C-FAR 2001

— A Partnership for Illinois Food and Agriculture

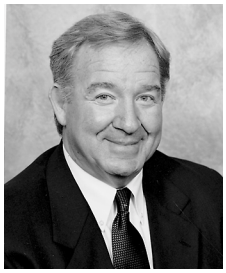
C-FAR

Illinois Council on Food and Agricultural Research

A Partnership for Illinois Food and Agriculture

The Illinois Council on Food and Agricultural Research (C-FAR) is a statewide coalition of food and agricultural leaders, government officials, legislators, research administrators, researchers, consumers, and other dedicated individuals working together to increase targeted, high-quality research in support of Illinois' number one industry. Since C-FAR's founding in 1993, this stakeholder partnership has steadily grown and matured, supporting and providing direction for valuable research that continues to expand agricultural markets; advance production technologies; increase revenue for crop and livestock producers; ensure safe, nutritious food supplies; protect our natural resources; and more. C-FAR research and outreach programs are providing immediate benefits for Illinois and its citizens, as well as protecting our state's future as an industry leader. Across the nation, C-FAR is recognized as a premier example of a public and private partnership.

State of Illinois
George H. Ryan, Governor



Illinois Department of Agriculture
Joe Hampton, Director

Food and Agricultural Industry Leaders

Consumers

University of Illinois at Urbana-Champaign

Southern Illinois University at Carbondale

Illinois State University

Western Illinois University

Other Research Entities

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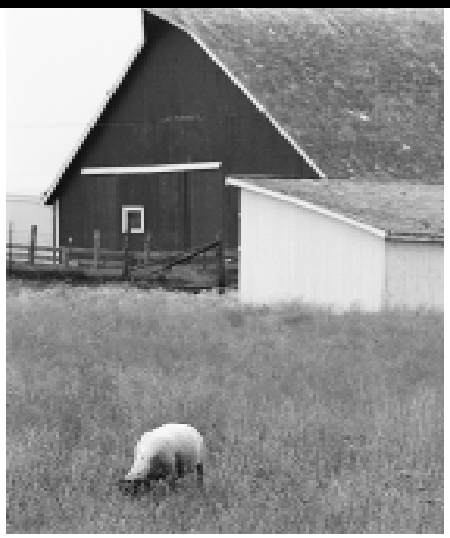
Message from C-FAR



Dear Friends,

The Illinois Council on Food and Agricultural Research (C-FAR) has grown and accomplished much since its establishment in 1993. C-FAR has not only brought together food and agricultural industry leaders from throughout Illinois, it has created productive bonds among the food and agricultural community, research institutions, and State of Illinois elected and appointed officials. C-FAR research has strengthened Illinois' number one industry by reaching out to all regions within our state and supporting a wide range of food and agricultural concerns and opportunities.

C-FAR-funded research initiatives continue to address a wide range of food and agricultural needs. The following are a few examples of how the C-FAR research portfolio is benefiting Illinois:

- More than 600 food service personnel and 150 local environmental health specialists have been trained in HACCP (Hazard Analysis Critical Control Points) procedures to prevent foodborne illnesses.
- A tomato line has been developed to serve as a delivery vehicle for a vaccine that protects people from respiratory syncytial virus (RSV), one of the most serious respiratory diseases.
- A wide range of Internet-based food and agricultural resources and tools are available to producers and consumers, including a nutritional analysis site that receives over one million hits per month.
- Selection methods that use DNA markers to identify soybean disease resistance will allow producers to reduce yield losses associated with soybean cyst nematode; these losses cost growers over $100 million in income annually.
- Over 250 beef industry leaders have participated in in-depth training during the past three years and can expect to gain premiums ranging from $50 to $150 per animal.
- Unique technologies have been developed to address issues related to swine odor and manure management with the goal of supporting the development of an environmentally sustainable, socially acceptable, and economically viable swine industry.
- Scientific data is aiding the development of appropriate, effective water quality policy and best management practices that can be adopted by farmers.

C-FAR research not only supports traditional production areas, including corn, soybeans, and livestock, but it also aggressively investigates new opportunities for Illinois producers such as aquaculture, alternative crops, and value-added initiatives.

Thanks to the commitment and dedication of State of Illinois officials, funding of food and agricultural research remains a high priority in our state. In 1995, Illinois ranked 26th among all states in food and agricultural research expenditures; according to FY00 data, Illinois now ranks 15th among all states. As new challenges and opportunities arise, a strong research program is necessary to ensure the future of our industry. The advancement of knowledge and development of cutting-edge technologies fortify our food and agricultural systems, secure the economic prosperity of our state, and strengthen our nation.

Jack Erisman
Chairman of the Board

Kraig A. Wagenecht
Executive Administrator

2001 Highlights

The Value Project team received the 2001 Achievement Award at the C-FAR Annual Meeting in February. Kevin Wright (second from left), Deputy Chief of Staff for Governor Ryan, presented the award.

All Working Group Meeting

Over 140 members attended the All Working Group Meeting on January 23 at Holiday Inn–Traders in Normal. Strategic Research Initiative leaders provided updates on their research programs, and working groups reviewed the FY01 research portfolio, final reports for research projects ending in FY00, and their respective research focus areas. C-FAR's first member handbook, developed to provide members with a useful reference on C-FAR programs and activities, was introduced and distributed.

Annual Meeting

Highlights of the February 20 annual meeting included meetings of the five working groups, presentation of the 2001 Achievement Award, election of the 2001 board of directors and working group leaders, and adoption of a Conflict of Interest policy. Kevin Wright, deputy chief of staff for Governor George H. Ryan, joined meeting activities to present the 2001 C-FAR Achievement Award. The recipient of this year's award was *The Value Project* research team: Burton Swanson (project leader), Mohamed Samy, Linda Eilks, Darrel Good, Emerson Nafziger, Rita Frerichs, and Andrew Sofranko from the University of Illinois at Urbana-Champaign; Michael Roegge and Peter Fandel from University of Illinois Extension; and Norman Walzer, Christopher Merrett, and Mary Holmes from Western Illinois University. Through their innovative approach and outstanding performance, the team has made great strides in improving Illinois farm income and strengthening rural communities through value-added agriculture. During the meeting, special recognition was given to past C-FAR chairman W. Lyle Roberts, Jr., a founding director who had served on the board of directors from 1993 through 2000.

Water Quality Forum

More than 100 individuals, including C-FAR members and others interested in Illinois water quality issues, gathered on March 1 at the Crowne Plaza Hotel in Springfield to learn about the latest water quality research efforts under way through C-FAR's Water Quality Strategic Research Initiative (WQ-SRI). This special event was cosponsored by C-FAR and University of Illinois Extension. Scientists involved with the WQ-SRI presented current research in three major areas: (1) movement and storage of nitrogen in Illinois watersheds, (2) modeling to support economic and ecological decisions, and (3) developing and testing promising new best management practices (BMPs). The event's guest speaker, Warren Goetsch, administrator of the Illinois Department of Agriculture's Division of Natural Resources, described the IDOA's recently formed Illinois Nutrient Management Task Force.

Working group chair A.J. Harland shares his views on research proposals at the semi-annual meeting.

C-FAR food safety strategic research initiative researcher Shari Barter, from Southern Illinois University, assists young fairgoers with an educational kiosk at the 2001 Illinois State Fair.

Attendees to the Swine Manure and Odor Management Field Day at the University of Illinois in Urbana were welcomed by sponsorship leaders Mark Gebhards, executive director of the Illinois Pork Producers Association; Robert Easter, interim dean of the University of Illinois College of ACES; and Jack Erisman, chairman of the C-FAR board of directors.

External Competitive Grants Program Proposal Review

The External Competitive Grants Program followed a new two-step review procedure for evaluating FY02 proposals. The first step was a request for and review of pre-proposals. Working group members evaluated pre-proposals based on relevance to C-FAR research focus areas, potential outcomes and benefits to stakeholders, and dissemination plans. The second step of the proposal process included inviting principal investigators of top-ranking pre-proposals to submit full proposals. Full proposals underwent scientific review and evaluation. Researchers from across Illinois submitted a record number of 162 pre-proposals, requesting more than $17 million in support, to the FY02 program. Approximately $2.2 million was available through this year's program. C-FAR working group members attended full-day meetings in March to review the proposals, discuss priorities, and make decisions about which projects to fund. Thirty research proposals were selected for funding, supporting research projects at the University of Illinois at Urbana-Champaign (UIUC), Southern Illinois University at Carbondale (SIUC), Western Illinois University (WIU), Illinois State University (ISU), University of Illinois at Springfield (UIS), Illinois Institute of Technology, and Illinois State Water Survey.

Semi-annual Meeting

At the August 21 semi-annual meeting, working group members met to discuss the FY03 External Competitive Grants Program, the maturity of the Strategic Research Initiatives (SRIs), and the upcoming membership retreat, as well as to review the FY02 research portfolio. Burton Swanson, leader of *The Value Project*, gave a special presentation on this initiative, which received the 2001 C-FAR Achievement Award. Members discussed the Grow Illinois FY03–FY07 funding request— if this request is granted, Illinois could rank 9th nationally in state funding for food and agricultural research by FY07. At this meeting, members also adopted a confidentiality statement designed to guide the review process for research proposals.

Swine Manure and Odor Management Field Day

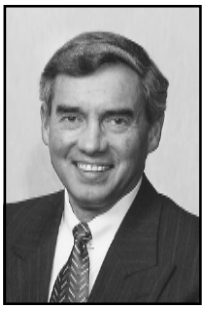
The first Swine Manure and Odor Management Field Day, jointly organized by C-FAR, the Illinois Pork Producers Association, and the University of Illinois, was held on August 29 at the University of Illinois Stock Pavilion. Swine producers and other interested professionals received current information regarding all aspects of managing manure and odors from swine units. The program focused on research funded through the C-FAR Swine Odor and Waste Management Strategic Research Initiative but also provided information from a range of other research projects and programs addressing key areas of swine management.

C-FAR Day

The first C-FAR Day was held on November 13 at the University of Illinois at Urbana-Champaign. C-FAR members enjoyed the opportunity to visit with researchers at their research facilities and to see ongoing research efforts firsthand. C-FAR-funded research featured at this special event included studies in biotechnology, sustainability of dairy farms, functional foods, agricultural remote sensing, commercial grape and wine production, and water quality. Future C-FAR Days will feature research initiatives at Southern Illinois University at Carbondale, Illinois State University, Western Illinois University, and other research entities that receive C-FAR funds.

Who's Who

2001 Board of Directors



Jack Erisman
CHAIRMAN OF THE BOARD, PANA

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

Fred Bradshaw
SECRETARY-TREASURER, GRIGGSVILLE

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

Carol Keiser
MEMBERSHIP CHAIR, CHAMPAIGN

Alan Puzey
VICE RESEARCH CHAIR, FAIRMOUNT

Terry Wolf
PAST CHAIR, HOMER

Staff

Kraig A. Wagenecht
EXECUTIVE ADMINISTRATOR

LeAnn M. Ormsby
COMMUNICATIONS DIRECTOR

Additional C-FAR Staff

Rhonda Hunter
ADMINISTRATIVE ASSISTANT

Barbara Haegele
SECRETARY

Ellen Jansen
SECRETARY

Dionne Simmons
SECRETARY

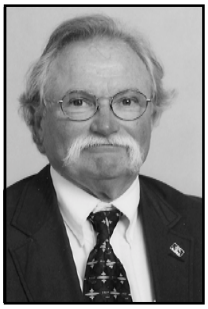
2001 Working Group Leadership

Expanding Agricultural Markets

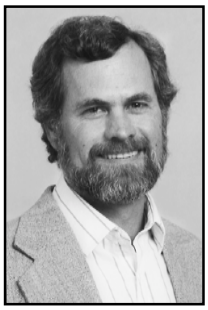
Nels Kasey
CHAIR, ASHMORE

Roger Hubele
VICE CHAIR, ENFIELD

Rural Economic Development



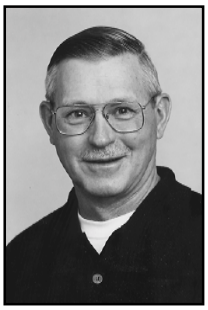
A.J. Harland
CHAIR, LAFAYETTE



Kevin Brussell
VICE CHAIR, CASEY

Agricultural Production Systems

Brent Bidner
CHAIR, MONTICELLO



Don Doehring
VICE CHAIR, WINDSOR

Human Nutrition and Food Safety

Carol Meyer
CHAIR, STEELEVILLE

Karen Little
VICE CHAIR, PLEASANT PLAINS

Natural Resources

Susan Adams
CHAIR, ATLANTA

Rollie Moore
VICE CHAIR, ONEIDA

2001 C-FAR Members

ORGANIZATIONAL MEMBERS

Association of Illinois Soil and Water Conservation Districts

Audubon Council of Illinois

Champaign County Farm Bureau

Dairy Management, Inc.

Environmental Law and Policy Center of the Midwest

Farm Credit Services of Illinois

Grain and Feed Association of Illinois

GROWMARK, Inc.

Hancock County Farm Bureau

Horsemen's Council of Illinois

Horseradish Growers of Illinois

Illinois Agri-Women

Illinois 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 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 & Vintners Association

Illinois Lamb and Wool Producers, Inc.

Illinois Landscape Contractors Association

Illinois Milk Producers' Association

Illinois Nurserymen's Association

Illinois Pork Producers Association

Illinois Pork Producers Association - Checkoff Division

Illinois Restaurant Association

Illinois Seed Trade Association, Inc.

Illinois Society of Professional Farm Managers 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, Inc.

Illinois Wheat Association

Institute of Food Technologists, Chicago Section

Kane County Farm Bureau

Kankakee County Farm Bureau

Knox County Farm Bureau

Lake Vermilion Water Quality Coalition

Macoupin County Farm Bureau

Madison County Farm Bureau

Mason County Farm Bureau

Mercer County Farm Bureau

Midwest Dairy Association

Rural Partners

Safer Pest Control Project

Southeastern Illinois Sustainable Agriculture Association

Southern Illinois University Agriculture Alumni Society

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

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

Warren–Henderson Farm Bureau

AFFILIATE MEMBERS

Central Illinois Agricultural Research Farms, Inc.

Greene Farm Management Services, Inc.

Illinois Crop Improvement Association, Inc.

Illinois Farm Development Authority

Illinois Forestry Development Council

Illinois Grape and Wine Resources Council

Illinois Institute for Rural Affairs

Illinois State Geological Survey

Illinois State University, Department of Agriculture

Illinois State Water Survey

National Center for Food Safety and Technology

Sangamon County Soil and Water Conservation District

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

Southern Illinois University at Carbondale, College of Agriculture

Southern Illinois University at Carbondale, Department of Agribusiness Economics

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

Southern Illinois University at Carbondale, Department of Forestry

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

Southern Illinois University at Carbondale, 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 Clinical Medicine

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 2001, C-FAR had 141 individual members.

C-FAR Committees

Research Committee

The purpose and charge of this committee is to

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

Committee members:

David Downs, chair; Alan Puzey, vice chair; Susan Adams; Brent Bidner; Kevin Brussell; Steve Calhoun; Len Corzine; George Fahey; Paul Gebhart; Molly Ann Godar; Pam Hansen; A.J. Harland; W. Michael Herrin; Nels Kasey; Steve Kasten; Dan Kelley; Karen Little; Carol Meyer; Steven Pueppke; John Quandt; Danny Terry; Frank Thorp; Walt Townsend; Derek Winstanley; Randy Winter; and Anthony Young.

Nominating Committee

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

Committee members:

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

Rules and Procedures Committee

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

Committee members:

Larry Fischer, chair; Rick Dean; Dale Hedrick; Patricia Lawfer; Kent Krukewitt; Norbert Soltwedel; Dennis Thompson; and Randy Vogel.

Research Partners

"For the University of Illinois College of ACES, C-FAR is a valued connecting point, helping us to better serve the important needs of our constituencies. C-FAR is an ideal model for sharing ideas and resources. It is through this sort of cooperation and coordination that we can increase the returns to the public on its investment in research and outreach projects. Together, we can help create a stronger food and agriculture economy; protect our valuable natural resources; and produce safer, higher quality, and more affordable food."

Robert A. Easter, Interim Dean
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

"C-FAR funding and stakeholder input have allowed Western Illinois University to continue building a research and outreach program that supports the needs of Illinois' food and agricultural sector. Over the past year, we have been able to work directly with Prairie Premium Agricultural Coalition in McDonough County to address their intermediate and long-term production and economic goals. WIU has also developed an alternative crops program in an attempt to investigate, secure, and introduce an economical third crop into the farmers' traditional corn–soybean rotation. Without C-FAR, this program would not be under way. "

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

"Illinois agriculturists and consumers have clearly benefited tremendously from the Illinois C-FAR investment. The savings reaped from protecting Illinois agricultural products has far exceeded our investment. C-FAR is truly a great economic generator for Illinois and has contributed significantly to improving the quality of food and of rural and urban living for Illinois residents."

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

"C-FAR has a major impact on the research and outreach programs of the Department of Agriculture at Illinois State University. Evidence of C-FAR's impact is widespread throughout the department: improved laboratory facilities, new equipment, and research projects in progress. The C-FAR partnership pays dividends to the citizens of Illinois in both short-run research results and long-run research capacity enhancement. The interaction between researchers and members of C-FAR provides mutual benefits—greater insight into the research process for C-FAR members and sharpened focus on 'problems that matter' for the researchers."

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, C-FAR Research Leadership, College of Agricultural, Consumer and Environmental Sciences, University of Illinois at Urbana-Champaign

Anthony W. Young, Associate Dean for Research, College of Agricultural Sciences, Southern Illinois University at Carbondale

Research Programs Fiscal Year 2001

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 FY01, Governor George H. Ryan and the Illinois General Assembly appropriated $15 million to C-FAR.

Funds are allocated to three C-FAR research programs:

Strategic Research Initiatives

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

Internal Programs

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

External Competitive Grants Program

C-FAR's enabling legislation stipulates that a minimum of 15% of the total appropriation be allocated to an external competitive grants program open to qualified researchers at nonprofit institutions, organizations, or agencies in Illinois. The C-FAR working groups evaluate and select the proposals for funding.

Proposal review currently follows a two-step process first implemented for the FY02 competitive grants program. The first step is a request for and review of pre-proposals. C-FAR working group members evaluate pre-proposals based on relevance to C-FAR research focus areas, potential outcomes and benefits to stakeholders, and dissemination plans. The second step involves inviting principal investigators of top ranking pre-proposals to submit full proposals. Full proposals then undergo scientific review and evaluation.

Strategic Research Initiatives

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 from FY99 to FY02. The following description of each SRI highlights portions of the SRI leader's report to C-FAR on the progress of his or her SRI's research and outreach efforts in FY01.

Information Systems and Technology

Sarahelen (Sally) R. Thompson, SRI Leader, University of Illinois at Urbana-Champaign

Gary D. Schnitkey, Interim SRI Leader in FY02, University of Illinois at Urbana-Champaign

Building on efforts initiated during the previous two years, the Information Systems and Technology Strategic Research Initiative (IT-SRI) focused on four areas in FY01: farm and agribusiness tools, water quality and natural resources, community and consumer interests, and research tools. The IT-SRI's goal is to improve the availability, integration, delivery, and use of information throughout the global food and agricultural systems, with special focus on Illinois. Most IT-SRI projects have matured to the point where they can provide food and agricultural decision makers in Illinois with important guidance. The following are a few examples of the many significant achievements of IT-SRI projects during FY01.

FARM.EDU

IT-SRI investigators collaborated in preparing a revised proposal for the development and delivery of the Integrated Online Farm and Resource Management Decision Support System, FARM.EDU. FARM.EDU will provide the basis for the IT-SRI in FY02 and beyond. The goal of FARM.EDU is to improve farm efficiency and profitability through development and delivery of a comprehensive, integrated farm and resource management decision support system. FARM.EDU will help farmers evaluate alternative management strategies. It will allow users to access site-specific information and customize decision tools to reflect the characteristics of individual farms. FARM.EDU will model the complexity and interrelated nature of the farm management decision process by

- aggregating, integrating, and enhancing decision support tools in the areas of marketing and risk management; analysis of value-added opportunities; livestock management; pest management; agronomic decision making; and natural resource management
- conducting cross-disciplinary research and employing new Internet-based technologies to support integration and development of FARM.EDU

Farm.doc

www.farmdoc.uiuc.edu

Farm.doc is a mature and highly successful product of the IT-SRI. Between April 1998 and January 2001, the total number of pages downloaded from farm.doc has jumped almost 1000%, from 7,291 in April 1998 to 70,323 in January 2001. Several new Web-based decision tools, focusing primarily on crop insurance, have been added to the system. Producers and Illinois Farm Business Farm Management (FBFM) field staff are using several outputs from A System for Aggregate Analysis of Spatially Distributed Crop Production Data. This software, developed by project researchers, allows producers to compare their site-specific performance information to aggregated standards. Tools developed by this project are available at the farm.doc site, www.farmdoc.uiuc.edu/finance/business.html.

Enhanced Farm Research Analyst

www.farmresearch.com/efra

Enhanced Farm Research Analyst (EFRA) software will soon be available to the public as freeware. EFRA software permits the rapid and inexpensive design of on-farm agronomic experiments. Experiments are implemented using GPS-connected computers on planters and input applicators. The On-tractor Information Manager, also known as the Agricultural Infotronic System (AIS), supports on-field data collection, communication, and delivery to support implementation of precision farming. The AIS is currently being tested in a laboratory environment. In addition, AIS research is being merged with the EFRA project under FARM.EDU for eventual practical testing and use.

ProSTAR+

The beta version of the Web-based agribusiness simulator ProSTAR+ is being tested at Illinois State University and presented at national scientific meetings. The overall goal of this project is to design and implement Web-based, interactive business simulations for educating and training individuals to effectively manage retail farm-supply businesses, both cooperative and noncooperative.

Agro-ecology/Sustainable Agriculture Program

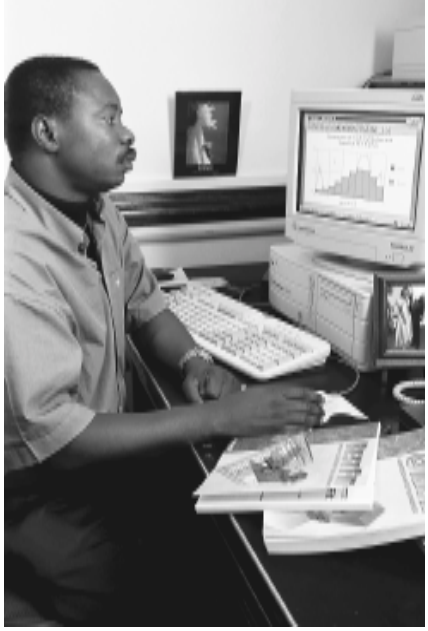
www.aces.uiuc.edu/~asap

The Agro-ecology/Sustainable Agriculture Program (ASAP) website fills a need for fast, well-organized, balanced, easy-to-use sustainable agriculture information. This need will intensify as demand for organic crops grows, farmers' desire to investigate higher value crops and value-added opportunities increases, and federal goals to reduce nutrient pollution are enforced. ASAP is not only a resource within itself but also an informative gateway and a complement to other IT resources within the College of ACES. FARM.EDU will provide ASAP users with the access to holistic decision-making models they have requested.

Pest Management and Crop Development Bulletin

www.ipm.uiuc.edu

The *Pest Management and Crop Development Bulletin* continues to grow both in terms of its content and audience. The project is expanding its contributor base to include a broader range of pest management disciplines. Principal contributors from entomology, plant pathology, weed science, and agronomy are also working to enhance the site. For instance, investigators are working with developers of the Interactive Agronomy Handbook to adapt the climate database and degree-days calculators for use in predicting insect development. The newly designed IPM Online website, unveiled in summer 2001, will be integrated with the Interactive Agronomy Handbook and other components of FARM.EDU.



Illinois TRAILL

http://il-traill.outreach.uiuc.edu

Illinois TRAILL has seen an increase of 28% in average user sessions per day for the Species-Net sites (increasing from 249 average user sessions per day in May 2000 to 319 in May 2001). Additions to Illinois TRAILL in the last year have included Illinois HorseNet; Illini Photoperiod; a biosecurity website focusing on bovine spongiform encephalopathy (mad cow disease) and foot-and-mouth disease; and the Ralph Rumen site, an interactive case study that allows you to visit a virtual farm, look at dairy herd improvement (DHI) reports, listen to training modules, and determine what problems are occurring on the farm.

Illinois Watershed Management Clearinghouse

http://web.aces.uiuc.edu/watershed

The Illinois Watershed Management Clearinghouse has developed a map engine that can be used by watershed planning groups as well as other agricultural and natural resource decision makers. Aerial photos and soil surveys, among other data layers, are currently accessible, and new data layers are being added as they become available. An acreage calculation tool has been developed and is linked to a worksheet for calculating Conservation Reserve Enhancement Program payments. Researchers are working with the Illinois Department of Natural Resources (IDNR) to develop a prototype map engine to make IDNR data available to the public. This collaboration will enable researchers to add several key natural resource data layers, especially those related to wildlife habitat, habitat fragmentation, and stream information, to the site. The partnership between IT-SRI researchers and the IDNR will greatly enhance resource management in watersheds and on farms. Landowners, developers, engineers, hunters, and numerous other groups and individuals have been using the clearinghouse to access site-specific information.

Interactive Agronomy Handbook

http://web.aces.uiuc.edu/iah

The Interactive Agronomy Handbook has developed several useful new calculators and other tools to support agronomic decision making. These tools include a limestone decision aid, an integrated seed drop calculator, a Soil Plan decision tool, a nutrient management worksheet, several wireless Web versions of *Illinois Agronomy Handbook* decision aids, and the Illinois Agriweather Toolbench (climate decision tools, including an extensive climate database).

Community Development Toolbox

www.ag.uiuc.edu/~lced/toolbox

The online Community Strategic Planning Development Tool, which provides community organizations with learning resources related to strategic planning, is the most recent addition to the Community Development Toolbox. Local leaders can use this resource to learn how to organize a committee of diverse stakeholders; brainstorm; create a mission statement for their organization; review the results of previous needs assessments; organize a report of their community's strengths, weaknesses, opportunities, and threats; and complete worksheets to manage and sort their goals, objectives, and strategies. This interactive process results in a draft strategic plan that incorporates all of the information the community organization entered.

