The Illinois Council on Food and Agricultural Research (C-FAR) is a statewide coalition organized to support Illinois’ number one industry.

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.
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Dear Friends,

In Illinois, we are extremely fortunate to have a unique set of resources, including some of the world’s most fertile land and an educated and dynamic population, that position Illinois’ food and agricultural industry to act as a leader in the nation and around the world. Capturing the opportunities that our valuable resources can provide is key to Illinois’ economic future. At the same time, the complexities of our nation’s food and fiber system continue to grow. Marketing options, value-added initiatives, environmental stewardship, and production efficiencies are just a few of the challenges that face Illinois producers. Furthermore, nutrition, food safety, and food quality are of primary interest and concern to all Illinois consumers.

Within C-FAR, we feel strongly that the best way to meet the challenges and take advantage of the opportunities we face is through a strong and vibrant public research system. For decades, public research at our universities and elsewhere has paved the way to hundreds, if not thousands, of developments that are in common use today. From research labs to commercialization, we benefit from these innovations each day.

Within C-FAR, we further believe that industry organizations and consumers can play a significant role in guiding our public research initiatives to ensure that they are results-oriented. Through bringing industry leaders and consumers together with some of the world’s most talented researchers, Illinois is proving that a partnership of real meaning benefits each and every citizen of our state.

C-FAR’s initial goals and aspirations for a new and improved public research system are steadily being met. With the gratitude of our membership and of every Illinois consumer, we proudly acknowledge the State of Illinois for its investment in our future. Governor George H. Ryan, Illinois Department of Agriculture Director Joe Hampton, and members of the Illinois General Assembly have responded to what was a spiraling degradation of our food and agricultural research system.

While our work is far from complete, Illinois is sending a message to the nation that we recognize and value our resources and the potential contribution they can make not only to Illinois, but also to the nation and the world. Illinois can and will be a leader in ensuring that both our own citizens and citizens around the world can rely upon an abundant, safe, and nutritious food supply.

C-FAR, through its many partners, welcomes these opportunities and challenges.

Terry L. Wolf
Chairman of the Board

Kraig Wagenecht
Executive Administrator
SRI External Reviews

In February and March, national experts from across the United States were invited to Illinois to participate in two-day reviews of four of C-FAR’s Strategic Research Initiatives (SRIs): Information Systems and Technology, Rural Community Development, Swine Odor and Waste Management, and Food Safety. A panel of three or four evaluators assessed the SRI in their area of expertise based on such factors as the effectiveness of the team approach, the quality of work being done, and the progress being made. Overall, the SRIs were recognized for their unique design and approach to studying critical issues and for exemplary research and outreach.

Annual Meeting

The highlight of the February 22 annual meeting was Governor George H. Ryan’s presentation of the first C-FAR Achievement Award. Governor Ryan spoke of the importance of agricultural research for Illinois and of C-FAR’s vital role in directing this research. Then he presented the C-FAR Achievement Award to the Beef Quality Initiative research team: Larry Berger, Dan Faulkner, Floyd McKeith, and Douglas Parrett from the University of Illinois at Urbana-Champaign; and Paul Walker from Illinois State University. This group’s outstanding research and outreach focused on developing innovative beef production systems that will produce more high-quality beef to meet consumer demand and lower production costs.

External Grants Review

Researchers throughout Illinois submitted a total of 123 proposals requesting more than $13 million to the FY01 External Competitive Grants Program. Fifteen percent of the total C-FAR appropriation (about $2.2 million of the $15 million FY01 appropriation) is allocated to this program. Working group members devoted considerable time and effort to reviewing and completing evaluations of proposals in their respective areas and attended full-day meetings in March to discuss priorities and make recommendations about which projects to fund. More than 100 people were involved in this process.

Twenty-six research proposals were selected for funding. These funds support research projects at the University of Illinois at Urbana-Champaign, Southern Illinois University at Carbondale, Western Illinois University, Illinois State University, Illinois Crop Improvement Association, Illinois State Geological Survey, Sangamon County Soil and Water Conservation District, Illinois State Water Survey, and U.S. Grains Council. Due to the growing number of proposals submitted to this program and in order to improve standards for proposal selection, a new two-step review process has been developed and is being implemented as part of the FY02 program.
Poster Session

On February 16, researchers showcased C-FAR-funded food and agricultural research in the State Capitol rotunda in Springfield. More than 40 scientists from the University of Illinois at Urbana-Champaign, Southern Illinois University at Carbondale, Illinois State University, Western Illinois University, and other research entities visited one-on-one with legislators and the public to describe their work and illustrate how it benefits both the food and agricultural industry and the citizens of Illinois.

Semi-annual Meeting

The August 21 semi-annual meeting featured opening remarks by Joe Hampton, director of the Illinois Department of Agriculture. Director Hampton expressed his support of C-FAR and acknowledged the importance of efforts made by C-FAR members. An important initiative discussed at the meeting was the “Grow Illinois” FY02-FY06 funding request. If granted, these funds could rank Illinois sixth nationally in state funding for food and agricultural research. During the meeting, members also reviewed recommendations for changes to the External Competitive Grants Program and adopted several changes to the organization’s bylaws.

Farm Progress Show

With 400 exhibitors showcasing a breathtaking collection of leading-edge technology and equipment on a 70-acre field, the Farm Progress Show, also known as the World’s Fair of Agriculture, is an event not to be missed. In September 2000, C-FAR researchers, board members, and staff participated in this special event to display the latest in food and agriculture research. Although the first of three days was canceled due to rain, an estimated 250,000 visitors attended the show in Cantrall, Illinois.
2000 Board of Directors

Terry Wolf
CHAIR, HOMER

Carol Keiser
VICE CHAIR AND MEMBERSHIP CHAIR, CHAMPAIGN

Constance Locher Bussard, R.D.
SECRETARY-TREASURER, SPRINGFIELD

Fred Bradshaw
LEGISLATIVE CHAIR, GRIGGSVILLE

Jack Erisman
RESEARCH CHAIR, PANA

David Downs
RESEARCH VICE CHAIR, ALLERTON

W. Lyle Roberts, Jr.
PAST CHAIR, BLOOMINGTON

Staff

Kraig A. Wagenecht
EXECUTIVE ADMINISTRATOR

LeAnn M. Ormsby
COMMUNICATIONS DIRECTOR

Additional C-FAR Staff

Rhonda Hunter
ADMINISTRATIVE ASSISTANT

Barbara Haegele
SECRETARY

Tracy Cramer
SECRETARY

Ellen Jansen
SECRETARY
2000 Working Group Leadership

Expanding Agricultural Markets
- **Nels Kasey**
  CHAIR, PARIS

Rural Economic Development
- **A.J. Harland**
  CHAIR, LAFAYETTE

Agricultural Production Systems
- **Steve Kasten**
  CHAIR, CENTRALIA

Human Nutrition and Food Safety
- **Carol Meyer**
  CHAIR, STEELEVILLE

Natural Resources
- **Susan Adams**
  CHAIR, ATLANTA

**Roger Hubele**
VICE CHAIR, ENFIELD

**Kevin Brussell**
VICE CHAIR, CASEY

**Brent Bidner**
VICE CHAIR, MONTICELLO

**Karen Little**
VICE CHAIR, PLEASANT PLAINS

**Angela Kazakevicius**
VICE CHAIR, POMONA
Organizational Members

American Dairy Association of Illinois
Association of Illinois Soil and Water Conservation Districts
Audubon Council of Illinois
Champaign County Farm Bureau
Farm Credit Services of Illinois
Grain and Feed Association of Illinois
GROWMARK, Inc.
Horsemen’s Council of Illinois
Horseradish Growers of Illinois
Illinois Agri-Women
Illinois Association of Drainage Districts
Illinois Association of Meat Processors
Illinois Beef Association, Checkoff Division
Illinois Beef Association, Dues Division
Illinois Chapter of Organic Crop Improvement Association
Illinois Cooperative Council
Illinois Corn Growers Association
Illinois Corn Marketing Board
Illinois Dietetic Association
Illinois Farm Bureau
Illinois Farm Business Farm Management Association
Illinois Farmers Union
Illinois Fertilizer and Chemical Association, Inc.
Illinois Forage and Grassland Council
Illinois Grape Growers and Vintners Association
Illinois Lamb and Wool Producers, Inc.
Illinois Landscape Contractors Association
Illinois Milk Producers’ 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 and 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
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
Orr Research Center Corporation
Rural Partners
Safer Pest Control Project
Southeastern Illinois Sustainable Agriculture Association
Southern Illinois University at Carbondale College of 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

*As of December 31, 2000
**Affiliate Members**

- Central Illinois Agricultural Research Farms, Inc.
- DeKalb County Lamb and Wool Producers, Inc.
- Greene Farm Management Services, Inc.
- Illinois Crop Improvement Association, Inc.
- Illinois Farm Development Authority
- 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
- Macoupin County Soil and Water Conservation District
- National Center for Food Safety and Technology
- Sangamon County Soil and Water Conservation District
- 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, Office of Economic and Regional Development
- University of Illinois at Chicago, College of Pharmacy
- University of Illinois at Springfield, Institute for Public Affairs
- University of Illinois at Urbana-Champaign, College of Agricultural, Consumer and Environmental Sciences
- 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 Pathobiology
- USDA - Rural Development
- Western Illinois University, Department of Agriculture
- Western Illinois University, Department of Family and Consumer Sciences

**Individual Members**

In FY00, C-FAR had more than 130 individual members.

*As of December 31, 2000*
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:
Jack Erisman, Chair; David Downs, Vice Chair; Susan Adams; Kevin Brussell; Steve Calhoun; Len Corzine; George Fahey; Jim Fraley; Paul Gebhart; Mollie Ann Godar; Pam Hansen; A. J. Harland; Nels Kasey; Steve Kasten; Dan Kelley; Karen Little; Carol Meyer; Steven Pueppke; Alan Puzey; John Quandt; Danny Terry; Frank Thorp; Walt Townsend; Derek Winstanley; Randy Winter; and Anthony Young.

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:
Larry Fischer, Chair; Kent Krukewitt; Patricia Lawfer; Norbert Soltwedel; Dennis Thompson; and Randy Vogel.

Nominating Committee

This committee is appointed annually by the board chair and approved by the board of directors. The committee must include at least five members from any class of membership. The board chair may appoint the past chair or another qualified individual to serve as chair of this 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:
W. Lyle Roberts, Jr., Chair; Steve Calhoun; Kendall Cole; Julie Dostal; Mark Gebhards; William McCartney; Jack Norman; and Bob Swires.
“C-FAR funding has allowed the SIU College of Agriculture to move toward higher technology research that benefits farmers, consumers, and the rural economy. Our faculty has leveraged every C-FAR-invested dollar almost seven times with other external dollars. Every dollar invested in rural Illinois can be an economic multiplier as high as 30 to 1. Clearly, C-FAR has been one of the State of Illinois’ best investments. Results from the investment are high, and our faculty is proud to have a direct relationship with the industry and state they serve.”

W. David Shoup, Dean
College of Agriculture
Southern Illinois University at Carbondale

“The State investment in food and agriculture through C-FAR has allowed Western Illinois University to advance beyond the realm of teaching agriculture to include valuable research endeavors. Our research initiatives now encompass programs that focus on sustainable agriculture, including pesticide-free crop production and the development of organic markets, as well as plant breeding that incorporates the development of commercially viable alternative crops. The collaborative C-FAR-funded research efforts taking place between Illinois research institutions and those beyond state boundaries are reaping huge rewards for Illinois and its citizens.”

Danny E. Terry, Chair
Department of Agriculture
Western Illinois University

“C-FAR funding has allowed the SIU College of Agriculture to move toward higher technology research that benefits farmers, consumers, and the rural economy. Our faculty has leveraged every C-FAR-invested dollar almost seven times with other external dollars. Every dollar invested in rural Illinois can be an economic multiplier as high as 30 to 1. Clearly, C-FAR has been one of the State of Illinois’ best investments. Results from the investment are high, and our faculty is proud to have a direct relationship with the industry and state they serve.”

W. David Shoup, Dean
College of Agriculture
Southern Illinois University at Carbondale

“The University of Illinois College of Agricultural, Consumer and Environmental Sciences is excited to be a part of the unique C-FAR partnership. History indicates progress is sparked by sound, publicly funded research, and Illinois should be very competitive among states in the public investment in food, agricultural, and natural resource research.

C-FAR will be the major vehicle through which Illinois achieves this goal. And it’s an important one, too. At stake is the strategically critical research and discovery engine that supports the food, agricultural, and natural resource sectors. A robust research and discovery engine, together with an appropriate enabling infrastructure, will fuel the Illinois economy and help maintain the prominence of the Illinois food, agricultural, and natural resource sectors into the 21st century.”

David L. Chicoine, Dean
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

“Any visitor to the University Farm or Department of Agriculture laboratories at Illinois State University will see the impact of C-FAR everywhere—renovated facilities, better equipment, research projects in progress. C-FAR has dramatically increased the research and outreach capacity of food and agriculture programs at Illinois State University.

C-FAR funds are an important tool for the recruitment and retention of qualified faculty members—and qualified researchers are the most important element of an effective research and outreach program.”

J. Randy Winter, Chair
Department of Agriculture
Illinois State University

Additional University Contacts

Steven G. Pueppke, Associate Dean for Research, College of Agricultural, Consumer and Environmental Sciences, University of Illinois at Urbana-Champaign

George C. Fahey, Jr., Assistant Dean, Research Leadership—C-FAR, College of Agricultural, Consumer and Environmental Sciences, University of Illinois at Urbana-Champaign

Anthony W. Young, Associate Dean for Research, College of Agriculture, Southern Illinois University at Carbondale
In 1995, the Illinois General Assembly and then-Governor Jim Edgar passed the Food and Agriculture Research Act, the important enabling legislation that provides the framework for C-FAR funding and research activity. In FY00, the C-FAR appropriation was $15 million.

Funds are allocated to three C-FAR research programs:

**Strategic Research Initiatives (SRIs)**
Team-based research efforts providing a targeted, multidisciplinary, and multi-institutional approach for addressing major issues and concerns of the Illinois food and agriculture industry and consumers.

**Internal Programs**
Funds for food and agriculture 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 organization’s total appropriation must 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.

The proposal process for this competitive grants program has been revised this year as a result of the growing number of proposals submitted and in an effort to increase the quality of C-FAR’s research portfolio. C-FAR members committed substantial time and effort to developing a new two-step review process, which will apply beginning in FY02. The first step of the new process is a request for and evaluation of pre-proposals. C-FAR working group members will review and evaluate preproposals 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 will undergo scientific review and evaluation.

Member participation follows a “working group” design with research organized into the following five focus areas:

- expanding agricultural markets
- rural economic development
- agricultural production systems
- human nutrition and food safety
- natural resources
In 1998, the C-FAR membership established Strategic Research Initiatives (SRIs) to implement a targeted, multidisciplinary, and multi-institutional approach to addressing the major issues and concerns of the Illinois food and agriculture industry and consumers. Five research areas were identified: Information Systems and Technology, Rural Community Development, Swine Odor and Waste Management, Food Safety, and Water Quality. The overall SRI effort has received annual allocations of $5 million in FY99, FY00, and FY01.

By early 2000, almost two years of ongoing research had been completed for four of the five SRIs (Water Quality research was not fully implemented until September 1999). At this point, C-FAR leaders decided it was an appropriate time to conduct an external review of the SRI research and progress. A priority was placed on garnering an outside perspective from national leaders in the four SRI research areas. The primary goals of the process were to (1) ascertain the degree of success of this collaborative research approach and (2) determine what changes, if any, in direction or process should be made. National experts from across the United States were invited to Illinois in February and March to participate in two-day intensive reviews of the SRI in their area of expertise. A panel of three or four evaluators was assembled and asked to provide professional opinions about the effectiveness of the team approach, the quality of work being done, and the progress being made.

The external review teams’ overall assessment of the SRIs was extremely positive. In general, the research teams were recognized for an outstanding level of performance and highly praised for their creativity of approach as well as the amount of research activity and output generated in a relatively brief time period. SRI leaders also received input on how their programs might be improved and ideas for integrating their research with programs outside of Illinois.

The following description of each SRI highlights portions of the SRI leader’s executive summary of research and outreach efforts as of July 2000. Also included are comments from the external review team’s evaluation of each SRI.
Illinois is now a leading source and beneficiary of information resources and tools in a wide variety of food and agricultural application areas due in a large part to the C-FAR Information Systems and Technology Strategic Research Initiative (IT-SRI). The IT-SRI targets four areas: farm and agribusiness tools, water quality and natural resources, community and consumer interests, and research tools. The IT-SRI goal is to improve the availability, integration, delivery, and use of information throughout the global food and agricultural systems, with special focus on Illinois.

Ongoing strategic evaluation and planning efforts, which include input from the Expanding Agricultural Markets Working Group, have ensured that the best information technology ideas of investigators around the state are represented in the IT-SRI. Several initiatives have passed milestones for first-stage success and are being expanded, evaluated, and refined in FY01. Researchers from the University of Illinois at Urbana-Champaign, Illinois State University, Southern Illinois University at Carbondale, Illinois Scientific Surveys, and American Farmland Trust continue to collaborate with each other and with stakeholder groups and various agencies.

The Web and other technologies offer opportunities for doing more with information, not only providing ways to increase the availability of information but also to present it in creative and integrated ways that add value. IT-SRI information systems often involve the user by enabling the user to enter information and receive customized feedback. These systems also bring the user closer to research-based information. The greatest accomplishment of the IT-SRI is that it has increased both the supply and demand for food and agriculture information products in Illinois.
We are unanimous in our agreement that the Information Systems and Technology SRI is an excellent program with important products and efforts that will have a positive impact not only on producers and consumers in Illinois but also on those across the country.

This SRI is making significant contributions to the welfare of people in Illinois and to the state of knowledge regarding IT application design, development, and delivery.

IT-SRI participants have developed unique knowledge and insights on how IT can be used to more effectively link dispersed users to the knowledge base that fuels and supports agricultural research and outreach.

(Statements from the IT-SRI External Review Team Report, March 2000)

For example, as a result of several IT-SRI projects, Illinois is becoming a leader in applying geographical information systems (GIS) to agriculture and natural resource management. Researchers are providing spatial databases, GIS-compatible software, simulation models, and decision support systems designed to help Illinois citizens improve the management of their natural resources.

The IT-SRI is funding 18 projects for FY01. A description of IT-SRI projects, progress, and outcomes may be found on the IT-SRI website (http://web.aces.uiuc.edu/sriit). The following are a few examples of current IT-SRI websites that are in demand because they offer important information and decision tools designed to help producers and consumers improve their lives and to help the food and agriculture industry be more efficient and profitable.

**Pest Management and Crop Development Bulletin**
www.ag.uiuc.edu/cespubs/pest

Producers are using the new online Pest Management and Crop Development Bulletin to stay current on scouting reports, pest predictions, and management advice. Interactive tools are planned to assist in related decision making. For example, the Weed Identification and Herbicide Decision Tool (http://web.aces.uiuc.edu/weedid), which matches herbicide options to weed management goals, was finished in time for on-farm use last spring. In June, the online newsletter averaged more than 2,000 hits per day.

**FARM.DOC**
http://www.farmdoc.uiuc.edu

FARM.DOC, short for Farm Decision Outreach Central, offers an integrated framework for research findings in six key areas: supply and demand outlook, benchmarks for evaluating farm financial performance, crop insurance information, marketing alternatives, production costs for major commodities, and legal information. This website provides Illinois farmers with more comprehensive risk management information and analysis. FARM.DOC offers such tools as “FAST: Farm Analysis Solution Tools,” which assists users in evaluating the financial performance of a farm, and “Outlook,” which offers popular weekly and monthly newsletters on economic topics. In 2000, the FARM.DOC site received over 40,000 hits per month.

**Nutrition Analysis Tool**
www.nat.uiuc.edu

During some months the Nutrition Analysis Tool (NAT) has received more than one million hits, proving how interested the public is in diet matters. The only known free nutrition tool on the Internet, NAT offers user-friendly features and covers a broad range of food options, including ethnic, specialty, convenience, and diet foods, as well as functional foods valued for health-promoting effects. A key goal of project developers is to help Illinois citizens make more informed choices, improve their nutrition behaviors, and consequently, improve their health.

**Interactive Agronomy Handbook**
www.aces.uiuc.edu/iah

One of the IT-SRI activities funded in FY00 was the development of an interactive online Agronomy Handbook. The Illinois Agronomy Handbook has a long tradition of imparting reliable, well-researched Illinois-specific crop production information. Video, interactive databases, and other Web-based tools add value to the print handbook by providing instantaneous and relevant information to producers, Extension specialists, and crop consultants. For instance, producers can use online calculators to receive customized fertilizer and herbicide recommendations, replanting dates, and seeding rates. The site will ultimately include an e-mail expert service.

The researchers involved with 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.
The Rural Community Development Strategic Research Initiative (RCD-SRI), also referred to as I-FARRM (Illinois Farming Alternatives and Rural Revitalization Methods), completed its second year of research and outreach to the great benefit of Illinois farmers and rural communities. The RCD-SRI consists of four component projects that combine an applied-action research model with an aggressive outreach and technical-assistance approach to (1) identify alternative and value-added agricultural opportunities in Illinois, (2) assist in enterprise development and expansion, and (3) explore farm–community linkage applications. The following are brief descriptions of the component projects:

- Rural Development Opportunities (RDO) examines current and projected trends in Illinois agriculture, agribusinesses, and rural communities.
- Rural Enterprise and Alternative Agricultural Development Project (READI) addresses serious challenges in rural community and economic development, with particular emphasis on
expanding income and job opportunities in rural alternative agricultural enterprises through a systematic program of research and technical assistance.

- Improving Farm Income and Rural Communities Through Value-Added Commodities (VALUE) explores strategies for improving farm incomes through specialty farm products and value-added processing.
- Community Development Tool Box (CDTB) provides Web-based interactive assistance to foster rural economic development.

The RCD-SRI’s total economic development impact to date is quite remarkable for such a new project. This SRI’s research and technical assistance have supported nearly 30 agri-enterprise start-ups or expansions that have yielded $2.05 million in new capital investment and $920,000 in new annual payroll. Leveraged project dollars exceed $2 million, and the total annual economic impact is estimated at $4 million. The following summary of accomplishments indicates how committed and dedicated RCD-SRI team members have been in their research and outreach efforts.

Farm-Based Enterprise Start-Up and Expansion Support

- Completed start-up and expansion research for farm-based enterprises throughout Illinois, including
  - White Owl Winery in Lawrence County
  - Hobbs Catfish Farm marketing plan
  - USSOY of Mattoon marketing study
  - Buckwheat feasibility study
  - Four agritourism enterprises, from Sangamon County to Union County
- Supported 24 agri-enterprise start-ups and expansions, including
  - KDOB Fishery in Marissa
  - Lau-Nae Winery in Red Bud
  - Grayson Hill Farms in Harrisburg
  - Illinois Aquaculture Cooperative in Pinckneyville

Research Publications and Databases

- Established I-FARRM website, linking farmers, rural residents, and researchers to project findings and resources as well as other relevant research and funding resources (Each I-FARRM project also has its own website.)
- Developed business-plan templates for wineries and vineyards
- Published 24 monographs and fact sheets on specialty corn and soybeans and other alternative and agri-enterprise subjects
- Currently completing publication on Illinois farmland use, price, and profit patterns
- Published four journal articles, four theses/dissertations, and two manuals

Public Education of Farmers and Rural Residents

The RCD-SRI has been extremely active and effective in outreach dissemination. Nearly 3,000 people have participated in the more than 30 workshops and conferences organized by the RCD-SRI. More than 20,000 people have been contacted directly, and more than 15,000 research pieces have been disseminated. The following list includes some of the activities held to achieve the RCD-SRI’s public education and outreach goals:

- Organized numerous conferences and workshops, including
  - Woodford County Value-Added Conference
  - Innovative Approaches to Agriculture Conference in Macomb
  - Aquaculture Opportunities Workshop in Carbondale
  - Fish Cage Workshop in Carbondale
  - Marketing Solutions Workshop
- Delivered 78 I-FARRM public presentations to various organizations, such as
  - Illinois Sustainable Agriculture Society Annual Meeting in Effingham
  - Rural Partners Conference in Springfield
  - Illinois Land and Water Resources Conference
  - Illinois Future Farmers of America
- Participated in six poster sessions, including the C-FAR poster sessions in Springfield
- Responded to more than 3,000 information requests
- Published press releases and articles in AgriNews as well as dozens of other farm-related publications and local newspapers
- Made direct contact with nearly 1,200 people through READI project

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

Please visit www.siu.edu/~i-farrm to learn more about the RCD-SRI program.
The overall objective of the Swine Odor and Waste Management Strategic Research Initiative (SO&WM-SRI) is to support the continued development of an environmentally sustainable, socially acceptable, and economically viable swine industry within Illinois through a broad-based, integrated program of research addressing issues related to swine odor and waste management. By definition, therefore, the ultimate aim of the SRI is to develop and demonstrate practical and economical approaches to solving the problems associated with swine odor and waste for adoption by swine producers within the state.

