentrations of 5  $\mu\text{M}$  significantly inhibited cell proliferation in the presence of platelet-derived growth factor ( $P < 0.01$ ). In L6 myoblast cultures, genistein concentrations greater than 1.25  $\mu\text{M}$  significantly inhibited cell proliferation ( $P < 0.01$ ). Protein degradation trials using tritiated leucine in the presence of the phytoestrogens (at concentrations of 1  $\mu\text{M}$ ) were also conducted on

L6 myotube cultures. Pair comparisons (using a phytoestrogen compared with estrogen) revealed significant stimulation of protein degradation with daidzein and glycitein ( $P < 0.01$ ) but not with genistein ( $P > 0.10$ ). Single comparisons with the control also resulted in significant stimulation with daidzein and glycitein ( $P < 0.01$ ) but not with genistein ( $P > 0.10$ ). A one-tailed univariate analysis of variance revealed a trend ( $P < 0.1$ ) in protein synthesis with genistein and glycitein treatment.

**Mikelle J. Roeder, Jacquelyn S. Harty, William J. Banz, Karen L. Jones, Todd A. Winters, Animal Science, Food and Nutrition**

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## ■ Wholesome and Tasty Meat: Teaming New Technology and an Old Vitamin

Preventing undesirable flavor characteristics in irradiated beef products would benefit both the meat industry and the consuming public. The primary goal of this study was to determine if dietary vitamin E (VE) supplementation in feedlot steers decreased the incidence of lipid oxidation and undesirable sensory characteristics in irradiated ground beef patties. Researchers for this project were testing the hypothesis that VE continues to perform as a postharvest antioxidant in irradiated beef patties and, thus, reduces the occurrence of undesirable sensory characteristics.

Lipid oxidation was increased 44% by irradiation in control beef patties. Vitamin E did not decrease irradiation-induced lipid oxidation regardless

of beef patty fat level. High-fat patties had higher thiobarbituric acid reactive substance (TBAR) values than low-fat patties. After three months of frozen storage, the patties were evaluated by a trained sensory panel. Researchers found that, regardless of fat content or vitamin E level, irradiation increased incidence of the following sensory characteristics: brothy, serummy/bloody, astringent, and wet dog/hairy. Wet dog/hairy was the most prevalent off-flavor occurring in 2.3 kGy and 7.6 kGy irradiation treatments. Ultimately, the results of this research indicate that, although vitamin E has antioxidant abilities, it does not effectively alter the development of off-flavors caused by irradiation.

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# VALUE-ADDED INITIATIVES AND SPECIALTY CROPS



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## Construction Composites from Wheat By-Products

To help offset declining economic benefits of wheat farming, researchers are working to develop technology that would convert wheat by-products into novel, marketable construction materials. The specific goals of this project were to (1) design and assemble composite fabrication facilities for producing wheat by-product wallboard (WBW) materials; (2) understand the structural properties of wheat straw under thermal perturbations and then use these structural characteristics to design better-quality materials from wheat straw; (3) acquire protocols and engineering procedures for the development and fabrication of WBW materials from wheat straw, starch by-products, and recycled gypsum; (4) enhance the mechanical strength, moisture resistance, thermal insulation, and acoustical characteristics of WBW material by evaluating how different variables affect the materials' characteristics; and (5) evaluate the mechanical, structural, and chemical properties of various model WBW materials designed.

Since the inception of this project in July 2000, researchers have made significant progress in establishing the viability of developing value-added materials from wheat by-products. Researchers conducted both fundamental and applied research on wheat straw and on the design and development of structural materials from wheat by-products. Primary research outcomes include the following:

- Through microscopic analysis of straw of various particle sizes, researchers noted that, on reducing the particle size to less than 25 micrometers, the straw's ground tissue separated from the epidermis. However, the structures close to the epidermis, including the lignin and porous structures, remained intact.

- Researchers used high-temperature, fast Fourier transform infrared (FTIR) analysis to evaluate straw's response to temperature conditions ranging from 30°C to 500°C. As a result of these tests, researchers proposed four distinct structures of wheat straw with the following temperature ranges: Phase I ranges from 30°C to 200°C, Phase II from 200°C to 360°C, Phase III from 360°C to 420°C, and Phase IV occurs at temperatures greater than 420°C.

- In Phase II of the straw structure, straw underwent an extensive polymerization reaction that affected both lignin and cellulose groups. Therefore, researchers recommend that materials be formulated at temperatures less than 200°C.

- The dynamic mechanical analyzer (DMA) experiments on wheat straw composites formed at different temperatures suggested that, as the temperature increased above 150°C, the storage modulus of the material increased. At 150°C, the storage modulus of the straw composite was 1 GPa; the highest modulus (5.5 GPa) was obtained in composites formed at 190°C.

- Researchers formulated a series of structural composites from wheat by-products, and they then used these to evaluate various fabrication parameters and how these parameters affected the strength, density, handling, and moisture sensitivity. The formulation temperature strongly influenced the flexural strength of the composite (that is, the strength of the material increased from 11.8 MPa at 150°C to 28.5 MPa at 190°C). Researchers also observed that post-curing the com-

posites improved strength at 170°C but that was not the case at 190°C. Chemically stripping the lignin from the straw diminished the strength of the material. Finally, researchers determined that the strength of composites formulated from pure straw binder compared favorably with the composites formulated using commercial polymers.

This research shows great promise of yielding economically viable, marketable materials. Researchers are currently evaluating three different potential materials that show promise of opening new markets for by-products of wheat and corn: (1) novel paperless wallboard materials, (2) high-strength, water-resistant structural materials, and (3) ultra-small straw particle insulation particleboard.

### A C-FAR External Competitive Grants project

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## Developing Marketing Resources and Networks for Producers of Value-Added Meat Products

Current economic trends favor more concentration in the agricultural sector with fewer livestock operations. Without the development of alternative markets and distribution systems to sustain enterprises that are not economically positioned to engage in aggressive acquisition, Illinois will continue to see the attrition of its livestock industry. The loss of 21% of the Illinois sow herd within the past year provides compelling evidence of this situation. This type of decline in livestock numbers may ultimately erode the infrastructure needed to maintain the livestock industry in Illinois.

This project focused on two primary tasks. First, researchers organized marketing networks for the purpose of partnering small and medium-sized livestock producers with similarly sized processors, purveyors, and retailers. Second, researchers created marketing resources to facilitate the development of sound marketing strategies. Research objectives included (1) performing a market research function in order to provide producers with the

consumer feedback necessary to refine their products for the market; (2) helping producers capitalize on quality and proximity to market advantages through focusing their efforts on markets in Chicago and other regional urban centers; (3) emphasizing the opportunities associated with new, emerging, and currently underserved markets, such as the diverse ethnic markets in urban communities; (4) developing a technical assistance center to help marketing alliance participants with marketing, business management, and new product development; and (5) establishing a referral network where small to medium-sized enterprises can find and be linked to other enterprises with common market goals and complementary goods and services.

Outcomes from this project include the following:

- Researchers surveyed 934 shoppers from six Chicago-area food stores for the purpose of identifying consumer preferences in meat products and comparing those preferences to available products.
- Researchers conducted more than 42 hours of interviews with meat industry decision makers, including representatives from IBP, Jewel, and Thoms Proestler Company. This information has helped identify markets that are currently not served by mass meat merchandisers and, thus, provides niche opportunities for small to mid-sized farmers entering the industry.
- A prototype website called MarketMaker has been developed. MarketMaker employs a number of marketing databases to identify potential consumer markets for value-added meat products in Illinois by specific geographic area. Business information is identified based on geographic location so that producers interested in direct marketing products can locate supply chain

partners and packers. Conversely, suppliers and food retailers can use the website to locate supply sources for value-added meat products.

- Researchers have created a platform for pairing small and mid-sized food-related businesses with farmers. Three independent grocery stores in Chicago have formed a partnership with a group of Illinois beef producers to develop and market high-quality beef products that will better serve their grocery store customers.
- A partnership with the Center for Neighborhood Technology in Chicago has been formed to pilot test supply chain models that will deploy fresh meat products to underserved minority populations in Chicago. One such project would enable regional lamb growers to sell halal lamb to Muslims through neighborhood community supported agriculture (CSA) programs.
- A technical assistance center (the Ag Entrepreneurship Development Initiative) has been opened for farmers interested in starting their own value-added business.

### A C-FAR External Competitive Grants project

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**Martha S. Bazik, Rock Island County**

**Daniel J. Jennings, Rockford Center  
University of Illinois Extension**

**Burton E. Swanson, Agriculture and Consumer Economics**

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## ■ Illinois Producer Market Education Workshop: Marketing Value-Enhanced Grains

This project focused on developing Illinois Producer Market Education Workshops to teach producers about marketing value-enhanced grains (VEG) to Mexico. The workshops are part of a long-term effort by the U.S. Grains Council to link U.S. VEG suppliers with buyers in foreign markets. The workshops focused on the process for exporting VEG to Mexico and included topics such as customer relationship building, VEG marketing, export contracting, payment terms, freight contracting, and arbitration. Examples of VEG on the market today include high-oil corn, hard endosperm corn, white corn, waxy hullless barley, and food sorghum.

Three interrelated activities on direct marketing products in Mexico have been conducted to date. The first activity was a one-day seminar designed to teach participants about the Mexico corn market and increase their awareness of marketing opportunities. This seminar was held in Chicago on July 22, 2000, and was attended by 40 participants. The second activity, a VEG direct marketing mission visit to Mexico (on February 10–16, 2002), was aimed at introducing Illinois producer marketing organizations to potential Mexican customers and at providing participants with a chance to discuss cross-border requirements with Mexican government officials. Fifteen people were on the mission team. The third activity was a two-day conference (jointly sponsored by the U.S. Grains Council, University of Illinois, Illinois Corn Marketing Board, and Illinois Department of Agriculture) that provided an in-depth analysis of the Mexican corn market and direct marketing opportunities. One hundred and eighty participants attended

this conference, held in Springfield on June 18–19, 2002. The U.S. Grains Council also brought in a team of Mexican buyers to interact with participants and for one-on-one meetings during this event.

Effective direct marketing has the potential to bring added value both to the consumer (Mexico) and to the supplier (Illinois producers), thus presenting a win-win situation for both sides. The economic benefits can be measured both quantitatively and qualitatively. Quantitatively, the producer typically receives a premium for VEG corn (these premiums range from \$0.10 to \$0.50 per bushel, depending on the type of corn and the end market), and by marketing their crops directly to end users, producers retain a greater margin on the sale. Qualitatively, direct marketing enables producers to diversify their operations, increase their market access, and offer a wider variety of products. This system also fosters a closer relationship between producers and end users, which is a key element in international trade contexts.