Nutrition Analysis Tool

www.nat.uiuc.edu

Five hundred new foods have been added to the Nutrition Analysis Tool (NAT) database, bringing the total to over 6,200 foods. Other enhancements to the site include expanding the educational resources page to provide links to a 5-a-Day the Easy Way site that encourages the consumption of fruits and vegetables, a Ways to Post Information Online page, and a Body Fat Percentage Calculator site that offers instruction on how to compute percentage of

body fat using skinfold thickness measures. A new version of the NAT in development will allow users to enter information about foods that are not available in the current database and to obtain a nutritional analysis that includes these foods.

Extension Integration and Outreach Efforts

Most IT-SRI projects are well-known throughout the University of Illinois Extension system and are extensively used in outreach programming. Several IT-SRI projects serve as the foundation for formal Extension programs. For instance, farm.doc is the basis for many of the Farm Business Management and Marketing Team's outreach activities. Farm.doc is also used extensively in a series of farm income meetings conducted annually by faculty in the Department of Agricultural and Consumer Economics. Similarly, Integrated Pest Management Online (www.ipm.uiuc.edu) and the Interactive Agronomy Handbook (http://web.aces.uiuc.edu/iah) contain material used extensively during the Corn and Soybean Classics, a series of meetings led by Department of Crop Sciences faculty. Illinois TRAILL information is used in Dairy Days and Swine Seminars, programs conducted by faculty in the Department of Animal Sciences.
In addition to outreach through University of Illinois Extension, the IT-SRI has publicized its products through other channels. In 2000, IT-SRI bookmarks that provide Web addresses and thumbnail descriptions of IT-SRI products were distributed widely.

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.

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

Rural Community Development

The Rural Community Development Strategic Research Initiative (RCD-SRI), also referred to as I-FARRM (Illinois Farming Alternatives and Rural Revitalization Methods), consists of four component projects that combine an applied-action research model with aggressive outreach and technical assistance with the goals of (1) identifying alternative and value-added agricultural opportunities in Illinois, (2) assisting in enterprise development and expansion, and (3) exploring 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 Initiative (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 Toolbox (CDTB) provides Web-based interactive assistance to foster rural economic development.

The following summary of accomplishments highlights the commitment and dedication of the RCD-SRI team members and the valuable outcomes and benefits resulting from this research program.

Business Plan and Feasibility Study Research for Farm-Based Enterprise Start-Ups and Expansions

- Twenty-nine business plans and feasibility studies have been completed including the following new ones in FY01: Webb Freshwater Prawn, Fogelsong Fish Farm, Weichert Enterprises, Alto Vineyards Website, Black Diamond Vineyards, and Owl Creek Vineyard Expansion.
- The business plan for the Illinois Aquaculture Cooperative (Pinckneyville, Illinois) is now finished. Researchers completed

comprehensive research on fish and aquaculture cooperatives as part of this study.

- Five more agritourism enterprises from Sangamon County to Union County have been established, including Little Cedar Bed and Breakfast, Holiday Farm Cabins, Anna-Union Art Guild, Weaver's Cottage, and Boyd Orchards.
- The Southern Illinois Community Foundation was formally incorporated and established.

Farm-Based Enterprise Start-Ups and Expansions

- Thirty-three agri-enterprise start-ups and expansions had been assisted by I-FARRM as of March 2001. FY01 projects include Webb Freshwater Prawn, Fogelsong Fish Farm, Weichert Enterprises, Alto Vineyards Website, Black Diamond Vineyards, Owl Creek Vineyard Expansion, and Illinois Aquaculture Cooperative.

Research Publications and Databases

- An I-FARRM website has been established. This site links farmers, rural residents, and researchers to project findings and resources as well as to other relevant research and funding resources. Each I-FARRM project also has its own website.
- A winery business plan template is now complete and is displayed on the I-FARRM and READI websites.
- A vineyard business plan template is now complete and is displayed on the I-FARRM and READI websites.
- Twenty-four monographs and fact sheets on specialty corn and soybeans and other alternative and agri-enterprise subjects have been developed. In FY01, at least eight additional monographs or technical reports were published. For example:
  - Technical reports, such as *Specialty Livestock Processing in Illinois*
  - Results of the 2000 On-Farm Specialty Crop Research Program
  - *2001 Specialty Corn and Soybean Marketing Directory*
  - Books, including *Introduction to Fish Farming in Illinois: Opportunities for the Family Farm* and *Collaborative and New Generation Agricultural Cooperatives* (two other books, *Illinois Agricultural Trends* and *Alternative Agriculture in the Heartland: The I-FARRM Story*, are under way)
  - A publication on *Illinois Farmland Use, Price and Profit Patterns* as well as one on *Projections of Illinois Agriculture to 2007*
  - Eight additional journal articles, four theses/dissertations, and two manuals

Public Education of Farmers and Rural Residents

The I-FARRM project continues to be extremely active and effective in outreach dissemination. In FY01 alone,

- I-FARRM researchers presented 134 public programs reaching 6,250 people.
- A total of more than 105,000 bits were recorded on the five I-FARRM project websites.
- At least 43 news articles and releases were documented on the projects, and 33 publications were distributed.
- Through workshops, face-to-face or phone technical assistance contacts, and website contacts, I-FARRM researchers and RCD-SRI component projects had a minimum of 180,000 contacts with farmers, academics, Extension professionals, and rural citizens.

The total economic development impact of I-FARRM is quite remarkable, especially given that this project is relatively young. I-FARRM's research and technical assistance have facilitated 41 agri-enterprise start-ups or expansions, yielding a new capital investment of $4.25 million and new annual payroll of $2.02 million. Leveraged project dollars exceed $3.5 million, and the total annual economic impact is estimated at $6.0 million or more.

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.

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

Swine Odor and Waste Management

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.

While it takes several years for a research effort of this nature to build momentum, the SO&WM-SRI researchers are already making major contributions and substantial progress. Research activities in FY01 built on foundations of facilities, expertise, and basic research established in the first two years of the SRI.

Building Infrastructure

Facilities and equipment essential to the current success and future efforts of the SO&WM-SRI were added or expanded. For example, an olfactometer for sensory analysis of odors was acquired. In combination with continued development of methods for sampling and analyzing odors, the olfactometer provides the SRI with analytical capability comparable to that at any research center around the world. Furthermore, the proving center's capabilities have been expanded through modifying the dynamic airflow chambers, a unique facility for controlled studies of odor reduction particularly in relation to nutrition. In addition, essential equipment was purchased for several SO&WM-SRI projects, including on-farm composting studies and evaluation of several waste-processing technologies.

Developing Expertise

When the C-FAR membership identified swine odor and waste management as a research priority in 1998, very few scientists working at Illinois institutions had expertise in livestock waste management. One significant impact of the SO&WM-SRI has been developing a multidisciplinary group of scientists with considerable expertise in a broad range of aspects of swine odor and waste management, as well as providing educational and training opportunities for many graduate students and postdoctoral research fellows. This expertise provides a considerable resource for Illinois to draw on in the future and, along with continued development of first-class facilities, places Illinois institutions at the forefront of research and technology development in this critical area.

Progress in Research and Technology Development

When the SRI started, no proven, economically sound approaches to solving problems associated with swine waste existed. C-FAR has supported research to develop a range of new, unique technologies to deal with the issues. Generally, a three-stage approach for technology development has been adopted:

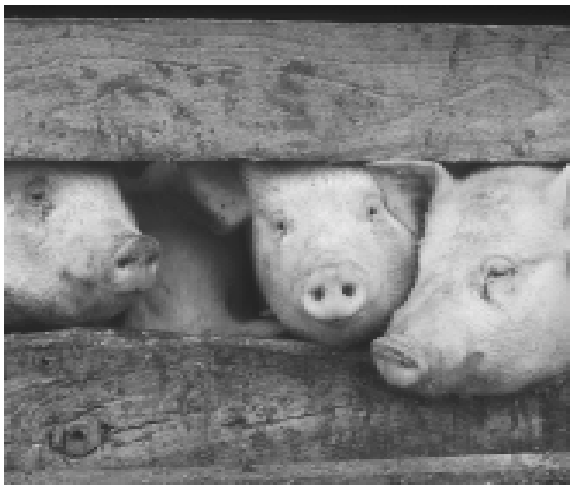
1. laboratory development and evaluation
2. pilot-scale testing
3. on-farm application evaluation

The SRI currently has projects at each of these stages.

Laboratory Development and Evaluation

Projects at the stage of initial concept development or laboratory-scale evaluation and process optimization include

- *Gravity Liquid–Solid Separation:* This project aims to develop a low-cost, low-input system to separate liquids from solids in swine slurry. Laboratory testing prior to design and construction of a pilot-scale separator has been completed.
- *Odor Analysis:* Several projects continue to investigate new approaches to odor analysis. An instrument that can quantify levels of some major components of hog odor has been developed and run through initial tests. This new tool will be useful for rapidly predicting odor level in many situations (for example, research, monitoring commercial barns, compliance, etc.).
- *Catalytic Converters:* Research has confirmed that catalysts convert a mixture of odorous gases in swine facilities into nonodorous, safe compounds. Researchers have carried out initial design work for a prototype on-farm system to be constructed and evaluated during FY02.
- *Thermochemical Conversion:* Researchers have continued efforts to define optimal operating conditions and develop a continuous operation system.



Pilot-Scale Testing

This phase of development involves the construction of a pilot-scale version to be tested on research farms (such as the UIUC Proving Center). For some technologies, this phase has been repeated to optimize both design and operation. Projects at this stage of development include

- *Aerodynamic Dedusters:* A large-capacity version of this technology was evaluated in the proving center. Researchers are collaborating with an Illinois company to design and construct dedusters for commercial evaluation.

- *Illinois Odor Control Proving Center:* Researchers have evaluated a range of technologies at pilot scale under commercial conditions. Major FY01 projects that were tested include technologies for reducing odor such as ozonation, facility cleanliness, wet scrubbers, dedusters, and lagoon covers. Researchers also improved procedures for characterizing odor carried on dust in swine buildings. A chimney-stack exhaust to increase atmospheric odor dispersion was designed and will be constructed and tested in FY02.

- *Aerobic Thermophilic Treatment:* A 1,000-gallon pilot system has been successfully tested and a commercial system is being developed. Important findings include significant energy yield and low levels of odor and pathogens in products that can be used as fertilizer in cropping systems.

- *Variable-Rate Technology Slurry Application:* This technology is now close to commercial application. Researchers have constructed and performed initial field tests on a prototype spreader and associated hardware/software.

On-Farm Application Evaluation

This phase of development involves the design and construction of commercial-scale equipment that is then tested on commercial units. Researchers have successfully moved several waste management and processing technologies to on-farm application evaluation.

- *Composting:* Two composting sites were established on Illinois commercial operations. Research at these sites will determine optimal practical approaches for liquid–solid separation (an essential prerequisite for large-scale composting) and for the composting process itself.

- *Anaerobic Sequencing Batch Reactor:* Research in this area moved from a laboratory-scale reactor to a commercial-size system on an Iowa farm, where ongoing research will optimize operation.

- *Nutritional Approach to Minimizing Phosphorus Emissions:* Pioneering research in this area is the foundation for current industry recommendations. Scientists continued studies on reducing levels of dietary phosphorus and trace minerals through the use of phytase and nutritional characteristics of new corn varieties (low phytate) and by-products (corn gluten meal). Findings of major importance include (1) microbial phytase does not improve use of dietary amino acids and (2) metabolizable energy content of low-phytate corns is lower than that of conventional hybrids.

- *On-Farm Odor Characterization:* Researchers completed the most comprehensive survey undertaken anywhere in the United States regarding odor levels in commercial finishing barns. Investigators sampled 26 barns on 10 Illinois operations with deep or shallow pits over time and characterized the odor levels for each. Results highlighted factors associated with odor, and this information is being used to target future research efforts.

Additional Projects

- *Community Concerns:* Researchers continued efforts to analyze sources of information available to the general public and to formulate approaches to improving communications with Illinois citizens on major issues in livestock production.

- *Legal Issues:* An extensive review of legal issues relating to livestock production was completed. Researchers compiled their findings in the article "How Environmental Regulations Affect Livestock and Poultry Production," which is available on the SO&WM-SRI website.

A major indication of this SRI's success and of the increased recognition of this program is the level of leveraged funding for cognate research efforts. In FY01, external funds totaled over $9 million, representing a sixfold harvest from the seeds planted by C-FAR in this SRI.

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.

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

Food Safety

The Food Safety Strategic Research Initiative (FS-SRI) has concentrated research and outreach efforts on basic and applied research from farm to family. Educational as well as research programs have included populations served by restaurants, long-term care facilities, schools, and preschool facilities. The efforts have focused on consumers, producers, physicians, food industry personnel, and other community leaders. Data indicate specific foods that have been statistically implicated in foodborne outbreaks in Illinois include fruits and vegetables, followed by poultry products.

While many factors are related to foodborne illnesses in Illinois, the most common are improper holding or cooking temperatures, poor personal hygiene of food handlers, contaminated equipment, and food from unsafe sources.

Even though most foodborne illnesses are relatively mild, researchers estimate that 1 to 3% of all people with a foodborne illness later develop secondary illnesses or complications that can occur in any part of the body. In 1995, seven foodborne pathogens were estimated to cost society $5.6 to $9.4 billion in medical charges and lost productivity. Today, *Clostridium botulinum, Staphylococcus aureus,* and *Salmonella* spp. remain among the major foodborne pathogens. During the last two decades, however, foodborne diseases such as shigellosis, listeriosis, campylobacteriosis, and diseases caused by pathogenic strains of *Escherichia coli* have become increasingly salient. These new concerns necessitate continued investment in research and technology development to improve the safety of the food supply. A better understanding of the genetics, physiology, and virulence of foodborne pathogens, as well as of how microbes, humans, and animals interact, has provided an intellectual and technological foundation for building new pathogen-control programs and disease-prevention strategies. Highlights of major FS-SRI accomplishments in FY01 follow.

Pathogen Detection and Epidemiology

- A commercial test kit for producers is under development, and researchers have started the process of licensing the use of the antibodies through the University of Illinois.
- Food industry representatives have emphasized the need for a nonthermal microbial inactivation technique. Since heat changes food flavors, such a technique is important to maintaining the taste of foods. The pulse-electric-field processing technique that this SRI has studied for the past two years is *not* a viable option at this time, but researchers are exploring the use of high-pressure processing techniques.

- A thermal process was used to treat 14,000 gallons of swine waste as the first step in preparing a food-safe fertilizer for fruits and vegetables. Results to date indicate that three of the pathogenic indicators were found in the 1,000-gallon reactor, and these were completely or nearly completely removed during system operation.

- Interest in small-farm poultry production has increased by 15 to 20% over the past year. Research indicates that small poultry producers using alternative methods of production (e.g., pasture–free range) have no more, and in some cases significantly less, salmonella infestation than those using traditional production methods.

- Five genetically modified organism (GMO) and non-GMO corn crops are being tested to determine any food safety or health-related risks. Animal diets have been formulated and breeding colonies are being established for the year 2 feeding trials. Physiological studies and fine-tuning of the microarray analysis are under way. Researchers are collaborating with Monsanto Company for additional crop supplies, analysis, and input.

- Researchers are applying risk-assessment methodology to the use of feedgrade antibiotics in pork production. They are developing an integrated economic framework to evaluate risks to human health as well as economic impact on pork production. Preliminary findings indicate (1) eliminating the use of subtherapeutic antibiotics in the grower-finisher unit pigs may have little impact on productivity; (2) feed-use efficiency is generally improved by increasing the number of different rations fed in the grower-finisher unit pigs, but antibiotics reduce feed-use efficiency when the number of rations is increased; (3) feed-use efficiency is decreased as the average number of treatment days per antibiotic is increased; and (4) as more diseases are diagnosed, the antibiotic use generally improves feed-use efficiency.

- Using a commercially produced wash rather than water yielded a greater reduction in *S. boydii* 18 on parsley; however, the commercially produced wash did not completely remove pathogens.

Hazard Analysis Critical Control Point (HACCP)

- Several HACCP training programs were implemented for Illinois' food service industry: 1,000 food safety training kits were distributed throughout the state and nation, as well as overseas; 600 food service managers or employees were trained in HACCP procedures to prevent foodborne illnesses; and 150 local environmental health specialists were trained in HACCP procedures.

- Researchers are developing educational materials designed to prevent foodborne illnesses from occurring as a result of unsafe practices at the retail food stores. A sample of 15 grocery stores throughout Illinois is testing HACCP materials developed through C-FAR. HACCP programs for small meat-processing facilities in Illinois are being revised so that small processors can begin to implement a HACCP system.

- Food service establishments, including day care centers, school meal programs, university dining services, long-term care facilities, hospitals, restaurants, catering, deli operations, and correctional systems, are implementing model HACCP programs.

- FS-SRI researchers, in cooperation with veterinary clinical medicine researchers and producers, are in the final stages of developing on-farm strategies for detecting and controlling salmonella. Nine hundred fifty Illinois pork producers and 350 U.S. swine veterinarians have contributed to a survey on pig production food safety. Four information sheets on pig production food safety have been provided to University of Illinois Extension educators. Other efforts include the following:

  - Project results have been shared with the 32,000 readers of the *Illinois AgriNews*.

  - The SafePork website (www.cvm.uiuc.edu/safepork) was created to describe pork food safety certification programs and to share

information with pork producers. (The website received a total of 695 hits in the first month of publication.)

- Interventions have been developed for on-farm food safety in six areas: pest control, biosecurity, production system management, herd health, feed and feeding, and transportation of animals.

- A preharvest HACCP website was published; the site includes science-based tools farmers and consultants can use to develop HACCP-based food safety systems for individual farms and farm systems.

Education and Outreach

FS-SRI researchers have partnered with other state, regional, and national entities to teach citizens about food safety and healthful eating practices.

- An unprecedented foodborne illness curriculum is being incorporated into the standard medical school curriculum. Baseline data indicates that medical students need training and education in identifying foodborne illnesses as well as health promotion activities related to foodborne illness.

- The theory that certifying pork products would be economically beneficial was supported when 452 survey respondents (74%) indicated that they were willing to pay from $.10 up to $1.00 per pound more for a product that was certified safe. Research shows that there is (1) an opportunity to capture value, meet market demand, and improve competitive position in export markets; and (2) a need to communicate the message that pork is safe. According to they survey, 60% of consumers are very or somewhat concerned about pork safety.

- Over 1,500 Illinois residents used the FS-SRI's award-winning educational kiosk. The food safety quiz is available for commercial distribution on CD-ROM and has been made available to University of Illinois Extension for use in programming and outreach.

- FS-SRI researchers developed a food safety school curriculum for grades K–6, which is recommended by the Illinois State Board of Education (ISBE) and available through the ISBE clearinghouse. The following are various K–12 educational efforts undertaken by the FS-SRI:

  - Public service announcements and videos related to food safety aired on public media outlets.

  - A total of 1,369 Illinois students, grades 3 through 10, were surveyed regarding their food safety practices, and over 100 teenagers, ages 15 through 17, have completed the food safety practices survey.

  - Over 100 students have tested the K–3-grade food safety curriculum, and more than 400 students have tested the 4–6-grade food safety curriculum.

  - Approximately 43,000 students and 1,400 classrooms have participated in the Chicago Tribune's "Food Safety: It's a Life Science" curriculum, supported in part by the FS-SRI, industry, and the Illinois Department of Public Health.

- The FS-SRI continues to meet the research needs of the state agencies mandated to address food safety:

  - A food safety symposium featuring FS-SRI research was held September 6–7, 2001. Sponsors included the Illinois Department of Public Health, Illinois Department of Agriculture, Illinois Restaurant Association, and the FS-SRI.

  - The FS-SRI coordinated efforts with the Illinois Departments of Agriculture and Public Health to feature a "Home Food Safe Kitchen" display at the 2001 Illinois State Fair.

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.siu.edu/~foodsafe* to learn more about the FS-SRI program.

Water Quality

James D. Westervelt, SRI Leader, University of Illinois at Urbana-Champaign

The Water Quality Strategic Research Initiative (WQ-SRI) has the following mission:
To produce high-quality water quality information, data, and tools and to distribute these materials to decision makers, resource managers, and the public.

WQ-SRI progress has been substantial over the past year. Close collaboration among field researchers is beginning to paint a clearer picture of the movement of nitrogen in tiled Illinois farmland. Field scientists and theoretical modelers are collaborating in joint efforts to understand the effects of fertilizer timing and rate on water quality in Illinois streams.

WQ-SRI projects continue to be combined into three groups. The first seeks to evaluate promising best management practices from agronomic, economic, and environmental perspectives. The second group seeks to more intimately understand the sources of nitrogen and its movement through Illinois' tiled watersheds. The third group is developing models that are useful in predicting consequences of alternative land management and agronomic practices and employing them at the state, watershed, and field scales.

Best Management Practices (BMPs)

A new experimental field has been established in Douglas County. This completely tiled field is well suited for carrying out fertilizer timing and rate studies. To date, 54 tile lines have been intercepted with tile-line samplers. Experimental fall, spring, and sidedress nitrogen treatments have been applied, and these experiments will continue for many years. In addition, researchers have focused efforts to develop a simulation model on this farm. This model will provide theoretical hypotheses regarding the expected effects of timing and rate as well as data to further refine future hydrologic and water quality models. The BMP research team completed a

study on the factors affecting phosphorus loss from agricultural soils. Results suggest that farmers should *not* maintain excessively high phosphorus soil test levels but should minimize erosion, match nutrient applications to crop needs, and incorporate or knife-inject fertilizer or manure where possible without destroying crop residues.

Researchers also continue to monitor in-field tests of the flow volumes and nitrate-nitrogen concentrations in shallow and deep tiles to test the hypothesis that shallower tiles placed relatively close together result in better water quality than deeper tiles. A year of measurements suggests that peak tile flows and flow volumes are generally decreased with shallow tiles. Interim results also indicate that tiles at 2- and 3-foot depths delivered 51 and 22% less nitrate-nitrogen, respectively, than tiles laid at a 4-foot depth.

Studies analyzing whether variable-rate nitrogen applications are an effective BMP for reducing nitrogen in waterways have yielded mixed results. Nitrate content and nitrogen movement change depending on soil types, soil structure, topography, precipitation, and soil chemistry. Researchers have hypothesized that nitrogen application rates could be reduced in areas of a field with relatively low yields because less nitrogen would be required. Experiments have suggested that this is not always the case; in fact, lower yielding areas can require higher nitrogen application rates. Preliminary results for tests performed at a Franklin County farm showed no significant differences in yield regardless of whether the fields received variable nitrogen application rates or uniform rates.

This project has been significantly reorganized for FY02. As a result, researchers expect to see a dramatic increase in the total number of fields in which farmers will run similar variable-rate application experiments. The goal is to develop a process for precision application of nitrogen that individual farmers can use to evaluate their fertilizer requirements and, thus, improve profits while reducing nitrogen loss.

Mass Balance

Understanding the sources and movement of nitrogen in Illinois soils is a major focus of the WQ-SRI. Scientists chose Big Ditch, a small watershed in the larger Lake Decatur watershed, as the locus for this research because of its particularly useful history of data collection. Researchers are collecting and analyzing data that is illuminating the reservoirs and fluxes of nitrogen. How the timing and rate of nitrogen applications affect surface water concentrations in this watershed is being examined. A group of groundwater scientists regularly monitor and analyze water table depth, flow rates, and nitrogen concentrations through data collected at a number of wells established for this study. Groundwater flow rates have been calculated, and a groundwater flow model has been developed for the Big Ditch watershed and surrounding areas.

Concentrations of nitrogen species have been measured at different times of the year, and this data continues to be collected. This group also made progress in using isotopic analysis and microbial methods to estimate denitrification rates in groundwater. Researchers will continue to collect information about fertilizer application rates in the Big Ditch watershed and to perform detailed studies of the movement of water and chemicals in a heavily instrumented field. Over 4,000 water samples are being used to characterize how water balance, tile flow, and water table in a tiled field respond to different storm events.

Researchers are also monitoring the uptake of nitrogen into corn and soybean crops and the return of nitrogen to the soil in the fall. The soil itself is a large reservoir of nitrogen and carbon, and carbon availability affects denitrifying bacteria's ability to return nitrogen to the atmosphere. An effort is under way to measure changes over the years to determine if concentrations of organic nitrogen are actually decreasing over time.

Finally, researchers are investigating conversion of nitrate in streams and ditches to the atmosphere. Denitrification rates in the Big Ditch watershed are being analyzed with respect to nitrate concentrations, soil and stream temperature, water depth, and flow rates.

The mass-balance research program is a collaborative undertaking of scientists from many departments and surveys. Researchers will be pulling the results of different projects together to paint a picture of nitrogen cycling in a representative tile-drained Illinois watershed. This picture will be in the form of rates of changes among different nitrogen chemicals and how weather, groundwater, soil processes, and crop affect these flows. This information will contribute to the scientific basis for evaluating BMPs and analyzing policy.

Modeling

Mathematical models are the best available tools for predicting how alternative policies might improve Illinois agricultural opportunities and water quality. Currently, the federally mandated development of watershed nutrient management plans relies heavily on the application of hydrologic and water quality models. The accuracy and suitability of these models is questionable. Furthermore, these models usually focus on only part of the system: the specific land use and how that land use might affect the water quality of associated streams. They tend not to explicitly consider economic consequences, impacts of economic opportunities on land use or land management changes, and social implications.

A number of important WQ-SRI projects seek to evaluate models, develop alternative models, and integrate multidisciplinary models to capture important feedback loops among the human and natural systems. As noted previously, scientists are working to develop a field-scale model that integrates groundwater, overland water, and tile flow routing with soil chemistry for use in a fertilizer timing and rate field study. At the watershed scale, two studies are applying and evaluating standard models that are often used to determine total maximum daily load allocations. Researchers are also evaluating the effectiveness of ADAPT, DRAINMOD, RZWQM, and ANNAGNPS for predicting water quality downstream from Illinois agricultural lands. Efforts to combine these models are expected to yield accurate, comprehensive watershed-scale models. In addition, researchers have customized the Dynamic Watershed Simulation Model using data from the Big Ditch and Court Creek watersheds.