Research Approach

Swine waste and odor issues are complex and multifaceted; a single approach or technology cannot adequately address these issues. The basic philosophy behind the
An excellent job is being done in the coordination of this research initiative.

The SRI leadership recognizes the role that social scientists play in this very complex issue.

The investment by the State of Illinois in the C-FAR program recognizes the importance of agriculture to the citizens of Illinois.

(Statements from the SO&WM-SRI External Review Team Report, February 2000)

SO&WM-SRI’s approach is that solving these problems requires integrated management involving most, if not all, components of and inputs into the swine production enterprise. Therefore, a multi-disciplinary research team has been established to identify and research the most appropriate solutions for producers in Illinois. The general steps followed for technology development and evaluation are

1. laboratory-based testing and process optimization,
2. prototype development and initial field testing, and
3. full-scale field testing and demonstration.

This logical progression from initial concept, to laboratory-scale validation, to initial practical evaluation on research farms, and finally, to field testing on producer units will ensure that technologies are fully evaluated, both practically and economically, before being promoted to the industry.

Current Efforts

The SO&WM-SRI is currently working with technologies at all stages of development, from laboratory evaluation to farm-based testing and demonstration. For example, a number of sites are being established within Illinois to demonstrate the process of composting swine manure, an approach developed at Illinois State University and funded in part via the SRI. In addition, the SO&WM-SRI has successfully developed unique technologies, such as catalytic converters and wet scrubbers for odor reduction, a number of approaches to removing dust and odor from within buildings, and thermochemical conversion and aerobic thermophilic digestion for waste processing. A number of these approaches are undergoing primary testing and will be moved to farm-scale evaluation in Year 3 of the SRI.

Nutrition research has concentrated on approaches to reducing the phosphorus output from swine units by improving this mineral’s availability in corn- and soybean-based diets. In addition, a screening of potential nutritional approaches to reducing odor has been carried out.

A review of the legislative and legal framework of waste and odor issues in Illinois has been completed, and a comprehensive document laying out this information has been posted on the SRI website. In addition, a review of the source and type of information relating to swine waste and odor issues that is available to the general public has been compiled as a basis for recommending more appropriate approaches to providing communities with unbiased, balanced input.

Computer-simulation models have been constructed to model nutrient and odor emissions from swine facilities as well as for economic comparisons of various approaches to solving the problems. In addition, a primary proving center has been established at the University of Illinois swine units for initial field testing of promising approaches developed within the SO&WM-SRI.

Future Goals

The first two years of SO&WM-SRI research have generated a large volume of results and provided the essential science-based foundation for developing sustainable solutions to waste and odor issues. In addition, many new technologies have been developed and/or evaluated for practical efficacy. In Year 3 of the SRI, major emphasis will be placed on moving technologies to the farm for commercial evaluation and on narrowing the number of technologies under evaluation to focus on those that show the greatest practical and economic feasibility. In addition, increased emphasis will be placed on communicating SO&WM-SRI results to producers as recommendations for reducing nutrient and odor emissions.

The researchers in the SO&WM-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 SO&WM-SRI program.
The Food Safety Strategic Research Initiative (FS-SRI) has the following mission and vision:

To promote multidisciplinary research that leads to the production of safe and healthful foods. Information about food safety will be disseminated through outreach programs, enabling the public to make informed choices about foods for optimal health. Consumers will have confidence that the foods they ingest will be safe and provide health-promoting benefits.

Illinois ranks among the top three states in the nation in incidence of foodborne illnesses. The FS-SRI has undertaken substantial research and outreach activities to ensure safe food production and handling practices. Research and outreach programs help individuals understand and fulfill their responsibilities in order to bring about “food safe” communities. FS-SRI researchers and the Illinois Departments of Public Health and Agriculture are working together on several important initiatives to ensure Illinois citizens’ health and safety in relation to food.

The Food Safety SRI is unique and an excellent model that should be promoted at professional meetings and in state government circles and that should be nominated for awards.

We are very impressed with the multidisciplinary focus of research projects, the accomplishments of projects, and the choice of topic areas.

The degree of partnering and leveraging of funds is impressive.

(Statements from the FS-SRI External Review Team Report, February 2000)

Food Safety

Jeannette Endres, SRI Leader, Southern Illinois University at Carbondale
The following summaries highlight major FS-SRI efforts.

**Pathogen Detection and Epidemiology**

Half of the resources available to this SRI are devoted to pathogen detection and epidemiology research. The outcomes focus on:

- Developing a rapid-acting *Salmonella* test
- Developing microbial inactivation techniques using pulse electric field processing
- Producing a safe food fertilizer from treated swine waste
- Assessing the prevalence of *Campylobacter* and *Salmonella* in poultry
- Identifying hazards and benefits of genetically modified organism (GMO) crops and their potential impact on human food safety
- Applying risk-assessment methodology to the use of feed grade antibiotics in pork production (This research uses an integrated economic framework to include the evaluation of risks to human health as well as economic impact on pork production.)
- Characterizing pathogens that survive on fruits and vegetables

**HACCP (Hazard Analysis Critical Control Point)**

This component focuses on educating and training producers, retailers, and consumers about HACCP principles to help reduce foodborne illnesses through safe food-handling practices.

Major efforts include:

- Organizing HACCP training programs for Illinois’ food service industry
- Developing food-safety training kits and utilizing these throughout Illinois, the United States, and internationally
- Training over 400 food-service operators in the restaurant and long-term-care industries
- Writing model HACCP plans for day cares and schools
- Writing a HACCP program for retail operations
- Developing on-farm strategies for detecting and controlling *Salmonella* with cooperation between veterinary clinical medicine researchers and producers (This project is an example of the unique C-FAR philosophy in practice.)

**Education and Outreach**

This component has emphasized forming partnerships with other state, regional, and national resources to teach all citizens food-safety practices. Efforts have focused on:

- Bringing together producers, physicians, food industry personnel, and other community leaders with the Illinois Department of Agriculture, Illinois and Springfield Departments of Public Health, and the SIU School of Medicine to plan and implement a “Food Safe” community
- Demonstrating the economic benefits of certifying pork products
- Developing an educational interactive kiosk
- Promoting a school curriculum through the *Chicago Tribune*

The researchers involved with the FS-SRI work closely with members of C-FAR’S Human Nutrition and Food Safety Working Group. Please visit [www.ag.uiuc.edu/sri/foods.html](http://www.ag.uiuc.edu/sri/foods.html) to learn more about the FS-SRI program.
Illinois is privileged to have abundant water resources. Use of these waters varies based on a number of factors, such as public vs. private water supply; flood control; fish and wildlife habitat; and recreational, agricultural, industrial, and navigation purposes.

Over three-quarters of Illinois’ land, or 27.8 million acres, is being utilized for agricultural production. The Midwest farm industry has been implicated as a primary contributor to chemical, nutrient, and sediment loads as well as downstream flooding. Under federal Environmental Protection Agency (EPA) requirements, the Illinois EPA has identified streams, rivers, and lakes in some 335 watersheds for which total maximum daily load plans (TMDLs) must be developed.

Water quality is not degraded solely by agricultural practices but by virtually every land use. The sheer domination of agricultural land in Illinois, however, makes agriculture an obvious choice to lead efforts to minimize land use effects on our waters. Furthermore, the individuals and organizations involved in agriculture have proven themselves willing and able to make progressive changes that lessen their impact on the environment when provided with the necessary knowledge and tools. Improvements in water quality in recent years demonstrate this willingness.

Scientific research must provide the data needed to aid development
of appropriate and effective water quality policy. Decision makers and resource managers must understand the dynamics of the systems involved, including the effects of point and nonpoint pollution sources, the fate of pollutants, and source attribution. Temporal and spatial variability and scaling must be determined and addressed in developing regulatory criteria (such as biocriteria, nutrient standards, impairments, hypoxia, and total maximum daily loads). To these ends, WQ-SRI research will offer insights and suggest solutions.

Current discussion of nutrient criteria at the federal and state levels will likely tighten water quality standards and have major impacts on food and agricultural production. New scientific data and improved tools provided through strategic research can ensure that policies and regulations are based on good science.

The FY01 WQ-SRI program supports about 30 projects arranged into three major programs: Development and Evaluation of Best Management Practices, the Fate of Nitrogen on Illinois Farmland, and Development and Application of Farmland and Watershed Simulation Tools.

Development and Evaluation of Best Management Practices

Agricultural best management practices (BMPs) are environment-friendly approaches that can be adopted by farmers. Research is underway to test four such practices with respect to farm economics and watershed ecology.

First, shallow rather than deep installation of tiles is expected to result in less nitrogen loss. Nitrogen that percolates below the level of the tiles remains in the soil where it is available for crop uptake and where it can be returned to the atmosphere as nitrogen gas through microbial action. To maintain effective tile drainage, the tiles must be installed closer together. Field studies are underway to identify conditions under which this practice is cost-effective. As an added advantage, retaining a higher water table can help increase yields in drought years.

Second, the loss of nitrogen in tile-drained fields under different application timing and rates is being examined. The economic implications are also being studied.

Third, the economic effectiveness of variable-rate nitrogen application is being evaluated for a number of different fields across the state. It has been hypothesized that variable-rate application of nutrients in a field can improve overall yields while decreasing field nutrient loss to waterways. This research will add to farmers’ knowledge base, enabling them to address water quality and economic goals simultaneously.

Finally, phosphorus loss under different application and incorporation techniques will be evaluated over several seasons.

Fate of Nitrogen on Illinois Farmland

Illinois farming has recently been implicated in the nitrogen loads in the Mississippi River and in the Gulf of Mexico’s “anoxic zone.” The fate of the nitrogen that farmers apply to Illinois fields is not fully understood. The nitrogen cycle takes the nitrogen through a variety of forms mediated by concentrations of oxygen and the presence and activity of various microorganisms. Researchers would like to understand what part of the nitrogen applied to a field actually reaches the mouth of the Mississippi.

To address this question, a number of projects are examining the rate of change between the different forms in the soil; in the air; in the groundwater; and in streams, rivers, and lakes. This program area focuses on a single watershed where researchers are studying various parts of the nitrogen cycle:

- Nitrogen uptake by plants and loss through harvest
- Development of nitrogen in the soil through new plant biomass
- Addition of fertilizers
- Movement of nitrogen through groundwater
- Loss of nitrogen to the atmosphere through in-stream microbial activity
- Movement of nitrogen through the soil to the water table and into tiles
- Loss of nitrogen through tiles

The goal of this coordinated effort is to accurately characterize the movement of nitrogen, which is fixed by legumes and applied by farmers, into the local ditches and out of the watershed. A final characterization will help improve the development of TMDLs for similar watersheds.

Development and Application of Farmland and Watershed Simulation Tools

Farm and watershed simulation models can be used to predict the direct and indirect consequences of alternative management strategies. The WQ-SRI is supporting the development and testing of models for this purpose at a variety of scales. A statewide model is being developed to test proposed state policies on Illinois’ contribution to Mississippi River nutrient loads. Existing modeling software developed by the U.S. Department of Agriculture and a number of universities is being tested for accuracy in Illinois fields. Existing models are generally weak in their ability to account for how drainage tiles affect nitrogen loss. A number of
projects are testing the ability of current models to account for this loss and are developing new models when necessary. New software developed under the WQ-SRI is being tested for watershed-scale and fieldscale applications.

These modeling efforts address two WQ-SRI objectives. The first is to support the best management practices and the nitrogen-fate programs. Models that are validated through testing can then be reasonably applied to watershed and farm management in Illinois. Second, over the next decade and beyond, Illinois farmers will be involved in the development of watershed-based nutrient management plans, or TMDLs. WQ-SRI-developed and tested simulation tools will help local efforts to apply the best available science to achieve economically, ecologically, and agronomically sensible plans.

Specific research efforts address the following issues:

- Examining optimal crop scheduling for a southern Illinois watershed based on economic and water quality considerations
- Building a decision support system that evaluates the costs and benefits associated with the development of riparian buffer strips
- Developing a watershed-scale simulation model to evaluate Conservation Reserve Enhancement Program (CREP) alternatives with respect to flooding, sedimentation, and nutrient loads in central Illinois watersheds
- Developing a statewide water quality model
- Applying simulation models to predict nutrient loads in an Illinois watershed
- Developing a combined overland, soil, and tile transport model at the field scale
- Developing an integrated ecologic, economic, agronomic, and hydrologic model for watershed management

The researchers involved with the WQ-SRI work closely with members of C-FAR’s Natural Resources Working Group.

Please visit [http://web.aces.uiuc.edu/sriwq](http://web.aces.uiuc.edu/sriwq) to learn more about the WQ-SRI program.
Introduced in 1999, the C-FAR Sentinel Program at the University of Illinois at Urbana-Champaign was developed to fund creative, problem-solving research projects that would be unlikely to secure funding through traditional channels. "The program was initiated to take advantage of windows of opportunity to do research that addresses C-FAR priorities," said Steven Pueppke, associate dean for research at the College of Agricultural, Consumer and Environmental Sciences (ACES).

The Sentinel Program is the third component of the University of Illinois C-FAR research portfolio. It complements and extends the research efforts of the other two components: the internal competitive grants program and the Strategic Research Initiatives (SRIs). Research projects are multi-investigator and multi-departmental, with most crossing college boundaries and bringing together investigators from a variety of disciplines. Sentinel Program awards range from $50,000 to $500,000 per year for up to five years.
Crop Rotation Collapses as a Pest Management Tool for Western Corn Rootworms: In Search of a Solution

**Principal Investigators**

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Mark Band, Keck Center for Comparative and Functional Genomics  
Scott A. Isard, Department of Geography  
Eli Levine, Center for Economic Entomology, Illinois Natural History Survey  
Harris Lewin, Biotechnology Center and Keck Center for Comparative and Functional Genomics  
Lei Liu, Keck Center for Comparative and Functional Genomics  
Paul Mitchell, Texas A&M University  
David W. Onstad, Department of Natural Resources and Environmental Sciences  
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Susan T. Ratcliffe, Department of Crop Sciences  
Hugh Robertson, Department of Entomology  
Joseph L. Spencer, Center for Economic Entomology, Illinois Natural History Survey

This three-year integrated, multi-disciplinary research effort focuses on solving a new threat posed by the western corn rootworm variants that can feed on soybean: loss of crop rotation as a pest management strategy. Researchers with specialties in crop sciences, ecology, entomology, genomics, and geography are working together to solve this critical problem. Their research efforts could eventually result in up to $500 million in savings for producers across the Corn Belt.

Restoring crop rotation as an approach to managing western corn rootworm is a key goal of this research effort, but researchers also hope to integrate a variety of tactics for controlling this pest. The team will research mechanisms behind behavioral change to better understand why and how this western corn rootworm variant evolved. They also will study diet, flight, and behaviors that might provide insight into pest monitoring and management recommendations. Additional goals are to develop (1) genetic diagnostic tools, (2) models for predicting spread and effectiveness of long-term strategies, and (3) transgenic corn rootworm hybrids and management practices to prevent resistance from developing. Researchers estimate that producers could realize an annual potential profit of more than $273 million by using transgenic corn rootworm hybrids to prevent corn rootworm larval injury.
SoyFACE

Principal Investigators
Stephen Long, Department of Crop Sciences
Donald Ort, USDA and Department of Crop Sciences
Evan DeLucia, Department of Plant Biology and Department of Natural Resources and Environmental Sciences

Atmospheric change is a growing concern for Illinois agriculture. If the current rate of increase holds, by 2050 Illinois’ atmosphere will contain 50% more carbon dioxide than it does today. Also of concern are the peak ozone levels in Illinois; they currently are estimated to decrease soybean yield by 20%, and peak levels are expected to be reached more frequently in the future. As carbon dioxide and ozone levels increase, soybean quality is expected to decrease (particularly protein content and possibly flavonoids), and nitrogen and water uptake is anticipated to decrease, thus threatening increased water pollution.

SoyFACE, a five-year Sentinel project that received initial funding in FY00, explores how atmospheric change affects major crops, providing information that will help us prepare our crops and crop systems for the future. With an open-air field laboratory design, researchers will be able to closely simulate future atmospheric conditions, including increased carbon dioxide levels and ozone conditions. Located at University of Illinois South Farms, the FACE (free-air gas concentration enrichment) research structure includes a series of rings created by tubing that delivers precise amounts of carbon dioxide and ozone to simulate different environmental conditions of the future. A computer monitors gas concentration and wind direction and velocity to control the amount of carbon dioxide and ozone released through a series of valves.

This facility is the first of its type and is expected to attract scientists from around the world. A prototype is undergoing preliminary testing and system fine-tuning, with four FACE rings expected to initiate experiments in the spring of 2001. SoyFACE will eventually consist of 20 FACE rings, each 70 feet in diameter. A team of 18 investigators with expertise in plant biology; crop management; and food, animal, and environmental sciences has been assembled to study how atmospheric changes affect crops and soil conditions and how to optimize future crop production. Researchers will work to develop new cultivars and cultural practices that will help position Illinois agriculture well for the next several decades.
Developing an Agricultural Remote Sensing Program at University of Illinois

**Principal Investigators**

Lei Tian, Department of Agricultural Engineering

Donald Bullock, Department of Crop Sciences

James Westervelt, Department of Agricultural and Consumer Economics

Emerging technologies for global positioning systems (GPS) and electronic-based geographical information systems (GIS) create a unique opportunity for utilizing remote sensing information in site-specific management of crops, forests, and other natural resources. In FY01 a new Sentinel research project was established to capitalize on these new technologies and establish an interdisciplinary program of remote sensing-based precision farming technology. This project’s investigators are cooperating with NASA researchers to develop new generation remote sensing-based tools and procedures for mapping within-field variability in order to prepare site-specific management options for large-scale productions.

Researchers will focus on developing and evaluating automatic ground-based sensing systems to (1) increase field data quality and complement the remote sensing system in tool validation research; (2) collect and share multilocation, multilayer data; and (3) set up a knowledge discovery in databases (KDD) environment for remote sensing-based, site-specific management studies. Coordinating efforts with University of Illinois Extension, researchers will assess the needs of Illinois agriculture, target research to address these needs, and work with Illinois producers and other end users to incorporate remote sensing technologies into their production systems. This C-FAR investment will enable researchers to be competitive for NASA and other federal funds.
FY01 Sentinel Projects

The Sentinel Program seeks to generate maximum impact from the C-FAR investment. As Steven Pueppke noted, “Ultimately, we want to solve targeted problems, but we also want to develop the capacity to address future research needs and leverage C-FAR dollars.” To facilitate these efforts, the Sentinel Program is funding five additional projects in FY01:

Soy Foods Center (Klein, Cadwallader, and others): This will be a world-class center that takes advantage of the health claim for consumption of soy, thereby increasing soy use in food.

Genotyping Center (Diers and Nelson): This will be a “biotech” laboratory focused on sorting out the genetic basis of economically important traits in Illinois crops. The center will allow for the development of new germplasm and varieties with traits that add value.

Illinois Agricultural Policy Center (Hauser and others): Faculty members will focus on analyzing the policy implications of the new farm bill and informing agricultural leaders of these implications. This effort may ultimately help create a farm bill that meets the needs of Illinois.

Profitability of Illinois Dairy Farms (Dahl and others): This is an outreach-oriented program to assist Illinois farmers in adopting practices that make dairy more profitable in the state.

Soybean Aphid (Onstad): Special funding for one year will support research on the soybean aphid to determine whether this insect poses any threat to Illinois soybean crops. This pest first appeared in the state in the summer of 2000.

Transgenic Swine Program

Principal Investigators
Matthew B. Wheeler, Department of Animal Sciences
Sharon M. Donovan, Department of Food Science and Human Nutrition
Walter L. Hurley, Department of Animal Sciences

Genetic engineering of plants and animals has been practiced for hundreds of years through selecting high-producing seed crops and livestock. However, recent advances in biotechnology provide unique opportunities that further our ability to efficiently produce cost-effective, high-quality food for human consumption. Transgenic technology, or the introduction of specific genes from one species into the germplasm of another, allows for the rapid and efficient introduction of value-added characteristics into livestock, including swine.

The Transgenic Swine Program, a new Sentinel project with initial funding in FY01, focuses on three primary goals: (1) to provide the infrastructure required to maintain existing lines of transgenic swine and to support the research necessary to obtain regulatory approval of these animals for human consumption by the Food and Drug Administration (FDA); (2) to support the development of accurate and precise analytical methods necessary to characterize the lines; and (3) to develop new lines of transgenic swine with improved productivity and health. Researchers will use a novel approach that focuses on transgenes directed towards the mammary gland or intestinal mucosa. An advantage of this approach is that both milk production and intestinal nutrient delivery have been identified as constraints on optimal piglet growth, and the mammary gland and gastrointestinal tract can therefore be used to improve piglet production. Furthermore, as neither mammary tissue nor intestinal mucosa are normally consumed by humans, this approach will bypass several potential regulatory hurdles associated with the FDA’s safety approval of the resulting lines of transgenic animals for human consumption.
C-FAR research projects, excluding the SRIs, are usually funded for one or two years. Funding is based on a fiscal year that runs from July 1 through June 30. The primary focus of these projects is to provide valuable outcomes that can be immediately utilized by the Illinois food and agriculture community and consumers. Dissemination and outreach efforts are highly encouraged.

In accordance with the enabling legislation, the majority of C-FAR 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 C-FAR.

To encourage and support research efforts from state agencies and organizations outside of the four universities, an external competitive grants 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.

The following sections provide a report on the internal and external research projects that were completed in 2000, as well as a listing of the research projects that were funded for FY01. Please visit the C-FAR website at http://web.aces.uiuc.edu/c-far/cfarreporting/public.cfm for more information about these projects.
Identifying and Segregating the Added Value Resulting from Trait-Specific Corn

The rapid introduction and acceptance of high-oil corn (HOC) and Roundup Ready soybeans have demonstrated the seed industry’s emerging traditional and transgenic plant breeding capability. Advances in this area have enabled seed producers to provide the food and agriculture system with trait-specific crops. Net farm income, and thus the economies of rural communities, will be enhanced to the degree that farmers become positioned to capture values generated by trait-specific crops. This investigation combined development and expansion of a near-infrared reflectance (NIR) analysis model of HOC with an analysis of perceptions about trait-specific crops held by food and agriculture system stakeholders. The research yielded an applied NIR analysis HOC model and helped identify factors that impede farm-level capture of the added values attributable to trait-specific crops.

A C-FAR External Competitive Grants project
Dennis R. Thompson, Steve W. Mbuvi, Illinois Crop Improvement Association, Inc.

Development of Added Value Low-Phytate, High-Oil Corn Hybrids

A major disadvantage of corn used in swine and poultry diets is that the grain contains high levels of phytate, a phosphorus-containing compound that nonruminants cannot digest. As a result, animals fed these grains excrete high levels of phosphorus that ultimately contaminates Illinois water supplies. Researchers have isolated a single recessive gene that reduces phytate levels in grain by 50 to 60%. The goal of this research is to use the gene to develop high-oil, low-phytate corn hybrids that will both increase feed efficiency and reduce phytate.

Researchers developed four corn hybrids for use in a chick-feed experiment: normal corn; high-oil corn; low-phytate corn; and high-oil, low-phytate corn. Chicks fed each of the four hybrid types gained significantly more weight than control chicks fed a standard basal diet. Chicks fed the low-phytate corn diet had the greatest weight gains. This research benefits corn producers by adding value (approximately $.40 per bushel) to their product. It also benefits the people of Illinois by reducing phosphorus excretions that contaminate water supplies.

A C-FAR External Competitive Grants project
Robert J. Lambert, Crop Sciences
David A. Baker, Animal Sciences
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

The “Quick Fiber” Process to Enhance Dry-Grind Ethanol Profitability

The purpose of this research was to design a process for recovering coarse fiber from a mash following germ recovery (i.e., the “Quick Germ” process). Researchers sought to evaluate how temperature, specific gravity of the liquid, and amount of residual germ affected fiber recovery and fiber purity. Research showed that the fiber can be collected with the germ by increasing the specific gravity of the process water at the germ cyclones. After drying, the germ can be separated from the fiber. When the germ is removed first, the amount of coarse fiber and the purity of the fiber vary based on soak time, temperature, and specific gravity. However, the effect was not significant over the range of parameters likely to be used.

A C-FAR External Competitive Grants project
Steven R. Eckhoff, Agricultural Engineering
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign
Developing Strategies to Manage the New Western Corn Rootworm Strain in Illinois

This project’s specific research objectives were to (1) monitor and forecast the spread of the new western corn rootworm strain within Illinois and across the Corn Belt, thus providing producers and government agencies with the data necessary to make informed pest management decisions; (2) identify the behavioral and physiological differences between the old and new western corn rootworm strains as the basis for developing novel pest management strategies; and (3) test promising management tactics for their utility in preventing and reducing economic damage by western corn rootworms in rotated cornfields.