### A C-FAR External Competitive Grants project

Dale Posthumus

U.S. Grains Council/Grains Foundation

## ■ Value-Added Through Service Innovation: New Opportunities for Agricultural Producers

In recent years, there has been much interest in how to break out of the commodity price/income cycle of low margins, high volatility, and economic uncertainty. In addition, structural changes in agriculture have radically altered the economic system that delivers products through the food supply chain. Producers are increasingly looking for alternatives, such as

value-added opportunities. The justification producers generally offer for integrating into the value-added arena is the desire to capture higher returns downstream. However, no value-added venture in Illinois has yet provided structural evidence for economically viable opportunities. The primary goal of this research was to provide such evidence. While recent research in this area has focused on successful ventures after the fact, this study took a unique approach in that it analyzed opportunities that had yet to be explored. This research sought answers to the following questions:

- Are there opportunities for producers to add value to their commodities by adding service?
- If such opportunities exist, what are they?
- What are the critical organizational, contractual, and financial issues at stake?
- What are the policy and training implications for producers to engage these opportunities?

Project investigators examined a number of potential value-added opportunities for producers and have developed multiple resources to benefit producers, agricultural leaders, and agricultural educators. Researchers have

developed numerous publications; provided more than 25 presentations regionally, nationally, and internationally; and produced multiple fact sheets and Web-based products (for details on these products, visit [http://web.aces.uiuc.edu/c-far/cfarreporting/display.cfm?project\\_id=275](http://web.aces.uiuc.edu/c-far/cfarreporting/display.cfm?project_id=275)). In addition, researchers developed a seminar on value creation through service innovation that was given to 25 Extension educators as part of their professional development requirement. Furthermore, research conducted for this project resulted in two conferences with the theme of “building the chain backwards.” The first conference, Mexican Food-Grade Corn Market—Building the Chain Backwards: From Mexican End-Users to Illinois Producers, was held in Springfield on June 2, 2002, and the second, Livestock Business Development Conference, took place in Bloomington on July 2, 2002.

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### **Evaluation of E-Diesel as an Alternative Fuel in Agricultural Machinery**

The purpose of this three-year project was to evaluate the use of ethanol-diesel blends under on-farm conditions in both tractors and combines operating under relatively high-load conditions. Specific goals were to

- determine the economic impact of using E-diesel fuel to the profitability of the individual farmer and to the broader agricultural sector;
- demonstrate E-diesel as an alternative fuel for use in tractors and combines;
- compare machine performance and durability with E-diesel to that with standard diesel fuel; and
- determine if E-diesel is suitable for on-farm use without engine modification.

Five different tractors and combines fitted with unmodified engines, including a tier II emissions-compliant engine, were compared in side-by-side tests. In these tests, one vehicle of each type ran on E-diesel fuel containing a blend of 10% ethanol and 1% additive while a corresponding model vehicle ran on #2 diesel fuel. Results from in-field vehicle performance and fuel usage monitoring show that the

engines consumed an average of about 3 to 5% more E-diesel fuel than #2 diesel. This increased consumption was expected based on the corresponding decrease in the fuel’s energy content. Preliminary estimates with the tier II engine showed much smaller differences in fuel consumption, which may be attributed to the different engine technology. Researchers estimated a maximum power drop of about 4% in vehicles running on E-diesel; as a result, they factored in a timeliness penalty of less than 1% for vehicles working in the field. Discussions with the vehicle operators on the farm indicated that they did not notice any differences in the performance of the vehicles resulting from the lower energy content of the E-diesel fuel. Furthermore, results of the analysis of oil samples taken from the vehicles showed no abnormal wear, and a teardown of one of the engines fitted to a combine that had operated during two harvesting seasons also revealed no abnormalities. After the successful operation of tractors and combines during 2000, farmers requested that they be able to extend the use of the fuel blend to other vehicles on their farms, thus demonstrating the positive impact of using E-diesel.

An economic analysis shows that E-diesel use in agricultural machinery may increase an individual farm’s cost of production by \$0.22 to \$0.60 per acre due to the higher fuel consumption and its higher estimated price. Nevertheless, E-diesel was found to be cost-competitive with other emissions-reducing alternatives, such as exhaust control technologies and biodiesel.

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## ■ Fate of 2,4-D in a Genetically Modified Grape Plant

Grapes (*Vitis* spp.) are highly sensitive to the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D). One of the most serious obstacles facing grape growers in Illinois is lack of tolerance to drift levels of this commonly used herbicide. In 1996 at Koechle Vineyards in Nauvoo, for example, nearly 500 vines, some of them 10 to 40 years old, were killed by 2,4-D drift. Baxter Winery in Nauvoo reported a 30% yield loss due to 2,4-D damage in 1998. This damage occurred in spite of informal grower agreements to avoid the use of 2,4-D in the Nauvoo area of Hancock County, Illinois. Such losses are even more common in other regions of Illinois, where 2,4-D use is widespread. The long-term goal of this project is to reduce or eliminate such losses by developing grape cultivars tolerant to 2,4-D drift.

Several wine grape cultivars have been established in tissue culture medium, and researchers have developed ways to regenerate whole shoots from single cells. Some of these cells were transformed with a strain of *Agrobacterium tumefaciens* that added a gene to make auxin (iaaM) and a kanamycin marker. Researchers then used these transformed plants to develop a gene construct that includes a gene capable of degrading 2,4-D. The construct has been placed in *Agrobacterium* and is now being tested on tobacco. Additional research is under way that uses the construct to make 2,4-D-tolerant grapes.

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## ■ Establishing Guidelines for Plasticulture of Strawberries in Illinois

Consumers are demanding large-size, high-quality strawberries. Current Illinois matted-row production systems for strawberries do not produce adequate amounts of these high-quality berries and are costly to harvest. The overall purpose of this research was to evaluate an annual strawberry plasticulture system that has been used in the southeast and in California to produce large, high-quality berries. Specific objectives were to evaluate the winter survival and productivity of strawberries grown in a plasticulture system in the southern half of Illinois and to determine the best planting time, cultivar, and winter protection for these systems in Illinois.

In trials conducted during two winters, researchers found that strawberries grown in annual plasticulture systems had excellent winter hardiness at all three locations (the northernmost location was outside of Mattoon). The plasticulture system produced large, high-quality, flavorful berries that could be easily harvested. The berries were competitive against other strawberries (grown in California) available in supermarkets. Researchers further noted that, in the plasticulture system, the Sweet Charlie cultivar produced the greatest early yield while the Chandler cultivar produced the

greatest total yield. Planting strawberry plants in mid-to-late September resulted in the best winter survival and greatest productivity, and the heavier row covers provided the best winter protection. Researchers also found that growers could easily produce plugs with strawberry plants for use in the plasticulture system. This research demonstrates that plasticulture systems have potential for strawberry production in southern Illinois.

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## ■ On-Site Nitrogen and Chlorophyll Quick-Tests to Improve Nitrogen Fertilizer Efficiency in Illinois Vegetable Production

The overall goal of this research is to improve efficient use of nitrogen (N) fertilizer in dryland and irrigated vegetable production (specifically, pumpkins and sweet corn) by developing a reliable set of guidelines for the SPAD-chlorophyll quick-test specific for Illinois production conditions. To achieve this goal, researchers for this project pursued several related objectives: (1) characterizing the relationship between N fertilization rate, fruit yield, plant N, and SPAD-chlorophyll in sweet corn and pumpkin cultivars; (2) establishing critical levels of leaf SPAD values for pumpkins and sweet corn that accurately interpret in-season plant N status; and (3) determining the extent to which variety and N fertilization regime (dryland versus drip-fertigated) might influence SPAD readings, plant N status, and critical SPAD values.

In both pumpkins and sweet corn, leaf SPAD readings were affected by location (dryland versus irrigated production), cultivar, and N fertilization rate. Specifically, researchers observed that leaf SPAD readings were higher in dryland production than in irrigated production

and that SPAD readings increased as rates of N fertilization increased. In both crops, leaf SPAD readings were more responsive to N fertilization rate under irrigated culture than in dryland production. Cultivar effects, although significant, were numerically small. In both crops, leaf SPAD readings were highly correlated with leaf N concentrations throughout the growing season; however, relationships under dryland culture were weaker than under irrigated production. In addition, researchers derived critical SPAD values (that is, readings associated with maximum or near maximum yields) for both crops. In pumpkins, the critical SPAD values ranged from approximately 56 to 59 units at anthesis; in sweet corn, the critical values ranged from approximately 51 to 53 units at the V10 stage. In both crops,

these values appear to be reasonable approximations for both dryland and irrigated production, although with a higher degree of accuracy for irrigated production. Researchers proposed a range of critical SPAD values because plant N requirements varied with cultivar and growing conditions.

The results of this research suggest that the SPAD-chlorophyll quick-test can be a useful tool for detecting real-time N deficiencies. This tool has the potential to allow Illinois pumpkin and sweet corn producers to fine-tune N management during the season, particularly for irrigated production.

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# RURAL COMMUNITY AND FAMILY STUDIES

## Establishing Paternity Under Welfare Reform in Rural Illinois Counties

The goals of this project are to gain a better understanding of the rural dimension of poverty and welfare reform and to inform policy makers at the state and federal levels about how reforms affect rural families. The primary objective of this project is to evaluate whether new methods (particularly sanctioning) improve Illinois welfare recipients' cooperation with child support enforcement (CSE) policies. In particular, researchers took a comparative approach to studying paternity establishment (PE), child support enforcement, and the differential impact of recent PE and CS policy reforms on rural families from 20 central Illinois counties. The state CSE agency provided data covering approximately 51,000 children whose families had an open welfare case between 1995 and 1997. Researchers analyzed these data to test several specific hypotheses: (1) paternity for nonmarital children (children whose parents were not married to each other at the time of the child's birth) living in rural areas is more likely to be established eventually and is established more quickly; (2) nonmarital children living in rural areas are more likely to be awarded child support eventually and more quickly; (3) welfare recipients living in rural areas are less likely to be sanctioned for noncooperation with PE and CS policy; (4) stricter cooperation requirements and sanctions since reform have been relatively less effective at increasing PE and CS orders in more rural areas; and (5) CS offices in more rural areas increased their sanctioning of clients after PE and CS reforms at a relatively lower rate than other offices.