Scientists are linking models for monitoring water quality with economic processes and opportunities in watersheds. Decision support tools are being developed that will help farmers evaluate alternative riparian buffer treatments along streams with respect to improvements in water quality and farm income. A powerful modeling environment has been developed that helps a watershed optimize water quality and economic opportunities by evaluating alternative cropping systems across all farms in the watershed. These efforts can empower local landowners to make decisions optimal for both economic returns and water quality considerations. At the state scale, it is important to evaluate how fertilizer applications and land use patterns affect downstream water quality. Researchers are developing a spatially explicit statistical model that correlates water quality measurements at state and federally monitored sites with upstream land use, soil type, fertilizer application, topography, and crops. This model promises to allow future users to create virtual water measurement stations at any point in the Illinois river system and to obtain projected readouts based on that system's past history. It will also predict how water quality might change in response to changes in fertilizer timing and rate and land use.

Much of the WQ-SRI research relies on whole-system manipulation experiments that typically require many years of data collection before scientists can perform conclusive statistical analyses. However, the WQ-SRI's close integration of simulation modeling and field studies is providing some opportunities to test and validate researchers' understandings of the processes underlying the experiments. The complicated interactions among soil chemistry, soil ecology, crop growth, weather and climate, economics, farm management, and hydrology will continue to provide research challenges for the foreseeable future. Through its WQ-SRI, C-FAR is significantly contributing to research that addresses and seeks to understand the connections between human and natural components of the complex Illinois landscape.

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* to learn more about the WQ-SRI program.

C-FAR Sentinel Program

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

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. "We're now at the point where the impacts of the Sentinel Program are becoming obvious. The FACE (free-air gas concentration enrichment) project is a good example. We have now collected the first full year of field data on the effect of elevated carbon dioxide in the atmosphere on the corn–soybean rotation. For the first time anywhere in the world, we are beginning to understand how changes in the atmosphere are going to affect yield and quality of corn and soybeans," 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. Research projects are multi-investigator and multidepartmental, 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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Natural selection plays the central role in shaping the biological world, yet its glacial pace makes the evolutionary change occurring around us appear all but invisible. Occasionally, exceptional circumstances permit us to witness the process of natural selection. Today in east-central Illinois, the behavior of the western corn rootworm, Diabrotica virgifera, is changing under intensive selection as a result of crop rotation, thus circumventing the most cost-effective and environmentally benign management tool.

In 2001, investigators continued to evaluate how developmental asynchrony of corn and soybean fields may affect population dynamics of a new strain of western corn rootworm. Researchers developed experimental sites on large tracts of land in east-central Illinois (the area with the most serious crop-rotation problems) as well as in northwestern Illinois (outside of the problem area).

Using different planting dates and crop varieties, researchers created four developmental ranges of corn and soybean. Absolute population estimates of western corn rootworm egg densities were determined for both experimental sites from soil samples taken in 2000. Additional samples were collected during the 2001 growing season. At the east-central Illinois site, both the late-planted corn (5/15/00) and the four varieties of soybeans had significantly higher egg densities than early-planted corn (4/15/00). In northwestern Illinois, eggs were laid only in the corn plots regardless of planting date (4/24/00 or 5/15/00); no eggs were laid in the two soybean varieties planted in northwestern Illinois.

These results indicate that crop phenology influences egg laying and that the new strain of western corn rootworm has not reached northwestern Illinois. However, surveys of nearly 500 soybean fields from 99 Illinois counties during midsummer of 2001 revealed that the new strain of western corn rootworm is moving slowly to the northwest. More detailed maps and analyses of these data are available at www.staff.uiuc.edu/~s-isard/Beetles.

Researchers also continued to analyze flight patterns and intensity of western corn rootworm adults above soybean fields (10 meters above canopy). During the peak flight period of summer (mid- to late-July), more than 200,000 western corn rootworm adults fly over each acre of east-central Illinois corn and soybean fields. Approximately 80% of these adults are mated female beetles looking for suitable egg-laying sites. Because western corn rootworm movement occurs on this scale, spraying soybean fields with insecticides to prevent egg laying is not likely to be cost effective.

Researchers have created two simulation models to investigate novel crop rotation schemes that may help counteract the evolution of rotation resistance in the new western corn rootworm strain. Preliminary results indicate that a three-year rotation with wheat or oats may serve as a better pest management approach than striving to find repellent soybean varieties. Modeling efforts indicate that soybean fields would have to repel at least 90% of western corn rootworm adults to effectively limit egg laying.
It is interesting to note that, thus far, molecular analyses have not revealed any genetic differences in the new western corn rootworm strain and the population that inhabits northwestern Illinois. Researchers are performing further and more detailed molecular analyses, however.

SoyFACE: Research and Discovery Program to Abate the Threats and Harness the Potential of Atmosphere Change to Benefit Illinois Agriculture

Principal Investigators

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Evan H. DeLucia, Department of Plant Biology

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

A permanent 80-acre site for the project was established just south of the UIUC campus. Half of the acreage is maintained in corn and half in soybean, rotating annually. Four FACE (free-air gas concentration enrichment) rings, each 70 feet in diameter, and four control rings were built within the soybean crop immediately after sowing and prior to emergence. The carbon dioxide concentration within the FACE rings was elevated to that anticipated for the year 2050—that is, about 50% higher than today's concentration. The facility successfully maintained this elevation from crop emergence to harvest.

The most dramatic effect observed was that crop maturation was delayed by three weeks. In mid-September, the crop remained green when the surrounding field was yellow and brown. Grain maturation was similarly delayed. These findings suggest that, as carbon dioxide levels rise year by year, soybean will require progressively longer seasons in which to mature. This delay was seen in most of the 20 cultivars tested. At the time of this writing, the final harvest had not been conducted, so effects on grain yield are as yet unknown.

Throughout the year, researchers collected subsamples which show increases occurred in height (10%), photosynthetic carbon uptake from the atmosphere per leaf (24%), and total dry weight (29%). They also observed significant increases in the numbers of nodules and root mass and a significant decrease in water loss. In 2001, researchers constructed and successfully operated prototype rings for elevation of ozone and carbon dioxide in soybeans. These prototypes will be used in replicated experiments in 2002. Over 300 individuals visited the SoyFACE facility during 2001, including growers, high school teachers, and researchers. Those who joined the research team in 2001 included 14 undergraduates, 11 graduate students across a range of departments, a high school teacher from Chicago, and a professor from the University of Paris. The facility was featured in *National Geographic* and filmed by three television crews during 2001. Researchers from 40 universities and research organizations in 12 different countries, from Australia and Japan to Mexico and Germany, visited the site to discuss potential research collaborations. This widespread interest represents significant opportunities to leverage external expertise. In addition, groups from five Big Ten universities discussed potential research using the SoyFACE facility in 2002.

This project received additional external funds in 2001: Archer Daniels Midland provided carbon dioxide; the Argonne National Laboratory contributed four additional FACE rings for corn; the Olga G. Nalbandov Fund supported an international FACE conference at UIUC; and USDA-ARS funded a postdoctoral researcher. The estimated value of external support in 2001 is $186,000.

Developing an Agricultural Remote Sensing Program at University of Illinois

Principal Investigators

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James D. Westervelt, Department of Agricultural and Consumer Economics

The College of Agricultural, Consumer and Environmental Sciences formally dedicated the new 1,500-square-foot Illinois Laboratory for Agricultural Remote Sensing (ILARS) on April 18, 2001. This space houses an extensive collection of image/data gathering and processing instruments and computers that support a number of Illinois farm research projects. The laboratory was established through a five-year grant of approximately $1 million from the University of Illinois C-FAR Sentinel Program.

The ILARS facility supports the collection and processing of data gathered on the ground and from aircraft to assist with research on precision agriculture, watersheds, and Illinois crop yields. During the 2001 growing season, experiments have been performed on commercial and university research farms to demonstrate new remote sensing–based field operations. The U.S. Department of Agriculture and the Illinois Department of Natural Resources both provide funding for the laboratory, and they collaborate in using the facility to generate annual Illinois agriculture land use maps. In addition, researchers have submitted several major cooperative proposals to federal agencies, and more than $300,000 in external funding for laboratory projects was received in 2001.

The laboratory is also used to support courses at the University of Illinois at Urbana-Champaign. Access to ILARS made development of the course Precision Agricultural Remote Sensing (AGE 396) possible. First offered in fall 2000, the course covers techniques and applications of digital remote sensing systems in precision agriculture, and it provides students with hands-on experience working with airborne and ground-based remote sensing data. ILARS also supports other classes that teach students remote sensing techniques for precision farming. ILARS has provided the foundation for a variety of collaborative relationships. For example, investigators work closely with similar research labs at other universities and with government agencies such as NASA and the USDA. Several local, domestic, and international visiting scholars have been hosted at the laboratory. Researchers have presented papers and exhibits at major conferences such as American Society of Agricultural Engineers, American Society for Photogrammetry and Remote Sensing, and InfoAg 2001. On the more local level, researchers have worked closely with NASA contractors to provide remote sensing data collection and processing services to the Illinois agricultural industry. For example, University of Illinois Extension was given assistance in a study that uses remote sensing to identify tile lines.

Transgenic Swine Program

Principal Investigators

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The Transgenic Swine Program has three objectives. The first is to translate the existing lines of hemizygous alpha-lactalbumin (a-LA) and insulin-like growth factor-I (IGF-I) transgenic swine into commercially viable, federally approved food sources for human consumption. Researchers have been working with the Food and Drug Administration to address FDA-approval requirements. As part of this process, researchers have begun to establish and implement good laboratory practices (GLPs) at the research farm and in the laboratory.

The program's second objective is to develop accurate and precise analytical techniques for measuring milk production and for safety testing. Researchers have developed several new techniques, and these are currently being validated.

The third objective of the Transgenic Swine Program is to develop additional lines of transgenic swine with agriculturally beneficial characteristics. Researchers recently submitted a patent application for the IGF-I transgenic animals, and they are now crossing existing lines to develop homozygous a-LA and a-LA/IGF-I transgenic swine. Researchers have also isolated clones of porcine sucrase-isomaltase and salivary amylase to use as promotors driving the expression of transgenes in the intestine and salivary glands, respectively.

In addition to these efforts, researchers are exploring various other questions that concern swine producers. For example, previous research demonstrated that a-LA sows

produce more milk in early lactation and that piglets suckling these sows are significantly heavier at weaning. Researchers are now assessing whether the enhanced milk production has a detrimental effect on sow health and subsequent fertility. Thus far, they have found no differences in reproductive efficiency between control and a-LA transgenic sows. Researchers are also evaluating whether the improved preweaning growth of piglets suckling a-LA sows is maintained through the grower and finisher stages of production, and they are assessing carcass composition and meat quality at slaughter.

Illinois Center for Soy Foods

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

The center has developed improved prototype soy-fortified bakery products well suited to American diets. ICSF products were showcased at several public events in 2001, including the National Council on Agricultural Biotechnology's annual meeting in Chicago and the College of Agricultural, Consumer and Environmental Sciences' Open House. ICSF has also opened a retail store, Soy Source, to test-market new soy foods and has developed a cookbook series on how soy products can easily be used in the American kitchen. The first book in this series is titled Tofu in the American Kitchen, and it should be available through the ICSF website (www.soyfoodsillinois.uiuc.edu) in early 2002.

The center has made educational and outreach efforts a high priority. ICSF staff have organized training sessions on various topics, including how soy is processed (Processing of Textured Soy Protein); how to apply soy as an ingredient (Application of Soy in Meat Products); and what soy's nutritional benefits are (U.S. Private Voluntary Organizations Training). In August, ICSF collaborated with the Dominican Republic's government to deliver a

Principal Investigators

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training session promoting the use of soymilk in their school lunch program.

ICSF has also provided more than ten companies with research and technical support on problems related to extrusion and dairy analogues, and it is currently working to develop similar relationships with four more companies. ICSF researchers participated in several major national and international conferences in 2001. Finally, the center has developed a website, www.soyfoodsillinois.uiuc.edu, as a consumer resource on how to use soy in the kitchen.

The center's value is affirmed by the soybean industry's strong support, including donations of soybean processing equipment and research grants worth about $150,000.

Illinois Genetic Marker Center

This center is a biotechnology laboratory focused on identifying the genetic basis of economically important traits in Illinois crops. The center will allow researchers to develop new germplasm and varieties with traits that add value.

The primary activity of the center to date has been hiring personnel and setting up infrastructure. In May 2001, Robert Elshire was hired as laboratory manager, and renovation of the center facilities at 269 National Soybean Research Center began.

In addition, essential equipment has been purchased for the laboratory, including a high-capacity thermocycler, centrifuge, ultralow freezer, refrigerator, computer server, and additional miscellaneous laboratory equipment. Center staff also evaluated capillary-based sequencing machines and decided to postpone purchasing one due to the limitations of these systems and their analysis software. The systems will be reevaluated next year. In the meantime, researchers will use automated slab gel sequencers. Five of these machines were donated by Monsanto, and four are currently operational.

The center began limited operation in early October 2001 and will operate at full capacity in January 2002.

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Illinois Agricultural Policy Center

The Illinois Agricultural Policy Center's primary purpose is to evaluate policy implications of the new farm bill and to inform agricultural leaders regarding these implications. The center's ultimate goal is to help create a farm bill that meets the needs of Illinois.

The center was created in the spring of 2001, and work during FY01 was developmental in nature, focusing mostly on gathering data and updating computer models that are presently being used to analyze current farm-bill proposals. Researchers focused on updating and implementing the Illinois Resource Agricultural Model as well as other farm-program simulation models.

In addition to the data and modeling work done in FY01, researchers gave a presentation on farm-bill issues to eight members of the Illinois delegation in Washington, D.C., in April. At the request of Senator Dick Durbin's office, researchers undertook a study on U.S. sugar policy and the Chicago confectionery industry, completing a formal report in June. During June and July, center staff also surveyed 5,000 Illinois producers (1,300 valid responses) on farm-bill issues.

Currently, center staff are focused on measuring the impacts of alternative commodity titles that are proposed for the 2002 farm bill.

Principal Investigators

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Managing the Soybean Aphid

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Philip L. Orwick, National Soybean Research Laboratory

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

The goal of this project is to provide Illinois farmers with the information necessary to continue to raise soybeans profitably within the constraints imposed on them by the soybean aphid. The intention is to enhance the efficiency of soybean production systems by recommending rational approaches to this new threat to farmer profit and the environment.

The soybean aphid has clearly shown that it will remain a pest in Illinois. Researchers have confirmed that the aphid, which was first found in Illinois in 2000, spent the winter on buckthorn shrubs in Illinois. The aphid was found on buckthorn in October 2000 and May 2001. The team has also tracked its abundance and distribution in the state during the last year. The aphid was first observed in the northeastern section of the state and along major rivers in the north, but by the end of July 2001, it was found from the Wisconsin to the Kentucky borders of Illinois. A suction trap for detecting aphids was placed at Dixon Springs, and it proved its worth by alerting the team to the presence of the aphid in the far south before it was discovered in southern soybean fields. Within a week of capturing the aphid in the suction trap, the team had collected the aphid at several soybean fields in southern Illinois.

Researchers have determined that the growth of populations in soybean fields depends on the variety of soybean planted, the abundance of natural predators, and the occurrence of major rainstorms. Other observations regarding aphid population dynamics include (1) aphid populations often increased more than tenfold in a single week; (2) some populations had peak densities in late July, while others continued to increase after that date; and (3) the density of aphids in a few soybean fields reached over 1,000 aphids per plant on average. Another major phenomenon researchers observed among aphids is the formation of winged nymphs as the population grows. Early in the season only 5 to 10% of the aphids form wings as adults and fly away, but by mid- to late-July, the proportion can rise to 90%, causing populations to crash within a week. This phenomenon must be studied further in 2002.

Researchers performed controlled studies to determine whether aphid reproduction rates would be reduced on certain soybean genotypes, including those classified as having dense pubescence. Most, but not all, soybean genotypes with dense pubescence reduced the rates of aphid reproduction. In the field, insect-proof cages were used to evaluate aphid colonization on some soybean genotypes and on some Glycine soja lines. Some of the G. soja lines were rated as highly resistant to the aphid.

In laboratory studies, researchers confirmed that the aphid can transmit soybean mosaic virus strains. Aphids collected from soybean plants displaying severe virus-like symptoms transmitted the symptoms to healthy seedlings in the greenhouse. The symptomatic plants do not react with antisera to any of the viruses that commonly infect soybeans. Additional tests will be required to determine the identity and the pathogenicity of the causal agent.

Several avenues have been used to ensure timely dissemination of information regarding the soybean aphid and its distribution within Illinois and the Midwest. An interactive website, Soybean Aphid Watch 2001 (www.pmcenters.org/Northcentral/Saphid/Aphidindex.htm), was developed to monitor the distribution and densities of the soybean aphid for the Midwest as well as to provide general information about the soybean aphid. Use of the Web allowed Extension specialists and researchers to disseminate new information regarding the soybean aphid quickly and cost effectively. Extension specialists and researchers have also presented numerous talks at field days and training sessions across the state. In addition to the state-based activities, members of the Illinois team led the effort to develop a Pest Alert fact sheet as part of the regional educational efforts of the Soybean Aphid Response Team (NC-502).

Manipulation of Photoperiod to Enhance the Sustainability of Illinois Dairy Farms

Principal Investigators

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Management of photoperiod (the duration of a cow's exposure to light each day) in dairy cattle can be a profitable tool for producers. Properly implemented, photoperiod technology leads to immediate milk production responses, requires little capital investment, and has a quick asset turnover. These features make photoperiod management particularly attractive as a method for helping producers meet current challenges and improve long-term viability of the Illinois dairy industry.

The outreach activity of project researchers during the last year has been impressive. Presentations were made at 10 Illinois Dairy Days meetings, reaching at least 40% of the dairy producers in Illinois; at the Western Herd Management meeting that represents approximately 20% of the national dairy herd; and at three international meetings attended by producers, veterinarians, and researchers in Canada, Argentina, and South Africa. In addition to those presentations, researchers published three popular press articles and five symposium proceedings articles. Researchers have also disseminated information on photoperiod management through a website at http://il-traill.outreach.uiuc.edu/photoperiod.

The project's outreach efforts appear to be quite successful. A survey conducted in January 2001 indicated that over 80% of Illinois dairy producers were aware of photoperiod management as a production enhancement approach and that 19% of the respondents were already applying the techniques on their farms.

Researchers have also made progress with regard to the project's applied research objectives. The first field study testing the viability of photoperiod management in Illinois began on October 1, 2001. This study involves pairs of farms with similar production and management levels. Within each pair, one farm has installed lighting and is applying long-day treatment to the lactating herd, while the other farm serves as a control and provides no photoperiod treatments to the herd. Researchers will evaluate milk production, herd health, and implementation costs for six months. A second study to investigate the potential for year-round photoperiod application is currently being designed and should be in progress by spring of 2002.

FY02 Sentinel Projects

Creating Niche Market Opportunities in Animal Feeding for Small Farmers with Soybeans *(Neal R. Merchen; George C. Fahey, Jr.; Carl M. Parsons; Michael F. Hutjens; Steven T. Sonka; Randall E. Westgren; Richard L. Wallace; Rodney L. Frazier)*
The overall goal of this project is to identify and refine processing methods for soybean meal that can be applied in small-scale processing facilities. Such new methods will add value to soybeans as a feedstuff for food-producing animals. These research findings can then be used to create niche markets for added-value soy products, thus providing small-to-medium size soybean producers an opportunity to increase the profitability and efficiency of their enterprises.

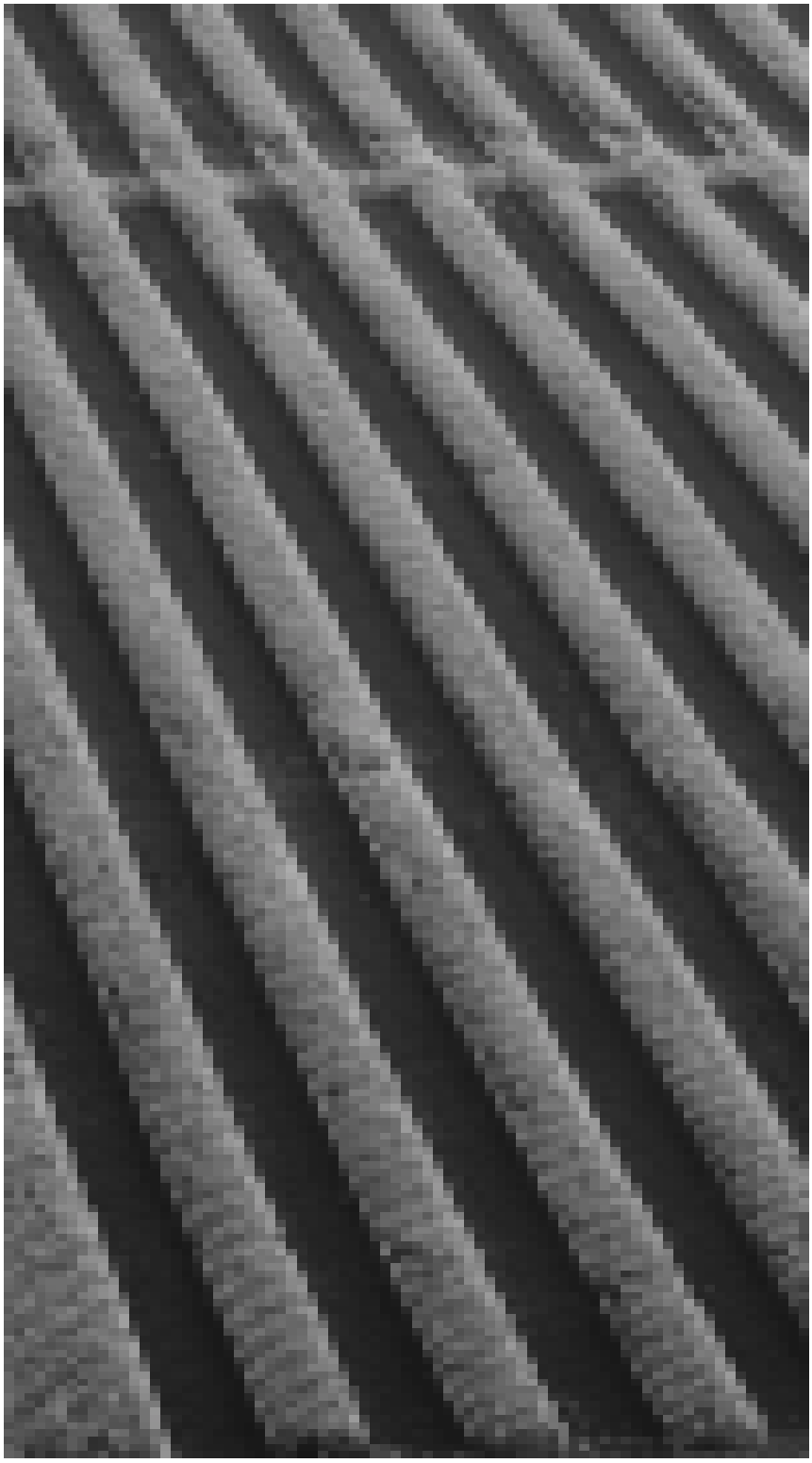
Plant Disease Molecular Diagnostic Initiative *(Kris N. Lambert; Dean K. Malvick; Terry L. Niblack; Weidong Chen)*
This project addresses a range of serious plant diseases in Illinois, including the soybean cyst nematode and soybean sudden death syndrome. To facilitate disease management, molecular procedures will be developed to screen for plant resistance to pathogens, determine pathogen aggressiveness, and identify pathogens in plants.

Internal and External Research Projects

In accordance with the Food and Agriculture Research Act (the C-FAR enabling legislation), the majority of research funds are allocated on a percentage basis to Illinois' four food and agriculture research universities: University of Illinois at Urbana-Champaign (82%), Southern Illinois University at Carbondale (11%), Illinois State University (4%), and Western Illinois University (3%). Each university solicits requests for proposals (RFPs) as part of an internal competitive grants program to select innovative, high-quality research that addresses the needs of the Illinois food and agriculture community and consumers as defined by the C-FAR membership. C-FAR's External Competitive Grants Program is designed to also encourage and support research efforts from state agencies and organizations outside of the four universities. This program solicits RFPs from nonprofit research entities within the state. By legislation, a minimum of 15% of the C-FAR allocation is dedicated to support these research projects. Working group members review and select proposals submitted to this program. Projects supported through the university internal programs and the External Competitive Grants Program are typically funded for one or two years. Funding can be extended based on need. Support is provided on a fiscal year that runs from July 1 through June 30. The following sections provide a report on the internal and external research projects that were completed in 2001, as well as a listing of the research projects that were funded in FY02.

Please visit the C-FAR website at http://web.aces.uiuc.edu/c-far/cfarreporting/public.cfm for more information about these projects.

Crops



Corn Hybrid and Drying Temperature Effects on End-Use Quality

The purpose of this research was to assess the effect of drying temperature on the milling quality of several corn hybrids. The specific objectives were to (1) use a laboratory-scale dryer to dry corn samples at four drying temperatures and then evaluate hybrids' wet milling yields based on drying temperature differences; and (2) improve estimates of added value for processing of specialty corn hybrids, including waxy, high-starch, and hard endosperm hybrids.

Researchers evaluated 15 commercial hybrids, including three waxy varieties, in this study. These hybrids were grown on the Agricultural Engineering Farm at the University of Illinois, and they were harvested at three different moisture levels, approximately 30, 25, and 14% wet basis. Researchers used a convection dryer at Illinois State University to dry the two samples with higher moisture levels. These samples were dried at temperatures of 50°, 70°, 85°, and 100°C to a target moisture of about 14% wet basis. Samples harvested at 14% wet basis were not dried further. Researchers measured stress cracks in the samples as an index for the effect of drying severity. The dried samples were then scanned with an Infratec 1229, which uses near-infrared transmittance, and researchers predicted extractable starch yields using an equation with an R^2 (coefficient of determination) of 0.81 and SECV (standard error of cross validation) of 1.33. A differential scanning calorimeter (DSC 2920), an electron microscope, and water activity measurements were used to study the effects of high drying temperature on gelatinization of starch. The results indicated significant differences between the two highest harvest moistures, with the corn harvested at 25% wet basis having higher starch yields than that harvested at 30% wet basis. Corn dried at temperatures of 50° and 70°C had significantly higher starch yields than that dried at 85° and 100°C.