Annual statewide sampling efforts revealed significant variations in the density of adult western corn rootworms among soybean fields and also confirmed the slow spread of the new western corn rootworm strain into northern Illinois. A computer model based on sampling data predicts continued northeastern spread of this new western corn rootworm strain, demonstrating that rotation-resistant western corn rootworms are not just an Illinois phenomenon but constitute a growing regional threat. In addition, researchers discovered that other crops, such as alfalfa and oats, are just as susceptible to soybeans to egg-laying by western corn rootworm females. Thus, restoring the utility of crop rotation as a pest management tool will require more complex and long-term rotations. On-farm experiments conducted in Iroquois County demonstrated that corn was not abandoned as an egg-laying site in east-central Illinois. In fact, late-planted corn appears to be a competitive egg-laying “sink” with soybean fields. This finding suggests that crop phenology is an important cue in the egg-laying behavior of this new western corn rootworm strain.

In other experiments, researchers determined that the number of adult western corn rootworms differed significantly among 31 standard and exotic soybean cultivars, indicating that soybean cultivar characteristics may reduce western corn rootworm abundance and egg-laying in certain fields. Another set of experiments revealed that western corn rootworm adults that consume soybean foliage become “agitiated” and are more likely to fly than those that eat corn tissue. This finding helps to explain the daily movement between corn, soybeans, and other crops during the growing season. By furthering their understanding of western corn rootworms’ complex behavioral adaptation to crop rotation, researchers will position themselves to develop novel strategies that may ultimately restore the utility of crop rotation as a pest management tool.

Michael E. Gray, Randall L. Nelson, Crop Sciences
David W. Onstad, Natural Resources and Environmental Sciences
College of Agricultural, Consumer and Environmental Sciences
Scott A. Isard, Geography
May R. Berenbaum, Entomology
College of Liberal Arts and Sciences
University of Illinois at Urbana-Champaign
Eli Levine, Joseph L. Spencer, Center for Economic Entomology
Illinois Natural History Survey

Evaluating Drying Effects Upon Corn Quality

The objectives of this research are to (1) develop a laboratory dryer that can separately dry multiple lots of corn at the same time, (2) test the dryer and validate uniformity of airflow and air temperature, and (3) use the dryer to evaluate how drying temperature affects milling quality for a large number of corn hybrids.

To date, researchers have developed a dryer and dried several samples, and they are currently analyzing the samples. The goal of this project is to develop a dryer design that provides corn-producing seed companies with a method for uniformly drying a large number of screening samples in their hybrid development process. Researchers will demonstrate the utility of this project by drying up to 30 hybrids submitted by seed companies and determining how drying temperature affects milling quality for each hybrid. This screening procedure will benefit companies that produce seed corn by enabling them to develop improved corn hybrids. The corn industry as a whole will also benefit as corn producers grow these improved hybrids. It is estimated that better hybrid screening can improve corn starch yields by 2 to 3% and thus increase the value of corn by $.10 to $.20 per bushel. The long-term effect of this research will be to increase the value of corn produced in Illinois, which may result in higher prices paid to corn producers while maintaining low food costs for Illinois consumers.
Control of Stewart’s Wilt on Sweet Corn with New Sources of Resistance

The objective of this project was to improve the control of Stewart’s wilt (Erwinia stewartii) on sweet corn. Particular emphasis was placed on using new sources of host resistance and controlling main-stalk death resulting from infection prior to the 2-leaf stage.

Researchers identified 36 maize accessions that are more resistant to Erwinia stewartii than currently grown commercial sweet corn hybrids. Further breeding studies were performed on 11 hybrids with superior resistance. Resistance to systemic infection was demonstrated to be effective at about the 3-leaf growth stage. Prior to the 3-leaf stage, newly developed seed treatment insecticides provided the best control. Based on efficacy data from this project, the U.S. Environmental Protection Agency granted a section 18 approval for use of the seed treatment insecticide Gauchito (imidacloprid) on sweet corn in 12 states in 2000 and in 13 states in 2001. Another seed treatment insecticide, Adage (thiamethoxam), which is equivalent to the imidacloprid used in this project, was recently approved for use on corn as well. In 17 trials at 15 locations in Illinois in 1998 and 1999, seed treatment insecticides reduced systemic Stewart’s wilt by 50 to 80%. According to integrated pest management officials in Illinois’ sweet corn processing industry, all processing sweet corn planted in Illinois in 2000 was treated with Gauchito. This new method of controlling Stewart’s wilt prevented yield losses of more than $1.8 million in Illinois in 2000. The benefit of these new controls was substantially greater in New York where Stewart’s wilt was significantly more severe in 2000 than in Illinois.

Influence of Weed Competition Duration on Corn Yield

The development of transgenic corn hybrids tolerant of postemergence herbicides has allowed corn growers the flexibility of using a total postemergence herbicide program for weed control. This approach allows weeds to grow with the crop for an unspecified period early in the growing season. This project focuses on how early-season weed competition affects soil moisture, plant nitrogen level, and final grain yield.

In this study, researchers applied a single postemergence glyphosate treatment to glyphosate-resistant corn at different stages of weed-resistance. The application was made at each site when the tallest weed species present was either 2, 4, 6, 9, or 12 inches high. After this application, weeds were allowed to reinfest plots. Researchers then sampled each site for soil moisture, nitrogen levels, and grain yields, finding the following:

- Just before the herbicide application, the percent volumetric water content in the upper 12 inches of the soil profile was determined. At one of five sites, soil moisture in weedy vs. weed-free plots was statistically equivalent. At the 12-inch site, however, the soil moisture in weedy-free plots was slightly higher than that in weedy plots.
- Corn and weed tissue was sampled for nitrogen content just before the herbicide application. Corn growing in weed-free conditions had significantly greater nitrogen content than corn growing in weedy conditions at the 9- and 12-inch sites. At the 12-inch site, weeds contained more than 55 lbs nitrogen per acre.
- The height at which weed control minimized yield losses was site-dependent. An average of the findings across all sites indicates that weeds should be controlled before they are 6 inches high to avoid yield losses. Results also indicate that it is possible to make a single glyphosate application too early. Glyphosate application to 2-inch weeds resulted in reduced yields at one of five sites due to a significant weed reinfestation.

Because corn yield reductions from early-season weed competition...
vary widely it is difficult to set a specific timing guideline for weed control that applies to all species across all locations and years. This research demonstrates that while competition for soil moisture may contribute to yield losses resulting from early-season weed competition, competition for available nitrogen appears to be of greater importance. The window for making a single postemergence glyphosate application in glyphosate-resistant corn and avoiding any potential yield loss seems very narrow. This information may provide a rationale for using soil-applied or residual herbicides in conjunction with glyphosate in glyphosate-resistant corn. It also provides evidence that sequential postemergence applications may be needed in some cases.

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The Use of Transgenic Corn for Control of Ear Rot and Mycotoxins

This project examined whether transgenic corn hybrids could be used to control ear rot and mycotoxin contamination of corn grain. Researchers successfully used bean chitinase and corn alpha-glucanase genes, either alone or in combination, to produce 18 independently transformed plants. These transformed plants were then evaluated in the field for resistance to Aspergillus ear rot and aflatoxin production than H99 or Pa91. These research findings suggest that chitinase and ß-1, 3-glucanase are not mechanisms for resistance to Fusarium ear rot and fumonisin production. However, other chitinases or ß-glucanases, possibly with different promoters, do have the potential to effectively control Aspergillus ear rot and aflatoxin production.

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Nutritional Quality of Transgenic Corn

Corn requires large quantities of nitrogen in the form of chemical fertilizers or organic manures to achieve economically optimal yields. Unfortunately, from 5 to 40% of the nitrogen applied to corn is not used by the plant and may be converted to nitrates, a form of nitrogen that poses a threat to water quality. A potential solution to this problem is to alter corn’s nitrogen metabolism so that it removes nitrogen more efficiently from the soil and incorporates it into amino acids useful to the plant. If present in sufficient quantity, these amino acids could also change the profile of other corn-plant nutrients and greatly increase corn’s value as livestock feed, human food, or a processing ingredient. A gene (gdhA) that is involved in nitrogen metabolism has been successfully isolated from E. coli and added to the genome of corn. This gene enables the corn plant to take more nitrogen from the soil and convert it into amino acids. This gene also allows nitrogen to accumulate in the corn plant in a nonenergy-dependent manner, thus improving nitrogen uptake and possibly altering the nutrient composition (particularly starch components) of the corn plant. The goals of this research were to modify an in vitro assay to (1) estimate protein and starch digestibility in monogastrics using several inbred and hybrid corn lines, (2) measure and screen several inbred and hybrid corn lines for digestibility, and (3) conduct a digestibility trial in swine to estimate nutrient availability.
An in vitro assay system for evaluating crude protein and starch digestibility in monogastrics has been utilized to evaluate several inbred and hybrid corn lines for digestibility. The transgene did not influence either crude protein digestibility or in vitro starch digestibility. Presence of the transgene did not influence resistant starch, percentage starch, total glucose, free glucose, or glucose released after 120 minutes of digestion. While researchers documented significant location effects, these effects are not uncommon in field growth trials. Crude protein percentage did not vary between the control and transgenic corn, but amino acid content may have been altered. Approximately 2,000 lbs of gdhA-positive and gdhA-negative corn were harvested during 2000. Samples have been sent for amino acid analysis to enable ration formulation. The digestibility study is expected to begin in the spring of 2001 using swine fitted with steered ileocecal cannulas (small flexible tubes inserted into the cecum that allow the food particles present at the end of the small intestine to be collected directly). The adoption of this transgene could have substantial impact on corn price and utilization, especially in relation to its use as animal feed. Given that 1.45 billion bushels of Illinois corn are used for livestock feed each year, transgenic corn could increase the value of Illinois corn by $305 million annually.

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100 Generations of Selection for Oil and Protein in Corn—What Happened?

The long-term goal of this research is to add genetic value to the Illinois corn crop. The long-term objectives of the project are to (1) develop corn germplasm with unique levels of protein and oil concentration in the grain, (2) determine the limits to selection for oil and protein in the corn kernel, and (3) determine whether genetic variability for these traits can be exhausted. To attain these objectives, researchers are working with germplasm that has been selected for 100 years for oil or protein concentration in the grain. This project was aimed at developing processes that would allow researchers to evaluate genetic progress over the last 35 generations of selection. The primary outcomes and impact of this research will come during the next phase, which includes running evaluation trials on the last 35 generations. These tests will be part of a new C-FAR project slated to begin in July 2001.

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Processing and Structural Characterization of Zein-Based Films

The long-term goal of this research is to increase the use of corn products. This project focused on zein, a major corn protein that is abundant in coproducts of ethanol manufacture. Previous research determined the feasibility of producing zein-based biodegradable, flexible films that are potentially useful in food packaging. The research objective was to investigate the effect of film conversion processes, such as fusion lamination and coating, on water resistance and gas permeability of zein films.

Researchers formed zein films by using oleic acid to plasticize zein. Plasticized zein films were highly permeable to moisture and gases. The first objective of this research was to investigate how lamination and coating affected the permeability of films. Zein films were laminated in a Carver press (a commonly used laboratory press) and coated with tung oil or linseed oil. Laminated films were clearer, tougher, more flexible, and had a smoother finish than nontreated sheets. Fusion lamination decreased gas permeability of zein films, but it had no major effect on moisture permeability. Coating films with drying oils reduced water vapor permeability. Coatings also affected the film’s tensile properties by acting as a composite layer, preventing crack propagation, and increasing film strength. Zein films were suggested for modified atmosphere packaging (MAP). MAP is increasingly used with minimally processed produce. Increased MAP usage coupled with environmental concerns have created a need for biodegradable films. The second research objective was to evaluate how well treated zein films performed as MAP for fresh broccoli. Zein films, as well as polyethylene

ZEIN FILM FILLS A NEED FOR BIODEGRADABLE PACKAGING.
film, allowed the development of modified atmospheres inside packaged broccoli florets stored at refrigeration temperatures. Broccoli florets maintained their original firmness and color after refrigerated storage. Zein films prepared using the process developed through this research are potentially useful as MAP films for fresh produce.

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Enhanced Production by Increasing Level of Disease Resistance in Soybeans

The objective of this research was to evaluate whether antifungal protein genes and other plant defense genes could effectively inhibit growth and pathogenesis of various soybean fungal diseases, including sclerotinia white mold, brown stem rot, sudden death syndrome, phomopsis, and others.

Using Agrobacterium rhizogenes, researchers introduced constructs carrying various antifungal genes and plant defense genes into soybean cotyledons. Several transgenic hairy root cultures carrying these genes were then used for in vitro inoculations with various fungal pathogens of soybean. Results indicate that several of these antifungal genes significantly inhibit growth and proliferation of various fungal pathogens, including Fusarium solani, Macrophomina phaseolina, Phytophthora sojae, and Rhizoctonia solani. These inoculation experiments were replicated three times, and the whole experiment was repeated over time. These encouraging results suggest that developing soybean lines carrying some of these antifungal protein genes should lead to the selection of disease-resistant soybean lines.

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Enhancement of Soybean Inoculation for Maximizing Yields

The intent of this research is to (1) block or reduce the infection and nodulation of soybean roots by native (soil) bradyrhizobia via the presence of antagonistic organisms (Streptomyces), and (2) induce infection and nodulation of soybean roots by developed strains of Bradyrhizobium japonicum efficient in nitrogen fixation and resistant to the antibiotics that inhibit the native bradyrhizobia. These developed strains will have a competitive advantage over the native bradyrhizobia, resulting in enhanced nodulation by the desired inoculum and a potential increase in nitrogen fixation and yield.

Two mutant strains (out of 90) of B. japonicum that are both resistant to kanamycin and neomycin and competent in soybean nodulation and nitrogen fixation were characterized for competition studies. When used with Streptomyces kanamyceticus as co-inoculants for soybean in a greenhouse soil-pot study, nodule occupancy of 45 to 55% was achieved, and a significant increase in shoot nitrogen content (22 to 25% over the noninoculated control) was identified. These results show that a desired strain of B. japonicum will successfully nodulate soybean when complemented with a co-inoculant strain. The potential impact for the soybean producer is an increase in yield and seed nitrogen content. Continued development of this project may result in an economic benefit of $20 to $35 per bushel of soybean.

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Soil Properties and SDS Development

Researchers sought to compare the development of soybean sudden death syndrome (SDS) under controlled soil temperature and moisture conditions. In total, 48 intact surface soil cores (15 cm in diameter and 30 cm in depth) were collected from the Agronomy Research Center in Area 22A, which was known to have SDS disease in the 1997 growing season. A greenhouse study was conducted on these soil samples at two different moisture contents under two different temperature conditions (22°C and 27°C). Soil cores were housed in temperature-controlled water baths.
both lateral and tap roots was significantly greater when soil temperature was 20ºC as opposed to 27ºC. Soil moisture alone had no significant effect on root infection.

Understanding the factors that relate to SDS makes it possible to correct some of the soil and environmental conditions that are favorable to the disease. Actions could include increasing soil macroporosity or decompacting compact soil layers and providing better surface and internal drainage of the soil profile. It is estimated that every 10% decrease in the SDS disease index will increase soybean yield by approximately 7%.

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Study on Mechanisms of Toxin Tolerance to Sudden Death Syndrome (SDS) in Soybean Cultivars

Soybean sudden death syndrome (SDS) is an increasing problem. In 1998, it was estimated that Illinois would lose $60 million in soybeans to the disease. Research goals of this project were to (1) learn more about the physiological process of infection and SDS toxin metabolism and detoxification, and (2) determine whether it is possible to select enzymatic activities that might improve resistance levels. Researchers tested six different enzymes that may be related to resistance: CoA lyase, glucose-6-phosphate dehydrogenase, hydrogenperoxide lyase, phenylalanine ammonia lyase, polyphenol oxidase, and t-cinnimic acid 4-hydrolyase.

Test results were sufficiently variable that researchers could not make conclusive statements about enzymatic processes related to SDS resistance or susceptibility in soybeans. Researchers need to conduct additional studies that involve increasing inoculum concentration, sampling roots at later times, sampling roots seasonally, and using different inoculation methods that would minimize root damage. The primary impacts of this research have been to improve research methodology, encourage adoption of more environmental control for the experiments (e.g., use of growth chambers), and encourage use of RNA differential displays for identifying more appropriate enzyme(s) for comparative study.

A C-FAR External Competitive Grants project

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Improving Soybean Health Using Fungal Endophytes

Fungal endophytes are fungi found inside healthy aerial plant tissue. These endophytes do not cause overt symptoms in or apparent injury to the host. This research project involved detecting the occurrence of endophytes in soybean plants in Illinois and adjacent states and testing for beneficial interactions of endophytes with the pathogen *Phialophora gregata*, which causes brown stem rot.

Researchers isolated soybean endophytes in almost every soybean field that was sampled. Furthermore, testing demonstrated that select strains of soybean endophytes improve soybean health and increase soybean resistance to the brown stem rot disease. Brown stem rot disease causes 9 to 44% of soybean yield loss in the north-central United States; therefore, reducing occurrence of the disease will significantly benefit soybean growers.

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Biodegradable Polymers from Soy Oil and Soy Molasses

Soy molasses is an extremely low-market-value by-product of soy milling. Currently, polyhydroxyalkanoates (PHAs) produced from corn syrup sell for about $14 per pound. At this rate, they cannot compete with petroleum-based plastics in the general plastics market. In contrast, because demand for soy molasses is currently so low, a soy molasses–based PHA production system could approach the unit costs of petroleum-based plastics and, in the process, create a significant new market for Illinois soybeans. Increasing availability of inexpensive PHAs would benefit consumers and the environment by putting more biodegradable plastic products in the marketplace. The long-term objective of this research is to develop a com-
mmercial production system for bio-
degradable polymers using Illinois agricultural products as feedstocks for the fermentation. Specific objectives are to (1) isolate naturally occurring bacteria that can convert soy molasses trisaccharides into biodegradable polymers at high yield, and (2) screen the isolates for polymer production from other common sugars and agricultural products.

Researchers used enrichment culture methods to isolate trisaccharide-degrading bacteria from soybean and other soils and aquatic environments using raffinose as enrichment substrate. Sixteen strains of aerobic raffinose-degrading bacteria were isolated and screened for their ability to convert raffinose into poly-
hydroxybutyrate and related alkanoates. A major limitation to the commercial production of readily bio-
degradable PHAs has been the lack of inexpensive feedstocks that can compete with conventional thermal plastics made from oil. The carbohydrates in soy molasses may fill this void, and this research to find suitable converting organisms is the first step toward a future soy molasses-to-PHA bacterial fermentation. Such a fermentation would increase the demand and market value for soybeans, specifically soy molasses.

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 wheat disease that significantly reduces wheat yield and quality in Illinois and many other wheat-producing states. Scab causes notable yield losses, lower test weight, reduced grain quality, and reduced milling yield. The fungus also produces mycotoxins that are detrimental to both humans and livestock. Long-term objectives of this project are to (1) develop soft red winter wheat varieties that combine resistance to scab with resistance to other diseases, high yield potential, acceptable milling and baking quality, and acceptable winter hardiness; and (2) develop molecular markers associated with genes for scab resistance that can be used for marker-assisted selection.

Researchers established effective phenotypic evaluation techniques for use in the greenhouse and the field, made several hundred crosses with scab resistance sources, evaluated many breeding lines, and identified a number of lines with scab resistance. Researchers also made significant progress in developing molecular markers for scab resistance genes. Combining scab resistance with all of the other traits necessary for an adapted variety will require additional crosses and phenotypic evaluations. Development of user-friendly molecular markers will improve the efficiency of selection for scab resistance and will benefit breeding programs working to produce scab-resistant wheat varieties.

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Alteration of Oilseed Lipid, Protein, and Carbohydrate Using Antisense Technology

Oilseeds vary dramatically in their content of carbohydrates, lipid, and protein. Lipid content ranges from 2% in plants such as Gramineae to over 50% in oil palm. A long-standing question in the field of seed biology concerns the mechanisms that cause this diversity. How is photosynthate that enters the developing seed partitioned between the pathways of lipid, protein, and carbohydrate biosynthesis? Since these reserves are an important nutritional component of human and animal diets, determining the factors that control photosynthate partitioning is critical to manipulating these pathways in order to enhance nutritional quality. The major objectives of this proposal were to (1) alter plant fatty acid biosynthesis in *Arabidopsis thaliana*, a weed that is a member of the *Brassica* (mustard) family; and (2) determine how these alterations affect carbohydrate, lipid, and protein levels. Researchers hypothesized that as photosynthate was directed away from one of the major storage components, such as lipid, it would be redirected into one or both of the others (carbohydrate and/or protein).

Researchers generated transgenic plants containing various constructs designed to alter expression of different acyl carrier protein (ACP) isoforms. The primary focus of this project has been to characterize one set of transgenic plants that contains significantly increased levels of a

BACTERIAL FERMENTATION MAY BOOST SOY MOLASSES MARKET VALUE.
seed-specific ACP isoform in leaf tissue. By altering leaf tissue so that it contains a seed ACP isoform, researchers have also influenced the plant’s fatty acid composition. This finding is the first in vivo evidence that ACP isoforms actually influence fatty acid composition. To explain this phenomenon, researchers are exploring structural information about ACP. The transgenic experiments suggest that segments of the promoter of this ACP isoform play a significant role in determining tissue-specific expression. Researchers are attempting to learn more about what controls tissue specificity by further characterizing this promoter. This research involves additional transgenic plant development with various promoter segments inserted driving beta-glucuronidase (GUS) expression. Analysis of these transgenic plants is underway. Researchers have generated other transgenic plants with different ACP isoform profiles as well. One promising set of plants demonstrates antisense reduction of ACP-2 isoform and reduced levels of oil in the seed (by approximately 15%). Additional independently transformed plants are being generated and homozygotes are being selected. Carbohydrate and protein analyses are also being conducted. This basic work will benefit the scientific community by furthering the understanding of how to regulate fatty acid biosynthesis. Consumers will benefit as transgenic plant development yields more desirable oilseeds for the marketplace. Finally, food processors may benefit from the development of technology that reduces oil biosynthesis directly so that they do not have to remove excess oil in processing.

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“Smart Sprayer” Expert System for Site-Specific Weed Management

The purpose of this project was to develop new decision-making software and a control system for the existing “smart sprayer” system. This research integrated a real-time machine vision sensing system and individual-nozzle controlling device with a commercial map-driven-ready herbicide sprayer to create an intelligent sensing and spraying system. A “smart sprayer” has been developed and tested for real-time selective herbicide application in corn and soybean fields. The weed sensing system estimates weed size and population as functions of position in the field, and the variable-rate herbicide delivery system is controlled to change the local dosage based on the current field conditions. The machine vision system was specially designed to work under outdoor variable lighting conditions. Multiple vision sensors were used to cover the target area. Instead of trying to identify each individual plant in the field, weed infestation conditions in each control (or management) zone were detected. To increase the delivery accuracy, each individual spray nozzle was controlled separately. The integrated system was tested to evaluate the effectiveness and performance under varying commercial field conditions. Using the onboard differential global positioning system, geo-referenced chemical input maps (equivalent to weed maps) were also recorded in real time. The maps generated using this system have been compared with other sensing and referencing systems.

Field experiments were conducted in large plots in 1999 and 2000 to evaluate the machine vision–controlled precision sprayer. Experiments were carried out in multiple fields and under normal Illinois commercial farming conditions. Field experiments showed that selective and variable-rate herbicide application methods had advantages over the uniform application method. Using a variable–application-rates algorithm, herbicide savings from comparing on/off and variable-rate applications with uniform application are 51 (single) to 72% (4-level), where the single (economical) threshold for on/off application was set at a weed density of 1% and the variable rate was set to four different levels: 10, 33, 66, and 100% of the label recommendations.

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Study of Glyphosate (Roundup) Resistance Mechanisms

The herbicide Roundup is in widespread use around the world. It is used on over half of the soybean acres in Illinois, and the development of Roundup-resistant corn will further increase usage. Thus, it is important to prevent development of Roundup-resistant weeds that would decrease the herbicide’s effectiveness. To this
end, researchers conducted studies to determine how easy it is to obtain plants and plant cell cultures that are resistant to Roundup. This project enabled researchers to determine whether resistance can be obtained, how frequently resistance occurs, and what mechanisms cause resistance.

Researchers performed several studies on the model plant *Arabidopsis*. They did not find any resistant plants upon testing 780,000 mutagenized seedlings grown in petri plates with Roundup. They also found no resistance when plants growing in soil were sprayed with a relatively low herbicide rate that did not completely kill the plants. The small amount of seed produced by the survivors of the sprayed plants was grown and sprayed again so that a total of eight cycles of recurrent selection occurred. These plants did not become more resistant over time. Different *Arabidopsis* populations collected from different places around the world demonstrated some variation in resistance.