Researchers analyzed data covering the central Illinois welfare cases with a nonmarital birth, about 20% of

which (or 6,000) contain rural youth. Researchers found that, the more rural the county, the greater the likelihood that paternity is established and CS orders are obtained within six months of the case opening. In the post-reform era, however, the relationship between how rural the county is and the likelihood of PE becomes negative, suggesting that reforms are less effective the more rural the area. Researchers also found increased incidence of non-cooperation in urban areas after PE and CS reforms passed. Incorporating Bureau of Labor Statistics unemployment rate data to control for changes in general economic conditions enhanced consistency of the above results with the hypotheses. Contrary to expectations, when they controlled for percent rural, researchers found that, the greater the degree of urbanization, the greater the likelihood of establishing PE or CS within six months. Due to the small number of counties with urban areas, this finding could reflect performance or management differences among CS offices, an explanation that warrants further investigation.

These results can be used to assess the success of policies across communities and to suggest policies that are most effective in rural areas. By identifying which counties established more paternities and more CS orders, this research can be used to support specific policy recommendations. For instance, one policy recommendation might be to identify the practices used in the most successful field offices and extend them to other offices.

**Andrea H. Beller, Agricultural and Consumer Economics**

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**Elizabeth T. Powers, Institute of Government and Public Affairs**

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## The Enhanced Child Development Laboratory Research Database Program

The purpose of this project was to create an enhanced research database initiative designed to facilitate an interdisciplinary, longitudinal, and programmatic research agenda at the Child Development Laboratory (CDL). This project has allowed faculty in the Department of Human and Community Development and the College of Agricultural, Consumer and Environmental Sciences to work collaboratively with investigators on the University of Illinois campus in identifying potential solutions to critical developmental issues confronting children and their families in rural and urban communities throughout Illinois.

During the course of this project, the infrastructure for the CDL Research Database initiative has been refined, with improvements made to streamline the process of collecting baseline data from enrolled children and their families each fall. Researchers have developed, pilot-tested, and refined protocols that guide investigators' access to and use of data from the database for individual subprojects. Researchers also developed protocols and policies for establishing formats to facilitate reciprocal exchange of data from subprojects via the database. To encourage investigators from across campus to participate in this program, researchers created flyers and held a series of informational meetings. The infrastructure for the research database initiative that was developed and refined as part of this project is now firmly established and will continue to be used to facilitate collaborative and interdisciplinary research projects conducted at the Child Development Lab.

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# NATURAL RESOURCES

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### ■ Aerial Infrared Mapping of Subsurface Drainage Systems

The primary objective of this project is to provide researchers, farmers, farm managers, policy makers, farm organizations, and agribusiness interests in Illinois with maps that show the layout of subsurface drainage (tile) systems in the Lake Decatur watershed, one of the most heavily tiled watersheds in the state. These maps are important to researchers developing hydrological and water quality models. This information is also useful for farmers, farm managers, policy makers, farmer organizations, and others interested in maximizing the returns from farming.

The tile mapping project has served as a model for similar projects initiated by several Soil and Water Conservation Districts. To date, maps of more than 186,000 acres have been requested, primarily by farmers and farm managers. In addition, researchers have presented details of this project at several events, including Agronomy Day at the University of Illinois; a lecture at the Overholt Drainage School in Wooster,

Ohio; the annual meeting of the Illinois Land Improvement Contractors Association; and four Extension meetings in Illinois.

#### **A C-FAR External Competitive Grants project**

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### ■ Map Illinois: Archival and Online Distribution of Illinois DOQs

State and federal agencies with interests in Illinois entered into a joint funding agreement with the United States Geological Survey (USGS) to purchase a full set of digital orthophoto quarter quadrangle (DOQ) files for the state of Illinois, at a cost of \$3.4 million. DOQs are based on aerial photography that is registered to map coordinates, and they are well suited for virtually any mapping project. Illinois DOQs provide the most comprehensive, up-to-date, large-scale geographic base data available for the state.

The USGS National Aerial Photography Program Three (NAPP III) generated the DOQ data. NAPP III aerial photographs were taken between 1998 and 2001. The DOQ data set comprises 210 gigabytes of uncompressed data (11 to 44 gigabytes after compression). Very few organizations would have been able to access or obtain this data in its original format; therefore, the only practical way to distribute the data was by posting compressed files on the Web and making them available free of charge through the Illinois

Natural Resources Geospatial Data Clearinghouse (Illinois Clearinghouse) at <http://www.isgs.uiuc.edu/nsdihome>. This research project provided support for the file processing necessary to archive and distribute 4,173 DOQ files for the state of Illinois.

DOQ data were first made available online in June 2000. Initially, only 200 files were available, but by June of 2001, 2,891 DOQs had been delivered from the USGS and made available online at the Illinois Clearinghouse. Visitors to the website downloaded about 44,450 DOQ files (that is, about 98 gigabytes of data) during that time period. DOQ data for all of Illinois were available through the clearinghouse by February 2002. The DOQ data continue to be very popular, with an average of 480 DOQ files downloaded per day.

Since it was made available to the public in June 2001, the DOQ Interactive Map Service has received much acclaim. It won third place in the 2001 Geography Network Challenge sponsored by the Environmental Services Research Institute (ESRI) and National Geographic. Staff for the DOQ project earned the ISGS Outstanding Team Award for 2001. Additionally, the State of Illinois placed second in the GIS/Transportation Category of the Digital State Survey. Press releases from the Illinois governor's office about the digital state award also favorably cited the Illinois Clearinghouse's data distribution efforts.

#### **A C-FAR External Competitive Grants project**

**Robert J. Krumm, Sheena Beaverson,**  
Illinois State Geological Survey

## Assessment of Best Management Practices in the Lake Springfield Watershed

The ultimate goal of this project is to preserve and enhance water quality and habitat within the Lake Springfield watershed. To accomplish this goal, researchers must meet several key objectives: (1) develop a clear understanding of what is happening in the watershed from a water quality perspective; (2) identify an array of practical, cost-effective farming practices; and (3) create an action plan for implementing these practices.

Researchers have finished collecting field data, but they are still analyzing and interpreting these data. To date, researchers have reliably determined the stage-discharge relationships of the two major subwatersheds. They have also identified some likely best management practices (BMPs). For example, preliminary assessments indicate that reduced- and split-herbicide applications are very effective in reducing off-site movement of chemicals. Winter wheat buffers or grass filter strips are also very effective tools in reducing off-site movements of chemicals and sediments.

When implemented, the BMPs identified through this project will benefit users of Lake Springfield and the entire watershed. Water treatment costs will be reduced (by up to \$200,000 annually), and expensive dredging operations (in excess of \$8,000) will be deferred or eliminated altogether. The improved water quality will also benefit all aquatic ecosystems in the watershed. Finally, the costs to implement the BMPs will be economically neutral to producers at worst, and, in

many cases, they will benefit producers economically.

### A C-FAR External Competitive Grants project

Mark S. Cochran, Sangamon County Soil and Water Conservation District

## Effectiveness of Vegetative Filter Strip (VFS) Systems for Treating Dairy Farm Wastewater

The purpose of this research is to examine two aspects of manure management: (1) controlling the accumulation and movement of nitrogen (N) and phosphorus (P) and (2) limiting the spread of pathogens and antibiotic resistance. On dairy farms, feedlot runoff and milking facility wastewater are the most concentrated sources of N, P, and pathogens. The vegetative filter strip (VFS) system is a low-cost method for treating dairy farm wastewater. The VFS system has been approved for use on small dairy farms (those with fewer than 300 cows) in Illinois; however, few dairy farmers have adopted the VFS system, perhaps due to the lack of long-term data on the system's effectiveness. Researchers for this project studied the VFS system at Southern Illinois University's Dairy Center, which has been in continual use for 25 years, to evaluate the effectiveness of VFS systems generally. They tested levels of N, P, pathogen indicator organisms, and their antibiotic resistance patterns in the soil and water within and around the VFS.

In the first part of this study, researchers tracked movement of N and P from the effluent applied to the VFS into the surrounding surface waters. By comparing the N and P values from 1975, when the system was initially constructed, to the values in 2001, researchers determined that the VFS system is very efficient at remov-

ing N and P from the effluent and preventing these pollutants from entering surrounding surface waters. The VFS system currently removes more than 90% of the effluent nutrient load prior to entry into the waters surrounding the VFS.

In the second part of this study, researchers evaluated movement of pathogen indicator organisms and their antibiotic resistance patterns from the effluent to the surrounding surface waters. Due to a lack of data from 1975, a direct comparison is impossible. However, based on the indicator organisms found, researchers determined that the VFS system reduces the levels of these organisms significantly. Researchers found between 100 and 10,000 times more pathogen indicator organisms in the effluent than in the surrounding surface waters. In their evaluation of the antibiotic resistance patterns of these organisms, researchers found evidence that the movement of antibiotic resistance may be perpetuated by animals other than the cows housed at the dairy center. Best management practices to optimize VFS effectiveness include reducing clean water influx into the system and enhancing biosecurity measures to prevent introduction of antibiotic-resistant organisms into the system.

### A C-FAR External Competitive Grants project

Kenneth E. Griswold, Gary A. Apgar, Animal Science, Food and Nutrition  
Edward C. Varsa, Plant, Soil and General Agriculture  
College of Agricultural Sciences  
John D. Haddock, Microbiology  
College of Science  
Southern Illinois University at Carbondale

### **Fertilizer Nitrogen Management to Optimize Water Quality of Lake Bloomington, Illinois**

The purpose of this research is to provide for the sustainable development and use of natural resources in Illinois, specifically to protect and enhance water quality. The objectives of this study are to (1) quantify sources of nitrate-nitrogen in water that enters Lake Bloomington, Illinois; (2) elucidate how agricultural fertilizer nitrogen management influences water quality; and (3) help develop nitrogen (N) fertilizer recommendations that promote the safe stewardship of Illinois farmland while maintaining high-quality drinking water.

This project represents a unique approach to studying field N loss in agricultural soils: it combines an on-farm study of N levels in tile drainage with the participation of many local groups in identifying effective N management strategies. Researchers are currently evaluating proposed agricultural fertilizer N practices on a farm that represents the agricultural practices of many producers in Illinois. The experimental site is located in an area of the

Lake Bloomington watershed that has contributed to nitrate-N contamination of drinking water supplies. In addition, various participating agencies, including the McLean County Soil and Water Conservation Board, the Natural Resources Conservation Service office in McLean County, the McLean County Extension unit, and the City of Bloomington, have formed a cooperative working group called the Lake Bloomington Sustainable Water Quality Program. This group meets on a semi-annual basis to discuss research findings that are important to the management of Lakes Bloomington and Evergreen.