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Verification of Nitrogen Fertilizer Recommendations for Illinois Corn Production

Improvements in fertilizer nitrogen (N) management are crucial to making corn production more sustainable and environmentally friendly, which was the overall goal of this research. Specifically, researchers sought to verify how well the fertilizer N rate currently recommended in Illinois, 1.2 lbs of N per bushel of grain, applies to current production systems using modern-day hybrids. Researchers conducted a series of on-farm and experiment-station trials, which represented a wide range of cultural practices and production conditions, to evaluate fertilizer N needs for corn. A separate experiment compared fertilizer N needs of a modern hybrid to those of one that was commonly grown in the 1970s when the current recommendation system was devised. Documenting that the determined N recommendation system is adequate (or too high) for modern hybrids will provide researchers with hard evidence they can use to support their recommendations against overapplication. Reducing fertilizer N applications will both save farmers money and improve the quality of Illinois waters.

Of the 45 N-rate response trials that researchers conducted over the past three years, in no instance was more than 1.2 lbs of N per bushel of grain needed to optimize productivity, and in most cases, considerably less was required. Averaged over locations and years, researchers calculated that the optimum N rate in biological terms was 0.91 lb of N per bushel; the optimum economic rate would be slightly lower. In contrast to what most growers believe, the highest yielding sites actually had the lowest per bushel N requirement, while the opposite was true for the lowest-yielding sites. This finding refutes using extra fertilizer N as yield insurance, which is the most common reason given by growers for overapplication. Compared to the 1970s hybrid, which required 133 lbs of N to produce a maximum yield of 142 bushels per acre, the modern hybrid produced a maximum yield of 165 bushels per acre with only 120 lbs of N, suggesting that modern hybrids are more efficient in their N use. These results confirm that following the current N recommendation system will assure that enough N is available for optimal corn yield in almost all cases.

A C-FAR External Competitive Grants Program project

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University of Illinois at Urbana-Champaign

Accurate Estimates of Seed Transmission of *Erwinia stewartii* Necessary to Modify Quarantine Restriction on Illinois Corn and to Gain Wide Acceptance

The specific objectives of this research project were to estimate the (1) rates of seed-to-seedling transmission of *Erwinia stewartii* based on appropriately large samples and (2) severity of host infection (which is associated with host resistance and susceptibility) required for plant-to-seed transmission of *E. stewartii*.

Researchers determined that levels of Stewart's wilt resistance that prevent systemic infection of corn inbreds and hybrids are sufficient to prevent transmission of *E. stewartii* in seed and grain. Rates of *E. stewartii* plant-to-seed transmission differ depending on the Stewart's wilt reaction of the plants producing the seed. Infection of kernels on seed parent plants with resistant reactions was about 0.0007 to 0.025%. Infection of kernels on seed parent plants with moderate reactions was about 0.07 to 0.19%. The rate of seed-to-seedling transmission of the bacterium was estimated to range from 0.034 to 0.043%. Based on these estimates, the probability of introducing *E. stewartii* in grain or seed produced on plants with moderate or resistant reactions is about 1 in 2,500,000 and 1 in 25,000,000, respectively. USDA APHIS officials have used these research findings in discussions with international organizations about phytosanitary inspections required for maize grain and seed to be exported from the United States to South Africa and other countries. The International Seed Federation (FIS) also used this information in a qualitative pest risk assessment (PRA) sponsored by the FIS to reevaluate quarantine restrictions for *E. stewartii* that are presently placed on corn seed produced in the United States. The PRA is posted on the FIS website, www.worldseed.org/ishis.htm.

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Process Research to Enhance Nutritional Value of Corn Wet Milling Coproducts

Wet milling uses corn as a renewable resource and generates starch, protein, oil, and fiber products. Protein and other nutrients recovered from the wet milling process can be used as low-valued animal food ingredients. A more efficient wet milling process will allow for the processing of more corn with existing capital. Researchers investigated whether stainless steel microfiltration membranes were suitable for dewatering corn wet milling coproduct streams. Researchers evaluated light steepwater streams as well as light and heavy gluten streams. The ultimate goal of this research is to develop a filtration process that will recover nutrients at higher concentrations with greater nutritional value than conventional evaporators and centrifuges.

Researchers determined that tubular stainless steel microfiltration membranes (0.1 micron nominal pore size) presented a practical alternative to centrifugation for increasing solids content of gluten streams. It is important to note that this project investigated batch filtration only; additional research comparing the results of continuous filtration to centrifugation will be necessary. Results indicate that the microfiltration process recovered nutrient content of gluten material as effectively as conventional centrifugation. Furthermore, microfiltration worked well to increase solid content of light steepwater and was found to remove components responsible for evaporator fouling from the permeate stream. Microfiltration was also able to concentrate solids to higher levels than conventional centrifugation technology, which would have a significant impact on processing corn gluten meal. Since evaporation uses approximately 20% of the energy needed for corn wet milling, control of fouling in steepwater evaporators could be a major benefit to processors. Results of this study suggest that microfiltration is a feasible alternative for diverting some of the steepwater solids into the corn gluten meal coproduct.

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Efficiency Gains with Corn Containing Transgenes for Improved Nitrogen Utilization

Recently, scientists have inserted a gene, referenced as GDH with glutamate dehydrogenase expression, into corn; this gene has the trait of improving nitrogen-use efficiency of the crop. The GDH gene reduces the amount of photosynthetic energy required for amino acid and protein synthesis in the plant, thus leaving greater amounts of the sun's energy for dry matter production and yield. Previous research suggested that using GDH-modified corn could increase yields by up to 10%. The purpose of this research was to evaluate the effectiveness of GDH-modified corn over a wide range of soil and environmental conditions and in the presence of different rates of applied fertilizer nitrogen and nitrapyrin (N-Serve). Researchers conducted these studies at two southern Illinois locations during the course of two years (2000 and 2001).

In both years of the study, grain yield, harvestable ears per acre, and grain quality were all generally reduced in GDH-modified corn compared to non-GDH corn. When growing conditions were most favorable for yield, researchers observed the most marked differences in responsiveness of GDH-modified corn versus non-GDH corn. When growing conditions were less favorable (due to drought), researchers observed fewer differences between the hybrids. Researchers noted that corn hybrids with GDH inserted produced higher yields than non-GDH corn only under droughty conditions. This finding suggests that the GDH gene may improve yields for drought-tolerant hybrids. Researchers have not yet determined the mechanism in plants that relates drought severity to GDH responsiveness. Further investigation is necessary to understand this process. Responsiveness to nitrogen fertilization was similar in hybrids with and without the GDH gene, and adding N-Serve to the nitrogen fertilizer had no effect on crop performance.

A C-FAR External Competitive Grants Program project

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Weed Management in Strip-Tillage Corn

In recent years, strip-tillage corn production has been of significant interest to Illinois producers who want to adopt a more conservative tillage program but have observed some disadvantages in no-till systems. The goal of this research was to examine weed management issues that occur in a strip-tillage corn production system and to use this information to educate producers who are adopting this practice. Specifically, researchers sought to determine how weed emergence patterns, herbicide performance, and corn grain yield in strip-tillage corn compared with those in traditional no-tillage and conventional-tillage systems.

Researchers observed greater initial emergence of giant foxtail, common waterhemp, velvetleaf, and common cocklebur in the conventional tillage system than in no-till and strip-tillage systems. This difference was attributed to the fact that soil disturbance at planting in the conventional-tillage system creates an optimal environment for weed seed germination and growth. Since strip-tillage was performed in the previous fall, no soil disturbance occurred close to planting, thus reducing early emergence of weeds. This lack of soil disturbance at planting also minimizes early weed emergence in the no-tillage system. Greater soil moisture in the no-tillage and strip-tillage systems may have contributed to reduced weed emergence as well. Beyond four weeks after planting, researchers observed very few differences in weed emergence in the three systems. Researchers compared how well herbicides controlled weeds across the three tillage systems by applying two standard herbicide treatments (preemergence and postemergence) to each test plot. The preemergence herbicide application provided greater control of giant foxtail and common waterhemp in the conventional-tillage system than in the no-tillage system. No differences were observed across tillage systems using the standard postemergence application. Weed control in the strip-tillage system generally fell within the range between the no-tillage and conventional-tillage systems. A major factor affecting the level of weed control achieved was corn stand establishment. In general, the no-tillage system had reduced corn stands, which allowed for greater light infiltration and resulted in greater weed emergence and competition. Finally, researchers noted that corn yield in the strip-tillage system was greater than or equal

to that in the no-tillage system.

These research findings demonstrate that strip-tillage has the potential to provide corn growth and yield similar to conventional tillage, and strip-tillage has the advantage of reduced weed emergence just after planting. Therefore, using the strip-tillage system for corn production does not increase weed management difficulties, and it may actually help growers avoid some weed problems associated with no-tillage or conventional-tillage systems.

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Regulating the Biosynthesis of Important Tryptophan Pathway–Derived Products

European corn borers are a significant pest affecting maize production in Illinois. Various sources estimate that corn borers cost U.S. farmers $350 million dollars annually by significantly affecting production of field corn, popcorn, seed corn, and sweet corn. DIMBOA (2,4-dihydroxy-7-methoxy-1,4-benzoxazin-3-one) is maize's natural defense mechanism against first-generation European corn borers as well as diseases like northern corn leaf blight and stalk rot. Because DIMBOA biosynthesis is under developmental control, this natural defense is only effective in seedlings and does not protect mature plants against second-generation borers. The objective of this project was to determine if changes in a key control enzyme, anthranilate synthase (AS), in the tryptophan (Trp) biosynthesis pathway were related to the levels of the nutritionally important amino acid tryptophan and of DIMBOA in various maize genotypes and mutant lines. This information could be used to increase or alter the biosynthesis pattern of these important compounds produced by maize, thus increasing pest resistance.

Researchers made significant progress in understanding the mechanisms that regulate the Trp and DIMBOA pathways during seedling growth. AS activity was measured in seedlings of several different maize genotypes with different DIMBOA levels and of mutant maize lines with different AS kinetic properties. No correlation was found between AS properties (total activity, affinity for the substrate chorismate) and the range of DIMBOA levels observed in the maize genotypes tested. Total AS activity was highest in three-day-old seedlings, as was the concentration of DIMBOA and Trp. These findings are consistent with the hypothesis that AS Trp-feedback inhibition acts as the primary control mechanism regulating pathway flux. In a mutant line containing a Trp-feedback-insensitive AS, high levels of free Trp were observed, suggesting that the Trp pathway flux increased significantly. Researchers have crossed this mutant with various genotypes and are currently testing whether the additional Trp pathway metabolites can be directed toward increased biosynthesis of DIMBOA. In a mutant line that does not make DIMBOA, Trp levels were higher, suggesting that a common pathway intermediate pool is utilized for Trp and DIMBOA biosynthesis. For seedlings of 12 maize genotypes and mutant lines, researchers have measured the levels of messenger RNA encoding 8 enzymes in the Trp and DIMBOA pathways, and they have detected changes in the relative expression levels of these genes. Researchers will conduct additional experiments to determine the significance of these changes. Findings to date support the preliminary conclusion that, in seedlings, the ratio of the enzymes utilizing the final common intermediate affects the ratio of products produced.

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Identification of Resistance to Soybean Cyst Nematode in *Glycine tomentella*

Soybean cyst nematode (SCN) is the most economically damaging soybean pest in Illinois and throughout the United States. It is estimated that in 2000 alone, losses caused by SCN robbed Illinois soybean producers of $250 million. Once established in a field, SCN infestation is difficult to eradicate and requires long-term management strategies. Producers currently use crop rotation and genetic resistance to manage SCN, but since SCN populations in the field are highly heterogeneous, one concern is that they may eventually overcome the resistance genes deployed by plant breeders. The primary goals of this project were to (1) find the best sources of SCN resistance in the perennial *Glycine tomentella*, (2) determine the chromosome number of these resistance

sources, and (3) develop crosses of *G. tomentella* and soybean that are likely to produce fertile hybrids.

Approximately 97% of the *G. tomentella* accessions demonstrated resistance to at least one race of the nematode, and 35% of the accessions were resistant to all three races tested. At all four chromosome levels (n = 38, 40, 78, and 80), at least a few *G. tomentella* accessions were resistant to all three nematode races. Researchers determined the chromosome number of these multiple-race resistant accessions and entered the data in the wild perennial database. The fact that many accessions demonstrate multiple-race resistance increases the likelihood that resistance can be transferred to soybeans. As researchers identify resistance, they can determine the genetic components of resistance for intra-specific and inter-specific populations.

Another important outcome of this study is that scientists developed a reliable and reproducible greenhouse method using clay pots for assessing resistance in the perennials and soybeans. This enabled researchers to test resistance levels in *G. tomentella* accessions and soybeans by allowing multiple nematode generations to develop. This screening method is an important new development that may be adapted by other researchers.

This project has laid the foundation for transferring nematode resistance from the wild perennial *G. tomentella* to soybean. Phase II of this research will focus on determining how SCN resistance is inherited and transferring new sources of genetic SCN resistance to soybean cultivars.

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Enhancement of Soybean Co-inoculation for Optimal N_2-Fixation and Maximizing Yields

Scientists have estimated that the biological nitrogen-fixation process in soybeans could save producers as much as $125 million in nitrogen fertilizer annually. Additionally, $50 to $60 million of nitrogen fertilizer credit is assigned for a soybean–corn or soybean–wheat rotation. The primary focus of this research was to isolate and select soil microorganisms that possess antibiotic-like activity (bradyrhizobicin) against the organism that nodulates soybean, *Bradyrhizobium japonicum*. The specific objectives of this research were to (1) isolate soil microorganisms that inhibit *B. japonicum* with bradyrhizobicin; (2) obtain crude extracts of bradyrhizobicin for the development of *B. japonicum*–resistant strains; and (3) enhance infection and nodulation of soybean roots by developed strains of *B. japonicum* efficient in nitrogen fixation and resistant to bradyrhizobicin under greenhouse conditions.

Researchers initially identified 104 soil isolates antagonistic to *B. japonicum* from soybean fields in southern Illinois. Upon additional testing, the final collection of soil isolates inhibitory to *B. japonicum* was reduced to 20. Researchers then developed filter-sterilized extracts of these antagonistic organisms and used these to partially characterize the substance inhibitory to *B. japonicum* growth. Following a 10- to 30-fold concentration, the extracts from 4 of the 20 soil isolates were found to show substantial inhibitory activity to *B. japonicum* strain 123, a strain common in southern Illinois soils. Additionally, the extracts from two of these four isolates showed significant bradyrhizobicin activity against three other *B. japonicum* strains. Researchers are also currently conducting a soil-pot greenhouse study to assess the co-inoculation of soybeans with two good nitrogen-fixing strains of *B. japonicum* (resistant to bradyrhizobicin) and the four soil isolates responsible for bradyrhizobicin production. The co-inoculum treatments that show enhanced nodulation by our selected strains of *B. japonicum* will be used in 2002 field studies. If the field tests of these co-inoculants confirm increases in soybean seed nitrogen content as well as in crop yields, the results will significantly benefit soybean growers throughout Illinois.

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Enhancement of Soybean Inoculation for Maximizing Yields

The primary focus of this research was to evaluate whether co-inoculating soybean with selected antibiotic-resistant strains of *Bradyrhizobium japonicum* and *Streptomyces kanamycetius* under field conditions would improve soybean yields and seed nitrogen content. Building on findings from the project described on page 43, the specific objectives of this research were to (1) assess the infectivity (nodule formation) of *B. japonicum* co-inoculated with *S. kanamycetius,* (2) assess the efficacy in nitrogen fixation by soybeans co-inoculated with selected strains of *B. japonicum* and *S. kanamycetius,* and (3) determine the potential benefit in soybean yield and seed nitrogen content from co-inoculation.

In 2000, researchers conducted a field study in Carbondale, Illinois, to determine whether co-inoculum treatments produced increases in nodule number (infectivity), nodule occupancy, leaf nitrogen content (efficacy in nitrogen fixation), soybean yield, and seed nitrogen accumulation. When plated on the appropriate growth medium, all six antibiotic-resistant strains of *B. japonicum* showed a substantially higher nodule occupancy than the noninoculated treatment. All six strains receiving the co-inoculum treatments had higher yields (ranging from 15 to 28.4% more) than the noninoculated control, and two of the co-inoculated strains produced significantly higher yields compared to the control. Additionally, all six co-inoculated strains had higher levels of accumulated seed nitrogen (ranging from 13.8 to 28.7% higher) compared to the noninoculated control, with three of the co-inoculated strains demonstrating substantially higher seed nitrogen content. Investigators are continuing this research with field inoculation trials at the SIUC Carbondale and Belleville Research Centers for the 2001 growing season. It is hoped that these field trials will confirm preliminary findings that co-inoculum treatments increase soybean seed nitrogen content and yield.

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Development of a Universal Soybean Genome Map

The development of a universal soybean map will be extremely useful for several purposes: (1) establishing the genetic position of economic traits that improve soybean yields, (2) protecting plant variety, (3) detecting quantitative trait loci (QTLs), and (4) map-based cloning of economically important genes. The objective of this project is to use a complete set of 20 simple primary trisomics (2n = 41) of the soybean to map simple sequence repeats (SSR) to the specific individual soybean (*Glycine max*) chromosomes. Researchers approached this task by first crossing *Glycine soja* (the wild annual relative) to each of the 20 primary trisomics. The F1 hybrids with 2n = 41 were then grown in the greenhouse and allowed to self-pollinate. Leaf material from at least 100 individual F2 plants was used for DNA extraction and SSR analyses. Based on the modified genetic segregation ratios in F2, researchers mapped the SSR markers to specific chromosomes.

SSR markers usually segregate in a codominant (1:2:1) fashion in F2 populations. Deviation from the 1:2:1 ratio suggests that the marker is associated with a particular chromosome. Based upon this principle, researchers have associated SSR markers with 12 of the 20 soybean chromosomes. The relationship between soybean chromosomes and molecular linkage group is as follows: Chromosome 1 = D1a+q, 3 = N, 4 = C1, 5 = A1, 8 = A2, 9 = K, 13 = F, 15 = O (only a portion), 16 = L, 17 = D2, 18 = G, and 20 = I.

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Hydrogenation of Soybean Oil by a Novel Low-Temperature Electrochemical Process

Trans fatty acids have recently been implicated in causing coronary diseases; therefore, lowering trans fatty acid levels in foods is a high priority. The objectives of this research are to (1) produce hydrogenated soybean oil with a lower level of trans fatty acids, (2) use extremely mild reaction conditions to conduct hydrogenation, and (3) disseminate information to concerned parties.

Researchers have developed a procedure for hydrogenating soybean oil that subjects an emulsion of soybean and water to a very mild electrical current at temperatures as low as 45°C. Electrochemically

hydrogenated soybean oil contains 80% less trans fatty acids than soybean oil produced commercially using the gaseous hydrogenation processes operated at high temperature and high pressure. Researchers have used such analytical techniques as fatty acid profile measurements by gas chromatography, cyclic voltammetry, and infrared spectroscopy to understand the chemical reaction driving this new hydrogenation process. This research has been the basis for a number of publications and presentations to professional organizations. In addition, researchers are pursuing a patent application for this electrochemical hydrogenation procedure.

A C-FAR External Competitive Grants Program project

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Engineering Resistance to the Soybean Cyst Nematode

The soybean cyst nematode (SCN), *Heterodera glycines,* is the most damaging pathogen of soybean in the United States, causing hundreds of millions of dollars in damage every year. The only viable and environmentally sustainable control strategy for SCN is the use of nematode-resistant soybean plants. The goal of this research is to engineer novel resistance genes that will protect soybean from the soybean cyst nematode. This project has three objectives: (1) to isolate genes that encode nematode intestinal proteins, and then to use these genes as targets for engineering nematode resistance; (2) to optimize the expression of foreign proteins in nematode feeding cells using a rapid soybean hairy-root transformation method; and (3) to express nematicidal proteins and/or RNA in soybean roots using an optimized expression system, and then to evaluate these transgenic roots for resistance to the soybean cyst nematode.

To clone SCN intestinal genes, researchers had to construct a cDNA library using SCNs that were just starting to feed from the plant. Researchers used a dissecting microscope to dissect four SCNs from the plant roots. Nematode mRNA was then isolated and converted to cDNA. The cDNA was polymerase chain reaction (PCR)-amplified to obtain large amounts for library construction. Because this cDNA was amplified from whole SCNs that were just starting to ingest plant metabolites, it was assumed to contain cDNAs from intestine-specific genes. Researchers confirmed this assumption by using the PCR-amplified cDNA to clone SCN cysteine protease, a known intestinal gene. In addition to the SCN protease, investigators also cloned a small peptide hormone gene from SCN. This peptide hormone is known to regulate blood sugar in insects and is likely performing a similar function in nematodes. In the next phase of the project, researchers will focus their efforts to engineer SCN resistance on these two nematode intestinal proteins.

In addition to cloning SCN target genes, researchers also assayed transgenic soybean roots that expressed proteins potentially toxic to SCN. One transgenic line tested extensively is a soybean expressing a chitinase. Researchers observed that transgenic roots expressing large amounts of the chitinase do not support as much SCN infection as roots expressing low amounts of this protein. Based on these promising results, the transgenic lines are being retested. If the new test also shows low SCN infection levels, researchers might have identified a new SCN resistance gene, which is good news for soybean growers.

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Physiological–Biochemical Basis for SDS Resistance in Soybeans and Other Species

Sudden death syndrome (SDS) is a mid- to late-season disease with distinctive foliar symptoms that more commonly occur in high-yield environments. SDS was first observed in Arkansas in 1971, but throughout the 1980s and 1990s it has been reported in most states throughout the United States. Yield losses from SDS range from slight to nearly 100%, depending on disease onset and severity. Research goals were to (1) study the fungal–plant interactions between the SDS fungus and *Fusarium solani* f. sp. *glycines* (fsg) in soybeans as well as other hosts and nonhosts; (2) characterize the plant and fungal metabolites important in these interactions; and (3) quantify the antifungal effects of plant constituents on the growth and development of the SDS fungus.

Eleven root extracts (five from corn and six from soybean) were tested to

determine their effects on the conidial germination of fsg. Preliminary results showed that six extracts (three from soybean and three from corn) stimulated germination of conidia compared to the control treatment (applying distilled water). Three extracts from soybean inhibited the germination. One extract from corn (chloroform-soluble) caused conidia to swell and cell walls to break. Even after one week, no conidia germinated, indicating that this extract may have strong antifungal activity that inhibits germination of fsg conidia. Researchers also tested several naturally occurring compounds to determine if they would inhibit conidia germination or fsg growth. At concentrations of 400 micromolar, two of the four compounds tested, trans-hexenal and salicylaldehyde, inhibited germination for up to one week. Caffeic acid at 500 micromolar also inhibited germination, while sodium salicylate stimulated germination. In the growth assay, researchers used varying concentrations of the test compounds to inoculate plugs of fsg on plates of potato dextrose agar. Growth was assessed by measuring the diameter of the colonies after a seven-day period. The highest inhibitory activity was found in molecules that were aromatic, such as benzaldehyde and salicylaldehyde. Conjugated aliphatic compounds, such as alpha-beta unsaturated carbonyls (citral and trans-2-hexenal), were also inhibitory, but saturated aliphatics were not. Volatile aldehydes are readily formed in soybean plants during periods of stress such as insect or fungal predation. This research advances the study of SDS and other fungal diseases of plants and helps in the development of commercial fungicides.

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Round-Up Ready Gene Transfer from Transgenic to Non-transgenic Soybeans

The goal of this project was to better understand how the Round-Up Ready gene is transferred from Round-Up Ready to non-Round-Up Ready soybean varieties via pollen movement. The results of this study will help growers and the seed industry develop strategies for minimizing this contamination. Researchers measured the frequency of cross-pollination by planting non-Round-Up Ready varieties at various distances, ranging from 0.76 meters (1 row) to 19.81 meters (26 rows), away from Round-Up Ready varieties. In addition, the role of insects in pollen movement was studied in (1) a field surrounded by a wildlife area that had high insect populations, (2) experimental plots using insect-proof cages with very low insect populations, and (3) field experiments with sterile soybean male lines. Finally, researchers evaluated whether hybrid corn could be used as a physical barrier to soybean pollen movement.

In 1999 and 2000, non-Round-Up Ready soybean varieties were planted in rows adjacent to a Round-Up Ready source. Seeds harvested from non-Round-Up Ready varieties were planted in 2000 and 2001, and sprayed twice with Round-Up Ultra™. Researchers screened approximately 600,000 plants in the field. The frequency of cross-pollination of the Round-Up Ready to non-Round-Up Ready soybean in the adjacent row (spaced 0.76 meter apart) was 0.064% in the soybean field, 0.030% in the field that used corn (4 rows, 3.0 meters apart) as a barrier in between Round-Up Ready and non-Round-Up Ready soybeans, and 0.108% in the fields surrounded by a wildlife area. Researchers observed no cross-pollination in a greenhouse test which used the insect-proof cage with low levels of insects. The results of two experiments showed that the frequency of Round-Up Ready cross-pollination in the soybean field was 0.024%. Researchers observed the highest rate of cross-pollination (0.057%) in experimental plots near the wildlife area, but using corn as a barrier in these plots decreased the cross-pollination to 0.013%. In laboratory tests, researchers used the test strip developed by Strategic Diagnostics, Inc., to evaluate the presence of Round-Up Ready gene. They confirmed that the gene was present in all plants in 2000 and in randomly selected plants in 2001 that survived the Round-Up Ultra™ treatment.

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Molecular Markers for Parasitic Ability of Soybean Cyst Nematode

Molecular studies of Soybean Cyst Nematode (SCN) variability and virulence will assist in the development of SCN-resistant soybeans that would help reduce the significant yield losses due to this pest currently experienced by soybean producers. The objective of this research was to use amplified fragment length polymorphism (AFLP) to identify molecular markers associated with virulence of SCN populations that have adapted to germplasm lines expressing different genes for resistance to SCN.

Researchers identified a number of DNA fragments that are specific to some SCN races. These were observed in races 2, 4, 5, 6, and 14. For example, a 142-bp DNA fragment that is specific to SCN race 5 has been isolated, cloned, and sequenced. A BLAST search of the GenBank nucleotide database indicated significant similarities between this sequence and an EST from the root-knot nematode, *Meloidogyne incognita,* (accession number BE225510). In addition, researchers identified a fragment of approximately 126-bp for race 6 populations that was virulent on all sources of resistance. This potential marker must be isolated, cloned, sequenced, and proved dissimilar to proximate fragments for races 1, 2, and 4 on PI90.763. A different primer combination produced a 330-bp fragment in race 2 populations on Peking, Cloud, PI88.788, and PI209.332, but not in those populations selected on PI89.772 and PI90.763. Finally, researchers identified a 220-bp DNA fragment that distinguishes between highly inbred race 3 populations of SCN that are virulent and avirulent (no female development) on PI89.772.