When cell cultures of *Arabidopsis*, *Datura innoxia* (a relative of jimson weed), tobacco, carrot, and soybean were grown with Roundup levels that only partially inhibited growth, the cultures gradually became more resistant as the herbicide concentration was increased. In most cases, increased resistance resulted from an increase in the gene number of the enzyme Roundup inhibits. As a result, the enzyme itself increased thus leading to Roundup resistance. In several cases, however, resistance occurred without higher numbers of genes or higher enzyme activity. Researchers are now studying these lines to determine the cause of the resistance.

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**Evaluation of Site-Specific Management Practices Based on Historical Crop Yields from Precision Farming**

This research focuses on identifying the specific management factors best for improving the productivity of both high-producing and low-producing regions of fields. The specific factors studied were optimum corn seeding rates across fields of variable productivity in conjunction with rates of fertilizer nitrogen. Researchers have developed different statistical models to determine the best combination of seeding rates and nitrogen rates for optimizing yields and economic returns for corn producers.

In a two-year study, researchers evaluated seeding rates of 18,000 to 38,000 seeds per acre in two different fields on a Franklin County, Illinois, farm. Normalized yield variability for this farm ranged from more than 115% to less than 75%. In year 1, the optimum seeding rate for achieving maximum yield for the soils in the 40-acre field was approximately 27,000 seeds dropped per acre. At that seeding rate, the yield was about 25,400 plants per acre. The optimum seeding rate did not appear to change significantly as different levels of soil productivity were encountered throughout the field. For the most part, corn throughout the field did not respond to fertilizer nitrogen. No significant yield increase was observed with nitrogen rates of up to 200 lbs per acre. A shortage of soil moisture caused portions of the field with lower normalized yield to achieve higher yields than areas with normalized yields of 95 to 105%. Depressional areas with a history of lower yield actually produced higher yields during the first year of this study. During year 2 of this study, there was a very favorable growing season, and as a result, a high seeding rate of 37,000 seeds per acre produced the optimum corn yields.

**A C-FAR External Competitive Grants project**
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**Genetics of Gray Leaf Spot and Rust Resistance in Forage Grasses**

Gray leaf spot is a fungal disease that affects perennial ryegrass and tall fescue, as well as other grasses. This disease occurs only in the United States and, given favorable environmental conditions, causes plant death within 72 hours. Currently, few grass varieties are resistant to this disease, particularly in perennial ryegrass. The goals of this research were to (1) identify resistant sources through disease screening in the field and greenhouse as well as through a
literature search, (2) create genetic mapping populations to study how resistance is inherited, and (3) isolate DNA markers associated with resistance.

This project has enabled researchers to identify germplasm sources with high levels of resistance to gray leaf spot. These resources are currently being used to develop resistant varieties. Various breeding companies have selected populations with parentage from these accessions for varietal development. In addition, the development of an efficient screening protocol for this disease has allowed researchers to work with several breeding companies to identify resistance in their breeding populations. As a result of these efforts, new varieties are expected to emerge on the market in the near future. The release of resistant varieties will reduce dependence on chemical pesticides, the only means of control for this disease currently available.

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**Enhancement of Agronomy Research Capacity**

The overall objective of this project is to enhance the agronomic research capacity at Illinois State University and thus provide a strong foundation for generating useful data and research results for the citizens of Illinois. To conduct valid plot experiments in the field, researchers must be able to accurately measure grain yield, test weight, and moisture for corn and soybean plots. Taking such measures requires special agronomic research field equipment that can be used successfully on relatively small (research-sized) test plots. The addition of a noncommercial combine will be used for several currently funded C-FAR projects, including a compost project (three separate research studies) and a tile research project at Lake Bloomington, Illinois.

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**Complete Nucleotide Sequence and Genetic Analysis of an Agrobacterium Ti Plasmid**

_Agrobacterium tumefaciens_ is the most efficient gene delivery system for producing transgenic plants. Unfortunately, some plants, such as corn and soybean, are recalcitrant to transformation by this bacterium. Certain Ti plasmids, such as pTiBo542, may prove useful for transforming these crop plants. The goal of this research was to (1) determine the complete nucleotide sequence of the agropine Ti plasmid pTiBo542 in _Agrobacterium tumefaciens_, and (2) define the regions of this plasmid that are involved in tumorigenesis and other plasmid functions.

Researchers have completed the nucleotide sequence and its analysis. The plasmid is a closed circular DNA molecule of 244,975 base pairs comprising 13 functional regions, including 3 T-regions, the vir region, the replication region, 3 sets of genes for conjugal transfer, 3 regions for opine catabolism, and 2 spacer regions. The sequence of this Ti plasmid will be useful to scientists interested in designing improved vir helper plasmids. The sequence also will be useful to scientists studying the mechanism by which _A. tumefaciens_ transfers DNA to plants. In the long run, the farmer will benefit from the impact of this information on plant transformation technology.

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Minimizing Protein Content in Diets for Transition Dairy Cows

Research was conducted to (1) determine how increasing the crude protein (CP) content in diets for late-gestation dairy cows from 12 to 15% of dietary dry matter affects cow health, feed intake, and subsequent milk production; (2) compare the effects of increased CP from a low-rumen-degradability source (animal and marine proteins) with a conventional low-cost protein source (soybean meal); and (3) determine how these dietary changes affect metabolism around the time of calving in dairy cows.

Initial results of this study indicate that feeding Holstein dairy cows diets with more than 12% CP during the late gestation period does not benefit milk production, milk composition, body condition, or feed intake. These findings suggest that the investment of up to $.25 per cow per day for this more expensive protein supplementation program would yield little return. However, cows fed the high-protein, low-rumen-degradable protein source before calving had a lower incidence of retained placenta and tended to have fewer health problems in general.

Because each incidence of metabolic disorder around the time of calving is estimated to cost dairy producers over $300, an additional investment of $6 to $7 per cow in feed cost before calving could be beneficial. To avoid inefficient protein use by cows and excessive loss of nitrogen into the environment, diets must be balanced so that they contain sufficient metabolizable protein and not just crude protein.

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Manipulating Amino Acid Supply in Cattle Using Porcine Meat and Bone Meal

A goal of this research was to establish the value of porcine meat and bone meal (pMBM) as a protein source for growing cattle and lactating dairy cows. Porcine meat and bone meal is an important by-product of the pork industry (150,000 to 160,000 tons are produced annually in Illinois) and has probably been undervalued as a protein supplement for ruminant animals. The efficacious use of pMBM as a protein source for cattle would benefit Illinois agriculture by (1) reducing costs and improving efficiency of costly feed inputs (i.e., protein supplements) in beef and dairy production systems, (2) expanding the market for and increasing the value of pMBM and soybean meal or corn gluten meal as opposed to feeding them any of the protein sources alone. In conclusion, this research demonstrated that porcine meat and bone meal is an excellent source of protein for use in beef and dairy diets. It is most effective when used in combination with other supplemental protein sources.

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University of Illinois at Urbana-Champaign

Protecting Large, Round Hay Bales with Edible Water-Shedding Covering

The goal of this research was to develop an edible covering for large, round hay bales that simultaneously protects the hay from weather damage and serves as a nutrient supplement. Researchers developed a covering that protects the hay until repeated freeze–thaw cycles occur. Approximately ten freeze–thaw cycles were used as the standard; these events could occur during the course of a year but usually would be concentrated between the months of November and March. The covering...
sustained some cracking in winter conditions. Hay protected with the covering was more digestible than unprotected hay. Furthermore, cattle will consume the starch–salt covering with the hay as long as other salt sources are removed from the diet.

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

Larry L. Berger, Animal Sciences  
Graciela Padua, Food Science and Human Nutrition  
College of Agricultural, Consumer and Environmental Sciences  
University of Illinois at Urbana-Champaign

### Transplantation of Spermatogonia in Livestock

The immediate goal of this research is to successfully transplant spermatogonia in swine while the long-term goal is to extend this technology to cattle. Transplanted spermatogonia allow the recipient male to produce spermatogonia derived genetically from the donor. In theory, the genetic benefits of artificial insemination, including the selection of a genetically outstanding male, could be achieved without the drawbacks of artificial insemination (e.g., labor involved in inseminating and high failure rate). Currently, production of transgenic livestock is expensive, and the methods used cannot guarantee that the transgene will locate in the reproductive stem cells and thus be heritable. If this transplantation technology succeeds, it will provide a direct method for placing the transgene in the stem cell where it will pass on to all offspring.

Through this project, researchers have demonstrated that (1) cells from donor bull and boar testes can be isolated, (2) the extracted cells contain stem cell spermatogonia, (3) native spermatogenesis can be greatly reduced by destroying most of the spermatogonia in potential recipient boar testes, and (4) dye can be successfully injected via the rete testis in up to 25% of the seminiferous tubules of the recipient boar. In May 2000, researchers performed the first actual spermatogonia transplantation in four boars. The boars were transplanted at six months of age, and they have now reached sexual maturity. The first litters of piglets sired by the transplanted boars were expected on or about December 30, 2000. The donor boars were Hampshires (black with a white belt) and the recipient boars were Durocs (solid red color). Color and color patterns of the offspring along with DNA tests will enable researchers to determine the success of the transplantation technique. The demonstration that the transplant was successful in one or more of the four boars awaits the birth of several groups of piglets in the winter of 2000–2001. If successful, the project will have an immediate impact; however, further research will be necessary to perfect the technique in swine and extend the technology to cattle.

Carl Hausler, Animal Science, Food and Nutrition  
College of Agriculture  
Lonnie Russell, Physiology  
School of Medicine  
Southern Illinois University at Carbondale

### Transplantation of Spermatogonia in Livestock

This research project received funding one year after the “Transplantation of Spermatogonia in Livestock” project, which was yielding promising results. Research efforts were coordinated between the two projects. The goal of this research is to develop new technology that will increase the efficiency of breeding large numbers of females to a few highly selected boars and bulls. The primary beneficiaries will be the livestock producers of Illinois, who will have ownership of this technology. Furthermore, the potential of altering the genome of the spermatogonia before transplantation creates an avenue for low-cost production of transgenic livestock. This innovation would put the Illinois livestock producer at a competitive advantage in meat production technology and might improve the livestock economy in our state.

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

Lonnie D. Russell, Physiology  
School of Medicine  
Carl L. Hausler, Animal Science, Food and Nutrition  
Southern Illinois University at Carbondale

### Effects of the Rendement Napole Gene on Growth, Carcass, and Meat Quality Characteristics

The Rendement Napole (RN) gene was originally identified in Europe where the dominant allele of the gene was shown to negatively impact pork quality, producing meat with pale color and low water-holding capacity. Slaughter and processing sectors of the swine industry suffered major economic losses as a result of increased meat wastage and unsaleable products. This research project is investigating the effects of the RN gene on growth, carcass characteristics, and meat quality in pigs.

Animals
result of these quality detriments. The dominant allele of this gene has only been identified in Hampshire pigs, but this breed is widely used in commercial swine production in the United States. The primary purpose of this project was to establish the frequency and impact of the dominant allele under U.S. production conditions. The specific goals addressed were to (1) determine the frequency and establish the impact of the dominant allele in U.S. Hampshire populations, (2) develop and compare phenotypic (muscle glycolytic potential) and genotypic (molecular markers) tests to use in determining the genotype of individual pigs for this gene, and (3) establish populations of pigs that could be used to identify the gene and molecular markers for pork quality attributes.

This research project, the first to investigate this gene in the U.S. context, has yielded a substantial number of important outcomes and impacts for the swine industry, including:

- realization that the dominant allele was present in more than 80% of purebred Hampshires and in a significant proportion of commercial hybrid animals
- quantification of the large negative impact of this gene on pork quality, which highlighted the need to eliminate the dominant allele from swine populations
- development of a simple, inexpensive phenotypic test to classify the RN genotype of individual pigs (This test has been used by all of the major U.S. breeding-stock suppliers to eliminate the dominant gene from their populations.)
- increased recognition by the swine industry of the critical importance of pork quality and of integrated approaches to improving pork color and water-holding capacity

Floyd McKeith, Michael Ellis, Animal Sciences
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

More Efficient Pen Design for Growing Pigs

The purpose of this project was to provide Illinois swine producers with objective, research-based information on which to make facility design and management decisions. In particular, there are a number of new, innovative approaches to housing and managing pigs that are being widely adopted within the industry; however, design and management decisions for these systems have been based largely on subjective opinion. The specific goals of this research were to (1) quantify the effects of large group size (i.e., up to 100 pigs per group) on pig performance, behavior, and well-being from weaning to market weight and (2) determine the optimum stocking rate, floor space allowance, and facility layout (location of feeders and waterers) for large groups of pigs. These goals were addressed in a series of large-scale studies, involving over 5,000 pigs, carried out in commercial swine facilities.

The primary outcomes and impacts from this project follow:

- Swine producers are applying research findings regarding critical aspects of pen designs for pigs in their own facility design and management decisions.
- A group of collaborators, consisting of Illinois swine producers and associated industry personnel, has been formed to provide input regarding the priority issues for the program as well as facilities for the research.
- A multidisciplinary team of scientists has been assembled to research current and emerging facility design and management issues.

Michael Ellis, Stanley Curtis, Gilbert Hollis, Bradley Wolter, Animal Sciences
Gary Schnitkey, Agricultural and Consumer Economics
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

Soy Phytoestrogens and Swine Reproduction

Soy products contain estrogenic compounds called phytoestrogens that have been shown to affect reproductive function in animals. Genistein is the most common phytoestrogen in soybeans, and it remains
in the meal after processing. Soybean meal makes up a significant percentage (approximately 20%) of most swine diets. This research concentrated on how these compounds affect swine reproduction. Specific goals were to determine whether soy phytoestrogens fed to gilts prepuberty through gestation positively affect breeding and/or increase litter sizes and to evaluate whether soy phytoestrogens affect subsequent reproduction in sows or their offspring that were exposed to these soy phytoestrogens in utero.

Results show that soy isoflavones may stimulate ovulation propensity by inhibiting follicular atresia (i.e., the development of more follicles that can ovulate). Although the results of this study are still being analyzed, preliminary findings indicate an increase in litter size of one to two pigs in swine fed a high-isoflavone vs. a low-isoflavone diet. An average increase of one pig per litter nationwide would produce 17 million more market pigs to meet expanding world needs (i.e., export market). In addition, a positive influence of soy phytoestrogens on reproduction will increase demand to isolate these compounds. These research results could be economically beneficial to swine and soybean producers by making pork production more efficient and by increasing the utilization and/or demand of soy products in the swine industry.

Todd Winters, William Banz, Thomas Rosenthal, Robert Arthur, Animal Science, Food and Nutrition
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Ultrasound Detection of Intramuscular Fat in Swine

Researchers evaluated whether ultrasonic evaluation was an effective method for determining marbling in the swine’s longissimus dorsi muscle. They also evaluated how the intramuscular fat pattern obtained through ultrasonic scanning of the muscle correlated with other meat quality traits.

The pork quality traits measured included pH at 24 hours, subjective quality scores, Warner-Bratzler shear force (WBS) (i.e., the amount of force required to cut through a piece of meat), Hunter color values, and lipid content. Intramuscular lipid was significantly correlated (P < .01) with both loin firmness (r = .429) and marbling score (r = .872), but not with WBS measured on samples aged five days postmortem. Lipid content predictions based on images collected by both ultrasound operators did not correlate significantly with WBS or color of pork loins; however, the correlation between marbling and predicted lipid content from ultrasound operator 1 approached significance (r = .273; P < .10). No similar relationships were observed in lipid content predictions obtained from ultrasound operator 2. These research results make clear that ultrasonic evaluation will be a useful technology in predicting intramuscular lipid in pork loins. This research benefits U.S. pork producers by helping them to select seed stock that will produce swine with better marbling and, thus, to produce pork with better eating qualities.

A C-FAR External Competitive Grants project
John P. Carlson, Bruce Engnell, Agriculture
Lee Tichenor, Computer Science
Western Illinois University
Steven Lonergan, Animal Science
Iowa State University

Develop an Automatic Oil Sprinkling System to Reduce Dust and Odor from Swine Facilities

Previous research has demonstrated that sprinkling a small quantity of vegetable oil on the floor surfaces of swine facilities is an effective and economical method for reducing dust and odor. The initial demonstration of this approach used manual spraying, making the process labor intensive. Off-the-shelf technology currently available can be used to automate the oil sprinkling procedure, thus making it practical and economical for commercial swine facilities. The objectives of this research were to (1) investigate various types of spray nozzles and pumps with the highest potential for use in the automatic oil sprinkling system (AOS) and (2) develop an electronic control system that can reliably and economically perform the automation sequences for the AOS.

Researchers tested a total of 12 different nozzles with different types of spray patterns, ranging from square to hollow cone to flat fan patterns. A system comprised of a tank, pump,
and electric motor (originally intended for a pressurized water system) was used as the primary motive force for the AOS. Four basic types of nozzle spray patterns have been tested: full cone, hollow cone, square, and rotating flat fan. Different flow rates for these nozzles have also been tested. The test results identified the rotating flat-fan, tank-washing nozzle as most effective. The individual components for the flow control system, including the controller, solenoid and check valves, oil pumps, piping, and distribution, have been purchased and are ready for implementation. The oil sprinkling rate and control strategy have also been developed.

A C-FAR External Competitive Grants project
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Zebra Mussels were not successful at treating waste.

Particle Image Velocimetry (PIV) to Study Ventilation Patterns in Livestock Buildings

This research focused on developing a particle imaging velocimetry (PIV) technology to measure full-scale room airflow and studying alternative ventilation strategies for livestock buildings. Specific objectives were to (1) develop a PIV system and associated techniques for measuring low-speed airflow in a full-scale ventilated room, (2) measure air distributions and airflow patterns typical of different air distribution and ventilation systems used in animal buildings, (3) use digital-image processing and data-analysis techniques to determine quantitatively the airflow patterns and air velocity distributions measured in objective 2, and (4) analyze the effect of different ventilation systems on room airflow patterns and regional velocity characteristics for typical animal buildings.

This project’s unique contribution was the development of a 2-D PIV system and techniques capable of quantitatively measuring full-scale indoor airflow with no disturbance to the flow fields. Researchers can apply this measurement technology to indoor air studies for commercial, industrial, and agricultural buildings. Ventilation equipment and systems can be evaluated to optimize their performance and form the best possible local environments for animals and human workers. Researchers can simulate realistic conditions to determine proper ventilation strategies. Data collected from this study can be used to optimize room airflow in related practical situations, support indoor aerosol distribution studies, and validate the existing numerical models.
Microbial Removal of Swine Slurry Odor

Concerns about odor control and disposal of swine waste have inhibited expansion of production facilities and resulted in increased regulatory control. Hog wastes can be used as a good nutritional source for agronomic crops. However, the practice of land spreading these wastes has become unacceptable due to contamination of water resources by runoff and the odor of untreated slurry. Hog slurry odor is caused by (1) soluble branched-chain and straight-chain volatile fatty acids (VFAs) and (2) sulfur-containing compounds released by the hydrolytic activity of bacteria. The objective of this research is to develop an alternative strategy for treating odors that emanate from swine waste lagoons.

The study explores a treatment approach that takes advantage of the unique metabolic characteristics of iron-reducing bacteria (FeRB). When provided with insoluble ferric iron (Fe(III)), these organisms can rapidly degrade the organic components that cause swine waste odor in the absence of air. Low numbers of FeRB are naturally present in swine waste lagoons; their growth is limited simply by a lack of Fe(III). When researchers used strain NU to inoculate swine waste collected from the swine lagoons with added Fe(III), the individual VFAs (i.e., acetate, propionate, butyrate, isobutyrate, valerate, and isovalerate) were rapidly converted to nonodiferous, nontoxic carbon dioxide. In control swine waste incubations that were untreated, the VFA content either remained constant or increased due to the degradation of complex organic matter, which increased the associated odor. An unbiased group of ten people were asked to rate the odor associated with the treated sample vs. the untreated sample on a scale of 1 to 10, where 1 is the best and 10 is the worst. The treated sample received an average rating of 1.5 while the untreated sample was rated 10.

Monitoring Groundwater Quality Near Livestock Waste Pits and Lagoons

This project monitored how four swine confinement facilities, using either deep pits or lagoons for manure storage, affected groundwater quality. At the pit site underlain by clayey silt and shale, pit leakage did not appear to impact groundwater quality. At the other pit site, where sandstone is located within 6 meters of land surface, researchers detected localized impacts to groundwater quality. Because both facilities are less than three years old, long-term impacts cannot be determined.

Groundwater was impacted at the two swine facilities that use lagoons for manure treatment. Each of these facilities has been operating for at least five years. Researchers attributed different contamination levels at these two sites to differences in local geologic conditions. At the first site, where groundwater was collected from a shallow sand layer, contaminants were detected up to 300 meters down-gradient of the lagoon. Deeper groundwater samples collected at this site (from about 7 meters below ground surface) were not impacted by the lagoon. At the other lagoon site, clayey silt was predominant, and groundwater contamination was detected up to 30 meters down-gradient of the lagoon. Although impacts to shallow groundwater have been detected, there is no evidence of contamination migrating off-site. These research findings demonstrate the need for regulations to protect groundwater near livestock confinement facilities and help support some of the concepts for groundwater protection presented in current livestock waste regulations.

A C-FAR External Competitive Grants project


Charles A. Smyth, Crop Sciences
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign
Economic Impact of Control and Prevention of Enzootic Pneumonia and Other Swine Diseases in Illinois Pigs

The primary objectives of this research were to (1) estimate the economic impact of enzootic pneumonia (EP) and the value of management factors to control EP, (2) produce a more robust and realistic model of the economic implications of EP disease and its control or prevention, and (3) examine in detail the productivity and economic impact of vaccination for Mycoplasma hyopneumoniae as a means of controlling this disease.

Researchers created an Excel-spreadsheet-based model to predict the economic impact of disease in farms using batch-flow swine production; they then input farm-specific values that reflected farm-specific management scenarios (e.g., size of operation, prices and costs, productivity measures, etc.). This model provides producers with integrated and automated sensitivity analyses, enabling them to examine potential changes in their operations and assess the economic impacts of these changes. The model is also designed to estimate the economic impact of vaccination.

Gay Miller, Veterinary Pathobiology
Peter Bahnson, Veterinary Clinical Medicine
College of Veterinary Medicine
University of Illinois at Urbana-Champaign

Amino Acid Transport and Utilization by the Porcine Mammary Gland

The long-range goal of this research is to optimize the lactating sow’s nutrient utilization, thereby enhancing the Illinois swine industry’s capacity to meet world food demands while maintaining environmental standards. Efforts to refine existing nutrientrequirement estimates and to optimize lactating sows’ nutrient utilization must be based upon adequate knowledge of the mammary gland, the principle tissue involved in milk production. Current approaches for optimizing nutrient inputs to lactating sows are appropriately based upon the results of previous nutrition research. However, this approach remains inefficient, in part because knowledge of substrate utilization in the sow mammary gland is extremely limited. Achieving the long-term goals of this project will require assembling comprehensive information about a number of issues, ranging from mammary tissue physiology to whole-animal nutrition.

The specific objective of this project was to characterize the cellular uptake systems for lysine and valine, key amino acids in milk synthesis by the mammary gland and in balancing dietary amino acids for lactating sows. Researchers determined kinetic properties and substrate specificity of the porcine mammary gland’s lysine and valine transport systems.

Walter Hurley, Animal Sciences
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University of Illinois at Urbana-Champaign

Pastured Feeder Lamb Competitiveness

This project sought to test the idea that pastured feeder lambs could compare favorably with corn and bean production and offer a financially feasible alternative crop for highly productive farm ground. During the 1999 grazing season, lambs were placed on pasture at a stocking rate of 20 lambs per acre for a test period of 91 days. The average daily gain for each lamb was 0.31 lb, for a total gain of 27.3 lbs per acre. The prevailing market value of $.67 per pound was used to calculate a gross income of $345.87 per acre (18.9 lambs per acre finished the test). Deducting $292.91 per acre for variable production costs leaves a net income of $52.96 per acre for the season.

In 2000, the stocking rate was increased to 30 lambs per acre, and the test period was extended to 102 days. The average daily gain for these lambs was 0.47 lb, for a total gain of 47.9 lbs per lamb. With 29.2 lambs per acre finishing the test, the gross gain was 1,398 lbs per acre; the 2000 market value of $.81 per pound yielded a gross income of $1,132.93 per acre. Deducting $292.91 per acre for variable production costs, a net income of $840.02 per acre was achieved. The average net income per acre over the two-year study was $446.49. This outcome suggests that sheep production competes well with corn and bean production and may fit well in the standard crop rotation or be adopted as a stand-alone system.

Pasture plant populations were sufficiently high to act as a filter strip.
reducing rain and chemical runoff to undetectable levels. At the end of the second year of this study, the plant levels are such that these pastures can continue to be used for sheep production before they must be reworked and placed in a crop rotation. Due to the even spread of the animal manure throughout the pastures, additional chemical fertilizers were not used in this study.