**Kenneth D. Smiciklas, Aaron S. Moore,**  
Agriculture  
College of Applied Science and  
Technology  
Illinois State University

### **Passive Subsurface Bioreactors for Enhanced Edge-of-Field Water Treatment**

The overall goal of this project was to evaluate how effectively subsurface bioreactors remove nitrates from drainage water. The specific objectives were to (1) demonstrate the efficacy of passive subsurface bioreactors in removing nitrates from tile outflow, (2) evaluate the effectiveness of different materials that can be used as carbon sources in subsurface bioreactors, and (3) develop design criteria for subsurface bioreactors.

In tests using laboratory-scale systems, researchers established relationships between bioreactor size and nitrate removal with several different carbon sources. It appears that wood chips are

the best carbon source for the bioreactors. Researchers used the results of the laboratory experiments to design several field-scale systems. Designs were developed for (1) existing tile systems that empty into a surface water body, (2) existing systems that feed into a main drain, and (3) bioreactors to be installed with new tile systems. On average, bioreactors installed in the field have reduced nitrate loads by 20%. Experiments are under way to increase the removal efficiency of these systems by increasing the percentage of the total flow that passes through them.

**Richard A. Cooke, Agricultural Engineering**  
College of Agricultural, Consumer and  
Environmental Sciences  
University of Illinois at Urbana-  
Champaign

### **Effects of Tillage, Lime Rate, and Timing of Limestone Application on Acid Soils**

Modern tillage systems, such as reduced-tillage and no-tillage systems, provide shallow incorporation of surface-applied materials at best. Concern about over-liming the top few inches of agricultural soils has prompted producers either to reduce lime rates (and apply lime more often) or to perform some sort of soil inversion to mix the lime deeper into the soil profile. One problem with the second approach is that tilling highly erodible soils in southern Illinois leads to increased erosion and disturbs the natural physical and biological processes that enhance productivity in long-term no-tillage systems. Furthermore, the effects of adding liming materials to no-tillage systems in southern Illinois are very difficult to predict because there is only limited knowledge of how periodic application of liming materials to the surface affects lime

movement down an acid soil profile over time. It is still unclear whether periodic inversion of the soil is needed to improve root growth and nutrient uptake within the top layers of soil. The objectives of this field study were to (1) evaluate the effects of tillage, lime rate, and time of limestone application on corn and soybean growth and (2) assess the changes in soil acidity for an already acidic soil.

Researchers conducted soil tests at three locations in Illinois: Dixon Springs, Carbondale, and Brownstown. In a continuous chisel system, researchers found that, on average, the surface pH (that is, the pH level in the top 2 inches of soil) at Dixon Springs, Carbondale, and Brownstown changed 0.5, 1.2, and 0.7 pH units per year, respectively. Changes in surface pH under continuous no-till production ranged from 0.4 to 0.6 pH unit per year. Researchers determined that, in a no-till system, slow movement of the lime material and lack of tillage prevent soil contact from changing pH significantly, even in the surface 2 inches. Inversion of the lime material with a rotary tiller prior to continuous chisel or no-till produced results similar to those under continuous chisel without inversion. The pelleted lime treatment increased pH in the surface by only 0.2 to 0.3 pH unit per year.

Applying limestone to the continuous chisel treatment increased pH in the surface 6 to 8 inches at Dixon Springs

and Carbondale but only in the top 4 inches of soil at Brownstown. In all three locations, the increases were found in one-half to three-quarters the depth that the tillage implement ran. Applying limestone to no-till plots (at a half rate) increased the pH only in the surface 2 inches of soil at each location, as expected. The decreased depth of the pH change is due to both the relatively insoluble nature of limestone and the lack of incorporation by tillage. When a rotary tiller is used to incorporate the limestone, the increase in pH by sampling depth was similar to or slightly less than that found in continuous chisel treatment. The annual application of pelleted lime increased the pH in the surface 2 inches only slightly. Finally, researchers noted that, even given the relatively acidic soils found at all three locations, the no-lime control treatments produced grain yields comparable to the “best” treatments for 18 out of the 20 site-years studied. Researchers observed negative effects resulting from low pH levels only in soybeans grown at the Dixon Springs location during 2000 and 2002.

#### **A C-FAR External Competitive Grants project**

**Stephen A. Ebelhar, Adam H. Anderson,  
Carl D. Hart, Crop Sciences**

**College of Agricultural, Consumer and  
Environmental Sciences**

**University of Illinois at Urbana-  
Champaign**

**Edward C. Varsa, Terry D. Wyciskalla, Plant,  
Soil and General Agriculture**

**College of Agricultural Sciences**

**Southern Illinois University at  
Carbondale**

## **Identification of Carbon Sequestration Factors in Illinois Agricultural Systems**

Scientists estimate that 40% of soil organic carbon (SOC) has been lost since the prairies were first converted to agricultural production. Much of this lost SOC has been released into the atmosphere in the form of carbon dioxide, thus contributing to the greenhouse effect. Developing agricultural production methods that could return the SOC in Illinois to its precultivated level would remove considerable carbon dioxide from the atmosphere and reduce the greenhouse effect. Increased SOC will improve soil tilth, increase water-holding capacity, and raise levels of plant-available nutrients in the soil. Thus, increased SOC fosters the sustainable use of Illinois' natural resources, particularly the atmosphere, soil, and water. The goal of this project was to produce a review of the literature that would (1) identify environmental conditions (landscape, atmospheric, management) that result in increased SOC accumulation and (2) identify deficiencies in knowledge about SOC accumulation.

The result of this work is a scientific review of SOC sequestration literature, with a bibliography of 3,093 publications. This work examines soil-

forming factors in Illinois and synthesizes the literature on (1) the history and genesis of soils and vegetation and (2) the response of SOC to agricultural practices. Prairie soils, the fertile soils on which much of the agricultural production in the Midwest occurs, have two to three times more SOC in the top 1 meter than do forest soils. These agricultural soils are poorly drained for the most part, and they have higher levels of soil biomass, macro- and microfauna, and microbial activity than do forest soils. Furthermore, numerous roots contribute to the development of soil macroaggregates that protect SOC from oxidation. While early studies of SOC examined full soil profiles, recent studies focus on SOC accumulation in the surface plow layer. This shift in emphasis has had two primary effects. First, scientists have a better understanding of surface-layer SOC than of subsoil SOC; the latter is where 80% of SOC resides. Second, scientists have consistently underestimated the potential to sequester carbon in agricultural soils. It is possible to sequester SOC in agricultural soils by reducing tillage (thus allowing the development of macroaggregates to protect the SOC) and applying a balanced fertilizer program. Because organic carbon is contained in

SOC, which generally has a carbon-to-nitrogen ratio of 10:1, increasing SOC requires adequate nitrogen (N) in the system. It follows that, as SOC is increased, the amount of N in the system will also increase, resulting in potential environmental concerns.

These findings have important implications for future carbon sequestration research. First, this research demonstrates that carbon sequestration studies should be designed to include whole-plant/whole-soil interaction as well as an evaluation of all the nutrients associated with SOC. Second, this project also highlights how important it is to evaluate the potential benefits and problems that might arise by increasing SOC presence in the soil.

#### **A C-FAR External Competitive Grants project**

**Steven E. Hollinger, Edward Krug, Illinois State Water Survey  
University of Illinois at Urbana-Champaign**

#### **Modeling Herbicide Degradation in Soils: An Integrative Modeling and Experimental Study**

The objective of this study was to further our ability to predict the degradation and leaching of herbicides by microorganisms in agricultural soils. To achieve this objective, researchers used an integrated experimental and modeling approach to study processes that influence herbicide degradation and leaching. A central hypothesis of the study is that microbial processes in soils are strongly influenced by submillimeter-scale solute diffusion rates, which are strongly dependent on soil water content and soil structure. Recognizing and accounting for this

type of heterogeneity may be important to developing models that can effectively link laboratory studies to spatially aggregated models, which are typically used for modeling herbicide fate and transport in soils.

Outcomes fully or partially supported by this project are highlighted in three research articles. A paper titled “Effects of Soil pH and Soil Water Content on Prosulfuron Dissipation,” by Ryan P. Hultgren, Robert J. Hudson, and Gerald K. Sims, has been published in the *Journal of Agricultural and Food Chemistry* (Vol. 50: 3236–3243). A second paper, titled “Effect of Water Velocity on Solute Velocity and Dispersion,” focuses on modeling solute transport in soils. Written by Manoj K. Shukla, Timothy R. Ellsworth, Robert J. Hudson, and Donald R. Nielson, this article has been accepted for publication in the *Soil Science Society of America Journal*. A third paper on herbicide adsorption is being finalized for submission.

**Robert J. Hudson, Timothy R. Ellsworth, Natural Resources and Environmental Sciences**

**College of Agricultural, Consumer and Environmental Sciences**

**University of Illinois at Urbana-Champaign**

**Gerald K. Sims, USDA-ARS**

## Evaluating Three Emerging Cut-Perennial Crops for Production in Rockwool or Media-Based Systems

Illinois houses more than 300 floricultural crop production facilities that supply horticultural products throughout the United States. The total contribution of horticultural companies to Illinois' economy exceeded \$3.9 billion in 1999. To keep domestic markets satisfied with unique products and to compete effectively with internationally grown products, producers must identify alternative cut crops. Three common landscape perennials have potential as cut-flower crops: *Scabiosa columbaria*, commonly known as pincushion flower; *Centranthus ruber*, commonly known as Jupiter's beard; and *Agastache foeniculum*, commonly known as Anise hyssop. Pincushion flower can produce multiple 30- to 40-centimeter stems topped by a 3- to 5-centimeter pale blue flower(s) within 8 weeks of transplant under 22°C /16°C day/night temperatures and natural light. Using a 20-10-20 formulation of nitrogen-phosphorus-potassium fertilizer at 300 parts per million of nitrogen results in healthy stems. Under similar conditions, Jupiter's beard produces somewhat longer stems (40 to 50 centimeters) capped

by a 5- to 7-centimeter cluster of pale red flowers, and Anise hyssop produces several 45- to 55-centimeter stems terminating in a spike of showy flowers about 10 weeks after transplant. The objective of this research was to determine if these species are suited for mass production in rockwool or media-based cut-flower systems.