Researchers for this project have sequenced and cloned one marker for race 5 populations virulent on several sources of resistance. This result lays the foundation for additional studies using specific primer combinations to develop a molecular probe for identifying SCN populations that have the specific 142-bp DNA fragment associated with virulence.

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Mechanisms Behind Reduced Severity of Soybean SDS Following Delayed Planting

Sudden death syndrome (SDS), caused by the soilborne fungus *Fusarium solani* f. sp. *glycines,* is arguably the most important fungal disease affecting Illinois soybean, and it has become a significant problem in many soybean-producing states. Host resistance is the preferred control method, but to date, only partially resistant varieties have become available. Consequently, cultural strategies for managing SDS must be explored as well. Of these strategies, delayed planting has been shown to reduce both incidence and severity of SDS in some but not all cases. Because delayed planting has had inconsistent results, scientists are reluctant to specifically recommend this practice for managing SDS. However, the limited success of this approach suggests that it might indeed be a useful strategy if researchers can unravel the effects of some mitigating environmental factors. Consequently, this project focused on two major objectives: (1) to examine how delayed planting affects soybean root colonization by the SDS fungus and subsequent disease development; and (2) to study how soil temperature and soil moisture influence viability of fungus propagules in soil, their infectivity on soybean roots, and resultant root colonization.

In general, researchers first observed foliar symptoms during August, and these symptoms increased in severity over time. SDS was most severe and increased to the highest levels on plots planted at the recommended date (planting date [PD] 1). Delaying planting by three (PD 2) or six (PD 3) weeks reduced both foliar and root disease levels substantially. Peak soil temperatures at a depth of 20 cm were 17.5°C for the three weeks immediately following PD 1, 23°C for that same period following PD 2, and 25°C for that period following PD 3. Because the SDS fungus is known to prefer cooler soil temperatures, researchers initiated a series of greenhouse studies that addressed how soil temperature and moisture affect SDS. Experiments involved soil cores that were removed from fields with a history of SDS and transferred to temperature-controlled water baths. Treatments were arranged in a factorial manner and consisted of two soil temperatures (20 and 27°C) and two soil moisture levels (low and high), each replicated eight times. Gypsum blocks were placed 20 cm deep to monitor soil moisture. The plants were grown for 129 days, by which time they had entered repro-

ductive stages. Root dry weights were lower at 20°C than at 27°C, and lower in dry soil than in wet. Recovery (%) of fungus from both tap and lateral roots, as well as populations (cfu) of the fungus from these same tissues, were greater at lower soil temperatures and higher soil moistures. Researchers observed no significant interactions between these two experimental treatments. These findings demonstrate that soil temperature and moisture have a profound effect on root infection by *F. solani* f. sp. *glycines* and support anecdotal observations about the importance of soil factors in SDS control.

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A New Enzyme for Reducing Damage Caused by Oxidative and Drought Stress

Drought and disease are two major problems limiting Illinois crop yields, accounting for more than 50% of growers' economic losses. Drought and dry spells consistently cause the greatest reductions in yield and profitability. A primary objective of this project is to use biotechnology to improve drought tolerance and reduce oxidative stress–induced damage in crop plants. Researchers have focused their efforts on trigonelline (TRG) because of several desirable properties. Research has shown that TRG stabilizes enzyme activity in vitro, and it is further postulated that TRG will function as a compatible solute in response to salinity and water-deficit stress. TRG is also associated with resistance to fungal infection—it has been shown to confer leaf resistance to fungal infections in barley. TRG seems to provide protection against oxidative stress–induced DNA damage as well. Researchers for this project proposed to purify the TRG biosynthetic enzyme, S-Adenosyl-L-methionine:nicotinic acid-N-methyltransferase (NNMT) (EC 2.1.1.7), from soybean (*Glycine max*) and to clone the corresponding gene.

In laboratory experiments, researchers purified NNMT 2,650-fold with a recovery of 4%. The purification procedure included ammonium sulfate (45 to 60%) precipitation, linear gradient DEAE-Sepharose chromatography, adenosine-agarose affinity chromatography, hydroxyapatite chromatography, and gel filtration (Sephacryl-S-200). It is important to note that funding for this project has allowed the research group to develop expertise in how to purify key enzymes from soybean and to establish one of the only public research laboratories studying this important class of enzymes and molecules in soybean. The information obtained through this research will allow breeders to improve the drought stress– and disease-tolerance of soybean by selecting for altered TRG content.

A C-FAR External Competitive Grants Program project

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Future for Wheat in Illinois

Wheat acreage in Illinois has been on a downward trend for the past 20 years. Several factors have contributed to this trend. The rate of increase in Illinois average wheat yields has been less than half the rate of increase in corn and soybean yields from 1980 through 1999. During the 1990s, yield variability increased for wheat, while it declined for corn and soybeans. Structural changes in the world wheat market have weakened the price of soft red winter wheat relative to corn and soybean prices. The nominal dollar cost of production per bushel for all three crops has remained nearly constant over time. Thus, a lower yield trend, increased yield risk, a weaker price, and no cost of production advantages have put wheat at a disadvantage.

Despite these trends, wheat is a profitable crop when double-cropped with soybeans in the southern regions of the state. Wheat with double-crop soybeans returned $12 to $19 per acre more than a corn–soybean rotation in the two southern crop reporting districts. For individual growers, wheat may be profitable without double-crop soybeans on soil types where wheat yields can reach approximately 60% of corn yields or where opportunities for straw production are available or improvements in timeliness can be made. Growers who plant wheat on part of their acreage are more likely to complete corn and soybean plantings on time and avoid yield losses.

Researchers for this project evaluated whether it would be profitable for Illinois wheat producers to grow higher-valued hard red winter wheat rather than soft red winter wheat. Initial tests by the University of Illinois indicate that hard red wheat yields from 3.9 to 9.4 bushels less than soft red winter wheat. The average

premium of $0.41 per bushel during the 1990s would be sufficient to justify hard red wheat production at a 4 bushel difference but not at a 9 bushel difference. Furthermore, whether Illinois growers would receive a $0.41 premium is questionable given the necessity to segregate the wheat. At the present time, there are not sufficient public and private resources available to develop, maintain, and segregate two classes of wheat in Illinois at current volumes of wheat production.

A C-FAR External Competitive Grants Program project

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Exploration of Wheat Kernel Hardness and Protein Levels in Search of Added Value

The primary objective of this investigation is to create a value-added platform that will improve communication among researchers, breeders, growers, and processors, and thus enhance the long-term viability of Illinois' wheat industry. A better system of communication will reduce the time gap between the basic and applied research in the value-added areas of kernel hardness and protein level as they relate to quality in the milling and baking industry. The goals of this investigation include the following: (1) development of a database for Illinois wheat quality that includes information about protein content, test weight, kernel characteristics, and milling characteristics; (2) correlation of milling characteristics and wheat parameters measured by the

Perten SKCS 4100; (3) development of an Illinois-specific near-infrared (NIR) calibration for protein; and (4) correlation of milling characteristics and the wheat protein content measured by the Infratec 1229 NIR instrument. To achieve these goals, researchers studied 1,200 wheat samples from six statewide locations of the University of Illinois Variety Trials Program.

In the process of developing calibrations for the Infratec 1229 NIR instrument, researchers evaluated three different statistical methods. Principal component regression (PCR) resulted in a calibration for protein with an r2 value of 0.984 and a standard error of prediction (SEP) of 0.147. The partial least squares (PLS) method gave an r2 value of 0.984 and an SEP of 0.150. The modified partial least squares (MPLS) model outperformed these calibrations slightly, with an r2 value of 0.985 and an SEP of 0.145. In all three cases, the NIR methods correlated very well with classical methods for protein determination. Milling and baking scores as well as flour yields were highest for samples with hardness index values between 4 and 16. Alkaline water-retention capacity (AWRC), a measure of the water-binding capability of dough, increased with hardness index, confirming the 4 to 16 range. Particle size index (PSI) was similar to the hardness index in effects: optimum AWRC and milling and baking scores were in the PSI range of 73 to 77. The results of this study indicate that the hardness index and particle size index are quick and reliable automated methods for determining wheat and flour quality. They provide a highly desirable alternative to standard methods, which can be labor- and time-intensive.

Researchers also evaluated three wheat varieties (Madison, P2540, and Clark) based on planting location and found that location had a significant effect on milling and baking scores, flour yield, and AWRC. One location gave consistently low milling and baking scores and high AWRC. Protein levels in Madison wheat varied significantly depending on location. Flour protein correlated well with wheat protein at all locations. These findings demonstrate that the performance of a particular variety in one environment may not necessarily predict performance at others.

Wheat breeders will be able to use this data to develop varieties that meet the changing demands of the world market, providing top agronomic potential to wheat growers in the state.

A C-FAR External Competitive Grants Program project

Dennis R. Thompson, Steven Mbuvi, John C. McKinney, Sandra Harrison

Illinois Crop Improvement Association, Inc.

Composite from Recycled Plastics and Agricultural Fibers

The processing of agricultural fibers and plastic waste to form new composite materials is being investigated. New products developed from these materials could have tremendous economic potential for farmers and Illinois, in general. Specific objectives of this research were (1) optimizing techniques for manufacturing and testing the nonwoven agricultural

fiber/plastic panels and the extrusion melt-blended composites from recycled plastics, kenaf stalks, and wastepaper; (2) determining the recyclability of these new types of value-added composites; and (3) reaching out to industry and the farm community to publicize the results of this study and to help them grow kenaf, a new fiber crop in the state, as a value-added product.

Test results showed that cornstalks, corncobs, and kenaf stalks can be used as a filler in a high-melt flow polypropylene to yield impact properties similar to those found in injection molding products filled with wood. Both corn- and kenaf stalks can be used as the substitute for wood fiber. However, researchers found that kenaf fiber quality is superior to that of cornstalks. To optimize manufacturing of the fiber/plastic composites, more than 90 experimental panels in sizes from 228 mm x 228 mm x 6.35 mm to 406 mm x 406 mm x 6.35 mm were made from various combinations of cornstalk, kenaf, and wastepaper fibers with plastics. For comparison purposes, researchers used both virgin and recycled plastics in their experiments. Kenaf stalk was grown at the University of Illinois' South Farm and in Dixon Springs, Illinois. The stalk was harvested after a growing season from 150 to 180 days, and it ranged from 25 mm to 35 mm in diameter. The office waste paper was collected. For the nonwoven mat, the recycled polyester fiber was spun from recycled soft-drink containers. Researchers found that adding 10% polypropylene and phenolic resin to kenaf and wastepaper panels did not significantly improve material properties. Researchers determined that either the nonwoven, air-laid technology or the extrusion melt-blended procedures could produce excellent composite panels from a formulation of 50% kenaf or wastepaper and 50% recycled plastics. Panels made from the nonwoven process obtained better properties than panels made from the extrusion method. When the coupling agent was used to improve the bonding property of recycled plastic, the kenaf/plastic composite showed good dimensional stability. All panels produced are recyclable.

A C-FAR External Competitive Grants Program project

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New Genes for Sustainable Agriculture II

The goal of this project is to identify specific weed genes with beneficial properties and to transfer or replicate these genes in crop plants in order to improve crop yields or disease resistance. Researchers at SIUC are currently studying two genes: the gene that regulates nitrogen partitioning, gsr, and the gene that increases general root resistance to disease, rrd. These genes are found in a weed that is conducive to gene isolation. Once they have isolated the weed genes, researchers will be able to (1) identify, isolate, and manipulate the equivalent genes in crop plants; or (2) transfer the weed genes directly to crop plants to increase genetic diversity. Therefore, the genes can contribute to both public health and grower profitability in Illinois and the United States.

Researchers have localized the gsr gene and transformed it into mutant plants. The genes are being prepared for crop transformation. The phenotypes generated have potential to improve yield and yield stability. Researchers have not yet isolated the rrd gene. Further studies will be necessary, as this gene appears to be part of a complex locus. Researchers are currently seeking funding to allow completion of the gene isolation procedure. On another front, similarities between soybean and *Arabidopsis* responses to *F. solani,* causal agent of sudden death syndrome, lead researchers to believe there are common mechanisms of infection and resistance that can be captured and exploited. The ultimate goal of green biotechnology studies such as this one is to improve the sustainability of agriculture.

A C-FAR External Competitive Grants Program project

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Animals

Effect of Sire Marbling EPD on Premium Required to Feed Steers for a Quality Market

Ninety-six Simmental-Angus steers sired by bulls of known marbling expected progeny difference (EPD) were early-weaned and individually fed high-energy diets. Researchers replicated this trial over two years, testing 48 steers per year. Ultrasound measurements of the steers were taken at 60-day intervals to estimate the rate of marbling deposition. When the steers reached approximately 14 months of age and a weight of 1,400 lbs, they were harvested at a commercial packing plant. Carcass quality grades for these steers ranged from select to prime, averaging low choice. Progeny of sires with the lowest marbling EPD had the lowest USDA quality grades (low select), and those from the highest marbling EPD had the highest quality grades (average choice). Rate of gain decreased and the amount of feed required per unit of gain increased with length of time on feed. However, quality grade as estimated by ultrasound measurement had little effect on feed efficiency. Cost of gain was not highly correlated with quality grade, showing that using sires with high marbling EPDs can improve carcass value without increasing the cost of production.

These research findings indicate that Illinois beef producers who retain ownership of their cattle all the way to harvest can benefit by using sires with high-marbling EPDs. By using high-marbling EPD bulls, producers can improve carcass merit of their cattle and obtain significant premiums. This research also suggests that using high-marbling EPD bulls does not increase cost of production in comparison to using low-marbling EPD bulls with similar growth performance. Using a combination of early-weaning and high-marbling EPD bulls provides Illinois beef producers with the potential to gain significant quality premiums without the discounts of yield grade four carcasses.

A C-FAR External Competitive Grants Program project

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Creation of a Strategic Profit Model for the Illinois Beef Industry

From 1996 through 1999, the average financial return to Illinois beef producers was a negative $19.91 per cow in the herd. The goal of this research was to develop a financial management information system Illinois beef cattle producers can use to evaluate production practices and marketing options for their ability to enhance the economic competitiveness of beef enterprises. An additional purpose of this project was to benchmark the quality and consistency of Illinois-harvested cattle as a first step toward helping producers identify marketing opportunities. This harvest data would be used to test the potential risks and rewards of marketing cattle through grids, formulas, or even branded products as opposed to selling cattle live.

Investigators utilized data collected through the Integrated Resource Management/Standardized Performance Analysis (IRM/SPA) program in Illinois as well as data from Iowa to develop a regional database detailing financial and biological cost-of-production data for midwestern cow–calf producers. Using regression analysis on this data, researchers determined that feed costs are responsible for over 50% of herd-to-herd variation in profitability among cow–calf producers. These costs far exceed the impact of items traditionally thought to be important, such as market price received, reproduction, and pounds produced. If the feed costs for just half of the cows in Illinois were reduced by one standard deviation, it would result in an annual industry savings of over $30 million. This database has been used to develop a strategic profit model for the beef industry, similar to the DuPont system of financial analysis. Business-minded producers can use this model to create strategies for achieving an expected level of return on equity. This model provides a conceptual representation that enables managers to measure the effects of alternative actions.

In addition, researchers have developed an Illinois Beef Quality Database to provide producers with documentation of carcass quality advantages of their cattle, as well as to identify areas requiring improvement. Producers can use this data to identify marketing options for specific types of cattle. This information has helped producers secure premiums for their cattle as

more structured, value-based marketing schemes are being evoked in the industry.

A C-FAR External Competitive Grants Program project

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Investigation into the Immune Response and Potential for Vaccine Development Against Cattle Lice

The ultimate objective of this study is to determine whether lice infestation involves the host's immune system and whether such involvement justifies developing a vaccine aimed at disrupting the growth patterns of the lice populations. Such a vaccine would have the advantage of eliminating pesticide use and its associated food safety concerns. Researchers for this project focused on three specific objectives: (1) monitoring the host immune potential as well as the specific immune response to lice (*Linognathus vituli*) infestation in lice-naive beef calves along with the anamnestic response during re-infestation; (2) monitoring the effect of host immunosuppression, which mimics concomitant stressors (such as shipping and pneumonia); and (3) assessing lice population dynamics and how infestation affects calves' weight gains.

While this study is still in progress, certain results are already apparent. Researchers have observed clear differences in weight gains between calves that are immunosuppressed and those that are immunosuppressed and lice infested. In addition, delayed-type hypersensitivity testing has shown a strong relationship between immunity and a strong CD3+ cell (in other words, a T-cell-mediated response). Researchers determined that immunosuppressed animals lacked a CD3+ response which allowed for a large host lice population, whereas animals with a strong cell-mediated response demonstrated anamnestic immunity to *Linognathus vituli* infestation. Researchers also observed that environmental factors play a role in decreasing lice populations. This study demonstrated as ultraviolet light (sunlight) increases, lice populations decline regardless of environmental temperature. Despite this finding, however, researchers determined that the cell-mediated anamnestic response was the overriding factor in removing lice populations. In conclusion, the host immune response appears to be the most significant factor influencing lice populations, but they are also affected by environmental factors including UV light.

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Efficacy of Two Pteromalid Parasitoids Against Muscoid Pests of Confined Cattle

Pteromalid parasitoids are very minute parasitic wasps that are known to kill more than 50% of flies in pupal stage. A natural enemy of flies, parasitoids can be very useful in controlling these pests in cattle feedlots. The objective of this research is to determine the seasonal effectiveness of using parasitoids to control muscoid flies in Illinois. Temperature, rainfall, and a variety of other factors affect the population dynamics of the pest complex afflicting feedlot cattle in Illinois. How seasonal environmental changes affect the reproduction and longevity of pteromalid parasitoids of house flies and stable flies is unknown. An important element of these first studies involved protecting parasitoids from predation and other factors, but later studies may show differential survival of parasitoids due to biological factors.

Preliminary research findings indicate that the parasitoids purchased from commercial sources may be more sensitive to difficult environmental conditions than are wild house and stable flies, allowing fly populations to grow at a more rapid rate during seasons when temperatures are too high for sufficient reproduction by parasitoids. Final data will yield good estimates regarding the times of year when parasitoids are less effective and growers should use other mechanisms for controlling flies.

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Determining the Effect of Dietary Forage Level and Linoleic Acid Concentration on the Conjugated Linoleic Acid (CLA) Levels in Beef

Conjugated linoleic acid (CLA), a naturally occurring fatty acid found primarily in ruminant animal sources, has significant antioxidant and anticarcinogenic properties. Development of health-friendly CLA-enhanced beef and milk will ameliorate negative public perceptions of beef and milk and, thereby, increase per capita beef and milk consumption. Increased consumption of beef and milk not only improves revenue for state beef and dairy farmers, but it also improves the domestic market for corn and soybeans. For every 1% rise in U.S. per capita beef and milk consumption, beef and dairy producers will need to purchase approximately 50 million additional bushels of corn and 7 million additional bushels of soybeans, annually.

Feedlot beef cattle are given high-grain, low-forage (15 to 20% of diet) rations in order to optimize daily gain and feed-to-gain ratios. If daily gain and feed-to-gain ratios are *not* optimized, then finishing cattle will require more days and consume more feed to reach target market weights, thus reducing profits to the producer. Previous research has shown that diets designed to alter beef's CLA content can potentially limit animal performance. When fed to cattle throughout the finishing period, diets with increased forage and linoleic acid levels appear to limit daily gain and feed-to-gain ratios. However, research has also shown that lipid composition of meat from feedlot cattle can be altered in short periods of time at the end of the finishing period. Therefore, the goal of the project was to develop short-term (six week) feeding strategies using increased levels of soy oil as a source of linoleic acid and increased levels of corn silage as a source of forage in finishing diets to alter CLA content of beef while limiting the economic cost to the producer.

The results of this research indicated the following:

- Feeding beef cattle the experimental diet during the last six weeks of the finishing period did *not* limit animal performance compared to the control diet. Therefore, short-term feeding strategies for altering CLA in beef may not limit daily gain, time on feed, or feed-to-gain ratios in finishing cattle.
- The deposition of CLA is not equal among the different meat cuts from beef cattle. The chuck contained greater CLA concentrations than the loin or round. The differences in CLA content may affect how beef cuts are marketed and alter future CLA enhancement strategies.
- Feeding a finishing ration containing 8% soy oil and 40% corn silage increased CLA content in the loin compared to feeding a normal 80:20 concentrate:forage finishing ration. CLA content averaged across all meat tissues was not increased when dietary soy oil and corn silage levels were increased. Therefore, short-term feeding strategies designed to alter CLA-content in beef may only be effective for specific meat cuts. Strategies to increase CLA across all tissues may require animals to be on CLA-enhanced feed for a longer period of time.
- Over the 47-day experimental feeding period, economic costs of the 8% soy oil, 40% corn silage finishing ration were $15.36 per head greater than with the normal 80:20 concentrate:forage finishing ration. A beef producer would need to receive a premium of at least $0.026 per kg ($0.011 per lb) on a 568 kg (1,300 lb) animal to cover this additional cost.

Overall, this research indicates that there is great potential to produce CLA-enhanced beef; however, further research is necessary to determine optimal feeding and management strategies for consistently producing these products.

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Manipulating Prepartum Nutrient Intake to Improve Transition Success in Dairy Cows

The broad, long-term objective of this research is to optimize the nutritional management of dairy cows during the transition period (that is, the three weeks before to three weeks after calving) in order to maximize dry-matter intake after calving, minimize disease incidence, and maximize peak milk production. Specific objectives of this research were to determine (1)

how nutrient intake during the far-off and close-up dry periods affected cow health, feed intake, and subsequent milk production; and (2) how dietary changes affected lipid metabolism and body tissue mobilization around the time of calving in dairy cows. Based on previous studies, researchers postulated that moderate feed restriction during the dry period would increase feed intake after calving and minimize fat accumulation in the liver, thereby improving transition success and decreasing incidence of health problems.

Researchers compared a program of moderate feed restriction with feeding ad libitum throughout the dry period. Cows on the restricted diet were offered only enough ration to provide 80% of National Research Council (NRC) recommendations for net energy intake. Cows fed ad libitum throughout the dry period consumed in excess of 150% of NRC requirements. After calving, cows were placed on the same lactation diet. In this experiment, researchers observed no benefit of feed restriction during the dry period. Cows fed ad libitum (1) improved in body condition score during the dry period but then began to lose gains before calving, (2) had lower non-esterified fatty acids (NEFA) in blood during the dry period but higher NEFA after calving, and (3) tended to have greater liver lipid at one day after calving. However, restricted cows were no more resistant to an induced ketosis than cows fed ad libitum. In addition, milk from restricted cows had lower fat and protein levels. Results from this experiment did not confirm earlier research findings; they instead highlighted potential problems associated with restricted feeding during the entire dry period. These results help to clarify messages to dairy producers and their advisers: restricted feeding during the entire dry period is *not* recommended at this time.

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Utilization of Ruminal Nitrogen and Fiber Interactions to Optimize Milk Production While Reducing Nitrogen-Waste Excretion in Dairy Cattle

The nitrogen (N) in dairy cattle manure can act as a pollutant of surface and groundwater. Reducing N intake in dairy cattle diets can lower N levels in manure. Scientists have estimated that future regulatory requirements for N reduction will necessitate cutting crude protein fed to dairy cattle from 18 to 15% of diet dry matter (DM). However, indiscriminate reductions in N intake can impinge on milk production, which is the dairy farmer's major income source. The purpose of this study is to investigate (1) how rumen degradable protein (RDP) level interacts with forage fiber quality to convert dietary protein to milk protein and (2) how these interactions will affect milk production efficiency under reduced-protein feeding conditions in dairy cattle diets. The specific objectives are to (1) determine if RDP and fiber quality interactions can be utilized to improve dietary protein capture and fiber digestion in the rumen under reduced-protein feeding conditions, and (2) formulate and test dairy cattle diets that utilize RDP and fiber interactions to optimize milk production while reducing N-waste excretion.

Preliminary experiments with a dual-flow continuous culture system that mimics the rumen of dairy cows indicated the following:

- Increasing the RDP level from 10.4 to 12.4% of diet DM and using high-quality alfalfa (RFV 140) instead of low-quality alfalfa (RFV 100) increased dietary protein capture as microbial protein. Fiber digestion was significantly improved with high-RDP diets, regardless of the alfalfa quality in feed.
- Greater levels of volatile fatty acids (VFA) were produced with diets containing low-quality alfalfa, which suggested that cattle might generate greater potential energy from diets containing lower quality fiber as long as these diets contained adequate levels of nonfibrous carbohydrates.
- Examination of bacterial populations supported by the diets in this study showed a tendency for diets

containing low-quality alfalfa to produce less diverse bacterial populations (that is, fewer different species) compared to diets containing high-quality alfalfa. Less diverse bacterial populations may be easier to manipulate for the animal's benefit.

Additional feeding studies with lactating cows are currently under way. These focus on determining how diets with high RDP and high-quality alfalfa versus diets with low RDP and low-quality alfalfa will affect milk production and N-waste excretion when crude protein is reduced from 18 to 15% of diet DM.

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Establishing Pregnancy at a Predetermined Time in Dairy Cows with Ovarian Cysts

Cystic ovarian disease is the reproductive condition that has the greatest negative effect on economic return in the dairy industry. The objective of this experiment was to determine if using the GnRH/PGF/GnRH ovulation synchronization procedure (OvSynch) while concurrently administering progesterone would reduce cystic ovarian disease in dairy cows and synchronize subsequent ovulations to achieve higher fertility rates.

Researchers demonstrated that the OvSynch procedure effectively cures cystic ovarian disease and that it can be used to synchronize ovulation both in nonafflicted dairy cows and in cows with ovarian cysts. In addition, they found that using an intravaginal progesterone insert (CIDR) along with OvSynch improved the incidence of ovulation and corpus luteum development subsequent to treatment. The 28-day post-treatment incidence of ovarian cysts in cows treated with OvSynch plus CIDR was similar to that of control cows; conversely, cows administered OvSynch alone had a higher recurrence rate for cystic ovarian disease. Furthermore, researchers observed that the 84-day pregnancy rates for cows previously afflicted with ovarian cysts subsequent to OvSynch plus CIDR treatment was 44%, while the pregnancy rates for cows not previously afflicted with ovarian cysts was 53 to 56%. These research findings demonstrate that use of the OvSynch plus CIDR procedure has the potential to significantly reduce the negative effect that cystic ovarian disease has on the dairy industry.