**A C-FAR External Competitive Grants project**
Charles E. Cavaness, DeKalb County Lamb and Wool Producers

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**Creation of a Branded Product in a Commoditized Industry**

Agricultural products have traditionally been marketed in a commodity market. In this system, the farmer, having little influence over the revenue side of the business, accepts the market price. Farmers have been advised to run their farms more like businesses, expanding production to make up for narrow profit margins and concentrating on cost reduction. As a result, the livestock industry has become increasingly concentrated: more units are produced by fewer operations. To ensure an economically healthy Illinois livestock industry, we must increase producer revenues by adding value to the end product. This project has resulted in a model that is transferable to all segments of Illinois agriculture. Practical strategies and guidelines have been developed to enhance the potential success of Illinois branded meat products while still working within the current structure for producing and distributing meat products.

**A C-FAR External Competitive Grants project**
Richard K. Knipe, Darlene Knipe, Dan Jennings, Dean Oswald, University of Illinois Extension
Brian Wansink, Agricultural and Consumer Economics
A. Richard Cobb, Animal Sciences
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign
Kenneth Johnson, Industry Consultant

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**Rotational Grazing for Sheep**

This research focused on evaluating the advantages and disadvantages of rotational grazing for lambs and ewes. In assessing how rotational vs. continuous grazing affects lambs, researchers focused on average daily gain during the grazing period; their assessment of ewes, on the other hand, was based on body condition scores. The results of this trial will better equip sheep producers to ascertain whether they should rotationally graze their pastures or continuously graze them as one large pasture.

As of November 15, 2000, all data was collected, and it is now being analyzed. Preliminary analysis of data from year 1 of this study shows that while there were no significant differences for rates of gain between lambs in the two test groups, rotational grazing extended the grazing period by more than a month for both the lamb and ewe segments of the trial. In addition, ewes on the rotational grazing regime were one condition score higher than ewes on the continuous grazing program in year 1 of the trial.

John Carlson, Agriculture
College of Business and Technology
Western Illinois University
Roger Staff, Natural Resources Conservation Service
Dean Oswald, University of Illinois Extension
Norbert Pohlman, Illinois Lamb and Wool Producers
Premiere Sheep Supply, Washington, Iowa
Evaluation of Central Ram Testing Records

The purpose of this research was to evaluate how environmental conditions affect the performance of rams in the Illinois testing facility. Researchers are comparing the rams’ average daily feed consumption, rate of gain, and overall feed efficiency with the average temperature and humidity during the feeding period. The data has been collected and is being analyzed. Analysis of the data from year 1 of this project indicates that until temperature and humidity reach high levels, they have little effect on the lambs’ performance. At high levels, however, temperature and humidity cause performance to drop sharply.

John Carlson, Agriculture
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Western Illinois University
Norbert Pohlman, Illinois Lamb and Wool Producers
Larry Miller, Illinois Ram Test Committee Chairman
Dean Oswald, University of Illinois Extension

Feasibility of Producing and Marketing Label Rouge–Type Poultry in Illinois

This research evaluates the feasibility of adapting the French Label Rouge poultry production system to Illinois. The Label Rouge system uses specialized genetics and a systemwide, on-farm production regime (optimized for small farms) to produce a high-quality product. The system is both economically and environmentally sustainable. On-farm production is tied to feed mills, hatcheries, and processors by a common hazard analysis critical control point (HACCP) system. In addition, the Label Rouge flock has very low contamination by foodborne pathogens such as Salmonella. The project goals are to (1) complete analyses of the system’s technical, economic, and market feasibility and (2) develop case studies identifying success factors in the French organizations.

The Label Rouge on-farm production system is adaptable to Illinois, save for one or two months of winter production when it is impossible to allow the birds outdoors. Depending upon the availability of genetics and processing facilities, cost feasibility is supported, especially given that restaurateurs in Chicago and St. Louis are willing to pay from $.79 to $1.13 per pound in delivered costs for dressed birds. Market feasibility surveys in those cities showed a significant latent demand for the birds, given attributes for freshness and organoleptic quality. Average prices expected by the trade were $2.96 per pound, more than twice the current average. Before this system can be implemented, investors must be found to support development of a hatchery and a processing plant that meet the HACCP-based requirements. Smallholders seeking a low-impact production system with high potential for compensation per hour of labor are most likely to benefit by adopting the Label Rouge system, but this production system also offers a diversification opportunity for row crop producers.

Randall Westgren, Agricultural and Consumer Economics
Kenneth Koelkebeck, Animal Sciences
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University of Illinois at Urbana-Champaign

Development of Salmonella Vaccines for Chickens

The long-term objective of this project is to design an effective, inexpensive vaccine against Salmonella enteritidis that can be easily administered to young chicks to protect chickens and their eggs from infection. The initial goal was to identify unique virulence factors that may serve as an effective vaccine target.

Researchers showed that mutations in the Salmonella enteritidis fimbiae (SEF) operon reduce virulence of S. enteritidis in laboratory mice by a factor of 10,000 to 100,000. These mutations prevent the bacteria from entering mouse macrophages. In contrast, mutations in the SEF operon increase virulence in chickens, suggesting that these fimbiae may play an important role in establishing chronic, asymptomatic infections in chickens. Thus, given these properties, the fimbiae may be a novel vaccine target. In addition, researchers extensively characterized S. enteritidis infections in chickens to develop a model that will facilitate subsequent characterization of disease. This research has shown that day-old Leghorn chicks are susceptible to Salmonella infections and that approximately 104 bacteria injected intraperitoneally is lethal to young chicks. At lower inoculations, S. enteritidis colonizes the ceca, cloaca, liver,
spleen, and reproductive tissue of the chicks. Older chickens effectively clear the infection given doses below that which results in lipopolysaccharide shock. To directly test the effectiveness of SEF as a vaccine, researchers plan to overproduce and purify SEF protein and then use this protein to immunize chickens. The immunized chickens will be tested for protection against \textit{S. enteritidis} infections. Further work on this project is being funded by the USDA’s Animal Health Division.

Janice Bahr, Animal Sciences
College of Agricultural, Consumer and Environmental Sciences
Stanley Maloy, Microbiology
College of Liberal Arts and Sciences
University of Illinois at Urbana-Champaign

### Use of Organic Acids to Improve Phosphorus Utilization in Poultry and Swine

The goal of this study was to determine whether supplementing chicken and pig diets with organic acids would improve phosphorus (P) utilization. To meet basic nutritional requirements, P must be added to chicken and pig diets. Chicks and pigs can only utilize about 30% of the total P in plants (such as corn and soybeans) because the P is tied up as phytate P. Poor utilization of plant P has negative economic and environmental impacts. Adding P to chicken and pig diets is an expensive process. Furthermore, chicks and pigs excrete much of this P, and the P in their feces often pollutes surface and groundwater. Limited research conducted between the 1930s and 1950s suggested that organic acids increased the phytate P utilization by rats. Thus, researchers wanted to determine if the same thing occurred in poultry and pigs.

Several studies were conducted to determine how added citric acid and sodium citrate affected P utilization by poultry and swine fed a P-deficient corn- and soybean-meal diet. Initial studies evaluated how adding 0, 1, 2, 4, or 6% citric acid, sodium citrate, or a mixture of the two to feed affected chicks. All organic acids improved weight gain and tibia ash markedly and similarly. Subsequent studies in young pigs (10 kg) indicated a slight response to citric acid for weight gain and the gain:feed ratio, but no response in fibula ash. Thus, organic acids appeared to have less influence on P-utilization in pigs than in chicks. An additional experiment showed that citric acid did not significantly affect the calcium (Ca) requirement. Two subsequent chick experiments were conducted to determine whether citric acid would reduce the level of supplemental P required in a corn- and soybean-meal diet. The results indicated that 6% citric acid reduced the amount of supplemental P needed by approximately 0.10%. Similar results were obtained with 4% citric acid in the second chick experiment. Another study was conducted to determine whether citric acid would be efficacious in laying hens fed a corn- and soybean-meal diet containing 0.10% available P (AP). Diets with 0, 1, 2, 3 or 4% supplemental citric acid resulted in significantly lower (P < .05) body weight and egg production compared to a 0.45% AP treatment, indicating that citric acid did not improve dietary P utilization in laying hens fed a corn- and soybean-meal diet. Researchers hypothesized that the lack of effect of citric acid in laying hens compared to chicks resulted from the high Ca level in laying hen diets.

Carl Parsons, David H. Baker, Animal Sciences
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### Developing Value-Added Products from Livestock Waste

Finding and developing alternatives to direct soil application of unprocessed livestock waste has become imperative. This research effort was designed to examine the economics and impacts of composting. Composting stabilizes nutrients, enhancing their availability to crops while decreasing their susceptibility to leaching. Composting also effectively controls pathogens that may be found in livestock waste, thus producing a sanitized product. Composting is a relatively simple process and does not require significantly more labor than traditional manure disposal methods.

Researchers determined that farmers can expect to receive $2 to $7 per wet ton of landscape waste in tipping fees. The cost to produce finished compost was determined to be $31.95 per ton. On soils with high organic matter content (3 to 4%), corn plants supplied with high rates of mature compost (30 to 60 dry tons per acre) grew and developed at a rate similar to that of corn supplied with 150 lbs of fertilizer nitrogen. Corn plants supplied with uncomposted beef and dairy manure grew...
and developed at a rate somewhat inferior to that of corn plants supplied with 30 to 60 tons per acre of mature compost or fertilizer nitrogen. Corn grain yields were similar for corn plants supplied with 30 tons per acre of compost or with 150 lbs per acre of fertilizer nitrogen. Applying 60 rather than 30 tons per acre of compost did not increase yields.

Regardless of the application rate, the use of mature compost did not alter most soil parameters of high organic matter soils one to five years after application. Concentrations of indicator microorganisms were absent or below minimum detection levels in soil and corn grain samples where compost was applied, suggesting no transfer of pathogens from manure.

Using mechanical separators without the assistance of flocculants to remove solids from swine slurry was of little benefit; no more than 40% of the separable solids could be captured. However, several chemical conditioners were found to effectively enhance solid–liquid separation of liquid swine manure. When combined with a continuous belt separator, the most effective polymer removed 95.6% of the separable solids, 92.4% of the total suspended solid fraction, and 79.2% of the phosphorus content. This portion of the research suggests that an effective waste handling system for large-scale swine operations may couple mechanical belt separators with chemical conditioners to separate the solid and liquid components of swine slurry. Such a system could facilitate composting of the solids portion and irrigation of the liquid portion.

Minimal investment is required to compost all waste (including liquid manure) produced by livestock operations with up to 700 animal units. The scope of swine operations with more than 700 animal units may limit composting to the solids portion of the liquid slurry. Such a limit is necessary due to the volume of carbon source (corn stalks, small grain straw, landscape waste, sawdust, etc.) required. This research recommends that large-scale swine operations couple solid–liquid separation with composting of the solids portion (which represents 3 to 8% of the total liquid volume) and irrigation of the liquid component.

Paul Walker, Kenneth Smiciklas, Patrick O’Rourke, Agriculture
Timothy Kelley, Health Sciences
College of Applied Science and Technology
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Inhibiting Pathological Bacterial Attachment to Mucosal Epithelium with Sugars

Bacterial infection is the leading cause of infertility in most domestic animals. Since the uterus is a closed environment, it is difficult to treat bacterial infections with systemic antimicrobial drugs. An added complication that is fast becoming a major problem is the increasing incidence of bacterial antibiotic resistance. Scientists predict that at the present rate of resistance acquisition, several strains of bacteria responsible for life-threatening disease will be resistant to every antibiotic known to science within the next five to ten years. One promising alternative to using antibiotics involves “fooling” bacteria into attaching to harmless substances rather than adhering to tissues. Following this treatment, eliminating the inappropriately bound bacteria from the body would be a simple matter and would prevent the establishment of infection. This research was designed to investigate whether the simple sugar, mannose, could inhibit the attachment of disease-causing bacteria to the internal lining of the uterus in horses and cows.

Two phases of research were undertaken: (1) in vitro investigations using tissue obtained from horses and cattle and (2) in vivo investigations within the uterus of the live horse. Mannose prevented the attachment (and subsequent infection) of Streptococcus zooepidemicus, Eschericia coli, and Pseudomonas aeruginosa to the uterine tissues of the horse in vitro. Mannose was not as effective in the cow in vitro tests. Discrepancies in the in vitro horse and cattle tests probably resulted from the species specificity of the bacteria used and the freshness of the tissue obtained following slaughter. In the live mare tests, mannose added to the uterus in concert with Streptococcus zooepidemicus effectively prevented subsequent infection of uterine tissues and dislodged bacteria that had been previously introduced into the mare’s uterus. On the other hand, when glucose was added with Streptococcus zooepidemicus, infectious organisms established themselves on
uterine tissues. These results demonstrate that mannose may be a useful tool for fighting established bacterial infections as well as for preventing infection from establishing itself.

Sheryl King, Animal Science, Food and Nutrition
College of Agriculture
Lynn Nequin, Physiology
School of Medicine
Southern Illinois University at Carbondale

Conference of New and Re-emerging Infectious Diseases

The Second and Third Conferences on New and Reemerging Infectious Diseases at the University of Illinois at Urbana-Champaign were held at the College of Veterinary Medicine on May 20–21, 1999 and April 20–21, 2000, respectively. Each of these conferences generated more than 100 registrants representing various disciplines within the University of Illinois, other universities, and health-related institutions from throughout Illinois and surrounding states. Based on the response of the participants, the conferences were very successful.

Because of this area of study’s interdisciplinary nature and because it has important public health implications, researchers plan to continue the series of Conferences on New and Reemerging Infectious Diseases. These conferences are designed to bring together a diverse group of scientists from different departments both inside and outside the University of Illinois. The conferences promote lively discussion of controversial issues but also facilitate a collegial interchange of new ideas for developing interdisciplinary interactions and strategies for the global control of infectious diseases.

Reproductive infertility and subfertility are an enormous cost to animal agriculture. Much reproductive infertility and subfertility is linked to problems with males. Unfortunately, laboratory assays of male fertility that are most commonly used are not accurate predictors of fertility. The goal of this research was to determine whether the sperm’s ability to penetrate the oocyte coat (zona pellucida) and the oocyte plasma membrane is related to fertility of bulls and boars.

To determine if subfertility is frequently caused by problems in oocyte penetration, researchers developed a new assay that uses two different stains to label the sperm nucleus. Researchers are currently testing whether conception rate and litter size in swine is related to the ability of the boar’s sperm to penetrate the zona pellucida, fuse with the oocyte membrane, and form a male pronucleus within the oocyte. If this relationship is established, researchers will be able to develop a simple and more accurate laboratory assay of male fertility.

David Miller, Roger Shanks, Animal Sciences
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

Neurochemistry of Growth and Leptin

The central nervous system (CNS) regulates an animal’s growth, development, and nutrient utilization. The neurochemical mechanisms affecting the hormonal, metabolic, and behavioral systems that regulate basal metabolism and energy balance are poorly understood. Initial research efforts to establish how leptin influences energy balance have centered on neuropeptides in the hypothalamus. Exogenous leptin reduced expression of neuropeptide Y (NPY) and increased expression of corticotrophin releasing hormone (CRH). These neuropeptides, together with monoamine neurotransmitters, affect feeding and metabolism and thus influence energy balance. There are no reports on how leptin affects the monoamine neurotransmitters. The immediate objective of this research is to identify the underlying neurochemical mechanisms in the hypothalamus that respond to feedback signals reflecting body composition, specifically leptin. The long-term objective is to define the neural mechanisms that regulate energy balance relative to growth of domestic animals.
Researchers found that administering the adipose tissue hormone, leptin, increased norepinephrine (NE) release in the ventromedial nucleus (VMN) of the hypothalamus. Leptin did not influence NE release in the dorsal medial nucleus (DMN) or paraventricular nucleus (PVN), two other hypothalamic areas containing the leptin receptor. The increased NE was caused directly by leptin in the VMN; this causal relationship was confirmed as microinfusions of leptin directly into the VMN also increased NE release. The differences in timing between peripheral and local administration are consistent with the time necessary for leptin uptake across the blood–brain barrier. The increase in NE following leptin administration was blocked by the sulfonylurea antagonist, glyburide. This finding suggests that the NE increase was mediated by glucose-responsive neurons in the VMN, which contain both leptin and sulfonylurea receptors.

J. Lee Beverly, Animal Sciences
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign
foods
Control of the Growth of the Foodborne Pathogen *Listeria monocytogenes*

*Listeria monocytogenes* is the foodborne bacterial pathogen that causes listeriosis. The fatality rate of listeriosis is up to 70%, and *L. monocytogenes* is believed to be the second most common cause of death from foodborne illness in the United States. In terms of medical expenses and product recalls, listeriosis carries considerable economic costs, estimated at $0.1–0.3 billion using a human capital approach and $1.2–2.4 billion using a labor market approach. The ultimate goal of this research is to develop novel food-grade chemical agents that can be added to food to protect against *L. monocytogenes*. Such agents would have considerable economic impact.

Branched-chain anteiso C15:0, a membrane lipid fatty acid, plays a critical role in enabling *L. monocytogenes* to grow at refrigeration temperatures. The enzyme branched-chain keto acid dehydrogenase plays an essential role in the biosynthesis of branched-chain fatty acids. Researchers synthesized three inhibitors of this enzyme and showed that they restrained the growth of *L. monocytogenes*, especially at low temperatures. These studies have focused attention on fatty acid biosynthesis as a tool for providing additional antilisterial barrier protection in foods.

A C-FAR External Competitive Grants project
Brian J. Wilkinson, Biological Sciences
Philip D. Morse, Chemistry
Illinois State University

Soy and Cardiovascular Health

The incidence of heart disease in women increases significantly after menopause, approaching that in males of the same age group. The cessation of estrogen synthesis is believed to be a primary cause of this increase in coronary artery disease and in the necessity for coronary artery bypass grafting among postmenopausal women. The goal of this research was to determine whether soy phytoestrogens can play a protective role in coronary artery bypass grafting among postmenopausal women. The estrogen receptor alpha, circulating estrogens, and phytoestrogens protected the heart during the experimental conditions imposed. Estrogen clearly enhances coronary flow, nitric oxide production or release, and mitochondrial function; it also prevents intramitochondrial calcium ion accumulation. As a result, when estrogen is present in its natural form or as phytoestrogens from soybeans, heart surgery procedures cause significantly less destruction of myocardial tissue.

David Gross, Veterinary Biosciences
College of Veterinary Medicine
Janice Bahr, Animal Sciences
Elizabeth Jeffery, Food Science and Human Nutrition
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

Soy Isoflavones and Breast Cancer Prevention

Breast cancer is the most prevalent cancer among women in the United States and is the second leading cause of cancer-related death. Research has demonstrated that dietary factors contribute to incidence of numerous cancers. The role of diet in cancer prevention is a significant public health concern and an active area of research. This project was undertaken to determine whether soy isoflavones affect the susceptibility of noncancerous human breast cells to cancer. Specifically, this research focused on how the soy isoflavone genistein affects intracellular mechanisms that regulate cell cycle progression in human breast cells.

The soy isoflavone genistein inhibited the proliferation of immortalized, noncancerous human mammary epithelial cells by causing a reversible block in cell cycle progression at the G2/M stage. This block in cell multiplication was due in part to genistein-induced changes in key enzymes (cyclin-dependent kinases and phosphatases) and proteins (p21waf1/cip1) that regulate the orderly proliferation of these cells. These changes were observed at physiologically attainable concentrations. Results of this re-
search further suggest that genistein may be capable of inhibiting the growth not only of normal human breast cells but also of breast cells in the early stages of transformation into cancer cells.

Keith Singletary, Food Science and Human Nutrition
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

Soy Protein and Soy Phytoestrogens: Effect on Longevity in Various Models of Aging

Research goals of this project were to determine whether eating a diet rich in soybean components will delay onset of age-related diseases and prolong life in genetically altered mice. This study initially focused on two lines of transgenic mice: the mice in one line die early due to tumors, kidney failure, and accelerated aging; the mice in the other line (hereditary dwarf mice) remain in good health until very late in life, living 45% (males) to 60% (females) longer than their normal siblings. Researchers later added studies of GH receptor knock-out (GHR-KO) mice, the newest model of delayed aging in mammals.

Transgenic, mutant, and GHR-KO mice were placed on either (1) a control diet containing no soybean components, (2) a diet containing soy protein with low phytoestrogen levels, or (3) a diet containing soy protein with high phytoestrogen levels. A total of 409 animals were entered in the study. Because most of the animals undergoing these tests are still alive, researchers cannot draw firm conclusions regarding how soybean components affect longevity. However, preliminary findings regarding groups where significant mortality (33 to 75%) has already occurred indicate that diets rich in soybean components have beneficial, life-extending effects. Since some of the mice being tested live up to four years, researchers must continue this study for another two years to obtain meaningful data on longevity.

A C-FAR External Competitive Grants project
Andrezej Bartke, Physiology
Southern Illinois University School of Medicine
William Banz, Todd Winters, Animal Science, Food and Nutrition
College of Agriculture
Southern Illinois University at Carbondale

Genetic Mapping of Phytoestrogen-Determining Genes in Soybeans

Soy products contain estrogenic compounds called phytoestrogens (isoflavones) that have beneficial physiological effects on humans and animals. In humans, soy phytoestrogens may reduce the risk of certain cancers and cardiovascular disease, and they ameliorate symptoms of menopause, including osteoporosis. Phytoestrogens also affect reproduction, immune function, and growth in farm animals, the primary end users of soybeans in the United States. The objective of this research was to use marker-assisted breeding to develop new soybean varieties with phytoestrogen concentrations and profiles that can be managed for specific needs within the livestock-production and human-health industries. Specific aims were to (1) use existing maps of the soybean genome to identify molecular markers linked to genes controlling phytoestrogen content, (2) provide growers with soybean varieties that contain consistently high levels of phytoestrogen, and (3) provide growers with value-added specialty varieties that have phytoestrogen profiles of commercial value to major soybean utilizers.

Researchers have identified a number of potential genetic markers for isoflavone content in soybeans. In initial molecular-marker studies for soy phytoestrogen production, researchers examined 100 recombinant inbred lines (RIL) from Essex X Forrest (two soybean cultivars that contrast for disease resistance, water-deficit tolerance, yield potentials, and phytoestrogen content). Isoflavone content of these soybeans was compared against 150 polymorphic DNA markers. Researchers are currently exploring other potential markers and fine-tuning these physical maps for isoflavone content. They have used these markers to select potential high-isoflavone soybean cultivars. A non-GMO, high-isoflavone soybean has great potential to expand the market for soy products both domestically and internationally, especially within the livestock as well as the functional food and nutriceutical industries. Soybeans with increased phytoestrogen content will add value by demanding a higher price while preserving yield, oil, and protein values. The human-consumption portion of the phytoestrogen market requires about 30 million bushels of soybeans per year, whereas animal
feed represents about 80% of the value of soybean meal. Therefore, the economic impact of this value-added trait may be significant.

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

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

Victor N. Njiti, David A. Lightfoot, Plant, Soil and General Agriculture

College of Agriculture

Southern Illinois University at Carbondale

**Neonatal Intestinal Function and Resistance to Diarrhea: Impact of Soy Fiber**

In the United States, children younger than three experience an average of 1.3 to 2.3 episodes of acute diarrhea each year. Diarrhea accounts for about 9% of hospitalization of children younger than five. Moreover, each year about 300 children younger than five years of age die of diarrhea and dehydration. The combined cost of inpatient and outpatient care for pediatric diarrhea is greater than $2 billion per year.

There is significant physiologic rationale to support adding dietary fiber to infant formulas. The goal of this project is to understand how various dietary fiber sources impact newborn infants’ small intestinal structure, nutrient digestion and absorption, mucosal immunity, and microbial colonization. The central hypothesis of this research is that adding soy fiber to infant formulas will promote gastrointestinal tract development in infants, thus protecting them against bacterial pathogens. This study involved 48 two-day-old piglets.

This research is expected to have a dramatic impact on producers and consumers. By demonstrating a physiological rationale for adding soy polysaccharide to infant formulas, this project may facilitate development of new products to promote within a niche market. In addition, this research increases knowledge regarding neonates’ optimal nutritional requirements, thus enabling nutritionists to develop infant formulas that enhance intestinal function in both healthy and diseased infants. Finally, although this work is aimed primarily at clinical applications relating to infant nutrition, the information gained will be relevant to pork producers for use in the postweaning period of growth stasis in piglets that is associated with decreased digestive and absorptive capacity of the small intestine.

Kelly Tappenden, Sharon Donovan, Food Science and Human Nutrition

H. Rex Gaskins, Bryan White, Animal Sciences

College of Agricultural, Consumer and Environmental Sciences

Richard Isaacs, Veterinary Pathobiology

College of Veterinary Medicine

University of Illinois at Urbana-Champaign

**A Program Proposal for Developing the University of Illinois Food and Brand Research Lab**

The long-term objective of the Food and Brand Laboratory is to stimulate and disseminate significant research on food-related consumer issues. Understanding the factors that motivate choices and consumption frequency of healthy vs. unhealthy foods will help researchers better determine how to increase consumption of functional foods that encourage a healthier, more nutritional diet. This lab is focused both on improving human nutrition, food quality, and health and on generating high-quality, synergistic, cross-functional research across the UIUC campus. The Food and Brand Lab will distribute unbiased, rigorous research relevant to managers of food companies and commodity groups and their consumers, and it will solicit feedback from these sources and consider that input in defining future projects. The published research generated by the Food and Brand Lab will help raise awareness of our university and its value to Illinois, the Midwest, and the country.