Researchers found that both the production system and the species grown affected the variables measured. The media-based system produced a larger quantity of marketable stems (34.6) more rapidly (79.5 days to harvest) than the rockwool system (with 11.2 marketable stems and 91.1 days to harvest). The stems of plants grown in the media-based system were also longer (63.0 centimeters) and larger in diameter (4.2 millimeters) than stems of plants produced in the rockwool system (with stems averaging 42.3 centimeters in length and 3.2 millimeters in diameter). Researchers found that the production system used affected number of days to first harvested stem for only one perennial: Jupiter's beard averaged 87.5 days to harvest in the media-based system and 123.8 days to harvest in the hydroponic system. The vase life (defined as when half of the flowers on the stem are dead or stem wilting occurs) of Anise hyssop was shorter (10.8 days) than that of pincushion flower (13.8 days) or Jupiter's beard (12.7 days). Researchers also observed that the vase life of cut stems was similar regardless of production system, indicating that the two systems were similarly effective in promoting stem health. Of the perennials examined, Jupiter's beard produced the highest quality stems based on stem length, stem diameter, and vase life. However, the mean number

of stems produced by this crop (6.25 per plant) was significantly lower than with pincushion flower (40.8 stems) or Anise hyssop (21.7 stems). Pincushion flower stem quality remained consistent between the two production systems, indicating that this species may be easily adaptable to hydroponic systems. Finally, researchers determined that Anise hyssop are not acceptable as cut flowers due to extreme brittleness of stems. The breakage observed during data collection combined with a shorter vase life indicated that this crop would not be useful as a cut flower in floral arrangements.

Results of this research demonstrate that perennial species responded differently to different production systems and that some species may be adaptable to modern facilities. Such adaptability has the potential to provide growers with unique products to complement existing production schedules, thereby adding three months of income during the summer season when bedding plants are not produced and cut perennials can be forced into flower.

**Daniel F. Warnock, Natural Resources and Environmental Sciences**  
**College of Agricultural, Consumer and Environmental Sciences**  
**University of Illinois at Urbana-Champaign**

## Ornamental Grass Evaluations for Illinois

Researchers sought to address two basic questions posed by many of the new Illinois producers, managers, and end users of ornamental grasses: first, what grasses will survive in Illinois, and second, how should the grasses be managed? To answer these questions, researchers planted a group of ornamental grasses in three locations (Godfrey, Urbana, and Lemont) to determine their suitability and survivability in northern, central, and southern Illinois. Researchers also addressed the question of whether spring or autumn is the best time to remove the dead foliage. Finally, researchers sought to identify herbicides that could be used for safe control of weeds in ornamental grass plantings. In several studies, researchers examined the tolerance of ornamental grasses to both pre- and postemergence weed controls by evaluating plant damage following herbicide application.

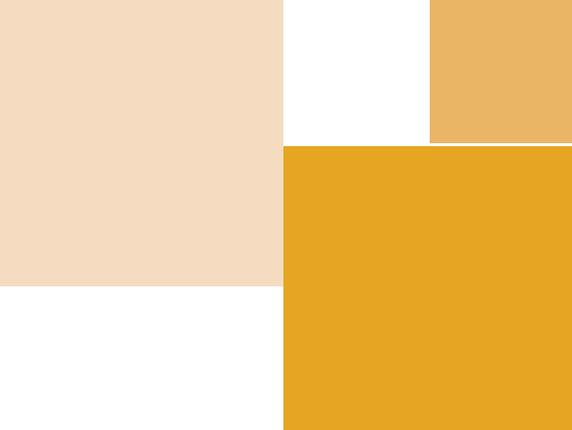
During the summer of 2000, 15 native and exotic ornamental grasses were planted in Godfrey, Lemont, and Urbana, Illinois, to determine their tolerance to each site. The grasses planted were Trailway side-oats grama,

common quaking-grass, Korean feather reed grass, Karl Foerster feather reed grass, tufted hairgrass, Elijah Blue fescue, Autumn Red flame grass, Adagio miscanthus, variegated miscanthus, Prairie Sky switch grass, Little Bunny fountain grass, hardy pampas grass, Blaze little bluestem, autumn moor grass, and blue moor grass. All species survived at all locations. Researchers concluded that, if appropriately sited, any species in this group should survive anywhere in Illinois. Additionally, researchers noted that the rarely planted Korean feather reed grass, Blaze little bluestem, autumn moor grass, and blue moor grass warrant increased planting due to great ornamental appearance at all three locations.

At the Urbana and Godfrey sites, researchers removed dead foliage both in the spring and autumn to determine the effects on subsequent growth and appearance. They found no differences in growth or appearance resulting from when dead foliage was removed. However, failure to remove dead foliage did negatively affect grass appearance early in the growing season but not during the latter portions of the season. Researchers also conducted studies in 2000 and 2001 to evaluate ornamental grass tolerance to pre- and postemergence herbicides. In 2000, the postemergence herbicide Lontrel (clopyralid), commonly used for broadleaf weed control, was applied to 35 container-grown grasses at two rates during two different periods. In 2001, two preemergence herbicides that control crabgrass and other warm-season annual grassy weeds, Gallery (isoxaben) and Snapshot (isoxaben + trifluralin), were applied to the 15 field-grown grasses. Results from each of these studies indicated that the ornamental

grasses were tolerant of these herbicides. Therefore, researchers concluded that, when used according to label directions, these herbicides would not damage any of the ornamental grasses evaluated for this project.

**Thomas B. Voigt, Natural Resources and Environmental Sciences  
College of Agricultural, Consumer and Environmental Sciences  
University of Illinois at Urbana-Champaign**



# FISCAL YEAR 2003: INTERNAL COMPETITIVE GRANT PROGRAMS



THE INTERNAL COMPETITIVE GRANT PROGRAMS AT THE UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN (UIUC), SOUTHERN ILLINOIS UNIVERSITY AT CARBONDALE (SIUC), ILLINOIS STATE UNIVERSITY (ISU), AND WESTERN ILLINOIS UNIVERSITY (WIU) TYPICALLY SUPPORT A WIDE RANGE OF NEW AND ONGOING C-FAR RESEARCH PROJECTS. DUE TO REDUCED C-FAR FUNDING APPROPRIATED BY THE STATE OF ILLINOIS IN FY03, THESE PROGRAMS WERE EITHER ELIMINATED OR DRAMATICALLY SCALED BACK, AND THEY NOW SUPPORT THE CONTINUATION OF A RELATIVELY NARROW SELECTION OF PRIORITY RESEARCH INITIATIVES. THE UIUC INTERNAL PROGRAM CONTINUED FUNDING OF PROJECTS IN ITS SENTINEL PROGRAM AND WAS NOT ABLE TO CONDUCT A COMPETITIVE GRANTS PROGRAM IN FY03. THE SIUC AND WIU INTERNAL PROGRAMS CONTINUED FUNDING SOME OF THEIR MULTIPLE-YEAR INITIATIVES. ISU FUNDS ITS INTERNAL PROGRAM PROJECTS ON AN ANNUAL BASIS AND FUNDED THE FOLLOWING PROJECTS IN FY03. THESE PROJECTS ALSO REPRESENT THE CONTINUATION OF ONGOING RESEARCH INITIATIVES.

## FY03 Projects

## Principal Investigator

### ■ Research Focus: Expanding Agricultural Markets

Bioavailability of Low-Phytate Soybean Meal for Trout

Kerry W. Tudor, ISU

### ■ Research Focus: Rural Economic Development

Business Faculty's Perception of Entrepreneurial Education at Illinois Community Colleges

Rick C. Whitacre, ISU

Using Worms for Processing Agricultural Biosolids into High-Value, Enviro-Socially Acceptable Soil Amendments

Gary R. Bachman, ISU

### ■ Research Focus: Agricultural Production Systems

Implementation of Precision-Farming Web-Enabled Management Tools for Farm Supply

Patrick D. O'Rourke, ISU

### ■ Research Focus: Human Nutrition and Food Safety

Irradiation of Processed Pork Products to Increase Profits in the Pork Industry

Bryon Wiegand, ISU

### ■ Research Focus: Natural Resources

Effects of Alternative Strategies for Handling Swine Slurry

Paul M. Walker, ISU

Fertilizer Nitrogen Management to Optimize Water Quality

Ken D. Smiciklas, ISU

Impact of Crude-Oil Contamination in Soil on Nitrogen Fixation Rates of Three Legumes

Robert Rhykerd, ISU

# FISCAL YEAR 2003: EXTERNAL COMPETITIVE GRANTS PROGRAM



IN ACCORDANCE WITH THE FOOD AND AGRICULTURE RESEARCH ACT, THE C-FAR ENABLING LEGISLATION, A MINIMUM OF 15% OF THE TOTAL C-FAR APPROPRIATION (MINUS FEES) IS TO BE DEDICATED TO AN EXTERNAL COMPETITIVE GRANTS PROGRAM. THIS PROGRAM GRANTED SUPPORT TO THE FOLLOWING ONE- AND TWO-YEAR PROJECTS IN FY03.

**Research Focus: Expanding Agricultural Markets**

**From Research to Marketable Wheat By-Product  
Composites: Phase II**

**Vivak M. Malhotra, SIUC**

**Increasing Butanol Yield by Fermenting Degermed Corn to  
Benefit Illinois Farmers**

**Nasib Qureshi, UIUC**

**Public Promotional Efforts for Dairy Industry Versus  
Structural Changes in the Dairy Industry**

**Phillip R. Eberle, SIUC**

**Research Focus: Rural Economic Development**

**Building Supply Chains Linking Illinois Livestock Producers with  
Urban Markets**

**Darlene S. Knipe, UIUC**

**Determining the Market Potential of Organic Food  
Production in Illinois**

**Martha S. Bazik, UIUC**

**Native Herbaceous Perennials as Alternative Crops for  
Illinois Nurseries**

**Janice M. Coons, Eastern Illinois  
University**

**Research Focus: Agricultural Production Systems**

**Evaluating Genetically Modified Organisms (GMOs) for  
Safety, Equivalence, and Reduction of Environmental Impact**

**David A. Lightfoot, SIUC**

**Meeting Community Standards to Improve Siting of  
Livestock Facilities**

**Peter D. Goldsmith, UIUC**

**Origin-Based Branding of Illinois Commodities**

**Brian C. Wansink, UIUC**

**The Effect of Using Disease-Free Planting Stock on  
Horseradish Yield and Quality**

**Robert M. Skirvin, UIUC**

**Research Focus: Human Nutrition and Food Safety**

***Mycobacterium paratuberculosis* Thermal Inactivation and  
Incidence in Fluid Milk**

**Joseph Dunn, Illinois Institute of  
Technology**

**Pasteurizing Fruit Juices with a Resonant Macrosonic  
Synthesis Pasteurizer**

**Hao Feng, UIUC**

**Soy Saponins as Colon-Cancer Inhibitors**

**Keith W. Singletary, UIUC**

**Research Focus: Natural Resources**

**Effects of Tillage, Lime Rate, and Timing of Limestone  
Application on Acid Soils**

**Stephen A. Ebelhar, UIUC**

**Evaluation of *Bt* Toxin Persistence in Soils**

**Michelle Wander, UIUC**

**Quantifying the Fertilizer N Needs of Corn Based on a  
New Organic N Soil Test**

**Edward C. Varsa, SIU**

# FISCAL YEAR 2003: STRATEGIC RESEARCH INITIATIVES



THE C-FAR STRATEGIC RESEARCH INITIATIVES PROVIDE A TARGETED, MULTIDISCIPLINARY, AND MULTI-INSTITUTIONAL APPROACH TO ADDRESSING MAJOR ISSUES AND CONCERNS OF THE ILLINOIS FOOD AND AGRICULTURE INDUSTRY AND CONSUMERS. THE SRI RESEARCH PORTFOLIOS INCLUDE THE FOLLOWING INITIATIVES IN FY03.