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Spray-Dried Porcine Plasma in Weanling Pigs

The objectives of these experiments were to investigate the mode of action of spray-dried plasma (SDAP) addition to weanling pig diets. Researchers conducted three trials using 276 pigs to investigate whether adding SDAP would (1) enable higher levels of soybean meal to be included in early pig diets and (2) influence circulating levels of immunoglobulin G specific to the antigenic soy proteins glycinin and b-conglycinin. Two additional trials using 193 pigs were also conducted to investigate how increasing levels of added SDAP in weanling pig diets would affect response to an antigenic insult. Researchers have collected growth-performance data for these trials and are currently conducting laboratory analyses.

The data generated from the first three trials suggests that SDAP addition to phase 1 nursery diets improves the pig's ability to utilize soybean meal, although the positive effect does not appear to be due to protection against the antigenic soy proteins glycinin and b-conglycinin. Data from the last two trials indicates growth performance and feed conversion improve with increased levels of added SDAP. The effect of SDAP addition on the immune response to an injected antigen has not yet been determined.

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Improving the Ileal and Fecal Digestion of Corn- and Soybean-Meal Diets in Growing Pigs Using Feed Enzymes, Steeping, and Particle Size Reduction

The typical corn- and soybean-meal (CSBM) diet fed to swine is not completely digestible. Fibrous components, such as cellulose, hemicelluloses, arabinoxylans, and oligosaccharides reduce the pig's ability to completely digest this diet. Also, a large portion of phosphorus is bound in the phytate molecule and thus has a low bioavailability. The average dry matter digestibility by pigs fed a CSBM diet is approximately 80%. One way to improve the digestion of this diet is to increase the breakdown of specific feed components in the pig's digestive tract. Adding feed enzymes that specifically degrade fibrous components or phytate has the potential to increase the breakdown of these nondigestible components. Additionally, recent research has shown that soaking feed in water (feed steeping) improves the digestion of nutrients and may increase the efficacy of feed enzymes. Furthermore, decreasing particle size increases exposure of the feed to digestive enzymes and has been shown to improve digestion and feed utilization. Therefore, the specific goals of this research were to investigate the impact of feed enzyme addition (fiber-degrading [FD] enzymes and/or phytase), steeping, and particle size reduction on nutrient digestion by pigs.

Two particle size diets were utilized in this study. For pigs consuming the smaller (555 microns) particle size diets, ileal and total tract dry matter (DM) and organic matter (OM) digestibilities were not affected by feed enzymes or steeping. However, adding the FD enzyme improved ileal and total-tract nitrogen (N) digestion, and it enhanced total-tract lysine digestibility. Adding phytase also improved total-tract N digestibility, and it enhanced ileal and total-tract lysine, valine, and threonine digestibilities. Similarly, for pigs consuming the larger particle size (731 microns) diet, ileal DM and OM digestibilities, as well as ileal and total-tract N digestibilities, were not affected by dietary treatment. Adding FD enzymes did improve ileal digestibilities of threonine and valine and total-tract digestibility of DM, OM, and threonine, but it did not improve ileal digestion of lysine and total-tract digestion of valine and lysine. Phytase addition only improved the ileal digestion of valine, but adding both phytase and the FD enzyme improved ileal and total-tract phosphorus digestibilities. Decreased particle size improved the ileal digestibility of OM only, but it improved the total-tract digestion of N, lysine, threonine, and valine.

These findings led researchers to the following conclusions. First, no significant benefits were derived from adding fiber-degrading enzymes to swine diets or from steeping these diets. The additional costs and labor associated with these practices are not warranted currently. Second, adding phytase to swine diets improved the digestibility of many nutrients examined. These data support previous research demonstrating improved amino acid digestibilities when phytase was added to swine diets. Phytase addition is beneficial for improving both amino acid digestion and phosphorus utilization. Finally, reducing feed particle size resulted in minor improvements in digestibility. However, the potential threat of ulcers must be considered when significantly decreasing diet particle size. More research in the area of particle size reduction is necessary before specific recommendations can be made.

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Hoop Structures: Evaluation of an Alternative Life-Cycle Pork-Production System

The overall objective of this research was to evaluate an alternative life-cycle pork-production system based on the hoop structure. Specific objectives were to (1) determine the effects of farrowing in a group by using a hoop structure furnished with farrowing huts of different designs, (2) evaluate the behavioral patterns of sows and piglets associated with group farrowing and lactation as well as hut design, and (3) start to develop a complete life-cycle pork-production system within the hoop structure environment. Researchers noted the following results:

Reproductive performance in hoop structure: Sows gestated without morbidity/mortality in any of three test groups. Conception rates were commercially acceptable for all groups; however, the number of pigs weaned was low, and the preweaning mortality rate was high for each test group. These findings suggest that the hoop structure does not present problems for breeding and gestation and is an acceptable replacement for intensive commercial buildings during these phases. However, farrowing and lactation were not successful in the hoop structure evaluated, leading to high piglet mortality rates. Further evaluation of farrowing and lactation systems is necessary.

Hut design effects in hoop structure: The hut designs used in the hoop structure led to unacceptably high pig mortality rates. While the hut design that included a roller bar in the hut entrance did not appear to affect mortality, it did seem to result in slightly lower body weights at weaning. The different hut designs did not seem to affect times sows rested, ate, drank, walked, stood, and nested. While spontaneous cross-suckling was observed among all dams and with all litters, sows in huts without roller bars nursed foreign pigs less frequently, and sows in huts with roller bars generally nursed less often. These findings suggest that using roller bars to keep piglets in huts is not advisable. While the increased space offered in the hoop-structure huts (versus crates) may improve sow state-of-being, it leads to high pig mortality rates. The hut design impedes the intensive management of sows necessary to process pigs. Furthermore, sows are not accustomed to using huts, and problems arose when aisles or concrete pads were used for farrowing. Pigs born in these huts chilled easily, and it was difficult to ascertain to which litter they belonged when they were not confined. Additional research on hut design is needed.

Performance of grow–finish pigs in hoop structure: Researchers observed that gilts gained body weight slower than barrows in the hoop structure and that crossbred pigs raised in the hoop structure attained body weights of approximately 110 kg in fewer days. These findings demonstrate that the mean growth rate achieved in the hoop structure (approximately 800 grams per day over two seasons) is commercially acceptable. Researchers concluded that hoop structures are an acceptable substitute for intensive, enclosed grow–finish houses, but alternative management techniques are necessary to manage larger groups. Additional research is warranted to further explore differences in feed efficiency across seasons.

A C-FAR External Competitive Grants Program project

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Regulation of Protein Accretion in Pigs with Viral and Bacterial Pneumonia

Approximately 99% of the U.S. swine herds are infected with *Mycoplasma hyopneumoniae*, and the prevalence of the porcine reproductive and respiratory syndrome virus (PRRSV) in U.S. swine herds is estimated at 60 to 80%. These microorganisms infect the respiratory system and are two of the most common pathogens isolated from pigs with porcine respiratory disease complex. These pathogens cause a chronic respiratory infection, which depresses growth performance of pigs and thus increases the number of days required to reach market weight. A conservative estimate indicates that mycoplasmal pneumonia costs producers $1.50 per pig. A better understanding of how the immune system regulates feed intake and protein accretion under chronic disease states is needed so that new ways to minimize the effects of disease on production efficiency can be developed. The broad, long-range goal of this research is to increase the efficiency of protein accretion in disease-challenged pigs. The specific objectives of this study were to evaluate how *M. hyopneumoniae* and PRRSV, either alone or in combination, affect growth performance in nursery pigs and to determine if growth was negatively correlated with serum levels of interleukin (IL)-1 and IL-6.

As anticipated, pigs infected with *M. hyopneumoniae* developed gross pulmonary lesions that affected about

15% of the total lung area by the end of the study. While PRRSV did not induce gross pulmonary lesions, pigs infected with both *M. hyopneumoniae* and PRRSV had a three-fold increase of mycoplasmal lesions. Surprisingly, the effects of *M. hyopneumoniae* and the obvious interaction between the two pathogens for the development of gross pulmonary lesions did not seem to affect growth performance or circulating cytokines. Results showed that feed intake, weight gain, and protein accretion were markedly depressed in pigs infected with PRRSV but not in pigs infected with *M. hyopneumoniae*. Circulating levels of IL-1 and IL-6 were increased in pigs infected by PRRSV but not those with *M. hyopneumoniae*. Researchers detected no interaction between PRRSV and *M. hyopneumoniae* for circulating IL-1 and IL-6 or for growth performance. There was a negative correlation between IL-1 and weight gain ($r = -0.72$), feed intake ($r = -0.80$), and protein accretion ($r = -0.72$); IL-6 was negatively correlated with weight gain ($r = -0.83$) and protein accretion ($r = -0.71$). Collectively, these data suggest that the acute effects of PRRSV infection on growth performance are independent of *M. hyopneumoniae* infection. Furthermore, they indicate that sick pigs' retarded growth and reduced feed intake may result from increased circulating levels of inflammatory and metabolically active cytokines like IL-1 and IL-6.

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Genetic Analysis of *Salmonella* Isolates from Swine Production Units

In the United States, there are nearly two million cases of salmonellosis annually, causing between 1,000 and 2,000 deaths. The economic costs of salmonellosis in the United States have been estimated to be between $1.5 and $2 billion annually. Because pork has been identified as an important source for *Salmonella* outbreaks in humans, control measures for reducing the prevalence of *Salmonella* infection on swine farms are recommended. However, successful control measures require understanding the sources and avenues of *Salmonella* transmission on swine farms. To accurately determine the pathways of transmission, researchers for this project had to estimate the genetic relatedness between *Salmonella* isolates and to correlate this information with ecological information on the time and location of sampling of the isolate.

This study compared two genotyping methods, pulsed-field gel electrophoresis (PFGE) and repetitive-sequence polymerase chain reaction (rep-PCR), with respect to their ability to differentiate 68 *Salmonella* isolates collected from nine Illinois swine farms. For the PFGE method, three restriction enzymes were used (Spe 1, Xba 1, and Avr 2). For the rep-PCR method, three primer enzymes were used (REP, ERIC, and BOX). Researchers used gel electrophoresis to separate genetic fragments and the Dice coefficient to compare fragment-size matching patterns. Genetic distance matrices for PFGE and rep-PCR were evaluated using cluster analysis. Researchers examined resulting dendrograms to identify transmission patterns, using corroborative ecological (spatial-temporal) information to determine the ecological compartments between which *Salmonella* was exchanged. By identifying biotic and abiotic reservoirs that exchange *Salmonella,* researchers can pinpoint potential sites for interventions to reduce the *Salmonella* transmission within the swine production ecosystem.

Both PFGE and rep-PCR were able to differentiate *Salmonella* isolates well. For each method, isolates from different farms were separated into different genetic clusters. The rep-PCR method performed slightly better than the PFGE method in differentiating isolates and had the added advantage of lower materials and labor costs. These findings highlight the promise of rep-PCR as a method for identifying *Salmonella* sources in epidemiologic studies.

With respect to identifying pathways of transmission, it was apparent that the most closely genetically related *Salmonella* isolates were generally obtained from the same spatial location on the same visit to a farm. However, isolates were not genetically separated on the basis of ecological compartment (animal species or environmental source). The different *Salmonella* genotypes identified appear to have no host-adapted preference,

and thus, *Salmonella* on a swine farm becomes widely diffused throughout the production ecosystem. These findings indicate that interventions to prevent the spread of resident *Salmonella* need to be targeted at the farm as a whole, with no clearly identified critical control point for intervention. However, further detailed quantitative research on spatial and temporal variation in *Salmonella* prevalence is needed to reject the hypothesis of uniform distribution of *Salmonella* throughout the swine production system. In particular, possible points of entry for new *Salmonella* into the ecosystem need to be investigated thoroughly, which may identify sources for the introduction of new genotypes.

A C-FAR External Competitive Grants Program project

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Effects of Conjugated Linoleic Acids on Lambs

The overall objective of this study is to evaluate how feeding lambs diets containing conjugated linoleic acids (CLAs) affects average daily gain, feed efficiency, ribeye area, ribfat, and lean composition. Researchers are evaluating both normal lambs and lambs exhibiting the callipyge gene. The ultimate goal is to determine whether CLA diets have beneficial effects that will enable sheep producers to produce higher quality lambs more efficiently and at lower costs. The implications of this research are particularly important in the case of callipyge gene lambs. While these lambs have generally proven to be more efficient and more heavily muscled, they have severe tenderness problems. It is thus hoped that the lambs fed CLAs will grow faster and more efficiently and produce superior carcasses, both in terms of quantitative and qualitative traits. In this manner, these results can be used to increase the capacity and efficiency of Illinois food production. Initial analyses of the first year's data suggest that CLA diets positively affect growth for all lambs but produce only minimal improvements in muscle quality.

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Measurement of DNA Methylation: A Tool for Predicting Cloning Success

The objective of this project was to develop a screening tool that would increase the efficiency of the animal cloning procedure. Not all cell lines or genotypes work equally well in the cloning process for reasons that are not fully understood. One possible explanation for this difference may be how tissue culture conditions influence the donor cell's responsiveness to DNA methylation. During the animal cloning procedure, donor-cell DNA must be able to express the genes necessary for development, thus the DNA of these cells may need to become less methylated. It is common for donor cells to be cultured in a reduced-serum environment for durations ranging from a few hours to several weeks prior to their use in the cloning procedure. The effects of the low-serum environment on the donor cells are not well characterized, but it is believed that such environments may alter the DNA methylation content of the donor cells. The purpose of this project was to evaluate the relative DNA methylation content of donor cells cultured in a reduced-serum environment.

Researchers developed eight donor-cell lines composed of presumptive fibroblast cells: four of these lines were established from ear explants taken from adult Holstein cattle located at the SIUC Dairy Center, while the other four cell lines were established from fetal tissues collected from a local slaughter facility. Researchers developed a DNA-methylation-sensitive restriction enzyme methodology to evaluate the relative DNA methylation of donor-cell cultures. This methodology was designed to be simple to perform, require low equipment inputs, and produce results in a timely manner so that the animal cloning procedure could be performed on the same day as the assay. These eight cell lines were evaluated for relative DNA methylation content after 0 (control), 2, 5, or 7 days under low-serum tissue-culture conditions. Researchers observed a cubic trend in the adult cell lines: DNA methylation increased

slightly from day 0 to day 2, but then decreased from day 2 to day 5 as well as from day 5 to day 7. No significant differences based on adult cell lines, day, or repetition were observed. Similarly, no differences were observed between fetal cell lines, day, or repetition, but researchers did note a significant interaction between fetal cell line and the days of serum depletion, suggesting that the relative DNA methylation of fetal cells is not predictable nor is it regulated in the same manner as the adult cell lines. These results suggest that it may be necessary to use different culture conditions for adult and fetal donor cells to increase the efficiency of the animal cloning procedure.

A C-FAR External Competitive Grants Program project

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The Enzymatic Conversion of Plant-Derived *S-methylmethionine* to Methionine in Animal Liver

Methionine is an amino acid required for normal animal growth. Because corn- and soy-based diets fed to growing pigs and chickens are deficient in this amino acid, methionine supplements must be added to the diets of these animals. The need for methionine supplementation drives a $500 million per year business. Researchers for this project proposed the existence of an enzyme that could use *S-methylmethionine* (SMM), a compound produced by many plants, as a methyl donor for the methylation of homocysteine to produce methionine. This enzyme was called SMM-homocysteine methyltransferase (SHMT). Homocysteine is a normal animal metabolite derived from methionine. About half of the homocysteine produced in the body is irreversibly converted to cysteine, a nonessential amino acid that is not in short supply in most animal diets, certainly not in corn–soy diets. In theory, the presence of SHMT in animals could produce a reaction converting more homocysteine to methionine. Thus, the need to supplement animal diets with methionine could be replaced by dietary SMM. Researchers for this project planned to characterize the enzyme and then determine whether it could replace methionine in rodent diets. Due to unforeseen difficulties, the animal studies were not completed, and the characterization of this enzyme is still in progress.

To date, researchers have been able to synthesize radiolabled SMM as a prelude to developing an assay to detect this protein's activity. They have also shown that SHMT activity is present in the liver and kidney of rats and humans. First seeking clues about the SHMT gene within the National Center for Biotechnology Information database, researchers will use functional genomics and basic biochemical techniques to learn about the characteristics of this enzyme by purifying it from rat liver.

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Foods

Improved Food Package Quality and Safety Using Nondestructive Ultrasonic Sensing

While new types of food packages made of either flexible, retortable pouch material or thermoformed plastic trays exist and are in low-level production for specialty items, it has not been possible to implement widespread use of these more efficient packages. The major factor limiting efficient production of these package types is the reliance on redundant manual inspection. Human inspectors are subject to unpredictable variations in performance, and the inspection process is further complicated by the fact that the packages are often made of opaque and/or overprinted materials which obstruct the actual heatseal. The goal of this project was to evaluate alternate nondestructive methods for detecting and/or imaging heatseal defects. After exhaustive testing, researchers determined that ultrasound was the only practical technology that possessed the resolution, accuracy, speed, and safety required.

Researchers developed a new signal-processing algorithm, the Boundary Amplitude Integral (BAI) method, which uses backscattered acoustic energy from pulse-echo signals to generate a synthetic sectional view of the material. This approach represents a quantum leap in the capacity to effectively use acoustic imaging for material evaluation. Researchers for this project also examined the factors that affect the resolution limits of acoustic imaging in detecting voids in heat-sealed food packaging materials, and they examined the issues associated with developing a real-time online scanning sensor. Ultimately, researchers sought to determine the limits of the method, the parameters affecting signal quality, and the operational constraints of performance. Their findings will lay the groundwork for developing an automatic inspection method. Automating this process will make production cost-effective, thus allowing the benefits of these new packages to reach consumers at competitive prices.

This research has generated a productive debate on food safety and quality in the food packaging industry, encouraging industry leaders to start focusing on large-scale quality control rather than seeking a single piece of new technology to weed out the failures of other manufacturing operations. Specifically, this research elucidated the operational parameters of the acoustic imaging methods that were developed, and it provided important information about different materials; different operational algorithms; and different scanning patterns, overlaps, and geometries. Researchers determined that greater efficiency results from optimizing scan patterns as well as considering spot size and gap/overlap patterns in the sample field. A relatively small and slow laboratory-scale device was built and used for the study, and performance even at that scale approached levels that would be cost-effective in industry operations.

A C-FAR External Competitive Grants Program project

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Trust, Credibility, and Other Social Variables in Communicating Food Safety

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

It is critical to be familiar with public perceptions of risks to food and agriculture posed by chemicals in food, food irradiation, food biotechnologies, and other new modes of agricultural production and food processing. Whether these risks are real or imagined, consumer concern about these processes significantly affects behavior in the marketplace. This research contributes to understanding the nature and scope of public concerns and perceptions relating to the safety of the food supply. By documenting baseline information through a survey of consumers, researchers can help businesses and outreach communicators develop programs and campaigns that effectively address these concerns. A published report of the study will be made available to the public in January 2002.

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Comparative Effects of Soybean Constituents on Cardiovascular Risk: In Porcine

Cardiovascular disease is the leading cause of death in the United States and other Western countries. A high-fat diet coupled with inactivity initiates this chronic disease. As fatty streaks develop on the arterial walls, blood flow is compromised. When blood flow is restricted in this way, more force is required to move blood, thus causing an elevation in blood pressure. The force of the rushing blood against the fatty streaks may cause these fragile streaks to break free and expose collagen, which is the initiator of the platelet aggregation pathway. As a result, a platelet plug may form and lodge in the narrowed arterial pathway, leading to either a myocardial infarction or cerebral vascular accident. In vitro testing has shown that the soy isoflavones genistein and daidzein inhibit platelet aggregation. This study explored platelet aggregation in intact male boars fed two different soy-based diets. In the experimental diet (IFD), the soy isoflavones were removed via an alcohol-wash extraction process; in the control diet (ID), the soy isoflavones were intact.

Researchers observed a significantly higher platelet aggregation rate ($p < .05$) in the IFD group than in the ID group. The ID group gained significantly more weight ($p < .05$) than the IFD group. The ID group also had significantly lower serum cholesterol levels ($p < .05$) and a trend toward lower triglyceride levels ($p = .08$) compared to the IFD group. These results indicate that platelet aggregation occurs at a slower rate in animals fed a diet containing soy with its accompanying isoflavones. This diet also lowers serum cholesterol and triglyceride levels while concomitantly increasing body weight. Increased body weight is usually associated with cardiovascular disease and elevated serum cholesterol and triglyceride. In this study, however, the animals fed a soymeal diet with intact isoflavones gained more weight but had significantly lower serum triglyceride levels and slower platelet aggregation rates. Further research is needed to elucidate soybean isoflavones' mechanism of action on platelet aggregation and other cardiovascular risk factors.

A C-FAR External Competitive Grants Program project

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Soybeans and Cardiovascular Risk: A Multidisciplinary Approach

Cardiovascular disease (CVD) accounts for 41% of all deaths in the United States and an estimated $274.2 billion in medical costs each year. Obesity, a primary risk factor for CVD, afflicts approximately one-third of all adults. Foods containing bioactive components (soybeans, for example) are receiving increased attention due to their functionality in disease prevention and treatment. Previous investigations using a nonobese model revealed that rats fed a soy protein diet high in phytoestrogens experienced a significant reduction in body weight and other CVD risk factors compared to rats fed a non–soy protein diet. A growing body of literature suggests that soy products can ameliorate some cardiovascular disease risk factors, most notably plasma cholesterol. Few studies to date have investigated the combined benefits of soy protein and soy phytoestrogens on cardiovascular disease risk, especially in populations at increased risk. Accordingly, this research team is evaluating how soy and soy phytoestrogens collectively reduce cardiovascular risk in various in vivo and in vitro models. The results of these studies will help define the dosage of soy constituents optimal for maximizing beneficial cardioprotective effects while minimizing undesirable effects (such as effects on reproductive tissues). In addition, this research will help characterize soy phytoestrogens' cellular and molecular mechanisms of action. The ultimate goal of these soy protein/phytoestrogen investigations is to develop more efficacious treatment options for cardiovascular conditions while increasing the visibility of soy products.

Researchers assigned lean and obese Zucker rats to one of three treatment groups: high-isoflavone soy protein (HS), low-isoflavone soy protein (LS), and non-soy (Casein) protein (C). In both the lean and obese rats, the HS and LS diets attenuated the thrombin-induced platelet serotonin release ($p < .05$) as compared to the C diet. This attenuation was greatest in the HS groups. Researchers also observed that obese Zucker rats fed the C diet had livers 1.6-fold larger (in terms of percentage of total body weight) than livers of lean rats. Substituting the HS

for the C diet normalized liver weights to the levels found in lean animals ($p < .05$). In both lean and obese rats, a soy diet significantly reduced liver triglycerides and cholesteryl esters ($p < .05$). Liver total cholesterol was completely normalized to that of lean animals ($p < .05$) by soy feeding, and plasma total cholesterol was reduced by 30%. In conclusion, these research findings demonstrate that a diet rich in high-isoflavone soy protein may provide beneficial alterations to platelet sensitivity, lipid metabolism, and liver function.

On another front, researchers examined the antioxidant capacities of soy phytoestrogens. Oxidation of low density lipoprotein (LDL) is a key factor in the etiology of cardiovascular disease. While soy phytoestrogens may depend on estrogen receptors for some biological activities, they have the capacity to act as antioxidants independent of the estrogen receptor. Researchers tested the antioxidant capacities of six phyto/synthetic estrogenic compounds on isolated human LDL subjected to oxidation by cupric sulfate. The compounds tested were daidzein (D), genistein (G), (+)- and (-)-Z-bisdehydrodoisynolic acid (DA), and (+)- and (-)-hydroxy-vallestril (HV). All compounds tested conferred some beneficial effect against LDL oxidation, but the four synthetic estrogenic compounds (+DA, -DA, +HV, and -HV) exerted more potent antioxidant protection of LDL than the soy phytoestrogens, D and G.

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Impact of Soy Components on Quality of Life During Aging

Research goals are to determine whether soy protein and soy phytoestrogens can improve health, functionality, and survival both in animals at high risk for cancer and early mortality and in animals genetically programmed for exceptionally long life. Although this study is still in progress, researchers have already obtained some clear results. Both high-isoflavone (HI) and low-isoflavone (LI) diets reduced plasma cholesterol and triglycerides, as well as hepatic free cholesterol and triglycerides, in high-risk transgenic mice. In this line of mice, both HI and LI diets also reduced fasting blood-glucose levels and improved glucose tolerance. Researchers also observed that the HI diet increased the abnormally low levels of cholesterol in the plasma of GHR-KO (growth hormone receptor knock-out) mice. These results document soy protein's hypocholesterolemic effects, provide novel information on the insulin-sensitizing potential of a soy diet, and suggest how soy protein and soy isoflavones interact with genes influencing life span.

In other studies, researchers are using a behavioral test that measures learning and memory to determine whether soy-derived diets influence mental functioning in aging animals. Both LI and HI diets improved performance on this test, with the HI diet being slightly more effective than the LI diet and results reaching statistical significance in two genetically different groups. Data collected in the course of these studies also provide information on how a diet rich in soy components affects life expectancy and age-related disease. Results to date indicate that the LI diet produced significant increase of life span in two types of mice, that the HI diet increased longevity in one of these groups, and that both LI and HI diets may be protecting transgenic mice from development of mammary tumors.

A C-FAR External Competitive Grants Program project

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Soy and Osteoporosis

Numerous dietary supplements that contain a mixture of estrogen-like compounds called isoflavones are currently on the market. Many women choose to take these supplements in place of hormone replacement therapy, thinking that these "natural weak estrogens" provide a gentler alternative for maintaining a woman's health past menopause and reduce the chances for developing estrogen-dependent cancers. Since numerous pathways in the body are regulated by estrogen, a number of changes occur as a result of estrogen loss at menopause. Perhaps the changes of greatest concern are an increase in cardiovascular disease and a loss of bone, which often leads to fractures in the spine, hip, and wrist. The majority of dietary supplements containing isoflavones are soy products. While the Food and Drug Administration has recognized the efficacy of whole-soy protein in fighting the onset of cardiovascular disease, there is no conclusive information about whether isoflavones help prevent osteoporosis, or bone loss. Researchers have therefore chosen to study the effect of dietary soy protein and isoflavone extracts on bone loss in ovariectomized rats, a model of menopause.