This project involved a number of laboratory studies as well as a 50-state study of the acceptance of functional foods. The findings from these studies provide a valuable benchmark of consumer beliefs, attitudes, and behaviors towards functional foods. In addition, researchers developed a unique method for profiling functional food user segments.

Steven Sonka, National Soybean Research Laboratory

Brian Wansink, Business Administration

College of Commerce and Business Administration

University of Illinois at Urbana-Champaign
Chemical Identification and Genetic Regulation of Broccoli Flavor

Broccoli and other cruciferous vegetables are dietary sources of sulfur-containing compounds such as glucosinolates (GS) and sulfur-containing amino acids (SAA). GS and SAA appear to benefit human health, and because the genetic form and concentration of these compounds varies substantially, it seems feasible to use genetic manipulation to develop new lines of these vegetables with enhanced health benefits. It should be noted that the typical flavor of cooked broccoli is believed to arise from heat or enzymatic breakdown of GS or SAA. If increases in specific phytonutrients cause undesirable flavors, the crucifer's commercial value will decrease. This study was designed to help define the characteristic flavor components of broccoli and relate these characteristics to chemical compounds known to have healthful effects. This research will provide information vital to evaluating the feasibility of breeding Brassica lines with enhanced anticarcinogens and acceptable flavor.

Food and seed industries will benefit directly from this research as new broccoli cultivars are developed based on the information obtained from these studies. These newly developed agricultural products will help direct marketers select seed that has the potential to increase sales. Consumers of new broccoli varieties will benefit from the enhanced phytonutrients and acceptable flavor characteristics. Increased consumption of the vegetables will result in reduced risk for cancer and other chronic diseases.

Barbara P. Klein, Food Science and Human Nutrition
John A. Juvik, Natural Resources and Environmental Sciences

Decreasing Body Fat by Consuming Conjugated Linoleic Acid–Enriched Milk Fat

Obesity and its associated problems have become major health concerns in the United States and other developed countries. Research has shown that growing mice and pigs gained less adipose tissue when their diets were supplemented with synthetically prepared conjugated linoleic acid (CLA). This effect may be caused by a specific CLA isomer, trans-10, cis-12 CLA. Milk fat and beef are the main dietary sources of CLA; however, the isomer in these products is cis-9, trans-11 CLA. The overall objective of this work was to determine whether the body-fat-reducing benefits obtained from consuming purified (CLA) are maintained when CLA-enriched foodstuffs are consumed. Other objectives were to (1) examine the growth response and body composition of rats consuming CLA as part of a high- or low-fat diet and (2) determine tissue incorporation of CLA.

Our results showed that feeding rats diets that contained 1% trans-10, cis-12 CLA decreased body adipose tissue composition. The results were more pronounced when the CLA was added as a synthetic preparation than when it was added as a component of milk fat. Although these changes were statistically significant, they were not of the magnitude that has previously been reported for similar tests performed on other species. These findings suggest that consuming CLA as a natural component of milk fat may provide anti-cancer benefits, but it will not change body composition.

A. Denise Beaulieu, James Drackley, Animal Sciences

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

Taste Perception and Food Intake in Older vs. Younger Women

The objectives of this study are to (1) determine tastant thresholds for older and younger women; (2) determine body weight, body composition, and usual food intake for older and younger women; (3) identify the foods older and younger women consider salty, sour, bitter, or sweet as well as their beliefs about the healthfulness of such foods; and (4) compare data for older women vs. younger women obtained through this study, and compare this data with data for older vs. younger men from a previous study.

Gender- and age-specific answers concerning taste perception can be used to guide Illinois citizens’ food choices and, in turn, to promote good
nutrition and health. Such knowledge can also be used to develop new food products that best complement the tastant-threshold profile of older and younger men and women.

Karen M. Chapman-Novakofski, M. Susan Brewer, Food Science and Human Nutrition
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

A Confocal Laser Scanning Microscope

This grant provided matching funds for the purchase of a confocal laser scanning microscope system to be housed in the College of Veterinary Medicine's Center for Microscopic Imaging. Four different departments, representing the Colleges of Agricultural, Consumer and Environmental Sciences and Veterinary Medicine, will use this instrument, and it will also be available to other interested researchers on campus. Since it was purchased in April 2000, the participant investigators and others have used the microscope to facilitate research in areas such as new and reemerging infectious diseases, zoonosis, food safety, reproductive biology, toxicology, and crop sciences.

Roberto Docampo, Lois L. Hoyer, Richard E. Isaacson, Ibulaimu Kakoma, Mark Kuhlenschmidt, Milton M. McAllister, Silvia N.J. Moreno, Veterinary Pathobiology
David R. Gross, Veterinary Biosciences
College of Veterinary Medicine
H. Rex Gaskins, Walter L. Hurley, David J. Miller, Matthew Wheeler, Animal Sciences
Lila O. Vodkin, Crop Sciences
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

Food on the Net

Goals of this research were to (1) understand how consumer behavior in online markets differs from behavior in other markets, (2) study the differences and similarities between online food markets and online markets for other products, and (3) identify the strategies retailers use in these markets and how these strategies affect market performance. The following are some of the primary research findings:

- The consumers most likely shop on the Internet are relatively more familiar with direct marketing than those less likely to shop online.
- Trends in online consumers’ behaviors seem to justify optimistic forecasts that dollar volume will nearly double each year.
- While online grocery retail markets are more competitive than offline markets, higher costs for transactions limit the size of online markets.

Michael Ward, Agricultural and Consumer Economics
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign
rural economic development
Due to the variation in field conditions within a field, setting a realistic yield goal for each part of the field is one of the critical problems in precision agriculture. Once yield goals are set, agronomic recommendations are available to determine the correct amount of seed, fertilizer, etc., for achieving target yields. If less fertilizer is applied, the yield may be reduced and the high profit cannot be obtained; if too much is applied, money will be wasted and the environment may suffer. The first step in setting yield goals is to develop an accurate model of the relationship between yield and soil, weather, and management factors. Such a model could be used to (1) predict yields within fields with specific weather, soil, and management conditions; (2) analyze these influencing factors; and (3) assist with decisions regarding fertilizer and seed applications.

Researchers employed an artificial neural network (ANN) to model the relationship between corn yield and the factors influencing corn yield (for this study, these factors were limited to soil, weather, and management). The ANN factors tested included network type, network topology, and network parameters. Four aspects of the network performance were evaluated: input factor trends, interactive effect between the input factors, sensitivity analysis, and optimum yield. Retraining the trained ANN for a different field with a sparse data set was also investigated. Researchers drew the following conclusions:

- The back-propagation, feed-forward neural network predicted corn yields with 80% accuracy; when an example with abnormally low yield was discarded, accuracy rose to 83.5%.

- Calculated yield trends were realistic (i.e., yields showed the expected increase, flattening, and then decrease as various input factors were increased).

- The network was able to capture the expected interaction between rainfall and amount of applied nitrogen fertilizer and between applied nitrogen and most other factors.

- Researchers found an optimum combination of input factors that allowed the ANN to predict a yield 75% larger than the maximum observed yield used in training the ANN.

- The calculated yields were most sensitive to rainfall (especially late-July rainfall), nitrogen fertilizer, and soil phosphorus.

- The trained network must be retrained for use on each specific field.

Patrick O’Rourke, Jeffrey Wood, Agriculture
College of Applied Science and Technology
Illinois State University
A New Foundation for Sustainable Apple Growing in Illinois’ Stressful Environment

Illinois orchardists have traditionally selected a rootstock for apple trees based on tolerance to the state’s stressful environment. The commercial standard, M.M.111, is no longer profitable because it produces a tree that is too big to efficiently harvest, prune, and protect from pests. Furthermore, the tree this rootstock produces, in conjunction with the fruiting variety grafted to it, is biologically inefficient in converting sunlight to fruit yield. The M.M.111 rootstock delays the onset of apple production for at least five years, resulting in a cumulative yield for the first ten years of orchard life that is 25 to 30% of the cumulative yield of the very efficient dwarf rootstock from Europe, M.9. Unfortunately, the M.9 rootstock is not well adapted to Illinois’ biotic and abiotic environment. The goal of this project was to determine the efficiency imparted by new (virtually untested) dwarfing rootstock used as interstems in combination with stress-tolerant rootstocks, such as M.M.111. This research is needed because new, biologically efficient rootstocks have been selected only for environments much less stressful than those encountered in Illinois; therefore, it is not likely that newly released rootstocks are well-suited to local conditions.

Researchers identified four new interstem–rootstock combinations that produced the necessary large fruit size and yields (at least 150% of that for the standard M.M.111); one of these rootstocks produced yield efficiencies 300% greater than those of the standard. This yield increase is very competitive with the yield advantage of the European rootstock M.9, but the new interstem–rootstock combinations should better tolerate Illinois’ environmental stresses. The 1.5 to 3.0 times greater efficiency of the combinations demonstrates significant opportunity to increase fruit growers’ net incomes since operating costs for an apple orchard grafted on the new, efficient interstems will be similar to those for an orchard propagated on M.M.111.

A C-FAR External Competitive Grants project
Bradley H. Taylor, Plant, Soil and General Agriculture
College of Agriculture
Southern Illinois University at Carbondale
Ed Billingsley, Agriculture
Rend Lake College
C. Chris Doll, Doll Horticulture Services

Establishing a High-Density Linkage Map for the Vf Gene for Scab Resistance

The overall goal of this project is to develop a high-density linkage map of the apple scab resistance gene Vf that can be used for marker-assisted selection and to isolate and clone this scab gene. Researchers used 15 closely linked amplified fragment length polymorphic (AFLP) markers to saturate the region of the scab resistance gene Vf. High-resolution mapping placed all 15 AFLP markers within an interval of 0.6 centimorgan (cM) around the Vf region: 7 markers were inseparable from the Vf gene, 1 was located to the left of the gene, and the remaining 7 were located to the right of the gene. This genetic map is the most saturated linkage map developed to date. In addition, 11 of the 15 AFLP markers have since been converted to polymerase chain reaction–based markers, also known as sequence characterized amplified regions (SCARs). These SCARs proved to be very effective and are now being used for marker-assisted selection and for map-based cloning of the Vf gene. For the latter, a bacterial artificial chromosome (BAC) library of the apple has been constructed. This library is now being used to isolate the Vf gene.

Schuyler Korban, Natural Resources and Environmental Sciences
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

Breeding for Disease Resistance and Increased Yields in Horseradish

Illinois horseradish growers have been the leaders in production of this herb since the late 1800s. However, Illinois horseradish production has declined since then, decreasing from a high of 80% to the current rate of 50 to 60% of U.S. production. This decrease resulted primarily from a disease that causes discoloration and internal rotting of horseradish roots. Growers currently produce four or five different varieties that represent a narrow genetic base. Without incorporating new disease-resistant varieties, horseradish production in Illinois will likely continue to decrease, which may reduce our dominance in...
the U.S. market as roots are increasingly imported from overseas producers. Cultural and chemical methods have not effectively controlled this disease. Because of the root ecosystem’s complexity, scientists have not been able to determine the primary cause of this disease and contributing factors. Therefore, the focus of this research was to evaluate horseradish for disease resistance in field settings. Researchers have also crossed several sources to identify new gene combinations for commercial production.

The varieties included in this study were common horseradish lines, cultivars from the Illinois Horseradish Germplasm Collection, and crosses made by various breeders. After several years of evaluations in field plots near Collinsville, Illinois, researchers have identified a number of varieties resistant to root discoloration and internal rotting. In addition, lines with higher root weight and increased quality based on root morphology were collected. A selection index was created based on these desirable traits along with corresponding error analysis to give weight to the best data available. Researchers are currently using tissue culture to propagate seven of these lines for large-scale production trials in grower fields. They expect these lines to be higher in production rates and quality than the current commercial lines. Synthetic varieties that represent a combination of the best traits available are also being produced, and crossing blocks are being developed to prepare for gene mapping studies that will isolate genes associated with these traits. New varieties with enhanced genetics will be created in the near future.

A C-FAR External Competitive Grants project
Robert C. Gerstenecker, Horseradish Growers of Illinois
Andrew Hamblin, Natural Resources and Environmental Sciences
College of Agricultural, Consumer and Environmental Sciences
Anthony Bratsch, University of Illinois Extension
University of Illinois at Urbana-Champaign

Impact of Low-Phytic-Acid Corn on Phosphorus Levels in Aquaculture Effluent

In areas where livestock or fish are produced, release of phosphorus-laden animal waste into natural waters is a major concern. Phosphorus discharges into phosphorus-limited waters typically create algae blooms that deplete oxygen supplies available to fish and other aquatic organisms. Feed is a major source of phosphorus in animal waste. Regular yellow dent corn, the type most commonly used in corn feeds, stores phosphorus as phytic acid, which cannot be utilized by monogastric animals such as swine, poultry, and fish. Thus, phytic acid passes through the digestive tract of animals into the waste stream. Animal feeds must in turn be supplemented with inorganic phosphorus to satisfy the animals’ nutritional demands, and this supplementation adds to the cost of feed for producers.

One potential method for reducing phosphorus in animal waste is to replace regular yellow dent corn in feeds with low-phytic-acid corn. Low-phytic-acid corn stores phosphorus as inorganic phosphorus rather than phytic acid, thus this corn contains .18 to .20% available phosphorus compared to .04 to .05% available phosphorus in regular yellow dent corn. Feeding trials at the University of Missouri revealed that growing pigs excreted 20% less phosphorus when fed low-phytic-acid
corn in place of regular yellow dent corn; there were no differences in growth performance, feed efficiency, or bone strength associated with the different feeds. Research analyzing how low-phytic-acid corn affects phosphorus levels in tilapia effluent is currently underway at the Illinois State University farm. The objectives of the research are to (1) increase the demand for low-phytic-acid corn, (2) reduce the cost of feed for aquaculture producers, and (3) reduce the amount of phosphorus released by aquaculture production units.

Kerry Tudor, Agriculture
College of Applied Science and Technology
Illinois State University

The Economics of Pesticide-Free Organic Row Crop Production

The aim of this research is to assess the economic risks and returns associated with an organic row crop rotation. Researchers surveyed organic corn and soybean producers and handlers to identify the agronomic practices and handling procedures that influence the quality of these commodities. They then combined this survey data with field data and cost-and-return budgets.

Forty-three percent of the survey respondents are strictly organic farmers. Over half of the respondents listed concern for the environment as their top reason for switching to organic production. Other factors listed include organic premiums, farm diversification, and lower input costs. Organic crop yields ranged from 0 to 20 bushels lower for organic vs. conventional soybeans and 10 to 45 bushels lower for organic vs. conventional corn. Yields were affected by a number of factors, including weather, location, plant variety, tillage practices, soil fertility, and weed management techniques. Major price discounts include the amount of clean out for split seeds, stained seeds, and foreign material. Almost half of the survey respondents indicated that they rely on an off-farm income source to reduce the risks of organic farming. Furthermore, over half of the respondents utilize forward contracting, or hedging, to sell their product, and almost three-fourths of the respondents utilize crop insurance despite the fact that they are only able to insure their crop at conventional price levels. Additional challenges of organic row crop production that were identified include the production costs and the need for additional research to aid organic row crop producers. Researchers combined survey findings with the budget estimates to assess the economics of organic row crop production.

Rick Hirschi, Agriculture
College of Business and Technology
Western Illinois University

Direct-Marketing Alternatives for Southern Illinois Farmers

Illinois’ agricultural producers are subject to wide swings in levels of production, price, and profitability. Cash-market prices are currently below production costs for our two principal crops, corn and soybeans. In addition, there is increasing uncertainty regarding the role government will play in providing support for and regulation of American agriculture. Producing specialty crops, such as fruits and vegetables, can help farmers diversify risks and stabilize income. Producing and marketing these goods is relatively labor-intensive and, thus, represents an opportunity for smaller farmers who lack the capital necessary for scale economies to substitute labor for capital. Moreover, because most fresh produce grown in Illinois is sold directly to the consumer, the value added from direct marketing contributes to higher prices than those received through wholesaling.

The purpose of this research is to assist current and prospective growers in identifying and analyzing product and marketing opportunities by providing them with information about how specialty crop producers in southern Illinois use direct-marketing methods. This information is currently being gathered, and its dissemination will enhance growers’ ability to make sound decisions for increasing the volume, diversity, and profitability of specialty and value-added farming enterprises. The primary beneficiaries of this research are current and prospective producers of specialty farm products, especially those with access to the sort of value-added direct-marketing opportunities used in southern Illinois. This research has the potential to extend benefits beyond growers and consumers to local economies through creating jobs and generating additional economic activity.

Livy Coe, Jeffrey Beaulieu, Agribusiness Economics
John Preece, Plant, Soil and General Agriculture
College of Agriculture
Southern Illinois University at Carbondale
Efficiency and Sustainability of Agriculture in Central Illinois

The objective of this research was to determine the sustainability and efficiency of central Illinois farms with respect to energy use, soil conservation, economics, and nutrient use. Although data were collected for two years, this study generated no research results regarding the efficiency and sustainability of seven real farms. The project was unsuccessful due to the following unforeseen difficulties: (1) the project could not be completed within the two-year funding period, (2) there were problems associated with data collectors, (3) mistakes in collection of field-level data burdened the farmers and record keepers, and (4) researchers needed to practice on a single farm before undertaking a seven-farm project.

A C-FAR External Competitive Grants project

David W. Onstad, Natural Resources and Environmental Sciences
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

Industrialization of Hog Farms and Rural Economic Development in Illinois

The size of hog operations in Illinois has increased dramatically in recent years. In 1987, Illinois hog farms with sales of more than 5,000 animals produced only 14% of all hogs and pigs sold in that state. By 1997, farms with sales of more than 5,000 animals produced nearly 50% of the total. These structural changes have had substantial social and economic consequences for rural communities, and their impact is controversial. In particular, it is not clear that the industrialization of hog farming economically benefits the rural communities where these operations are located. The objective of this study is to assess the impact of large hog farms on the economic welfare of rural communities in Illinois. The study uses data on retail spending from more than 300 rural towns in Illinois covering a 17-year period (1981–1997).

The results of this study refute the hypothesis that large hog-farming operations contribute to the vitality of local economies. On the contrary, researchers developed several models that consistently indicate that large hog farms negatively impact economic growth in rural communities. Towns located in counties with high concentrations of hog farming tend to have lower levels of retail spending than towns in counties with lower concentrations of hog farms. These results suggest that the economic vitality of rural communities depends on public policy. A “no intervention” policy suggests that policy makers have accepted the decline of rural communities as an inevitable result of agricultural industrialization and urbanization. A contrasting policy in which policy makers act to protect and preserve the economic vitality of rural economies could be called an “intervention” policy. The results of this study suggest that without public policy to protect rural communities, the most probable outcome is their continued decline as agriculture and livestock production units continue to increase in size.

Miguel Gomez, Agriculture
College of Applied Science and Technology
Illinois State University

Characteristics of Successful Rural Agribusiness Entrepreneurs

The primary objectives of this study are to (1) ascertain the attributes of successful rural entrepreneurs and (2) identify those factors (financing, taxes, etc.) that impede and/or accelerate the growth and success of small, agriculturally oriented rural businesses. Identifying the characteristics of successful businesspersons as well as the problems these individuals confront in their business activities will provide prospective entrepreneurs with valuable insights into their ability to achieve success. Identifying the impediments rural entrepreneurs face will help policy makers see the actions they can take to create an environment more favorable to small businesses.

Rick Whitacre, Agriculture
College of Applied Science and Technology
Illinois State University

Real-Time Responses of Illinois Farms in an Economic Downturn: Strategic Directions and Financial Market Response

The recent decline in commodity prices and diminished expectations for future prices have increased this study's focus on the real-time responses of Illinois farms in an economic downturn. The study aims to provide strategic directions and financial market responses to help farmers navigate through this challenging period. The study emphasizes the importance of diverse revenue streams, cost management strategies, and market diversification to enhance resilience in the face of economic fluctuations. The results highlight the need for ongoing support and resources to sustain agricultural communities during economic downturns.

C-FAR 2000 Annual Report
Financial analysis tools are available at http://www.farmdoc.uiuc.edu/. These tools have been used to train lenders and farmers to cope with reduced profit margins. Finally, a series of educational and outreach meetings is planned.

Paul N. Ellinger, Peter J. Barry, Gary S. Schnitkey, Agricultural and Consumer Economics

College of Agricultural, Consumer and Environmental Sciences

University of Illinois at Urbana-Champaign

Farmland Control Alternatives and Agricultural Competitiveness in Illinois

The general objective of this project was to evaluate how changes in land-control contracts and leasing arrangements influence the financial situations and risk positions of Illinois farm businesses. The specific objectives were to (1) document factors that cause ongoing changes in leasing, management, and land-control arrangements; (2) use simulated contract situations that reflect alternative risk-bearing and management responsibilities to determine farmers’ preferences and pricing thresholds; and (3) project farm-level financial performance under alternative contract specifications.

Researchers surveyed farmers and professional farm managers. The landowners surveyed cited a number of reasons for increased reliance on cash-rent leasing, including avoidance of risk-sharing, higher land prices, ease of understanding, avoidance of management sharing, and easier rent adjustment. Farm operators cited ease of bidding for acres, avoidance of management sharing, and easier rent arrangements as major benefits of cash-rent leasing. Increased use of cash leases is significantly related to higher income variability, lower soil quality, smaller tracts of leased acreage, shorter relationships with landlords, and larger net worth and higher debt-to-asset ratios of farmers. Levels of cash rent are associated primarily with differences in soil productivity, tract size, and net worth.

Researchers developed a lease-pricing model for farmland that is consistent with traditional leasing principles and allows greater flexibility in determining crop share levels either separately or in combination with a fixed cash payment. The share levels are linked to the farm’s soil productivity, the costs of each party’s resource contributions, and their respective cost structures. The resulting menu of lease prices can enhance the equitability of leasing contracts, expand the range of contract choices, promote mutual incentives for the leasing parties, and heighten the efficiency of leasing markets through greater standardization of leases.

Researchers for this project also measured how lease-contract choices affect transaction costs and specialty crop incomes and evaluated lease premiums on share vs. cash rents relative to risk reduction. Farmers generally prefer cash leases when transaction costs are high, specialty crop income is favorable, and lease premiums are small relative to the significant risk reductions associated with share leasing.
Evaluation of Human Resources and Agriculture Literacy Materials for the Sustained Economic Vitality of Illinois Rural and Urban Communities

The operational objective of the study was to answer the following research question: Do fourth-grade elementary school students’ Illinois Goal Assessment Program (IGAP) scores in science and social science differ in relation to (1) teacher background and (2) agricultural curriculum? This study evaluated two populations: a random sample of fourth-grade elementary school teachers who had previously attended a Summer Agricultural Institute (SAI) and a random sample of fourth-grade teachers who had not enrolled in the SAI. Fourth-grade teachers were used in this study because the state-administered IGAP is given to fourth graders. The IGAP test is a 35-minute assessment comprised of 80 multiple-choice questions. The test is administered statewide each year during the first two weeks of February. Individual results are available the first week of May.

Researchers found no statistical differences between the “Science” and “Social Science” test scores of students taught by the two groups of teachers. These findings suggest that SAI participation has not necessarily enhanced teachers’ ability to positively influence their students’ standardized test scores, at least not enough to demonstrate a significant difference when compared to the scores of students taught by non-SAI teachers.

Jeffrey Wood, Agriculture
College of Applied Science and Technology
Illinois State University

A Financial Evaluation of Entry Barriers for Illinois Farmers

In today’s agricultural environment, tremendous steps have been taken to improve production technology. Improved production has been accomplished largely as a result of research and improved technology. However, this progress has increased the capital requirements of production agriculture; in turn, profit margins have been declining in recent years. The combination of high capital requirements and low profit margins restricts farmers’ borrowing and repayment capabilities as well as their savings for the future. Trying to obtain financing can often be a difficult and frustrating experience for beginning farmers. Without financing, potential farmers might be forced to choose other occupations with lower capital requirements. The general objective of this project is to systematically and scientifically investigate the financial barriers that hinder the next generation of farmers from entering agriculture.

Results indicate that equity requirements are the primary hurdle to entering agriculture. Lower interest rates do not have as large an impact on the future viability of young farmers. The recent low commodity prices and uncertainty of government programs have further reduced margins and restricted growth opportunities. The difficulty of representing this ever-changing economic environment has complicated the development of a two-stage model of the financial needs and barriers facing prospective farmers. Additional funding from the Center of Farm and Rural Business Finance and Illinois Farm Development Authority will be used to continue this valuable project.