## FY03 Initiatives

## Principal Investigator

### Information Systems and Technology

FY03 Information Systems and Technology SRI Leader Support, GIS and Computer Support

Gary D. Schnitkey, UIUC

Farm-Based DASS and Improved Simulation Training for Farm Supplier Management

Patrick D. O'Rourke, ISU

Farm Decision Outreach Central (farm.doc)

Scott H. Irwin, UIUC

Illinois Farm Producers' Use of the Four Internet Protocols for Problem Solving

Jill K. Webster, SIUC

Illinois IPM Online

Kevin L. Steffey, UIUC

Illinois Technology and Research: Allied and Integrated for Livestock Linkages (TRAILL)

Richard L. Wallace, UIUC

Illinois Watershed Management Clearinghouse

Richard L. Farnsworth, UIUC

In-Field Management Prescriptions

Donald G. Bullock, UIUC

Interactive Illinois Agronomy Handbook

Robert G. Hoeft, UIUC

On-Machinery Information Management System for Precision Agricultural Operations

Qin Zhang, UIUC

The Community and Economic Development Toolbox

Julie Fesenmaier, UIUC

World Food and Sustainable Agriculture Information on the Web

David W. Onstad, UIUC

### Rural Community Development

FY03 Rural Community Development SRI Leader Support and Coordination

Raymond C. Lenzi, SIUC

Improving Farm Income and Rural Communities Through Value-Added Agriculture

Burton E. Swanson, UIUC

Rural Development Opportunities: A Research and Outreach Program

Roger J. Beck, SIUC

Rural Enterprise and Alternative Agricultural Development Initiative (READI)

Susan T. Kohler, SIUC

### Swine Odor and Waste Management

FY03 Swine Odor and Waste Management SRI Leader Support and Coordination

Michael Ellis, UIUC

Advances in Aerobic Thermophilic Treatment for Odor Control and Energy Production from Swine Wastes

James W. Blackburn, SIUC

Community Concerns and Citizens' Reactions to Large-Scale Swine Facilities in Illinois

Ann E. Reisner, UIUC

Contribution of Corn to Swine Odor

Gary A. Apgar, SIUC

Cost-Effective Catalytic Methods for Odor Reduction in Swine Facilities

Richard I. Masel, UIUC

Development and Dissemination of Practical Recommendations on Swine Odor and Waste Management

Michael Ellis, UIUC

## Dispersion Modeling and Source Characterization

Illinois Odor and Nutrient Control Proving Center (ION-PC)

Industry Communications and Information Delivery

Instrumental Measurement of Swine Odor Components

Legal Issues in Swine Odor and Waste Management

Odor Offensiveness: Qualitative and Quantitative  
Identification of Odor-Significant Volatiles in Swine Facilities

On-Farm Demonstration of a Solid-Liquid Separation  
System for Swine Slurry

Studies of a New *E. coli*-Derived Phytase

Systems Design and Management and Economic Modeling

Variable-Rate Technology Slurry Applicator

Various Capacity Aerodynamic Dedusters: Year 3—Development and  
Evaluation of a Large Concentric Deduster in a Swine Building

Allen L. Williams, Illinois State  
Water Survey

Yuanhui Zhang, UIUC

Michael F. Hutjens, UIUC

Keith Cadwallader, UIUC

Margaret R. Grossman, UIUC

M. Susan Brewer, UIUC

Paul M. Walker, ISU

David H. Baker, UIUC

Gay Y. Miller, UIUC

Ted L. Funk, UIUC

Yuanhui Zhang, UIUC

## Food Safety

FY03 Food Safety SRI Leader Budget and Food Safety Symposium

Bacterial Pathogen Content of Organic-Food Fertilizer  
Produced from Aerobic Thermophilic Treatment of Swine Waste

Characterization of *Shigella boydii* Serotype 18 Survivability,  
Including Fresh Produce

Development of Model HACCP Programs and Implementation  
Strategies for Food Service

Food Safety Curricular Materials for Schools

Medical School Food Safety Educational Curriculum

Planning for a Food-Safe Community

The Economic Impact for Producers and Consumers  
Arising from Feedgrade Antibiotic Use in Pork Production

Using Large-Scale Gene-Expression Analysis to Address Human-Food  
Safety Concerns About the Consumption of GMO Products

Jeannette M. Endres, SIUC

James W. Blackburn, SIUC

Hans P. Blaschek, UIUC

Hea-Ran L. Ashraf, SIUC

Martha Barclay, WIU

David Carpenter, Southern Illinois  
University School of Medicine

Ray Cooke, Springfield  
Department of Public Health

Gay Y. Miller, UIUC

William J. Banz, SIUC

## Water Quality

FY03 Water Quality Leadership SRI Leader Support and Coordination

Additional Studies to Improve Quantification of the Water and  
Nitrogen Balances on the Water Quality SRI/BMP Field Site

Chemical Transport Process Variability in a Tile-Drained Field

George F. Czapar, University of  
Illinois Extension

Robert J.M. Hudson, UIUC

Timothy R. Ellsworth, UIUC

**Decision Support for Water Quality Planning in Multiple-Ownership Watersheds**

**Jeffrey R. Beaulieu, SIUC**

**Enhancement of Water Quality and Farm Income: Decision Support for Riparian Management Systems**

**Jean C. Mangun, SIUC**

**Evaluation and Development of Soil Biogeochemical Process Models for Tile-Drained Fields**

**Robert J.M. Hudson, UIUC**

**Evaluation of N Management Practices on Corn Yield and the Environmental Fate of N**

**Robert G. Hoefl, UIUC**

**Factoring Crop N Accumulation into Budgets of N Mass Balances**

**Fred E. Below, UIUC**

**Flow and Transport in Shallow Subsurface Drainage Systems**

**Richard A.C. Cooke, UIUC**

**Long-Term Changes in Agricultural Soil N and C Pools**

**Mark B. David, UIUC**

**Mass Balance Integration**

**Mark B. David, UIUC**

**Modeling Hydrology, Sediment, and Agricultural Chemicals in Illinois Watersheds**

**Deva K. Borah, Illinois State Water Survey**

**Optimal Uniform and Variable Rate of N Application to Improve Water Quality**

**Madhu Khanna, UIUC**

**Shallow Groundwater Flow and Mass Flux of Nutrients (Nitrogen and Phosphorus) in the Big Ditch Watershed (A)**

**Edward Mehnert, Illinois State Geological Survey**

**Supplemental In-Field Denitrification**

**Richard A.C. Cooke, UIUC**

**The Role of In-Stream Processes in the Cycling of Dissolved Nitrogen (A)**

**Mark B. David, UIUC**

**Understanding and Modeling the Hydrology of Tile-Drained Watersheds**

**Prasanta K. Kalita, UIUC**

**Watershed Monitoring in Support of WQ-SRI Data-Collection Needs**

**Laura L. Keefer, Illinois State Water Survey**



# THE C-FAR INVESTMENT: SEIZING A COMPETITIVE ADVANTAGE

The Food and Agriculture Research Act, C-FAR's enabling legislation, states that "the purpose of this Act is to put a solid foundation of stable and long-term state support under the important public activity of food and agricultural research while improving accountability and gathering public input concerning that research." It also asserts that "Illinois should be among the top 10 agricultural states in state funding" since it consistently ranks in the top 5 states in gross agricultural production and is a national leader in food processing. Clearly, state legislators agreed with industry professionals that Illinois must be in the top 10 states for food and agricultural research funding to remain competitive in this industry.

However, based on data for FY01 (the most recent data available), Illinois ranked only 18th in the nation for funding of food and agricultural research, behind all other midwestern states except Missouri.\* For Illinois to place in the top 10 states for food and agricultural research funding, C-FAR would have needed an appropriation of about \$26 million in FY01. Today, the appropriation necessary for Illinois to make it into the top 10 would be higher still.

Gaining a competitive advantage also requires an intellectual environment that fosters innovation. Through its structure, C-FAR creates a unique environment that engages our state's industry professionals with scientific experts. This alliance maximizes the potential for intellectual, technological, and programmatic innovation. C-FAR funding has played a critical role in strengthening research capacity at Illinois' food and agricultural research institutions, including the University of Illinois at Urbana-Champaign (UIUC), Southern Illinois University at Carbondale (SIUC), Illinois State University (ISU), and Western Illinois University (WIU) as well as other key research entities in the state, such as the Illinois Institute of Technology and Illinois State Water Survey. As a result of C-FAR support, Illinois' research universities have been able to attract faculty of the highest caliber, provide graduate and undergraduate students with invaluable educational experiences, and enhance research facilities to remain nationally competitive. This important research base allows Illinois not only to increase efficiencies within existing food and agricultural systems but also to explore new opportunities for enhancing revenues and creating extra value.

\* Source: Inventory of Agricultural Research, USDA/CREES.



### Comparison of U.S. Midwestern Agricultural States' Annual Research Expenditures (FY01)



Source of this data is Inventory of Agricultural Research, USDA/CREES (land-grant institutions), which reflects FY01 expenditures (not appropriations) of state funds for food and agricultural research by land-grant institutions. The Illinois figure includes both C-FAR-appropriated funds and other general revenue funds as appropriated by the State of Illinois.