Researchers found that when soy protein is the sole source of dietary protein, bone loss resulting from ovariectomy is not significantly reduced. When adult ovariectomized rats (three months old) were fed diets containing 20% soy protein as the sole source of protein for three months, researchers observed no prevention of bone loss. In contrast, when the isoflavone extract equivalent to a 20% soy protein diet was fed to similar rats, researchers noted a slight but significant prevention of bone loss. This experiment was repeated using aged rats (12 to 15 months old) and a similar result was obtained. Researchers are currently preparing these data for publication. They have also used these results to obtain funding from the National Institutes of Health (NIH) for further evaluation of this phenomenon. The NIH study explores the hypothesis that a greater fraction of isoflavones is absorbed from an ethanolic extract than from the whole-soy protein. In addition, the NIH project will evaluate the safety of soy products in young adult rats with intact reproductive systems to determine whether young women can safely take these dietary supplements, as well as how the supplements affect bone and reproductive health.

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Blocking Breast and Colon Cancer Metastases by Soy

Cancer is a leading cause of death in industrialized countries. Epidemiologic studies point to increased consumption of plant foods as an important factor associated with lower risk for numerous cancers, including those of the breast and colon. There is considerable interest in understanding how plant foods help to prevent certain cancers so that strategies for reducing risk of developing this disease can be devised. Scientists are actively evaluating soy and some of its constituent phytochemicals for their bioactivity as anticancer agents. The purpose of this research was to determine the capacity of a soy extract and individual isoflavones therein to inhibit the growth of metastatic cancer cell growth in breast and colon cancer models.

Researchers evaluated a commercially available soy extract containing the isoflavones daidzein and genistein in addition to soy saponins. When added to mouse diets, this soy extract inhibited the growth of metastatic breast cancer cells that were implanted into young female mice. In comparative studies, researchers demonstrated that the soy extract more effectively suppressed mouse breast cancer growth than genistein or daidzein individually, but that genistein alone did inhibit tumor growth. These findings suggest that constituents of soy other than the isoflavones are able to act as anti–breast cancer agents. Researchers determined that the decrease in tumor growth was related to soy-induced changes in molecular markers for cancer suppression. Soy consumption did not, however, change the content of receptors for the hormones estrogen and progesterone.

A C-FAR External Competitive Grants Program project

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Effect of *S-methylcysteine* on Growth of Estrogen-Independent Tumors In Vivo and In Vitro

Cancer is the second most common cause of death in the United States. The purpose of this study was to determine if *S-methylcysteine* (SMC), a compound produced by many plants, could slow breast cancer growth in vivo (in the body) and in vitro (in cells grown in a culture). Researchers proposed that SMC would slow tumor growth as a result of its ability to disrupt methionine metabolism.

The primary results of this research show that dietary SMC significantly slowed the growth of human breast cancer cells (MDA-MB-231) when these cells were grown subcutaneously in immune-deficient (athymic) mice. Researchers observed that the effectiveness of SMC in mice was dose-dependent and was independent of dietary methionine. In contrast, SMC did not have a significant effect on the growth of MDA-MB-231 cells grown in a culture. Thus, researchers will not be able to use cell culture models to examine how SMC depresses tumor growth.

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Production of Beta-Sitostanol from Soybeans

The objective of this research was to develop a microbial fermentation process for producing beta-sitostanol, a food additive that lowers serum cholesterol level, from soybeans. High serum cholesterol is a major risk factor for coronary heart disease. Consumption of plant-derived stanols has been clinically proven to lower serum cholesterol level by 10 to 15%. Benecol is a commercial food product that contains beta-sitostanol obtained from the pulp waste of paper mills. By developing a process for converting soy phytosterols to stanols, researchers can create an alternative source of stanols that benefits farmers who produce oil crops as well as consumers with hypercholesterolemia. Research goals were to (1) isolate microorganisms with the metabolic capacity to transform soy phytosterols into stanols and (2) maximize the use of soy components for growth of the microorganisms.

Researchers obtained a consortium of bacteria that transforms soy phytosterols to their respective stanols from the bovine rumen. The composition of the consortium has been simplified by eliminating most of the species that are not essential to soy phytosterol transformation. The organisms in the consortium produce stanols while growing anaerobically on a fermentation medium that contains soy phytosterols, soy-derived amino acids (Soytone), and soy lecithin. Researchers increased the volume of the fermentation medium to 12 liters, resulting in recovery of approximately 15 grams of stanols from 24 grams of soy phytosterols. Now that the initial process-development phase has been completed, researchers can test the soy-derived stanols produced for their effectiveness in lowering serum cholesterol levels. This research has the potential to benefit soy farmers by increasing the demand for soybeans and consumers by lowering costs of foods containing phytostanols, lowering coronary heart disease and associated medical costs, improving health and productivity, and increasing longevity.

A C-FAR External Competitive Grants Program project

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Rural Economic Development

Illinois Producer Market Education Workshop: Marketing Value-Enhanced Grains

Researchers conducted a workshop on marketing value-enhanced grains (VEG) to Mexico on July 22, 2000, in Chicago. This educational workshop was marketed to Illinois producers, and it represents the first step in a long-term effort by the U.S. Grains Council to link U.S. VEG suppliers with buyers in foreign markets. The workshop focused on the process for exporting VEG to Mexico and included such topics as customer relationship building, VEG marketing, export contracting, payment terms, freight contracting, and arbitration.

The primary result of the seminar was to increase attendees' awareness of marketing opportunities and understanding of the Mexico corn market, as well as their familiarity with value-enhanced grains. More than 40% of corn produced in Illinois is sold for export; thus, there are realistic opportunities for producers to direct market VEG. Such direct marketing has the potential to provide both the consumer (Mexico) and the supplier (Illinois producers) with added value, presenting a win–win situation. The economic benefits can be measured both quantitatively and qualitatively. Quantitatively, the producer typically receives a premium for the VEG corn that is grown (these premiums range from $0.10 to $0.50 per bushel, depending on the type of corn grown and the end market), and by marketing their crops directly, producers will retain a greater margin on the sale. Qualitatively, direct marketing enables producers to diversify their operations and increases market access. The producer will also have a closer relationship with the end user, which is a key element in international trade contexts.

This research team plans to develop a U.S./Mexico supplier/buyer exchange program in 2002. This program will allow a producer, producer group, or producer cooperative to meet with their Mexican counterparts (small- to midsized end users) from various end-user backgrounds (feed, food, processing) in order to lay the groundwork for future direct-selling relationships.

A C-FAR External Competitive Grants Program project

Emily French, Dale Posthumus
U.S. Grains Council/Grains Foundation

Analysis and Development of Risk Management Tools for Illinois Crop Farmers

The overall goal of this research project is to develop and disseminate improved risk management decision tools that Illinois crop farmers can use to evaluate Federal Crop Insurance Corporation products. Successful risk management strategies depend on the ability to accurately characterize uncertainties, such as yield levels and crop prices. Therefore, researchers focused their initial efforts on developing appropriate measures of farm-level yield and revenue risks. Using large-scale historic farm-level yield databases, researchers then developed farm-level yield and price distributions. This distribution data is employed within a crop insurance evaluation model designed to guide farmers' evaluation of the dizzying array of alternative crop insurance products available to them.

Researchers for this project developed several models and tools that are currently available to the public. These tools include (1) a crop yield and risk database containing historical data from 1972 through 2000 by crop, location, and time period; (2) a crop insurance premium calculator that permits farmers to quickly and accurately compare the costs of alternative crop insurance products based on their own location and specific context; and (3) a crop insurance evaluation program that permits farmers to simultaneously evaluate all available crop insurance products for likelihood for payouts, net costs of insurance, and impacts on risk based on their own location and crops. Each of these models covers the entire state of Illinois, and all are available for download or use at the farm.doc website: www.farmdoc.uiuc.edu. In addition, the yield database has been distributed to over 5,000 individuals as part of the FAST tools developed by the Department of Agricultural and Consumer Economics at the University of Illinois. Illinois crop farmers' ability to make sound risk management decisions involving crop insurance has been dramatically improved by the tools developed through this research.

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Enhancing Disease Resistance in Apples via Genetic Engineering

Apples are attacked by various diseases, both fungal and bacterial, and growers in Illinois have to spray crops with various chemicals to control these diseases. In this project, researchers introduce disease resistance genes into apple and develop transgenic apples (e.g., "Gala") that are capable of expressing these genes. These genetically enhanced apples will carry genetic resistance to disease but at the same time retain all their other desirable horticultural traits, including fruit quality and production characteristics as well as tree growth habit.

A total of 27 transgenic apple lines were produced using genetic engineering tools. Researchers transformed these apple lines using constructs that contain a fusion transgene of maize glucanase and maize chitinase, both driven by the CaMV 35S promoter. The construct also carries the *uidA* gene, which codes for beta-glucuronidase (GUS) with an intron, that is being used as a reporter gene. Each apple line was propagated in vitro to obtain at least five to seven shoots per line. Researchers used the histochemical GUS staining technique to confirm all shoots as transgenic. More than 80% of these shoots have been rooted in vitro. They are now being acclimatized and will soon be transferred to the greenhouse. The remaining shoots are currently on the rooting medium. As soon as plants have been transferred to the greenhouse and have produced enough leaves, leaf tissue will be collected for DNA extraction, and DNA will be used for Southern and Northern analysis (the hybridization or binding of a clone to DNA or RNA which provides important information regarding the structure and the expression of the gene). Researchers will then inoculate all these transgenic plants with the pathogens apple scab, powdery mildew, and fire blight to evaluate them for disease resistance.

A C-FAR External Competitive Grants Program project

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Spring Frost Protection of Grapevines by Dormant Oil Application

Midwinter freeze and spring frost are the major climatic threats to grape production in Illinois. They can cause crop losses in excess of $5 million annually. Grape varieties that break bud early in the spring are most vulnerable to damage by frost. Therefore, delaying bud break of these varieties would reduce the probability of frost injury. Several frost protection methods have been tested and have yielded varied success. Although site selection remains the superior approach for protecting against frost, alternatives have included use of heaters, elaborate sprinkler systems, and wind machines. These methods are generally expensive and require high levels of energy input. The goal of this project is to determine whether applying dormant oils can effectively delay bud break in Illinois wine grapes grown and thus prevent crop loss resulting from spring frost. The use of organic oils has been chosen for several reasons, including cost-effectiveness, ease of use, and environmental safety. The specific objectives of this project were to determine if these oils are harmful to grapes, identify the optimal timing of oil application, evaluate the effect of oil application on bud break for various grape varieties, and evaluate how oil application affects yield components and fruit composition for each variety studied.

Researcher findings demonstrate that dormant oil application is a very promising method for protecting vines from spring frost. Researchers determined that as long as nonphytotoxic rates are used for a given variety, dormant oil application delays bud break significantly (by four to seven days). This delay can mean the difference between successfully producing a full crop or complete crop loss due to frost injury. In conclusion, dormant oil application appears to offer early budding varieties some protection against spring frost, and this method has numerous advantages over other approaches. First, it is cost-effective oil application costs are a fraction of those for other conventional protection methods. Second, this method is easy to use and requires minimal labor, equipment, and energy input. Finally, oil application is environmentally safe—the chemicals used in this method are not harmful to the environment and are biodegradable (soybean oil is the main ingredient).

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Improving Vegetative Propagation of Native Grape Cultivars

Vitis aestivalis (common name, Norton) is a grape species that is native to eastern North America, and as such, it is more tolerant than French–American hybrid grapes of disease-causing fungi that attack grapes in Illinois. Currently, only approximately two hectare (four acres) of this variety are being grown in Illinois. This cultivar is in great demand, however, because the berries produce juice that ferments into wines rivaling some of the best California red wines. Unfortunately, this cultivar is difficult to root from cuttings, which explains its limited planting. The goal of this research was to improve rooting of cuttings in this important clone.

Researchers conducted a series of experiments that resulted in improved rooting of hardwood and softwood cuttings of the Norton cultivar. In addition, they successfully transferred this rooting technology to commercial growers. Researchers determined that Norton hardwood cuttings rooted best with 5,000 to 10,000 mg/L potassium salt of indolebutyric acid (KIBA). More than 3,000 hardwood cuttings were tested with the following results. Hardwood cuttings with no KIBA rooted at a rate of 30%, whereas those with 10,000 or 15,000 mg/L KIBA rooted at a rate of 75%. Time in cold storage improved rooting substantially: hardwood cuttings that were stored for 55 days produced twice as many roots as those stored for only 15 days. Researchers also noted that after 48 days of cold storage, KIBA had little effect on rooting. The primary reason for this lack of response is that the stored control cuttings rooted very well (up to 90%) with no auxin. In tests of softwood cuttings, researchers observed that these rooted at a higher percentage than hardwood cuttings when both were placed in the medium under mist at the optimum times for rooting. Furthermore, softwood cuttings treated with 2,500 mg/L KIBA rooted better than those treated with 5,000 mg/L KIBA or those not treated with auxin. In addition, researchers observed that June was a much better month for rooting softwood Norton cuttings than August.

Researchers determined that for both hardwood and softwood, cuttings collected from more basal portions of the canes rooted better than those from more distal portions of the cane. On another front, researchers found that the gibberelling biosynthesis inhibitors paclobutrazol and chlormequat chloride did not have substantial effects on rooting Norton cuttings. Use of these inhibitors should not be recommended unless softwood cuttings are being rooted at a less than optimum time (August). When softwood cuttings are collected in August, 1,000 mg/L chlormequat chloride or 0.25 mg/L paclobutrazol stimulated the best rooting.

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Dependable Low-Cost Pollination Systems for Sustainable Fruit Production

Catastrophic losses of honey bees (*Apis mellifera*) caused by two parasitic mite species during the past decade have severely threatened the profitability and sustainability of fruit and vegetable farms across the nation. Apples and other tree fruits (valued at more than $16 million per year), small fruits, red clover seed, and vine crops (such as cucumbers and pumpkins) require insect pollination. With few wild or feral honey bees, populations of native insects are too small to achieve economic levels of pollination. In the past 12 years, the number of Illinois beekeepers has dropped by 50% as a result of colony losses and increased expenses. The major goal of this research is to provide growers of crops that require pollination, as well as beekeepers, with more dependable, lower cost pollinating systems. A second goal is to reduce dependence on package bee producers from southern states since the mites and African "killer" bees spread from that region. Researchers for this project compared the effectiveness of using small, more portable and economical colonies (nuclei) against that of using standard-size pollinating colonies (approximately four times the size of experimental nuclei).

Results demonstrated that (1) nuclei can overwinter with good survival rates (85%), somewhat lower than those of standard colonies; (2) these small colonies increase in population rapidly in spring so that 50 to 70% reach the accepted population standard by April 20 when they are needed for apple pollination; (3) at least 90% of

the nuclei grow well beyond the standard for cucumber pollination by mid-May; and (4) Italian and Carniolan lines of bees showed no statistical difference in terms of winter survival. Due to major losses of bees during the 2000–2001 winter (a problem throughout the Midwest), these conclusions are based largely on 1999–2000 data. In addition to the results described previously, project researchers identified several management approaches for increasing survival rates and/or reducing labor and other expenses. For example, data indicate that nuclei made during May–June survive at higher rates and may require less intensive management than those begun in midsummer or fall. Early nuclei grow larger populations, are able to store more honey and pollen, and require less supplementary feeding. Furthermore, the fall 2000 study indicated that nuclei prepared later might suffer greater losses to Varroa mites and Nosema dysentery.

The alternative pollination system evaluated for this project has several potential advantages. One estimate of potential economic impact is that a beekeeper with 50+ colonies who needs 50 additional colonies (for replacement or expansion) during a given year could save a minimum of $1,500 by making his nuclei rather than purchasing packages. Furthermore, in that first year he or she could earn an estimated additional $3 to $5 thousand from honey (at a market price of $2 per pound) because nuclei should produce 30 to 50 lbs per hive more than package colonies.

A C-FAR External Competitive Grants Program project

Stewart M. Jacobson, Institute for Public Affairs
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Field Evaluation of Tomato Germplasm for Early Blight *(Alternaria solani)*

Alternaria solani, or early blight, is the major pathogen affecting tomatoes, and it occurs with devastating effects throughout the United States wherever high temperatures (75° to 80°F) and high humidity (75% and above) prevail. A high dew point exacerbates the problem. Early signs of infestation are dark, girdling lesions around the base of the stem (stem rot) and circular lesions on older leaves. As the foliar lesions enlarge, concentric rings appear, forming a target pattern. Eventually the entire plant is defoliated. While varying levels of tolerance have been observed, immunity to early blight is not known in *L. esculentum*. Resistance to *A. solani* is controlled by multiple genes and is affected by epistasis, or gene interactions within a genotype. While the complexity of this disease has discouraged efforts to develop genetic tolerance, a few cultivars are available that express tolerance to *A. solani*. Currently, growers control this disease through such methods as applying 8 to 15 fungicide sprays each season, long crop rotations, and field sanitation. Increasing the use of genetically resistant plants has the significant advantage of reducing the amount of fungicides applied.

For this study, 15 cultivars of fresh market tomatoes were evaluated for *A. solani* under field-grown conditions. Cultivars were evaluated when approximately 50% of the fruit were ripe and again ten days later. Upon conducting stem, leaf, fruit, and whole-plant evaluations, researchers observed varying levels of tolerance to *A. solani*. In whole-plant evaluations, cultivars demonstrating the greatest tolerance to the pathogen included Mountain Fresh and Better Boy; those showing the least tolerance were Red Rider and Sunstart. Whole-plant and leaf evaluations yielded similar results. Fruit were severely affected in only three cultivars: Red Rider, Mountain Spring, and Fabulous. Of these three, Red Rider fruit was most severely affected. In stem evaluations, researchers observed that Sunrise had the greatest tolerance, while Red Rider was least tolerant.

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Western Illinois University

Management Strategies to Enhance Summer Squash Production in Southern Illinois

The research goals of this project were to (1) identify the summer squash cultivars that have superior virus resistance or tolerance and yields when grown under environmental conditions characteristic of southern Illinois, (2) determine if virus incidence can be reduced further in precocious yellow gene (PYG) and virus-tolerant summer squash cultivars by using white-painted mulches, (3) determine if yields can be increased in PYG and virus-tolerant summer squash cultivars

by using white-painted mulches, and (4) examine how using a no-till production system affects squash yields and quality compared to conventional tillage practices.

In evaluations of virus resistance/tolerance, researchers determined that the predominant cucurbit virus present in southern Illinois during the 1998, 1999, and 2000 growing seasons was watermelon mosaic virus (WMV). The WMV transgenic resistant cultivars evaluated demonstrated total resistance to the WMV strain found in southern Illinois. All of the PYG cultivars tested produced similar yields and demonstrated comparable susceptibility to virus infection. As a result of this research, growers have been informed that the most important virus in southern Illinois is WMV, and they are now selecting WMV-resistant cultivars of squash, cucumbers, and other cucurbit vegetables. In their mulch studies, researchers determined that white-painted black mulch and black mulch decreased the number of aphids flying into plots compared to bare soil, thus suppressing virus incidence. Use of these mulches appeared to increase fruit yields and quality in the virus-tolerant and susceptible squash cultivars evaluated.

Data obtained for the 1998, 1999, and 2000 growing seasons indicated that yield levels and quality of summer squash produced in a no-till production system are similar to those of squash produced utilizing conventional tillage practices. As a result of these research findings, Rendleman Orchards in Alto Pass, Illinois, is utilizing no-tillage squash production practices on about one-fourth of their squash and cucumber acreage (approximately 80 acres). No-tillage production has significant potential benefits—it can reduce growers' production costs by about 25% due to less mechanical cultivation of fields.

The most significant problem associated with using reduced-tillage systems in vegetable production is weed control. While many southern Illinois squash growers are trying no-tillage production, widespread use of this method is not practical until better weed management strategies have been developed.

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Market Research to Support the Development of the Illinois Aquaculture Industry

The purpose of this project was to promote and facilitate expansion of the Illinois aquaculture industry through developing a marketing strategy for independent aquaculture producers. Researchers accomplished the following goals:

- Contacting end consumers to assess their preferences regarding Illinois aquaculture products
- Identifying and contacting potential distributors and wholesalers for Illinois aquaculture products
- Gathering market information directly from commercial buyers of aquaculture products in Illinois
- Analyzing compiled market information
- Identifying current trends within the Illinois aquaculture market
- Disseminating market-trend information to independent Illinois aquaculture producers through market reports, fact sheets, workshops, and the Internet (www.siu.edu/~readi)

The most significant result of this research has been to provide independent aquaculture producers in Illinois with greatly improved market data and information about primary market contacts. This information, previously unavailable, has provided independent producers with the resources necessary to effectively market their product to commercial buyers and direct-market to Illinois consumers. This ability has greatly reduced the marketing workload for individual producers, allowing them to concentrate more heavily on growing their businesses through increased production. Ultimately, the main outcome of this project has been the growth of the aquaculture industry in Illinois, including the development of the Illinois Fish Farmer's Cooperative and the Shawnee Prawn Producers Association, as well as the increase in the number of fish farmers now operating within Illinois. The information compiled from this research, along with other information from various industry sources, has enabled these aquaculturists to successfully market their Illinois-grown products.

A C-FAR External Competitive Grants Program project

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Christopher C. Kohler, Fisheries and Illinois Aquaculture Center

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Economic Activities in Rural Illinois: Analysis and Strategy to Disseminate Information in Rural Communities

Development agencies, such as the Illinois Institute for Rural Affairs (IIRA), have recently begun to monitor economic growth conditions in rural Illinois. IIRA's research philosophy emphasizes moving beyond presenting "raw data" to producing value-added information useful to practitioners. The focus of this research project is to address this need and complement IIRA's current economic information system. The goals for this research are to (1) provide rural communities with information that will foster business development and, thus, facilitate the economic vitality of rural areas; and (2) develop and maintain an active collaboration with other rural development agencies in Illinois. Specific research objectives include designing statistical programs to produce economic data, elaborating reports on retail spending at the city or town level, providing Web-based economic data linked to the IIRA website, and collaborating with IIRA staff to produce and disseminate reports.

As part of this ongoing study, investigators have compiled retail sales tax data and entered this information into magnetic media. In addition, statistical programs were elaborated and utilized to obtain quarterly retail spending data at the town or city level. Currently, researchers are developing a computer program that will allow posting of quarterly retail-spending data via the Internet. This program will be interactive, allowing users to build tables and graphs according to their specific needs. This website, which is expected to be operational by April 2002, will be linked to IIRA's electronic atlas program that provides economic development and other information.

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GROW ILLINOIS AG: A Proposal to Inventory and Grow Innovative Illinois Enterprises

Goals of this research were to promote innovative agricultural enterprises and to help rural communities develop conditions favorable for local businesses. To this end, researchers established an expanding Internet inventory of Illinois alternative agricultural products and services (see www.siuc.edu/~illinois). Through the GROW ILLINOIS AG website, users can access information about producers of a particular product or in a particular location, contact information for these producers, and links to specific producers' websites (if available). Continued development of this site will include enhancing search and interactive capabilities to enable users to extract and send specific information.

GROW ILLINOIS AG researchers facilitated business retention and expansion projects in four rural communities. In the course of these efforts, community leaders and other volunteers have developed and implemented strategies that have positively impacted the economic vitality and health of their communities. For instance, in one rural town, community leaders initiated an awareness campaign about newly available Federal Empowerment Zone financing opportunities for businesses. In another case, community members commissioned a feasibility study that led to the formation of a marketing cooperative of organic farmers. GROW ILLINOIS AG has also responded to requests from more than 150 rural business people, referring them to local sources of information, technical assistance, and financing.

A C-FAR External Competitive Grants Program project

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Economic Performance of Market Advisory Services for Illinois Producers

Agricultural producers consistently identify price and income risk as one of their greatest management challenges. To deal with this challenge, many producers rely on market advisory services as a source of price risk management information and advice. The Agricultural Market Advisory Service (AgMAS) was initiated in September 1994 with the goal of providing objective and comprehensive performance evaluations of market advisory services for crop producers. Since its inception, the AgMAS project has been collecting real-time pricing recommendations for about 25 market advisory programs. This research project has supported the AgMAS mission by seeking to (1) determine the net price that corn, soybean, and wheat producers in

Illinois would receive by following advisory service recommendations; (2) evaluate the risk/return performance of advisory services; (3) investigate the predictability of pricing performance; and (4) identify the factors that drive producers' choice of market advisory service.

Data on corn, soybean, and wheat marketing recommendations of advisory services was collected for the 1995–1996 through 1999–2000 crop years. Researchers calculated the returns on the recommendations as a weighted-average net price that an Illinois producer would receive if he or she precisely followed the marketing advice. Analysis indicated a measurable ability for advisory services to outperform the soybean market, with the average advisory price for this five-year period running about $0.16 higher than the benchmark. The same services demonstrated no ability to outperform the corn market, with essentially no difference between the average advisory price and benchmark for the five years under evaluation. For a combined corn and soybean farm, this translated into an average revenue increase of about $3 per acre. The services demonstrate significant underperformance in the wheat market, with the average advisory price running about $0.21 cents lower than the benchmark for the five years. Researchers found no evidence that pricing performance is predictable from year to year. As a result, services that do outperform the average benchmark over time tend to demonstrate more risk than the benchmark price. Finally, analysis of a survey of advisory service subscribers revealed that a producer's choice of market advisory service depends not only on their perception of risk/return performance but also on the match between the marketing "philosophy" of the producer and service.

These research findings suggest that corn and soybean producers can improve their revenue per acre over market revenue by about $3 per acre by following the recommendations of a market advisory service. While relying on advisory services involves substantial risk, the potential for increased revenue is not inconsequential when compared to the net returns experienced in recent years. The results also suggest that wheat producers should exercise caution in following the advisory service recommendations. Finally, the research has had a positive effect on the way grain is marketed in Illinois through the stimulation of new and innovative marketing contracts. Specifically, the findings have been used as the empirical foundation for a new generation of pricing contracts offered to producers by the grain industry.

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Characteristics of Successful Entrepreneurs: Rural versus Urban

Entrepreneurs in three primarily urban Illinois counties (McLean, Sangamon, and Winnebego) were identified and surveyed. The goal of the survey was to determine the personal, financial, and educational characteristics of both successful and unsuccessful entrepreneurs. The survey also identified various factors (financing, taxes, etc.) that impede or accelerate the growth and success of small and medium-sized businesses. The success rate and the characteristics of urban entrepreneurs will be compared to those of rural entrepreneurs as determined through a FY00 C-FAR-funded project.