Paul Ellinger, Peter Barry, Agricultural and Consumer Economics
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

Economic Performance of Market Advisory Services for Illinois Producers

Producers rely heavily on market advisory services for price risk management information and advice. A goal of this research project was to complete an objective and comprehensive analysis of the performance of agricultural market advisory services. Specific objectives include (1) determining on an annual basis the net price that Illinois corn, soybean, and wheat producers would receive by following advisory service recommendations; (2) evaluating the pricing performance of market advisory services relative to market benchmark prices; (3) determining whether current and future pricing performance can be predicted from past
pricing performance; (4) evaluating the relationship of pricing performance to the riskiness of marketing recommendations; and (5) determining how Illinois producers use the recommendations of market advisory services.

Researchers collected data on advisory services’ marketing recommendations for corn, soybean, and wheat between the 1995–1996 and 1998–1999 crop years. They then calculated returns on these recommendations as a weighted-average net price that would be received by an Illinois producer who precisely followed the marketing advice. Results indicated that advisory services moderately outperformed the soybean market: 13 of 19 services evaluated during all four years had a four-year average soybean price that exceeded the average benchmark price. The same services demonstrated less ability to outperform the corn market: only 10 of the services yielded a four-year average corn price that exceeded the benchmark price. Furthermore, the services significantly underperformed in the wheat market: only 2 of 18 services tracked yielded a four-year average wheat price that exceeded the average benchmark price. Researchers found little evidence that pricing performance is predictable from year to year. They also noted that these services that outperform the average benchmark are more subject to risk than the benchmark price. Finally, a survey of Illinois market advisory service subscribers indicates that only about 10% of producers follow an advisor’s recommendations precisely.

This research has provided Illinois producers with valuable information that will help them decide which, if any, market advisory service to select. In addition, the information generated by this research has begun to impact the way grain is marketed in the United States. Research findings have been used as the empirical foundation for a new generation of pricing contracts the grain industry is offering producers. Firms such as Diversified Services and Cargill, along with e-markets, have developed new contracts that assure producers they will receive the average price for grain over some prespecified time period.

Scott Irwin, Darrel Good, Agricultural and Consumer Economics
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

Program for Rural Human and Family Development Research

Researchers for this project conducted applied research that promotes human and family development in rural Illinois, thereby contributing to the socioeconomic sustainability of rural areas. Objectives were to (1) identify strategies for extending services to rural children experiencing stresses from family transitions, such as parental death or divorce; (2) examine the efficacy of an intervention to promote rural peer support groups; (3) evaluate how community-related factors and familial social networks may influence young children’s socio-emotional adjustment; and (4) determine the status of rural youth and the availability of opportunities for community involvement.

Researchers assessed factors that facilitate implementing prevention programs in rural schools and identified strategies for establishing successful school-based programs. These findings were provided both to the developers of the Rainbows Program and administrators in rural school districts. Researchers also identified successful practices used by self-help group leaders to support parents and caregivers in rural areas, and the results were published as a “best practices” handbook which was provided to a regional self-help clearinghouse and to rural community leaders. In addition, researchers analyzed the relationships between family and friendship networks, parents’ perceptions of their children, neighborhood factors, and children’s socio-emotional development and used this information to identify the unique factors that affect rural families and educators as they work to promote rural children’s cognitive and social development. Finally, researchers assessed rates of substance use and violence behaviors among rural youth, and they explored the levels of risk and protective factors in youths’ lives that may affect the occurrence of problematic outcomes. These findings served as the basis for a series of youth assessment reports that were distributed to schools, Extension offices, and community leaders for use in community planning efforts.

Joseph Pleck, Laurie Kramer, Human and Community Development
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign
Parental involvement and partnerships among school staff, parents, and community stakeholders have been found to positively impact all aspects of young children’s school performance. Goals for this project included (1) developing an in-depth profile of the types of families being served by state-funded prekindergarten programs for children identified as at-risk for later school failure; (2) identifying, from multiple perspectives, potential antecedents and perceived barriers to effective family-school-community partnerships in rural prekindergarten programs; and (3) examining various ways in which families and community stakeholders can work with school personnel to identify and build strategies that lead to successful family-school-community partnerships.

Findings from this project indicate that families of children served by rural prekindergarten at-risk programs do not fit the stereotypical model of low-income and high-risk families commonly associated with such initiatives (e.g., single, unemployed mother with few social supports and living in subsidized housing). Researchers also found that the efforts of rural prekindergarten programs to establish effective family-school-community partnerships are plagued by many of the same problems experienced by their urban and suburban counterparts (e.g., overreliance on written communications, teacher-driven vs. family-driven initiatives, lack of family awareness of opportunities for partnership activities, etc.). At the same time, however, these programs face problems and barriers that are unique to their rural settings and that limit their ability to effectively implement partnership activities (e.g., “out-migration” for employment, families that qualify for services from the prekindergarten program based on meeting low-income and poverty guidelines in spite of their dual-earner family status, a lack of social support services for low-income and high-risk families beyond those available in the prekindergarten programs, etc.).

Researchers also identified several perceived barriers to effective family-school-community partnerships that run counter to idealized notions of strong family and community support for rural school systems (e.g., parents’ negative attitudes toward schools, lack of awareness of prekindergarten programs within the local school system, limited educational backgrounds of family members being served, negative perceptions held by school personnel of low-income and high-risk families, etc.). Taken together, these findings suggest the need to identify new strategies for addressing the problems and barriers to effective family-school-community partnerships in rural prekindergarten programs—strategies that move beyond the urban bias common to the conceptualization and implementation of these services. Results from this project have also provided a framework for developing these new strategies.

Brent A. McBride, Human and Community Development
Joyce Allen-Smith, Agricultural and Consumer Economics
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign
natural resources
Identifying and Reducing Sources of Nitrates in Illinois Waters

The objectives of this research were to (1) ascertain how rate and time of nitrogen (N) application affect nitrate-N concentration and content in water from tile lines, (2) evaluate how previous N management affects current N needs, (3) evaluate how previous N management affects recovery of fertilizer N, and (4) evaluate how previous N management affects fertilizer N transformations in soil.

Researchers found that in years when corn was grown, nitrate loss from tile lines was greater than in years when soybeans were grown. Nitrate loss was directly related to the rate of N used in the field, and it was highest on those fields where substantially more N was applied than is recommended by the University of Illinois. This finding held true regardless of whether corn or soybean crops were grown. Nitrate-N loss was greatest in years with excess precipitation and was very low in years with low rainfall (2000). Use of the recommended N application rate resulted in minimal N loss from tile lines. Residual soil nitrate-N levels were generally highest on fields with a history of excessive N application rates. Researchers did not observe a significant relationship between time of N application and N loss from tile lines.

Robert G. Hoeft, Emerson Nafziger, Crop Sciences
Richard Mulvaney, Natural Resources and Environmental Sciences
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

Aerial Infrared Mapping of Subsurface Drainage Systems

The goal of this project is to create detailed maps showing the layout of subsurface drainage (tile) systems in the Lake Decatur watershed, one of the most heavily tiled watersheds in the state. These maps will be distributed to researchers, farmers, farm managers, policy makers, farm organizations, and agribusiness interests throughout Illinois. The 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. This tile-mapping project has served as a model for similar projects initiated by several Soil and Water Conservation Districts across the state. To date, maps for more than 186,000 acres have been requested, primarily by farmers and farm managers.

A C-FAR External Competitive Grants project
Richard A. Cooke, Michael C. Hirschi, Agricultural Engineering
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

Decision Support for Watershed Management and Planning

This research focused on building a decision support system to inform farmers and landowners about the economic and hydrological impacts of their management decisions. The ultimate goal of this project is to highlight key linkages among socio-economic and ecological systems. To accomplish this goal, researchers integrated multiple-criteria decision support tools with watershed-scale models that simulate the transport of sediment, nutrients, and chemicals. ARCVIEW, a common geographic information system (GIS) software package, has been enhanced to support model execution and integration and to facilitate visualization of model results. Researchers have combined these tools in a user-friendly package that can be accessed by watershed management and planning groups. In particular, researchers have the following goals:

1. constructing a package of decision support tools for spatial modeling of land use changes in watersheds dominated by agriculture
2. extending existing economic models to more accurately reflect the decision-making processes of individual farmers
3. using the decision support tools to assess the impact of land use scenarios based on agricultural and environmental policies and recommendations of scientists associated with an ongoing USDA project, the Pilot Watershed Project, and the C-FAR Water Quality Strategic Research Initiative (WQ-SRI)
Initial research focused on the Big Creek watershed within the Cache River watershed. The Illinois EPA has cited Big Creek for excessive sediment and nutrient loads, and it is targeted for extensive study. Big Creek has also been designated an Illinois Pilot Watershed.

To date, researchers have used linear programming (LP) to develop model farms that reflect the farming practices in southern Illinois’ Cache River watershed. They have also developed an interface between this model, the ARCVIEW GIS, and the hydrological model AGNPS (AGricultural Non-Point Source) to create an effective decision support tool for watershed managers. This tool enables managers to relate non-point source pollution to appropriate remedial policy initiatives or management practices. In addition, this model demonstrates the economic (i.e., farm income and crop sales) and ecological (i.e., sediment loss and sediment yield) impacts of the land use changes that result from policy.

Future goals are to enhance these decision support tools to better account for how farmers actually make decisions (producers farm fields, they do not base their acreage decisions solely on soil series mapping units) and how issues such as pest management affect acreage decisions (a critical concern in southern Illinois). These as well as other concerns are being addressed as work on this project continues under the WQ-SRI modeling effort.

Jeff Beaulieu, Steven Kraft, Agribusiness Economics
College of Agriculture
Southern Illinois University at Carbondale
David Bennett, Geography
University of Iowa

**Assessment of Best Management Practices: Lake Springfield Watershed**

This project’s ultimate goal is to preserve and enhance water quality and habitat within the Lake Springfield watershed. To accomplish this goal, several key objectives must be met: (1) developing a clear understanding of what is happening in the watershed from a water quality perspective; (2) identifying an array of practical, cost-effective farming practices that reduce chemical and sediment runoff; and (3) creating an action plan for implementing these practices.

Preliminary results indicate that reduced- and split-herbicide applications effectively reduce off-site movements of chemicals. Winter wheat buffers and grass filter strips are also very effective tools for reducing off-site movements of chemicals and sediments. Researchers have reliably determined the stage–discharge relationships for one major subwatershed and have completed about 60% of the work for the other subwatershed. When implemented, the best management practices (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 $8,000,000) 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 at worst be economically neutral to the producer, and they will benefit producers economically in many cases.

**Nitrogen Management Effects in the Little Vermilion River**

The goal of this project was to quantify how changing nitrogen practices affect the quality of water leaving fields via subsurface drainage tiles. Researchers analyzed data for farm fields that had been monitored for six to eight years under other projects. The anticipated outcome was to demonstrate to producers that a strong relationship exists between nitrogen management strategies and the nitrogen load leaving drainage tiles from below the fields.

Researchers found that cooperating producers who applied nitrogen in the fall or very early spring had tile nitrate concentrations averaging 16.8 ppm while producers who used sidedressed nitrogen or manure had tile nitrate concentrations averaging 10.2 ppm. Application rates for the two groups differed, with the early appliers averaging nitrogen rates 14 kg/ha per year higher than the other group. Some of the cooperating producers altered their nitrogen application rates, adhering to the Illinois Agronomy Handbook recommendations for calculating optimal nitrogen rate. After four years of monitoring, researchers found that
the average nitrogen concentration for these producers was about 5.8 ppm lower than the average for those producers who did not change their practices. Awareness of the need to carefully consider nitrogen rates is expanding rapidly.

J. Kent Mitchell, Sharyl E. Walker, Michael C. Hirschi, Agricultural Engineering
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

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

Lake Bloomington is a major source of drinking water for residents of Bloomington, Illinois and the surrounding area. The lake has a history of nitrate (NO$_3$-N) concentrations that exceed 10 ppm. For the last several years, 36 sites within the Lake Bloomington watershed have been monitored on a weekly basis for NO$_3$-N concentration. Results to date indicate that agriculture plays a significant role in the release of NO$_3$-N into the water that feeds Lake Bloomington. In this study, researchers monitored six agricultural fertilizer nitrogen (N) management techniques for NO$_3$-N release via tile and surface drainage with the ultimate goal of determining which techniques most effectively minimized NO$_3$-N release into drinking-water supplies. Specific research objectives were to (1) examine whether the agricultural producer can minimize NO$_3$-N losses into Lake Bloomington by manipulating the timing or rate of N fertilizer applications, (2) provide useful information to adjust N fertilizer application practices to meet changing regulatory requirements, and (3) investigate the feasibility of regulating fall-applied N to reduce NO$_3$-N loading of surface-water supplies. Results to date indicate that applying fertilizer nitrogen in the spring significantly reduces NO$_3$-N release into tile water while producing grain yields equivalent to those of fields with fall-applied treatments.

Ken Smiciklas, Aaron Moore, Agriculture
College of Applied Science and Technology
Illinois State University

Improved Assessments of Available Soil N Sources in Corn–Soybean Rotations

Most corn is grown in rotation with soybeans, which are legumes that fix atmospheric nitrogen (N). In corn crops planted after soybeans, less fertilizer is needed than for corn planted after corn—this is called the soybean N credit. Many producers do not factor in this soybean N credit, and they overapply N fertilizer, which causes increased loss of nitrate to rivers. Many Illinois rivers used for drinking water violate the U.S. EPA standard of 10 mg N/L, in part as a result of overapplication of N fertilizer. For every field where the soybean credit is not taken, 40 lbs of excess N fertilizer may be applied, thus significantly increasing the nitrate available for leaching into rivers. The goal of this research effort was to provide an accurate account of plant-available N in corn–soybean rotations by examining soil N mineralization rates in corn and soybean fields in order to quantify the nature of the soybean N credit.

Findings from a two-year field study indicated that the soybean N credit results from a combination of decreased net soil mineralization in continuous corn production and increased residual soil N from symbiotic fixation. This study supports the results of previous laboratory studies in Wisconsin and suggests that quality, quantity, and time of incorporation of crop residues are important factors in regulating net soil N mineralization. Researchers also found that soil N mineralization could be determined through direct soil measurements or through measuring N accumulation in unfertilized corn plants. The current soybean credit of at least 40 lbs per acre was fully supported by this study. By taking the soybean N credit, producers can save on fertilizer costs ($8 per acre assuming $.20 per lb for N) and, more importantly, reduce the loss of nitrate to rivers. Given the intense scrutiny of nitrate losses from fields to rivers in Illinois and throughout the Corn Belt, producers can take this voluntary step that reduces fertilizer costs and N losses without reducing crop yields.

Mark David, Lowell Gentry, Natural Resources and Environmental Sciences
Fred Below, James Harper, Crop Sciences
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign
Effectiveness of Controlled Drainage on Poorly Drained Soils in Illinois

The primary objective of this research was to quantify whether controlled drainage systems effectively reduce nitrate concentrations in tile effluent. This project involves monitoring tile effluent from two pairs of fields continuously during a two-year period. Each pair of fields is similar in terms of soil type, crops grown, size, and climate, but one field consists of a controlled drainage system and the other has a conventional drainage system. This pairing greatly reduces climatological and soil differences (major sources of external variability), thereby decreasing the time required to draw reliable conclusions about complex systems like these.

Researchers determined that releasing drainage control valves two weeks before the optimum planting date does not result in significant yield losses on most soils in Illinois. No significant benefit was observed from installing drainage control structures on random or irregular drainage systems; however, installing these structures on systems with regular or patterned tiles reduces nitrate loads leaving the field. This practice can be easily implemented at a very low cost and with minimal changes in current agrotechnical practices.

Richard Cooke, Michael Hirschi, Agricultural Engineering
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

Small Mammals and Corn-Soybean Agriculture: Emerging Trends and Management Issues

This research examined whether the mammal fauna in Illinois crop-lands may in the near future contribute to a greater prevalence of zoonosis and compromised crop yields from disease and depredation. If this study points to serious concerns in these areas, follow-up studies will be designed to identify monitoring and management practices to minimize these risks.

Tentative results indicate that fields with minimal tillage and planting disturbances provide ample food and cover for small mammals during the cold season. Furthermore, significant numbers of animals that persist where food and cover is ample during the winter recolonize virtually all row crops during the growing season. If substantiated over a wider and more representative portion of intensive corn–soybean settings, these findings may have important long-term implications for agriculture and the health of Illinois’ rural population. For example, researchers found preliminary evidence that the small mammal fauna

- are a source for the spread of plant pathogens within and among fields;
- may cause significant economic damage to crops under certain conditions, even in intensive row crop settings; and
- are comprised largely of Peromyscus spp., a primary reservoir of zoonosis of serious consequence to humans in North America (e.g., tick-borne diseases and the hanta virus).

This third point is particularly noteworthy because (1) Lyme Disease (LD) is the fastest spreading infectious disease in the world next to AIDS, (2) the upper Midwest is now sustaining the highest rates tick-borne diseases in the United States, (3) the Illinois Department of Public Health (IDPH) has evidence that the disease may be rapidly spreading in this state, and (4) the IDPH has recently confirmed cases of small mammals in rural Illinois harboring tick-borne diseases and the hanta virus. Because small mammals have been presumed to be scarce in intensive row crop settings, there is no appreciation at this point of the potential for significant health risks to humans in rural Illinois as a result of increased densities of these animals.

Richard E. Warner, Phil C. Mankin, Timothy R. Van Deelen, Natural Resources and Environmental Sciences
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

Conservation Strategies for Agriculture: The Integration of Wildlife Management, Phase II

In recent decades, most wildlife species in Illinois’ farming environments have declined precipitously with the expanded production of row crops and associated clean-farming practices. The objective of this research is to integrate wildlife habitat conservation with agricultural practices, especially for those wildlife species and communities that are of economic importance and/or are becoming imperiled. This project attempts to gather the knowledge required to facilitate positive interactions of wildlife and farming in Illinois. It focuses on management of upland game species, such as pheasant and quail, and of neotropical migrant species that are currently experiencing pronounced declines.

The preliminary findings confirm that (1) there is considerable untapped potential for improving wildlife habitat while achieving the broader goals of farm policies and programs in Illinois and (2) many common farming practices can be fine-tuned to benefit wildlife. Several
policy makers and key state and federal agencies have asked for detailed information about the project and specific recommendations for land use practices that will benefit wildlife. The preliminary recommendations from this project are likely to be available as farm legislation is rewritten over the next one to two years. The findings are particularly appealing because they contribute to farm policies and practices that achieve multiple resource-conservation goals.

Richard E. Warner, Phil C. Mankin, Natural Resources and Environmental Sciences College of Agricultural, Consumer and Environmental Sciences University of Illinois at Urbana-Champaign

Conservation Reserve Enhancement Program: Environmental and Economic Implications

This research focuses on developing an integrated watershed model that combines detailed spatial-biophysical attributes of cropland with a hydrological model and an economic model. The integrated model will be designed to identify the cropland that should be enrolled in the Conservation Reserve Enhancement Program (CREP) to achieve its 20% sediment abatement and 10% nitrate abatement goals at least cost. The single watershed model has been extended to 12 watersheds in the Illinois River Basin to determine a cost-effective pattern of land retirement across watersheds. The framework developed here is also used to (1) identify farmer incentives for enrolling in CREP in a decentralized decision-making setting and (2) assess the implications of alternative rental payment instruments designed to induce land retirement. Researchers analyzed two alternative rental payment instruments: one pays a uniform payment per ton of abatement achieved by retiring a land parcel while the other pays a uniform payment per acre retired. The latter closely resembles an “offer system” widely practiced by governments. Researchers examined the implications of these rental payment instruments for the type of land enrolled, the extent of land retirement needed to achieve the environmental goals of the program, and the government payments required.

Researchers have completed development of an interface between the hydrological model AGNPS (AGricultural Non-Point Source) and a geographic information system that profiles the physical features of the areas under study and endogenous sediment transport coefficients. Analysis of the Court Creek watershed shows that the land parcels best suited to CREP enrollment are adjacent to the water body, are steep in slope, and have low productivity. Researchers also found that retirement of only 11% of the eligible land (within a 900-foot buffer of a water body) is sufficient to meet the 20% sediment abatement constraint and to reduce nitrates by 18% for that watershed. A rental payment instrument that offers a uniform payment per acre of retired land is 38% more costly than a uniform payment per ton of abatement. The multiwatershed analysis suggests that cost-effective abatement requires nonuniform allocation of abatement and enrollment of land across watersheds. If targeted properly, aggregate retirement of 7% of the eligible land in 12 watersheds would be sufficient to meet their 20% sediment abatement target. Imposing uniform abatement standards on all watersheds with a dollar per acre instrument is 2.5 times more costly than nonuniform standards using a dollar per ton instrument. These results suggest several ways to improve the CREP design to achieve cost-effectiveness:

1. The eligible zone for CREP should be restricted to a buffer area that is narrower than the typical floodplain, particularly along the main tributaries of the Illinois River.
2. All land within a narrow buffer, whether it is within a floodplain or not, should be considered equally suitable for enrollment.
3. The rental payment per acre should be modified to vary across land parcels depending on their slope and location.
4. It is important to have nonuniform abatement standards and enrollment targets across watersheds.