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## Summary of FY02 Expenditures and Obligated Funds

**External Competitive Grants Program .....3,938,921**

Expenditures..... 2,070,080

Research Obligations ..... 1,868,841

**Internal Programs and Other Programs/Accounts..... 11,855,186**

Expenditures..... 6,888,844

Research Obligations..... 4,919,100

Administrative Office Obligations..... 47,242

**Strategic Research Initiatives.....7,159,027**

Expenditures..... 4,191,409

Research Obligations ..... 2,956,423

Review Panel Obligations..... 11,195

**Illinois Department of Agriculture Fee .....50,000**

**Member Expense Account ..... 120,801**

**Total FY02 Expenditures and Obligated Funds ..... \$23,123,935**

Expenditures .....\$13,321,134

Research Obligations..... \$9,744,364

Program/Account Obligations ..... \$58,437

*Note: The total FY02 expenditures and obligated funds are higher than the FY02 appropriation because a portion of funds from the previous fiscal year are typically obligated for investment in the subsequent year.*

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## Summary of FY03 Allocations

External Competitive Grants Program ..... 1,059,773\*

University Internal Programs and Other Programs/Accounts ..... 3,083,958

Strategic Research Initiatives..... 2,750,000

Illinois Department of Agriculture Fee  
(\$50,000, or 1/2 of 1% of the total appropriation, whichever is less) ..... 34,840

Member Expense Account (1% of the total appropriation) ..... 69,680

**Total FY03 Allocations ..... \$6,998,251**

\* An additional \$29,199 of unexpended funds from the FY02 1% Member Expense Fund and an additional \$1,052 from an FY01 project that did not expend all of its grant were allocated to the FY03 External Competitive Grants Program.

**C-FAR FY02 Expenditure Summary: University Internal Programs and Other Programs/Accounts**  
(July 1, 2001 through June 30, 2002)

| Actual Fiscal Year Expenditures             |   |              |           |           |           |                 |              |  |  |
|---|---|--------------|-----------|-----------|-----------|-----------------|--------------|--|--|
| C-FAR Research Focus Areas                  | Expenditure Areas                             | UIUC         | SIUC      | ISU       | WIU       | Per Legislation | TOTALS       |  |  |
| Expanding Agricultural Markets              | Equipment                                     | 23,684       | 4,713     | 2,115     | 0         |                 | \$30,512     |  |  |
|   | Materials/Supplies                            | 60,472       | 99        | 790       | 0         |                 | \$61,361     |  |  |
|   | Personnel                                     | 308,866      | 13,019    | 14,663    | 0         |                 | \$336,548    |  |  |
|   | Services/Contracts                            | 48,974       | 10,057    | 615       | 0         |                 | \$59,646     |  |  |
|   | Transportation                                | 21,292       | 914       | 1,050     | 0         |                 | \$23,256     |  |  |
| Rural Economic Development                  | Equipment                                     | 10,906       | 5,898     | 200       | 14,515    |                 | \$31,519     |  |  |
|   | Materials/Supplies                            | 11,574       | 2,075     | 231       | 4,965     |                 | \$18,845     |  |  |
|   | Personnel                                     | 229,867      | 17,165    | 38,498    | 68,813    |                 | \$354,343    |  |  |
|   | Services/Contracts                            | 16,275       | 325       | 716       | 5,364     |                 | \$22,680     |  |  |
|   | Transportation                                | 24,931       | 0         | 1,947     | 4,520     |                 | \$31,398     |  |  |
| Agricultural Production Systems             | Equipment                                     | 547,877      | 65,657    | 38,762    | 597       |                 | \$652,893    |  |  |
|   | Materials/Supplies                            | 339,117      | 25,926    | 8,752     | 5,748     |                 | \$379,543    |  |  |
|   | Personnel                                     | 1,541,991    | 235,851   | 20,536    | 25,600    |                 | \$1,823,978  |  |  |
|   | Services/Contracts                            | 406,166      | 81,984    | 447       | 4,008     |                 | \$492,605    |  |  |
|   | Transportation                                | 48,925       | 6,563     | 0         | 0         |                 | \$55,488     |  |  |
| Human Nutrition and Food Safety             | Equipment                                     | 40,159       | 37,048    | 10,746    | 0         |                 | \$87,953     |  |  |
|   | Materials/Supplies                            | 89,175       | 42,680    | 5,493     | 0         |                 | \$137,348    |  |  |
|   | Personnel                                     | 684,344      | 84,371    | 15,615    | 0         |                 | \$784,330    |  |  |
|   | Services/Contracts                            | 50,804       | 49,319    | 5,309     | 0         |                 | \$105,432    |  |  |
|   | Transportation                                | 13,102       | 3,942     | 495       | 0         |                 | \$17,539     |  |  |
| Natural Resources                           | Equipment                                     | 8,432        | 0         | 13,199    | 866       |                 | \$22,497     |  |  |
|   | Materials/Supplies                            | 117,099      | 1,239     | 12,183    | 3,480     |                 | \$134,001    |  |  |
|   | Personnel                                     | 467,890      | 22,760    | 43,380    | 52,615    |                 | \$586,645    |  |  |
|   | Services/Contracts                            | 64,796       | 0         | 7,372     | 13,347    |                 | \$85,515     |  |  |
|   | Transportation                                | 8,698        | 0         | 4,953     | 1,390     |                 | \$15,041     |  |  |
| Subtotals                                   |   | 5,185,416    | 711,605   | 248,067   | 205,828   |                 | \$6,350,916  |  |  |
|   | Indirect Cost                                 | 0            | 0         | 14,824    | 10,908    |                 | \$25,732     |  |  |
|   | Research Support                              | 113,025      | 59,414    | 48,415    | 21,708    |                 | \$242,562    |  |  |
|   | C-FAR Administrative Office Achievement Award | 200,600      | 26,910    | 9,785     | 7,339     |                 | \$244,634    |  |  |
|   | 1% Member Expense IDOA Fee                    | 20,500       | 2,750     | 1,000     | 750       |                 | \$25,000     |  |  |
| Awards/Obligated Funds for FY03 Research    |   | N/A          | N/A       | N/A       | N/A       | 120,801         | \$120,801    |  |  |
|   |   | N/A          | N/A       | N/A       | N/A       | 50,000          | \$50,000     |  |  |
| Total FY02 Expenditures and Obligated Funds |   | \$10,208,568 | \$895,121 | \$400,700 | \$303,555 | \$170,801       | \$11,978,745 |  |  |

**C-FAR FY02 Expenditure Summary: External Competitive Grants Program**

(July 1, 2001 through June 30, 2002)

| Actual Fiscal Year Expenditures             |                    |             |             |           |           |                 |             |  |  |
|---|--------------------|-------------|-------------|-----------|-----------|-----------------|-------------|--|--|
| C-FAR Research Focus Areas                  | Expenditure Areas  | UIUC        | SIUC        | ISU       | WIU       | Other Entities* | TOTALS      |  |  |
| Expanding Agricultural Markets              | Equipment          | 5,693       | 39,283      | 0         | 0         | 0               | \$44,976    |  |  |
|   | Materials/Supplies | 26,297      | 44,020      | 0         | 0         | 1,202           | \$71,519    |  |  |
|   | Personnel          | 16,974      | 141,537     | 0         | 0         | 1,000           | \$159,511   |  |  |
|   | Services/Contracts | 10,211      | 41,050      | 0         | 0         | 3,000           | \$54,261    |  |  |
|   | Transportation     | 22,088      | 4,252       | 0         | 0         | 2,748           | \$29,088    |  |  |
| Rural Economic Development                  | Equipment          | 9,757       | 1,659       | 0         | 1,400     | 458             | \$13,274    |  |  |
|   | Materials/Supplies | 15,102      | 3,222       | 0         | 806       | 464             | \$19,594    |  |  |
|   | Personnel          | 141,771     | 109,936     | 0         | 10,898    | 24,236          | \$286,841   |  |  |
|   | Services/Contracts | 30,734      | 7,561       | 0         | 4,123     | 16,145          | \$58,563    |  |  |
|   | Transportation     | 16,940      | 1,062       | 0         | 0         | 5,427           | \$23,429    |  |  |
| Agricultural Production Systems             | Equipment          | 9,621       | 0           | 0         | 0         | 0               | \$9,621     |  |  |
|   | Materials/Supplies | 45,810      | 6,346       | 0         | 0         | 0               | \$52,156    |  |  |
|   | Personnel          | 217,316     | 76,694      | 0         | 0         | 0               | \$294,010   |  |  |
|   | Services/Contracts | 37,525      | 4,893       | 322       | 0         | 0               | \$42,740    |  |  |
|   | Transportation     | 20,439      | 3,667       | 0         | 0         | 0               | \$24,106    |  |  |
| Human Nutrition and Food Safety             | Equipment          | 404         | 415         | 15,700    | 0         | 16,706          | \$33,225    |  |  |
|   | Materials/Supplies | 36,376      | 4,646       | 0         | 0         | 32,010          | \$73,032    |  |  |
|   | Personnel          | 109,952     | 32,363      | 9,377     | 0         | 42,244          | \$193,936   |  |  |
|   | Services/Contracts | 22,170      | 461         | 0         | 0         | 328             | \$22,959    |  |  |
|   | Transportation     | 7,972       | 376         | 0         | 0         | 862             | \$9,210     |  |  |
| Natural Resources                           | Equipment          | 31,789      | 13,935      | 0         | 517       | 1,500           | \$47,741    |  |  |
|   | Materials/Supplies | 8,134       | 11,462      | 0         | 4,995     | 1,146           | \$25,737    |  |  |
|   | Personnel          | 230,323     | 43,061      | 0         | 12,195    | 35,119          | \$320,698   |  |  |
|   | Services/Contracts | 56,033      | 20,693      | 0         | 923       | 1,008           | \$78,657    |  |  |
|   | Transportation     | 13,685      | 1,319       | 0         | 0         | 1,620           | \$16,624    |  |  |
| Subtotals                                   |                    | 1,143,116   | 613,913     | 25,399    | 35,857    | 187,223         | \$2,005,508 |  |  |
|   | Indirect Cost      | 0           | 45,515      | 2,524     | 3,587     | 12,946          | \$64,572    |  |  |
| Awards/Obligated Funds for FY03 Research    |                    | 1,078,462   | 542,595     | 80,346    | 66,310    | 101,128         | \$1,868,841 |  |  |
| Total FY02 Expenditures and Obligated Funds |                    | \$2,221,578 | \$1,202,023 | \$108,269 | \$105,754 | \$301,297       | \$3,938,921 |  |  |

\*Other entities are the Illinois Crop Improvement Association, Illinois Institute of Technology, Sangamon County Soil and Water Conservation District, Southern Illinois University School of Medicine, University of Illinois at Springfield, and U.S. Grains Council.

**C-FAR FY02 Expenditure Summary: Strategic Research Initiatives**

(July 1, 2001 through June 30, 2002)

| Actual Fiscal Year Expenditures                    |                    |                    |                    |                  |                  |                             |                    |                  |  |
|--|--------------------|--------------------|--------------------|------------------|------------------|-----------------------------|--------------------|------------------|--|
| Strategic Research Initiative                      | Expenditure Areas  | UIUC               | SIUC               | ISU              | WIU              | Other Entities <sup>1</sup> | TOTALS             |                  |  |
| Information Systems and Technology                 | Equipment          | 39,128             | 0                  | 0                | 0                | 0                           | \$39,128           | 0                |  |
|  | Materials/Supplies | 25,366             | 294                | 26               | 0                | 245                         | \$25,931           | 245              |  |
|  | Personnel          | 459,310            | 13,045             | 21,880           | 0                | 30,425                      | \$524,660          | 30,425           |  |
|  | Services/Contracts | 64,237             | 1,984              | 375              | 0                | 0                           | \$66,596           | 0                |  |
|  | Transportation     | 14,938             | 0                  | 1,135            | 0                | 1                           | \$16,074           | 1                |  |
|  | Coordination       | 41,864             | N/A                | N/A              | N/A              | N/A                         | \$41,864           | N/A              |  |
| Rural Community Development                        | Equipment          | 4,292              | 5,571              | 0                | 0                | 0                           | \$9,863            | 0                |  |
|  | Materials/Supplies | 7,969              | 4,311              | 0                | 4,247            | 0                           | \$16,527           | 0                |  |
|  | Personnel          | 133,631            | 249,657            | 0                | 15,935           | 0                           | \$399,223          | 0                |  |
|  | Services/Contracts | 7,663              | 10,603             | 0                | 16,786           | 0                           | \$35,052           | 0                |  |
|  | Transportation     | 5,956              | 625                | 0                | 4,440            | 0                           | \$11,021           | 0                |  |
|  | Coordination       | N/A                | 81,175             | N/A              | N/A              | N/A                         | \$81,175           | N/A              |  |
| Swine Odor and Waste Management                    | Equipment          | 32,495             | 31,419             | 108,220          | 0                | 0                           | \$172,134          | 0                |  |
|  | Materials/Supplies | 89,263             | 7,500              | 7,036            | 0                | 2,230                       | \$106,029          | 2,230            |  |
|  | Personnel          | 422,656            | 40,888             | 19,353           | 0                | 0                           | \$482,897          | 0                |  |
|  | Services/Contracts | 89,281             | 5,375              | 5,436            | 0                | 4,995                       | \$105,087          | 4,995            |  |
|  | Transportation     | 19,570             | 3,263              | 0                | 0                | 0                           | \$22,833           | 0                |  |
|  | Coordination       | 90,650             | N/A                | N/A              | N/A              | N/A                         | \$90,650           | N/A              |  |
| Food Safety  | Equipment          | 1,777              | 10,079             | 0                | 219              | 3,325                       | \$15,400           | 3,325            |  |
|  | Materials/Supplies | 41,849             | 15,086             | 0                | 1,591            | 2,432                       | \$60,958           | 2,432            |  |
|  | Personnel          | 165,770            | 157,099            | 0                | 42,539           | 84,781                      | \$450,189          | 84,781           |  |
|  | Services/Contracts | 14,810             | 34,565             | 0                | 1,651            | 35,174                      | \$86,200           | 35,174           |  |
|  | Transportation     | 11,755             | 14,014             | 0                | 4,107            | 1,955                       | \$31,831           | 1,955            |  |
|  | Coordination       | N/A                | 84,972             | N/A              | N/A              | N/A                         | \$84,972           | N/A              |  |
| Water Quality                                      | Equipment          | 36,016             | 0                  | 0                | 0                | 0                           | \$36,016           | 0                |  |
|  | Materials/Supplies | 43,047             | 2,947              | 0                | 0                | 0                           | \$45,994           | 0                |  |
|  | Personnel          | 629,820            | 88,406             | 0                | 7,655            | 0                           | \$725,881          | 0                |  |
|  | Services/Contracts | 204,661            | 26,791             | 0                | 0                | 0                           | \$231,452          | 0                |  |
|  | Transportation     | 27,645             | 4,132              | 0                | 110              | 0                           | \$31,887           | 0                |  |
|  | Coordination       | 45,130             | N/A                | N/A              | N/A              | N/A                         | \$45,130           | N/A              |  |
| <b>Subtotals</b>                                   |                    | 2,770,549          | 893,801            | 163,461          | 99,280           | 165,563                     | \$4,092,654        | 165,563          |  |
| SRI Review Panel <sup>2</sup>                      |                    | N/A                | N/A                | N/A              | N/A              | N/A                         | \$0                | N/A              |  |
| Indirect Cost                                      |                    | 0                  | 72,795             | 8,173            | 8,853            | 8,935                       | \$98,756           | 8,935            |  |
| Awards/Obligated Funds for FY03 Research           |                    | 2,396,756          | 325,365            | 46,456           | 71,166           | 116,680                     | \$2,956,423        | 116,680          |  |
| <b>Total FY02 Expenditures and Obligated Funds</b> |                    | <b>\$5,167,305</b> | <b>\$1,291,961</b> | <b>\$218,090</b> | <b>\$179,299</b> | <b>\$291,178</b>            | <b>\$7,147,833</b> | <b>\$291,178</b> |  |

<sup>1</sup>Other entities are the American Farmland Trust, Iowa State University, Purdue University, Illinois Institute of Technology, Southern Illinois University School of Medicine, and the Springfield, Illinois, Department of Public Health.

<sup>2</sup>The SRI Review Panel account has a balance of \$11,195. There were no expenditures in FY02.

## C-FAR FY03 Allocations Summary Report

(July 1, 2002 through June 30, 2003)

|  | Internal Grants Programs |                  |                  |                 |                    |                                | External<br>Competitive<br>Grants<br>Program | Strategic<br>Research<br>Initiatives | Per<br>Legislation             | TOTALS      |
|--|--------------------------|------------------|------------------|-----------------|--------------------|--------------------------------|--|--------------------------------------|--------------------------------|-------------|
|  | UIUC                     | SIUC             | ISU              | WIU             | Internal<br>Totals |                                |  |                                      |                                |             |
| <b>C-FAR Research<br/>Focus Areas</b>          |                          |                  |                  |                 |                    |                                |  |                                      |                                |             |
| Expanding Agricultural<br>Markets              | 358,296                  | 0                | 11,860           | 0               | 370,156            | 256,644                        |  |                                      |                                | \$626,800   |
| Rural Economic<br>Development                  | 84,616                   | 1,479            | 14,407           | 80,956          | 181,458            | 225,742                        |  |                                      |                                | \$407,200   |
| Agricultural Production<br>Systems             | 1,038,280                | 110,000          | 7,593            | 0               | 1,155,873          | 184,500                        |  |                                      |                                | \$1,340,373 |
| Human Nutrition and<br>Food Safety             | 527,440                  | 71,000           | 10,866           | 0               | 609,306            | 196,736                        |  |                                      |                                | \$806,042   |
| Natural Resources                              | 207,368                  | 22,000           | 35,816           | 0               | 265,184            | 192,400                        |  |                                      |                                | \$457,584   |
| <b>External Reviewers</b>                      |                          |                  |                  |                 |                    | 3,751                          |  |                                      |                                | \$3,751     |
| <b>Strategic Research Initiatives</b>          |                          |                  |                  |                 |                    |                                | 2,750,000                                    |                                      |                                | \$2,750,000 |
| Food Safety \$440,000                          |                          |                  |                  |                 |                    |                                |  |                                      |                                |             |
| Info Systems and Technology \$453,750          |                          |                  |                  |                 |                    |                                |  |                                      |                                |             |
| Rural Community Development \$536,250          |                          |                  |                  |                 |                    |                                |  |                                      |                                |             |
| Swine Odor and Waste Mgmt. \$687,500           |                          |                  |                  |                 |                    |                                |  |                                      |                                |             |
| Water Quality \$632,500                        |                          |                  |                  |                 |                    |                                |  |                                      |                                |             |
| <b>Research Support</b>                        | 95,000                   | 53,500           | 0                | 0               | 148,500            |                                |  |                                      |                                | \$148,500   |
| <b>Research Discretionary</b>                  | 12,429                   | 53,700           | 27,399           | 0               | 93,528             |                                |  |                                      |                                | \$93,528    |
| <b>Indirect Costs</b>                          | 0                        | 0                | 5,397            | 4,048           | 9,445              |                                |  |                                      |                                | \$9,445     |
| <b>C-FAR Administrative Office<sup>1</sup></b> | 205,417                  | 27,556           | 10,020           | 7,515           | 250,508            |                                |  |                                      |                                | \$250,508   |
| <b>Achievement Award<sup>2</sup></b>           | 0                        | 0                | 0                | 0               | 0                  |                                |  |                                      |                                | \$0         |
| <b>1% Member Expense</b>                       | N/A                      | N/A              | N/A              | N/A             | N/A                |                                |  |                                      | 69,680                         | \$69,680    |
| <b>IDOA Fee</b>                                | N/A                      | N/A              | N/A              | N/A             | N/A                |                                |  |                                      | 34,840                         | \$34,840    |
| <b>TOTALS</b>                                  | <b>\$2,528,846</b>       | <b>\$339,235</b> | <b>\$123,358</b> | <b>\$92,519</b> | <b>\$3,083,958</b> | <b>\$1,059,773<sup>3</sup></b> | <b>\$2,750,000</b>                           | <b>\$104,520</b>                     | <b>\$6,998,251<sup>3</sup></b> |             |

<sup>1</sup>The C-FAR administrative office budget for FY03 is \$297,750. This budget consists of \$250,508 of FY03 C-FAR funds and \$47,242 of unexpended funds from previous fiscal years.

<sup>2</sup>FY03 funding for the C-FAR Achievement Award is not necessary because no award was given in 2002. FY02 funds committed for this purpose will be rolled to FY03.

<sup>3</sup>An additional \$29,199 of unexpended funds from the FY02 1% Member Expense Fund and an additional \$1,052 from an FY01 project that did not expend all of its grant were allocated to the FY03 External Competitive Grants Program.

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## ■ NOTES



# NOTES

**Illinois Council on Food and  
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