Madhu Khanna, Richard Farnsworth, Hayri Onal, Agricultural and Consumer Economics College of Agricultural, Consumer and Environmental Sciences University of Illinois at Urbana-Champaign
The internal competitive grants 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) support a wide range of valuable ongoing C-FAR research projects. New projects are evaluated for funding each year. These programs granted support to the following new projects in FY01 (July 1, 2000 through June 30, 2001):
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<td>A Selectable Marker for the Sugary Enhancer-1 (se1) Gene in Maize</td>
<td>John A. Juwik, UIUC</td>
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<td>Tetracycline Resistance in <em>Salmonella</em> Isolated from Illinois Swine</td>
<td>Bryan A. White, UIUC</td>
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<tr>
<th>Research Focus: Rural Economic Development</th>
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<td>Alternative Crops Breeding and Production Program for Western Illinois</td>
<td>Winthrop Phippen, WIU</td>
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<td>Characteristics of Successful Entrepreneurs: Rural vs. Urban</td>
<td>Rick Whitacre, ISU</td>
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<td>Economic Activities in Rural Illinois: Analysis and Strategy to Disseminate Information in Rural Communities</td>
<td>Miguel Gomez, ISU</td>
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<td>Economic Performance of Market Advisory Services for Illinois Producers</td>
<td>Scott H. Irwin, UIUC</td>
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<td>Laurie F. Kramer, UIUC</td>
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<td>An Integrated Approach to Reduce Pathogens and Nutrients in Runoff from Animal Production Systems</td>
<td>Prasanta K. Kalita, UIUC</td>
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<td>Value Added through Service Innovation: New Opportunities for Agricultural Producers</td>
<td>Peter D. Goldsmith, UIUC</td>
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<td>100 Generations of Selection—What Happened? The Next Step</td>
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<td>Competitiveness of Late-Emerging Waterhemp in Corn and Soybean</td>
<td>Robert V. Knox, UIUC</td>
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<td>Corn Hybrid and Drying Temperature Effects on End-Use Quality</td>
<td>Kevin Baker, ISU</td>
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<td>Development of Adjustment Factors for Rams</td>
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<td>Effects of Conjugated Linoleic Acids on Lambs</td>
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<td>Enhanced Production by Increasing Level of Disease Resistance in Soybean</td>
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<td>Enhancement of Soybean Inoculation for Maximizing Yields</td>
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<td>The Enzymatic Conversion of Plant-Derived S-methylmethionine to Methionine in Animal Liver</td>
<td>Timothy A. Garrow, UIUC</td>
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<td>Gene Expression in Cloned Bovine Fetuses</td>
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<td>Identification of Soybean Genotypes with Resistance to Charcoal Rot</td>
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<td>Improving Dietary Phosphorus Utilization and Decreasing Phosphorus Excretion by Poultry and Swine</td>
<td>Carl M. Parsons, UIUC</td>
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<td>Improving the Reproductive Efficiency of the Swine Breeding Herd through Precision of Mating and Accurate Diagnosis of Reproductive Status</td>
<td>Frederic L. Kolb, UIUC</td>
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<td>Influence of Bovine Viral Diarrhea on Cattle Production within Illinois</td>
<td>Randall S. Singer, UIUC</td>
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<td>Internet-Based Management Tools for Evaluation of Precision Farming Practices for Farm Supply Dealerships: Phase II</td>
<td>Patrick O’Rourke, ISU</td>
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<td>Oligosaccharide Effects on Swine-Gut Microbial Populations and Immunity</td>
<td>George C. Fahey, Jr., UIUC</td>
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<td>Quorum Sensing in <em>Pseudomonas syringae</em>: New Targets to Control a Plant Pathogen</td>
<td>Stephen K. Farrand, UIUC</td>
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<td>Recycling Livestock and Urban Wastes as Value-Added Coproducts</td>
<td>Paul Walker, ISU</td>
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<td>Sources of Genetic Resistance to Reduce Fumonisin in Corn-Based Food</td>
<td>Donald G. White, UIUC</td>
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<td>Soybean Cyst Nematode Interactions with Other Nematode Species and Tillage Effects on this Community</td>
<td>Jason Bond, SIUC</td>
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<td>Weaning Beef Calves on Pasture</td>
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<td>Wheat Scab Resistance: Breeding and Research on Molecular Markers</td>
<td>Kris N. Lambert, UIUC</td>
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<td>Dietary Genistein and NMU-Induced Tumor Growth in a Postmenopausal Animal Model</td>
<td>William G. Helferich, UIUC</td>
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<td>Effects of Extruded Fiber on Digestibility and Gastrointestinal Characteristics</td>
<td>Neal R. Merchen, UIUC</td>
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<td>Effects of Soybean-Derived Phytostanols on Serum Cholesterol Levels</td>
<td>John D. Haddock, SIUC</td>
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<td>Identifying Resistance to Alfatoxin Contamination in Corn</td>
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<td>Isolation and Characterization of Agronomic Antimutagens and Human Cancer Cell Growth Suppressors</td>
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<td>Soy Phytoestrogens: Neutriceuticals for Our Most Deadly Ailments?</td>
<td>Mikelle J. Roeder, SIUC</td>
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<td>Wholesome and Tasty Meat: Teaming New Technology and an Old Vitamin</td>
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<td>Engineering Resistance to the Soybean Cyst Nematode</td>
<td>Christy L. Sprague, UIUC</td>
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<td>Fall Application of Nitrogen for Corn in Southern Illinois: A Need for Revisitation</td>
<td>Edward C. Varsa, SIUC</td>
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<td>Fate of 2,4-D in a Genetically Modified Grape Plant</td>
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<td>Fertilizer Nitrogen Management to Optimize Water Quality of Lake Bloomington, Illinois</td>
<td>Ken Smiciklas, ISU</td>
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<td>Field Evaluation of Tomato Germplasm for Early Blight—<em>Alternaria solani</em></td>
<td>Marietta Loehrlein, WIU</td>
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<td>Measurement of 3-Dimensional Airborne Particulate Spatial Distribution in Indoor Environments</td>
<td>Yuanhui H. Zhang, UIUC</td>
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<td>Pesticide-Free Crop Production on the Allison and Cooperative Farms</td>
<td>Gerald Vigue, WIU</td>
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fiscal year 2001: external competitive grants program

The C-FAR External Competitive Grants Program granted support to the following projects in FY01 (July 1, 2000 through June 30, 2001):

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<tr>
<td>Application of Extractable Starch Corn Calibration in Illinois Country Elevators</td>
<td>Dennis Thompson, Illinois Crop Improvement Association, Inc.</td>
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<tr>
<td>Construction Composites from Wheat By-Products</td>
<td>Vivak Malhotra, SIUC</td>
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<tr>
<td>Improving Phytoestrogen Content in Soybeans: A Non-GMO Approach</td>
<td>Todd Winters, SIUC</td>
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<td>Measurement of DNA Methylation: A Tool for Predicting Cloning Success</td>
<td>Karen Jones, SIUC</td>
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<tr>
<td>Scale-Up of a High Productivity Continuous Reactor for Butanol Production</td>
<td>Nasib Qureshi, UIUC</td>
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<tr>
<td>Soy Isoflavones: A Value-Added Nutriceutical on Swine Reproduction</td>
<td>Todd Winters, SIUC</td>
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## FY01 Projects

### Research Focus: Rural Economic Development

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<tr>
<td>Assessing Needs for a Viable Illinois Dairy Industry</td>
<td>Phillip Eberle, SIUC</td>
</tr>
<tr>
<td>Develop Marketing Resources and Networks for Producers of Value-Added Meat Products</td>
<td>Darlene Knipe, UIUC</td>
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### Research Focus: Agricultural Production Systems

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<td>Development of Added-Value Low-Phytate, High-Oil Corn Hybrids</td>
<td>Robert Lambert, UIUC</td>
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<tr>
<td>Economic Optimization of Wean-to-Finish Pork Production Systems</td>
<td>Gilbert Hollis, UIUC</td>
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<tr>
<td>Evaluating Corn GMOs for Safety, Equivalence, and Environmental Impact</td>
<td>David Lightfoot, SIUC</td>
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<tr>
<td>Improving Illinois Beef Quality through a Heifer Artificial Insemination and Development Program</td>
<td>Darrel Kesler, UIUC</td>
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<tr>
<td>Variety Evaluation and Nitrogen Management of Wheat Types in Illinois</td>
<td>Stephen Ebelhar, UIUC</td>
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### Research Focus: Human Nutrition and Food Safety

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<tr>
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<tbody>
<tr>
<td>Antibiotic Resistance in Dairy Herds: Assessment of the Risk to Food Safety</td>
<td>Randall Singer, UIUC</td>
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<tr>
<td>Control of the Growth of the Foodborne Pathogen <em>Listeria monocytogenes</em></td>
<td>Brian Wilkinson, ISU</td>
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<tr>
<td>Dietary Protein and Exercise Are Keys to Body Weight, Fat, and Blood Lipids</td>
<td>Donald Layman, UIUC</td>
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<tr>
<td>Effects of Dietary Soy Isoflavones on Rejection of Organ Transplants</td>
<td>Timothy O’Connor, SIU-School of Medicine</td>
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<tr>
<td>Identification of Human Food Corn Hybrids with Low Levels of Fumonisins</td>
<td>Donald White, UIUC</td>
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### Research Focus: Natural Resources

<table>
<thead>
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<th>Topic</th>
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<tbody>
<tr>
<td>Assessment of Best Management Practices in the Lake Springfield Watershed</td>
<td>Mark Cochran, Sangamon County Soil and Water Conservation District</td>
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<tr>
<td>Economically Extending the Grazing Season for Cattle</td>
<td>John Carlson, WIU</td>
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<td>Effect of Tillage, Lime Rate, and Timing of Limestone Application on Acid Soils</td>
<td>Stephen Ebelhar, UIUC</td>
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<tr>
<td>Effectiveness of Vegetative Filter Strip (VFS) Systems for Treating Dairy Farm Wastewater</td>
<td>Kenneth Griswold, SIUC</td>
</tr>
<tr>
<td>Map Illinois: Archival and Online Distribution of Illinois DOQs</td>
<td>Christopher McGarry, Illinois State Geological Survey</td>
</tr>
<tr>
<td>Viruses, Antibiotics, Bacteria, and Nutrients in Groundwater at Swine Facilities</td>
<td>Ivan Krapac, Illinois State Geological Survey</td>
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</table>
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 FY01 (July 1, 2000 through June 30, 2001):

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<td>FY01 Information Systems and Technology SRI Leader Support and Coordination</td>
<td>Sarahelen Thompson, UIUC</td>
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<td>The Biology Workbench: Integration of Databases, Tools, and Interfaces on the Web</td>
<td>Harris Lewin, UIUC</td>
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<tr>
<td>The Community and Economic Development Toolbox</td>
<td>Julie Fesenmaier, UIUC</td>
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<td>Farm-Based DASS and Improved Simulation Training for Farm Supplier Management</td>
<td>Patrick O’Rourke, ISU</td>
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<td>Farm Decision Outreach Central</td>
<td>Scott Irwin, UIUC</td>
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<td>Illinois Farm Producers’ Use of the Four Internet Protocols for Problem Solving</td>
<td>James W. Legacy, SIUC</td>
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<td>Illinois Integrated Pest Management Online</td>
<td>Kevin L. Steffey, UIUC</td>
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<td>Illinois Technology and Research: Allied and Integrated for Livestock Linkages</td>
<td>Michael F. Hutjens, UIUC</td>
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<td>Illinois Watershed Management Clearinghouse</td>
<td>Richard L. Farnsworth, UIUC</td>
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<td>In-Field Management Prescriptions</td>
<td>Donald G. Bullock, UIUC</td>
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<tr>
<td>Interactive Illinois Agronomy Handbook</td>
<td>Robert G. Hoeft, UIUC</td>
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<td>Microbial Control Decision Making</td>
<td>David W. Onstad, UIUC</td>
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<td>“On-Machinery” Information Management System for Precision Agricultural Operations</td>
<td>Qin Zhang, UIUC</td>
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<td>Program Impact and Reporting System Pilot Project</td>
<td>Sarahelen Thompson, UIUC</td>
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<td>A System for Aggregate Analysis of Spatially Distributed Crop Production Data</td>
<td>Gary D. Schnitkey, UIUC</td>
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<td>Web Development for the Functional Foods for Health (FFH) and Nutrition Analysis Tool (NAT) Web Pages</td>
<td>James E. Painter, UIUC</td>
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<td>Burton E. Swanson, UIUC</td>
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<td>Community Concerns and Citizens’ Reaction to Large-Scale Swine Facilities in Illinois</td>
<td>Ann Reisner, UIUC</td>
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<td>Comparison of Various Approaches to Sample Collection and Odor Measurement</td>
<td>Stanley Curtis, UIUC</td>
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<td>Continuous Thermochemical Conversion Process of Liquid Livestock Manure to Produce Oil and Reduce Odor and Waste</td>
<td>Yuanhui Zhang, UIUC</td>
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<td>Develop and Evaluate a Low-Cost Inflatable Cover for Earthen Manure Lagoon to Reduce Odor Emissions: Year 3 Monitoring Evaluation</td>
<td>Yuanhui Zhang, UIUC</td>
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<td>Dispersion Modeling and Source Characterization</td>
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<td>Establishing a Production-Scale Solid–Liquid Separation–Aeration System for Swine Slurry</td>
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<td>Illinois Odor and Nutrient Control Proving Center (ION-PC)</td>
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<td>Impact of Nitrogen and Sulfur Reduction and Yucca schidigera Addition on Odor Characteristics of Effluent from Growing Swine</td>
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<td>Excretion in Swine Production</td>
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<td>Legal Issues in Swine Odor and Waste Management</td>
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<td>Odor Offensiveness: Qualitative and Quantitative Identification of Odor-Significant</td>
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<td>Swine Waste Treatment Using On-Farm, Full-Scale Anaerobic Sequencing Batch</td>
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<td>Martha Barclay, WIU</td>
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<td>On-Farm HACCP: Development of Farm-Level Strategies to Improve <em>Salmonella</em></td>
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<td>Ray Cooke, Springfield Department of Public Health in</td>
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<td>cooperation with SIU School of Medicine</td>
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<td>Safety of Pasture vs. Free-Range Chickens Using Organic and Traditional</td>
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<td><em>Salmonella</em> Detection and Control: Ensuring the Safety of Food Products</td>
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<td>Simple and Cost-Effective Tests to Detect <em>Salmonella</em></td>
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<td>Train the Trainer: HACCP Training in Food Services in Illinois</td>
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<td>Using Large-Scale Gene-Expression Analysis to Address Food Safety Concerns</td>
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<td>Conceptual Model of Nitrogen Mass Balance</td>
<td>Derek Winstanley, Illinois State Water Survey</td>
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<td>Conjunctive Overland Soil and Tile Transport Model for Farmland Drains</td>
<td>Ben C. Yen, UIUC</td>
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<td>Decision Support for Water Quality Planning in Multiple-Ownership Watersheds</td>
<td>Jeffrey Beaulieu, SIUC</td>
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<td>Effect of Time and Rate of Nitrogen Application on Nitrate Contamination of</td>
<td>Robert Hoeft, UIUC</td>
</tr>
<tr>
<td>Surface Water</td>
<td></td>
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<tr>
<td>Enhancement of Water Quality and Farm Income: Decision Support for</td>
<td>Jean C. Mangun, SIUC</td>
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<tr>
<td>Riparian Management Systems</td>
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<tr>
<td>Evaluation and Development of Soil Biogeochemical Process Models for</td>
<td>Robert J.M. Hudson, UIUC</td>
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<tr>
<td>Tile-Drained Fields</td>
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<tr>
<td>Evaluation of Nitrogen Management Practices on Corn Yield and the</td>
<td>Robert Hoeft, UIUC</td>
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<tr>
<td>Environmental Fate of Nitrogen</td>
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<tr>
<td>Factoring Crop Nitrogen Accumulation into Budgets of Nitrogen Mass Balances</td>
<td>Fred E. Below, UIUC</td>
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<tr>
<td>Factors Affecting Phosphorus Loss from Agricultural Soils</td>
<td>Robert Hoeft, UIUC</td>
</tr>
<tr>
<td>Flow and Transport in Shallow Subsurface Drainage Systems</td>
<td>Richard A.C. Cooke, UIUC</td>
</tr>
<tr>
<td>Long-Term Changes in Agricultural Soil Nitrogen and Carbon Pools</td>
<td>Mark B. David, UIUC</td>
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<tr>
<td>Watersheds</td>
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<tr>
<td>The Role of In-Stream Processes in the Cycling of Dissolved Nitrogen (A)</td>
<td>Mark B. David, UIUC</td>
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<tr>
<td>The Role of In-Stream Processes in the Cycling of Dissolved Nitrogen (B)</td>
<td>Karl W.J. Williard, SIUC</td>
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<td>Phosphorus) in the Big Ditch Watershed (A)</td>
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<td>Spatial and Temporal Variability of Nutrients in Illinois Streams</td>
<td>Misganaw Demissie, Illinois State Water Survey</td>
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<td>Spatially Aggregated Approaches to Modeling Nitrogen Dynamics in Tile-Drained</td>
<td>Gregory F. McIsaac, UIUC</td>
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<td>Watersheds</td>
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<td>Statewide Mass Balance Model for Estimating Allowable Nitrogen Application</td>
<td>Stephen Wente, UIUC</td>
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<td>Rates</td>
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<td>Understanding and Modeling the Hydrology of Tile-Drained Watersheds</td>
<td>Prasanta K. Kalita, UIUC</td>
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<td>Variable-Rate Nitrogen Management: An Agronomic, Economic, and Environment</td>
<td>Madhu Khanna, UIUC</td>
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<td>Assessment</td>
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<td>Watershed Monitoring in Support of WQ-SRI Data Collection Needs</td>
<td>Laura L. Keefer, Illinois State Water Survey</td>
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<td>Watershed-Scale Nitrogen Balance: Fertilizer Nitrogen Input</td>
<td>Gregory F. McIsaac, UIUC</td>
</tr>
<tr>
<td>WQ-SRI Outreach and Data Repository</td>
<td>James Westervelt, UIUC</td>
</tr>
</tbody>
</table>
Despite being a national leader in corn, soybean, and livestock production, Illinois ranked only 26th among states in funding of food and agricultural research in 1995. Concerned about the future of Illinois food and agriculture, dedicated individuals from across Illinois established the C-FAR organization to increase funding for research programs and related outreach in order to adequately support our state’s number one industry.

C-FAR efforts led the Illinois General Assembly to pass the Food and Agriculture Research Act, which resulted in an appropriation of $3 million in FY96. Each subsequent year, the State appropriation has increased by $3 million, with the FY00 and FY01 appropriations reaching $15 million. Thanks to the dedication of C-FAR members, strong support from the State of Illinois, and efforts by a broad range of C-FAR supporters, Illinois ranked 16th nationally in state funding of food and agricultural research (based on FY99 data). C-FAR members extend their appreciation and gratitude to Governor Ryan, the Illinois General Assembly, the Illinois Department of Agriculture, and other advocates for their continued support and commitment to C-FAR and its mission. As stated in the enabling legislation, our goal is that “Illinois should be among the top 10 agricultural states in state funding.”

**Illinois Investments in Food and Agricultural Research**

<table>
<thead>
<tr>
<th></th>
<th>FY95 (26th)</th>
<th>FY96 (22nd)</th>
<th>FY97 (19th)</th>
<th>FY98</th>
<th>FY99</th>
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<tr>
<td>Millions</td>
<td>$10</td>
<td>$15</td>
<td>$20</td>
<td>$25</td>
<td>$30</td>
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</table>

**SOURCE OF DATA IS THE INVENTORY OF AGRICULTURAL RESEARCH, USDA/CREES (LAND GRANT INSTITUTIONS), WHICH REFLECTS EXPENDITURE OF STATE FUNDS FOR FOOD AND AGRICULTURAL RESEARCH BY LAND GRANT INSTITUTIONS. FY96–99 FIGURES INCLUDE BOTH C-FAR-APPROPRIATED FUNDS AND OTHER GENERAL REVENUE FUNDS AS APPROPRIATED BY THE STATE OF ILLINOIS.**
Comparison of Selected Agricultural States’ Annual Research Expenditures (FY99)

SOURCE OF DATA IS THE INVENTORY OF AGRICULTURAL RESEARCH, USDA/CREES (LAND GRANT INSTITUTIONS), WHICH REFLECTS FY99 EXPENDITURES (NOT APPROPRIATIONS) OF STATE FUNDS FOR FOOD AND AGRICULTURAL RESEARCH BY LAND GRANT INSTITUTIONS. ILLINOIS FIGURE INCLUDES BOTH C-FAR-APPROPRIATED FUNDS AND OTHER GENERAL REVENUE FUNDS AS APPROPRIATED BY THE STATE OF ILLINOIS.
Summary of FY00 Expenditures and Obligated Funds

**External Competitive Grants Program** ...................... 3,750,396
Expenditures ........................................... 1,714,850
Obligations ........................................... 2,035,546

**Internal Programs** ............................................. 8,957,179
Expenditures ........................................... 5,683,995
Obligations ........................................... 3,273,184

**Strategic Research Initiatives** ................................. 7,341,034
Expenditures ........................................... 4,578,883
Obligations ........................................... 2,762,151

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

**Member Expense Account** .................................... 68,800

**Total FY00 Expenditures and Obligated Funds** ........... $20,167,409
Expenditures ........................................... $12,096,528
Obligations ........................................... $8,070,881

*Note:* The total FY00 expenditures and obligated funds are higher than the FY00 appropriation because a portion of the FY99 funds were obligated for investment in FY00.

Summary of FY01 Allocations

External Competitive Grants Program ............................ 2,301,200*

Internal Programs .................................................. 7,580,000

Strategic Research Initiatives ...................................... 5,000,000

Illinois Department of Agriculture Fee
($50,000, or 1/3 of 1% of the total appropriation, whichever is less) ........ 50,000

Member Expense Account (1% of the total appropriation) ............. 150,000

**Total FY01 Allocations** ........................................ $15,081,200

* An additional $81,200 (from unexpended funds in the FY00 1% Member Expense Account) was allocated to the FY01 External Competitive Grants Program by agreement with the Illinois Department of Agriculture.
## C-FAR FY00 Expenditure Summary: Internal Programs

(July 1, 1999 through June 30, 2000)

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<tr>
<th>C-FAR Research Focus Areas</th>
<th>Expenditure Areas</th>
<th>UIUC</th>
<th>SIUC</th>
<th>ISU</th>
<th>WIU</th>
<th>Per Legislation</th>
<th>TOTALS</th>
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<td>Services/Contracts</td>
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<td>Subtotals</td>
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<td>3,665</td>
<td>4,524</td>
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<td>26,950</td>
<td>9,800</td>
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<td>N/A</td>
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<td>$68,800</td>
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<tr>
<td>IDOA Fee</td>
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<td>N/A</td>
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<tr>
<td>Awards/Obligated Funds for FY01 Research</td>
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<td>10,132</td>
<td>96,351</td>
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<td>$3,273,184</td>
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<tr>
<td>Total FY00 Expenditures and Obligated Funds</td>
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<td>$7,635,479</td>
<td>$806,850</td>
<td>$290,800</td>
<td>$220,050</td>
<td>$118,800</td>
<td>$9,075,979</td>
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</table>

* FY00 Achievement Award expenditures are included in these figures.
# C-FAR FY00 Expenditure Summary: External Program

(July 1, 1999 through June 30, 2000)

<table>
<thead>
<tr>
<th>C-FAR Research Focus Areas</th>
<th>Actual Fiscal Year Expenditures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UIUC</td>
</tr>
<tr>
<td>Expanding Agricultural Markets</td>
<td></td>
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<td>Equipment</td>
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<tr>
<td>Materials/Supplies</td>
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<td>Personnel</td>
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<td>Services/Contracts</td>
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<td>Transportation</td>
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<tr>
<td>Rural Economic Development</td>
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<td>Equipment</td>
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<td>Materials/Supplies</td>
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<td>Personnel</td>
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<td>Services/Contracts</td>
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<td>Transportation</td>
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<td>Agricultural Production Systems</td>
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<td>Equipment</td>
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<td>Materials/Supplies</td>
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<tr>
<td>Personnel</td>
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<td>Services/Contracts</td>
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<tr>
<td>Human Nutrition and Food Safety</td>
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<td>Equipment</td>
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<td>Materials/Supplies</td>
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<td>Personnel</td>
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<td>Services/Contracts</td>
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<td>Transportation</td>
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<td>Natural Resources</td>
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</tr>
<tr>
<td>Total FY00 Expenditures and Obligated Funds</td>
<td>$1,789,112</td>
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</table>

* Other entities are DeKalb County Lamb & Wool Producers, Illinois Crop Improvement Association, Sangamon County Soil & Water Conservation District, and University of Illinois at Springfield.
# C-FAR FY00 Expenditure Summary: Strategic Research Initiatives (SRIs)

*(July 1, 1999 through June 30, 2000)*

<table>
<thead>
<tr>
<th>Strategic Research Initiative</th>
<th>Expenditure Areas</th>
<th>UIUC</th>
<th>SIUC</th>
<th>ISU</th>
<th>WIU</th>
<th>Other Entities*</th>
<th>TOTALS</th>
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* Other entities are American Farmland Trust, Foundation for Agronomic Research, Illinois Restaurant Association Education Foundation, and the National Center for Food Safety and Technology at the Illinois Institute of Technology.
<table>
<thead>
<tr>
<th>C-FAR Research Focus Areas</th>
<th>Internal Grant Programs</th>
<th>External Competitive Grants Program</th>
<th>Strategic Research Initiatives</th>
<th>Per Legislation</th>
<th>TOTALS</th>
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<tr>
<td></td>
<td>UIUC 82%</td>
<td>SIUC 11%</td>
<td>ISU 4%</td>
<td>WIU 3%</td>
<td>Internal Totals</td>
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</table>

* An additional $81,200 from unexpended funds in the FY00 1% Member Expense Fund was allocated to the FY01 External Program.
## Websites to watch:

<table>
<thead>
<tr>
<th>Service</th>
<th>Website</th>
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<tbody>
<tr>
<td>C-FAR</td>
<td><a href="http://www.ilcfar.org">www.ilcfar.org</a></td>
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<tr>
<td>Information Systems and Technology SRI</td>
<td><a href="http://web.aces.uiuc.edu/sriit">web.aces.uiuc.edu/sriit</a></td>
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<tr>
<td>Rural Community Development SRI</td>
<td><a href="http://www.siu.edu/~i-farrm">www.siu.edu/~i-farrm</a></td>
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<tr>
<td>Swine Odor and Waste Management SRI</td>
<td><a href="http://sowm.outreach.uiuc.edu">sowm.outreach.uiuc.edu</a></td>
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<td>Food Safety SRI</td>
<td><a href="http://www.ag.uiuc.edu/sri/foods.html">www.ag.uiuc.edu/sri/foods.html</a></td>
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<tr>
<td>Water Quality SRI</td>
<td><a href="http://web.aces.uiuc.edu/sriwq">web.aces.uiuc.edu/sriwq</a></td>
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</table>
| NAT Tools for Good Health        | [www.nat.uiuc.edu](http://www.nat.uiuc.edu)  
  *For analyzing diet and food choices.* |
| farm.doc                         | [www.farmdoc.uiuc.edu](http://www.farmdoc.uiuc.edu)  
  *Provides farmers with decision-making information and analysis tools.* |
| Illinois TRAILL                  | [il-traill.outreach.uiuc.edu](http://il-traill.outreach.uiuc.edu)  
  *Organizes livestock research, information, and expert services.* |
| Online Agronomy Handbook         | [web.aces.uiuc.edu/iah](http://web.aces.uiuc.edu/iah)  
  *Databases and online resources complement handbook.* |
| Pest Management & Crop Development Bulletin | [www.ag.uiuc.edu/cespubs/pest](http://www.ag.uiuc.edu/cespubs/pest)  
  *Provides scouting reports, management advice, and decision-aid tools.* |
| Illinois IPM Online              | [www.ipm.uiuc.edu](http://www.ipm.uiuc.edu)  
  *An environment for learning about integrated pest management.* |
| Illinois Watershed Management Clearinghouse | [web.aces.uiuc.edu/watershed](http://web.aces.uiuc.edu/watershed)  
  *Helps groups create and implement a plan to address local watershed issues.* |
| Community Development Toolbox    | [www.ag.uiuc.edu/~lced/cfarsriit.html](http://www.ag.uiuc.edu/~lced/cfarsriit.html)  
  *Addresses rural needs for data analysis.* |