The information derived from this project will be used in a paper to be submitted to the American Agricultural Association for presentation at the 2002 national meeting. Research findings will also be submitted to the popular press in the form of a news release. It is hoped that distributing this information to the business community as well as political leaders will help eliminate some of the impediments to developing successful small businesses.

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Natural Resources

Viruses, Antibiotics, Bacteria, and Nutrients in Groundwater at Swine Facilities

An understanding of how livestock confinement facilities impact groundwater quality is necessary in the development of regulations that protect groundwater resources but are not unjustly stringent to producers. The specific objectives of this project were to (1) determine the occurrence of enteric viruses, bacteria, and antibiotics in groundwater at four swine confinement operations that use either deep-pit systems or lagoons for waste management; (2) continue to monitor the concentrations of nutrients in groundwater; and (3) determine the occurrence of tetracycline-resistant bacteria in the groundwater and manure.

Researchers monitored two deep-pit and two lagoon sites that are located in areas representing geologic environments that have different levels of vulnerability to groundwater contamination. At one lagoon site, researchers measured concentrations of chloride, potassium, and ammonium significantly greater than levels commonly found in the area. Elevated chloride and nitrate concentrations were observed at the pit sites. Isotopic analysis of the nitrate suggested that elevated nitrate at one of the sites was likely derived from fertilizer rather than manure. These findings suggest that while manure leakage may be occurring at some facilities, contamination of groundwater has been minimal and has not spread off site. The contamination that has occurred is in shallow groundwater that is not currently being used as a potable resource. Enteric viruses were not detected in any of the groundwater samples collected from any of the research sites. Only one lagoon sample contained enteric viruses at a concentration of 151 MPN/100 mL. Based on management practices and hydrogeologic conditions at the study sites, these facilities do not pose a significant threat for contaminating shallow groundwater with enteric viruses.

Another focus of this project was to investigate the occurrence of tetracycline and tylosin antibiotics in groundwater. Researchers also screened 10 groundwater samples for the presence of 16 other antibiotics. Less than 4% of the groundwater samples contained either tetracycline or tylosin, and only 17% of the samples contained one or more antibiotics. Antibiotics were most commonly detected at one lagoon facility where the geology is such that groundwater is vulnerable to contamination. In the vast majority of cases (79%), researchers detected antibiotic concentrations less than 2 μg/L in groundwater; however, some of the lincosamide, sulfonamide, and tetracycline concentrations exceeded 1 mg/L in manure samples.

A C-FAR External Competitive Grants Program project

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Charles P. Gerba, Microbiology and Immunology

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Michael Meyer, Ocala Water Quality and Research Lab

U.S. Geological Survey

Modeling Nitrogen Dynamics at the Watershed Scale

Watershed simulation models are being developed to assist with watershed management and to identify land use practices that will protect water quality. These models can also be used to estimate impacts of alternative management or policy scenarios. The purpose of this project was to test the reliability of relatively simple watershed simulation models that attempt to estimate nitrate concentrations in streams and rivers based on such information as watershed land use, fertilizer sales, and environmental variables (for example, soil properties, precipitation, and temperature). Researchers examined several simulation model packages and conducted detailed simulations with the ADAPT (Agricultural Drainage and Pesticide Transport) model. A reliable hydrologic model is necessary for simulating nitrate transport. Researchers calibrated the ADAPT model to simulate the hydrology of specific fields and watersheds in central Illinois. Researchers also tested the model's ability to simulate hydrology without calibration on nearby streams. They found that the model simulates annual flow very well, and monthly and weekly flow reasonably well. ADAPT does not simulate daily flow very well, but this limitation is not critical since nitrate concentration is highly correlated to weekly flow. Researchers will continue work on the nutrient portion of the model as part of the Water Quality SRI, with an anticipated completion in August 2002.

A C-FAR External Competitive Grants Program project

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Water Quality of Subsurface Drainage from Alternative Cropping Systems

The objective of this research was to monitor the concentration and movement of nitrate and other agrichemicals in the subsurface drain effluent from three cropping systems in central Illinois. The cropping systems evaluated included an organic grain rotation and two conventionally fertilized corn–soybean fields. The information gained from this project will benefit citizens, agencies, and farmers who are concerned about water quality and who are interested in the potential of organic farming practices to reduce nitrate transport to surface water.

Researchers found that drainage water from the field used for organic grain production had nitrate concentrations about half as great as those from the corn–soybean rotation. Similar results have been observed in other fields in Illinois and elsewhere. Such reductions in nitrate levels depend on the specific organic management practices employed, however. For example, high nitrate concentrations have been observed in drainage water from organic fields after a green manure crop was plowed into the soil. This study is part of a larger, ongoing research project comparing different cropping systems.

A C-FAR External Competitive Grants Program project

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Corn Fertilizer Nitrogen Management to Optimize Water Quality

The use of nitrogen fertilizers in Illinois corn production is widespread because nitrogen is required for plant growth and most soils cannot supply sufficient nitrogen. Proper nitrogen management for maximizing yields is becoming an even more critical issue as environmental concerns about excessive nitrogen fertilization intensify. Lake Bloomington is a major source of drinking water for residents in the Bloomington, Illinois, area. This lake has a history of nitrate (NO_3-N) concentrations that exceed 10 ppm. Objectives of this research are to (1) quantify sources of NO_3-N in water that enters Lake Bloomington and (2) ascertain how corn fertilizer nitrogen management affects water quality.

Since 1993, 36 sites within the Lake Bloomington watershed have been monitored for NO_3-N concentration on a weekly basis. Researchers used data from 1993–2001 to calculate average NO_3-N concentrations for various sources within the watershed. They found that water from rain had NO_3-N concentrations of 1.1 ppm; surface water runoff, 5.0 ppm; wooded pasture tile, 1.3 ppm; organic production tile, 10.7 ppm; agricultural production tiles, 17.2 ppm; and subsequent creek water, 13.1 ppm. Researchers also observed that as creek water passed through small municipalities, its NO_3-N concentration dropped an average of 0.8 ppm. Researchers conducted a field study to evaluate nitrate-N release via tile drainage for six agricultural fertilizer management techniques. The control field released 0 lb N/acre; the fall-applied anhydrous ammonia (AA) field released 175 lb N/acre; the fall-applied AA + N-Serve field released 175 lb N/acre; the spring-applied AA + N-Serve field released 125 lb N/acre; the preplant spring-applied AA field released 175 lb N/acre; and the sidedressed AA field released 140 lb N/acre. Overall, spring application of AA produced grain yields similar to those of the fall-applied treatments. Fall application of AA resulted in tile water with greater concentrations of NO_3-N than found when the same rate of fertilizer N was applied in the spring. In addition, spring-applied AA increased plant N accumulation. These findings indicate that one method for reducing NO_3-N concentrations in water entering Lake Bloomington is to encourage spring application of fertilizer N. These results must be verified over a number of years to assess patterns in seasonal variations. The knowledge gained from this study will serve as a basis for developing nitrogen application recommendations that reconcile the need to ensure the productivity of Illinois with the need to maintain high-quality drinking water.

A C-FAR External Competitive Grants Program project

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Aquatic Plant Impoundments for Agrochemical Contaminant Management

The goal of this project was to assess phytoremediation, an impoundment approach for reducing exposure to agrochemical contaminants. Researchers attempted to quantify the degree to which aquatic plants and their associated microbial communities contributed to herbicide inactivation. The concept behind this approach is that plants or microorganisms in managed ponds will take up and inactivate certain herbicides. These ponds could be used in a drinking water treatment context for removal of atrazine or other regulated pesticides from raw water supplies. In greenhouse studies, researchers determined that *Ceratophyllum demersum* (hornwort) effectively removes atrazine. They also evaluated a second plant, *Phalaris arundinacea* (reed canarygrass), with atrazine under both greenhouse and mesocosm conditions. This plant was found to be ineffective, but a fungus associated with its seed was an efficient atrazine degrader.

Researchers observed that atrazine (with an initial concentration of 50 ppb) disappeared more rapidly from solution in microcosms containing the aquatic floating plant than from control microcosms containing no plants, although atrazine decomposed in the dark controls (those lacking illumination) also. Disappearance rates of atrazine from both the illuminated control and the plant-containing microcosms were light-dependent. Preliminary evidence, including the identity of products resulting from atrazine breakdown, suggests that photooxidation mechanisms, including the hydroxyl radical, contribute to the abiotic pathways of loss. Researchers tested nitrate and ferric iron complexes found in the growth medium for their potential photochemical activity. The ferric iron complex proved to be the principal, though not the sole, active species. When atrazine-14C was used in a 14-day experiment with hornwort present, researchers found roughly equal levels of the herbicide in the water and in the plant tissues. Products resulting from atrazine breakdown were the glutathione conjugate of atrazine, hydroxyatrazine, deethylatrazine, and deisopropylatrazine. When the plant tissues were sonicated and subjected to a size-selective filtration, researchers observed that the distribution of the herbicide was consistent with the majority of the activity taking place in a fraction consisting of microorganisms. However, autoradiography indicated that atrazine entered the cells rather than remaining localized on the surface, as would be expected from purely microbial degradation. A fungus (a *Penicillium* sp.) isolated from reed canarygrass seeds degraded atrazine with a first half-life of three days after an initial lag period of two weeks.

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Processed and Unprocessed Manure's Effect on Crop Yield, Soil, and Groundwater

This project is designed to (1) compare the relative effectiveness of unprocessed liquid swine manure effluent collected from a solid–liquid separator, and traditional inorganic fertilizer in corn and soybean production; and (2) evaluate how these different nitrogen sources affect subsurface water quality. The ultimate goal of this project is to identify alternative nitrogen fertilizer options that reduce risk of contaminating the quality of our water supplies.

Compared to groundwater, the unprocessed swine slurry and separated effluent had elevated levels of many constituents, especially NH_4-N, phosphate, BOD, Al, and Zn. The effluent had significantly lower concentrations of potentially harmful constituents than the slurry. Slurry had higher coliform concentrations than the separated–aerated effluent. Researchers did not detect microbial concentrations of coliforms and *E. coli* in soybean and corn grain samples, however. Researchers observed significantly elevated nitrate concentrations in the soil water beneath the inorganic fertilizer plot and slightly elevated concentrations beneath the effluent and slurry plots. Chlorine concentrations were elevated in groundwater beneath the effluent and manure plots, but other constituents that were elevated in the slurry and effluent were not found in anomalous concentrations in the subsurface water beneath these plots. Although groundwater quality was not significantly impacted by the slurry and effluent

amendments in this study, the fact that NO_3-N and chlorine concentrations were elevated in the wells impacted by previous long-term manure applications indicates the potential for groundwater quality degradation. The only two contaminants were NO_3-N and chlorine found in the groundwater; the metals and other elevated constituents found in the slurry (and effluent) did not appreciably migrate through the soil and, thus, were not good indicators of manure contamination of groundwater at this site.

In evaluating the impact of different fertilizers on crop yields, researchers determined that soybean yields were comparable regardless of treatment (whether treated with nothing, effluent, unprocessed slurry, or inorganic nitrogen fertilizer). Since soybean can acquire nitrogen from the atmosphere, this result was expected. Corn plants supplied with either effluent, inorganic nitrogen fertilizer, or unprocessed slurry tended to yield more grain than the control, which received no nitrogen application. Researchers observed no significant difference in grain yield based on the specific nitrogen source applied (effluent, inorganic nitrogen fertilizer, or unprocessed slurry). Data collected thus far suggest that effluent and slurry can serve as satisfactory alternatives for inorganic nitrogen fertilizer.

A C-FAR External Competitive Grants Program project

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Grassland Management School in the Grand Prairie Region of Illinois - I

Out of concern for the sustainability of Illinois agriculture, researchers are investigating farming practices that are built around synergies between plant and animal agriculture and also to protect the natural environment. In this study, researchers planned to complete three activities over a two-year period: (1) development and operation of animal observation areas at a five-acre historic farmstead site; (2) development and operation of a full-scale, year-round grassland management system to produce forage for livestock and environmental remediation; (3) development of a grassland management center to serve as the base for seminars and other outreach programs.

Researchers accomplished their primary goals—they established a historic farmstead site, full-scale grassland management system, and grassland management center, all of which are economically self-sustaining. This project would have benefited from more internal expertise in several areas, however. First, researchers lacked familiarity with animal welfare protocols and related facility requirements, especially pertaining to historic farm buildings, as mandated by the UIUC's Office of Animal Resources. While they initially expected to place farm animal exhibits in these buildings with minimal remodeling, they discovered that this was not possible. Second, researchers learned that more acreage was required to establish a full-scale, year-round grassland management system that would create net pasture revenues sufficient to cover all expenses and provide a greater return on investment than row cropping. Researchers also chose to protect fragile/C-D sloped forested acres from any significant grazing or browsing, thus reducing the high-energy pasture to 32 acres. An acreage scale of 160 acres is necessary to support the pasture enterprise at a UIUC level. Third, researchers expected the advisory council to attract a stakeholder base that would be reflected in increased attendance at events as well as in broader appeal to urban audiences. The project did receive very positive publicity in several media forms (newsprint, radio, and TV). Finally, researchers encountered marked differences among project stakeholders regarding how farming protects or destroys the environment. As a result of these differences, researchers were rarely able to build consensus among stakeholders on critical issues.

A C-FAR External Competitive Grants Program project

David B. Bowman, Office of Continuing Education

University of Illinois at Urbana-Champaign

C-FAR-Funded Projects Receiving Extensions

Researchers for the following projects were granted no-cost extensions to conduct further research. While the due dates for these projects have been extended, no additional funds were allocated for research. These projects will be reported on after their new maturity dates in 2002.

Influence of Corn Hybrid on Dry-Milling and Extrusion-Product Performance
FY00 External Competitive Grants Program
Kent D. Rausch, Agricultural Engineering
University of Illinois at Urbana-Champaign

Grassland Management School in the Grand Prairie Region of Illinois - II
FY00 External Competitive Grants Program
David Schejbal, Office of Continuing Education, Natural Resources and Environmental Sciences
University of Illinois at Urbana-Champaign

Innovative Nonsolvent Process for Textured Soy Protein
FY00 External Competitive Grants Program
Karl E. Weingartner, Food Science and Human Nutrition, INTSOY
University of Illinois at Urbana-Champaign

Aerial Infrared Mapping of Subsurface Drainage Systems
FY99 External Competitive Grants Program
Richard A. Cooke, Agricultural Engineering
University of Illinois at Urbana-Champaign

Refining Soybean Oil Using Supercritical Fluids and Membrane Technology
FY00 UIUC Internal Program
William E. Artz, Food Science and Human Nutrition
University of Illinois at Urbana-Champaign

On-Site Nitrogen and Chlorophyll "Quick Tests" to Improve Nitrogen Fertilizer Efficiency in Illinois Vegetable Production
FY00 UIUC Internal Program
John M. Swiader, Natural Resources and Environmental Sciences
University of Illinois at Urbana-Champaign

Modeling Herbicide Degradation in Soils: An Integrative Modeling and Experimental Study
FY00 UIUC Internal Program
Robert J. Hudson, Natural Resources and Environmental Sciences
University of Illinois at Urbana-Champaign

The Enhanced Child Development Laboratory Research Database Program
FY00 UIUC Internal Program
Brent A. McBride, Human and Community Development
University of Illinois at Urbana-Champaign

Effects of Soy-Protein Feeding on Diabetic Nephropathy
FY00 UIUC Internal Program
John W. Erdman, Food Science and Human Nutrition
University of Illinois at Urbana-Champaign

Effects of Soy and Genistein on Estrogen-Receptor Beta Signaling
FY00 UIUC Internal Program
Paul S. Cooke, Veterinary Biosciences
University of Illinois at Urbana-Champaign

Establishing Paternity Under Welfare Reform in Rural Illinois Counties
FY98 UIUC Internal Program
Andrea H. Beller, Agricultural and Consumer Economics
University of Illinois at Urbana-Champaign

Improving the Quality of Illinois Pork
FY99 External Competitive Grants Program
Floyd K. McKeith, Animal Sciences
University of Illinois at Urbana-Champaign

Fiscal Year 2002: Internal Competitive Grants Program

The internal competitive grant programs at the University of Illinois at Urbana-Champaign (UIUC), Southern Illinois University at Carbondale (SIUC), Illinois State University (ISU), and Western Illinois University (WIU) 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 one- and two-year projects in FY02.

FY02 Projects	Principal Investigator
Research Focus: Expanding Agricultural Markets	
Evaluating Three Emerging Cut Perennial Crops for Production in Rockwool or Media-Based Systems	Daniel F. Warnock, UIUC
Increase Capability to Measure and Modify Soybean Seed Composition and Functionality in Foods	Marvin R. Paulsen, UIUC
Research Focus: Rural Economic Development	
An Evaluation of the Potential Market for Hybrid Striped Bass Produced in Illinois	Kerry W. Tudor, ISU
Evaluation of the Role of New-Generation Pricing Contracts for Illinois Corn and Soybean Producers	Darrel L. Good, UIUC
Examination of Entrepreneurial Curriculum at Illinois Community Colleges	Rick C. Whitacre, ISU
Wines, Grapes, Tourism, and Rural Economic Development: Lessons Learned from the Shawnee Hills Wine Trail	John P. Salazar, SIUC
Research Focus: Agricultural Production Systems	
A Novel Management Strategy for PRRS Virus in Swine: Reducing Vaccine Failure	Tony L. Goldberg, UIUC
Biology and Management of *Sclerotinia* and *Aphanomyces* Diseases of Alfalfa in Illinois	Dean K. Malvick, UIUC
Comparing the Genotoxicity of Agrochemicals to Ubiquitous Food Additives	A. Lane Rayburn, UIUC
Conference on Long-Term Selection	John W. Dudley, UIUC
Developing Replacement Gilts for Increased Reproductive Efficiency	Robert V. Knox, UIUC
Engineering Resistance to the Soybean Cyst Nematode	Kris N. Lambert, UIUC
Enhanced Plant Production in Interior Plantscapes with Biological Control Agents	Raymond A. Cloyd, UIUC
Ethanol Policy in the Presence of Other Economic Distortions: Is a Win-Win Policy Change Possible?	David S. Bullock, UIUC
Evaluation of Ultrasound and Genetic Markers to Enhance the Value of Feedlot Cattle for a High-Quality Market	Paul M. Walker, ISU
Fate of Antibiotics and Antibiotic Resistance Genes in Feed, Feces and Treated Waste from Pigs	Roderick I. Mackie, UIUC

Fescue Toxicosis Associated Reproductive Loss in Cattle	Karen L. Jones, SIUC
Green Stem: A New Disease Threatening Illinois Soybean	John S. Russin, SIUC
Impact of Southern Root-Knot Nematode and Soybean Germplasm Development in Illinois	Jason P. Bond, SIUC
Improving Soybean Yield by Co-inoculation	Brian P. Klubek, SIUC
Investigations of Failed Postemergence Applications of Herbicides	Bryan G. Young, SIUC
Molecular Markers for Parasitic Ability of Soybean Cyst Nematode	Gregory R. Noel, UIUC
Molecular Pathogen Detection for Herd Health and Food Safety	Gail Scherba, UIUC
Photoperiodic Effects on Immune Responsiveness in Transition Dairy Cows	Geoffrey E. Dahl, UIUC
Reducing the Impact of Emerging Iridoviral Diseases on Illinois Aquaculture	Tony L. Goldberg, UIUC
Selectable Marker System for Sesquiterpene Biosynthesis and Application for Insect Pest Control in Tomatoes and Sweet Corn	John A. Juvik, UIUC
S-methylmethionine (SMM): A New Source of Sulfur Amino Acid Activity	Tim A. Garrow, UIUC
The Development and Testing of an Apparatus to Assist Rescuers during Extrication of a Victim That Is Partially Engulfed in Grain	Douglas Kingman, ISU
Validation of Dynamic Ideal Protein for Lactating Sows	Robert A. Easter, UIUC

Research Focus: Human Nutrition and Food Safety

Acyl Carrier Protein's Role in the Regulation of Fatty Acid Biosynthesis in Plants	Nicki J. Engeseth, UIUC
Dietary Protein Control of Insulin Action and Blood Glucose	Donald K. Layman, UIUC
Feeding Conjugated Linoleic Acid to Improve Bone Health and Meat Quality of Growing–Finishing Pigs	Bryon Wiegand, ISU
Gene-Expression Screen to Determine Anti-obesity Effects of Soybean Diets	William J. Banz, SIUC
Genistein Induces Thymic Atrophy: A Potential Human Health Risk?	Paul S. Cooke, UIUC
Impact of Soy Components on Quality of Life during Aging	Andrzej Bartke, SIUC
Irradiation of Processed Pork Products to Increase Profits in the Pork Industry	Bryon Wiegand, ISU

Mass Media Frames and Public Understanding of Agricultural Biotechnology	**Napoleon K. Juanillo, Jr., UIUC**
Medicinal Genes and Healthful Dietary Choices	**Laura L. Murphy, SIUC**
Neonatal Intestinal Function and Resistance to Diarrhea: Impact of Soy Fiber	**Kelly A. Tappenden, UIUC**
Soybean Isoflavones as Modulators of Neonatal Intestinal Development	**Sharon M. Donovan, UIUC**
The Economic Impacts of Food Safety Policies on Small Pork Processors in Illinois	**Miguel I. Gomez, ISU**

Research Focus: Natural Resources

Characterization of Nitrogen Use Efficiency in the Illinois Protein Strains	**Stephen P. Moose, UIUC**
Effects of Alternative Strategies for Handling Swine Slurry	**Paul M. Walker, ISU**
Fertilizer Nitrogen Management to Optimize Water Quality	**Ken D. Smiciklas, ISU**
Influence of Nontransgenic Engineered Plants on Phytoremediation of Crude Oil–Contaminated Soil	**Robert Rhykerd, ISU**
***Miscanthus x giganteus*: An Adapted Biomass Crop for Permaculture, Air, and Soil Enhancement**	**Stephen P. Long, UIUC**
Newfound Atrazine Resistance in Waterhemp	**Patrick J. Tranel, UIUC**
Use of Stockpiled Forage for Winter Sheep Grazing	**John P. Carlson, WIU**

Fiscal Year 2002: External Competitive Grants Program

The C-FAR External Competitive Grants Program granted support to the following one- and two-year projects in FY02.

FY02 Projects	Principal Investigator
Research Focus: Expanding Agricultural Markets	
Advanced but Affordable Composites from Agricultural By-Products	Vivak M. Malhotra, SIUC
Assessing the Role of Health Benefits in the Consumption of Soy-Based Foods	Wanki Moon, SIUC
Coproduct Characterization from Dry-Grind Ethanol Processing for Enhanced Value	Kent D. Rausch, UIUC
Determining the CLA Production Capacity of Ruminant Diets	Kenneth E. Griswold, SIUC
Enhancing Value of Corn by Fermentation to Butanol and Removal by Extraction	Nasib Qureshi, UIUC
Research Focus: Rural Economic Development	
Alternative, Flexible Pollination Systems for Sustainable Fruit Production	Stewart Jacobson, UIS
An Integrated Planning Tool for Dairy Systems That Are EES Viable in Illinois	Phillip R. Eberle, SIUC
Economics of Grazing Stocker Cattle as a Sustainable Alternative to Row Crops	Kenneth O. Nimrick, WIU
GROW ILLINOIS AG: An Expansion	Susan Kohler, SIUC
Increasing Wool Value through Producer Cooperatives and Niche Markets	Dean R. Oswald, UIUC
Innovative Finishing and Marketing Strategies for Small Beef Producers	Dan B. Faulkner, UIUC
Research Focus: Agricultural Production Systems	
Evaluation of Ultrasound and Genetic Markers for Cattle in a High-Quality Market	Larry L. Berger, UIUC
Harnessing the Benefits of an Apple Scab Resistance Gene	Schuyler S. Korban, UIUC
Increasing the Genetic Diversity of Illinois Horseradish	Andrew M. Hamblin, UIUC
Probiotics as an Alternative to Antibiotics in the Diet of Weaning Pigs	Roderick I. Mackie, UIUC

Remote Sensing Methods to Identify Nitrogen Deficiencies in Corn in the Low Organic Matter in Soils of Illinois	**Adam H. Anderson, UIUC**
The Post-Antibiotic Era of Food Production	**Keith W. Kelley, UIUC**
Utilization of New SCN Resistance Genes from *Glycine tomentella*	**Brian W. Diers, UIUC**
Value-Added Traits: Sustainability and Efficiency of Production Systems	**Khalid Meksem, SIUC**

Research Focus: Human Nutrition and Food Safety

An Evaluation of the Safety of a Genetically Modified Corn: A Porcine Model	**Gary A. Apgar, SIUC**
Biomarkers to Study Synergy Among Phytochemicals in Prevention of Cancer by AFB	**Matthew A. Wallig, UIUC**
Effects of Fumonisin on Atherosclerotic Disease	**Wanda M. Haschek-Hock, UIUC**
Irradiation of Processed Pork Products to Increase Profits in the Pork Industry	**Bryon Wiegand, ISU**
Mycobacterium Paratuberculosis Thermal Inactivation and Incidence in Fluid Milk	**Joseph Dunn, IIT**

Research Focus: Natural Resources

Evaluation of BT-Toxin Persistence in Soils	**Michelle M. Wander, UIUC**
Extent, Characteristics, and Management of ALS-Resistant Nightshade	**F. William Simmons, UIUC**
Hydrologic and Water Quality Consequences of Alternative Crop Management	**Gregory F. McIsaac, UIUC**
Identification of Carbon Sequestration Factors in Illinois Agricultural Systems	**Steven E. Hollinger, UIUC**
In-Season Site-Specific Nitrogen Management for Corn	**Shufeng Han, UIUC**
Online Hydrologic Model for Watershed Management	**James D. Westervelt, UIUC**

Fiscal Year 2002: Strategic Research Initiatives

The C-FAR Strategic Research Initiatives provide a targeted, multidisciplinary, and multi-institutional approach to addressing major issues and concerns of the Illinois food and agriculture industry and consumers. The SRI research portfolios include the following initiatives in FY02.

FY02 Initiatives	Principal Investigator
Information Systems and Technology	
FY02 Information Systems and Technology SRI Leader Support and Coordination	Gary D. Schnitkey, UIUC
Farm-Based DASS and Improved Simulation Training for Farm Supplier Management	Patrick D. O'Rourke, ISU
Farm Decision Outreach Central	Scott H. Irwin, UIUC
Illinois Farm Producers Use of the Four Internet Protocols for Problem Solving	James W. Legacy, SIUC
Illinois IPM Online	Kevin L. Steffey, UIUC
Illinois Technology and Research: Allied and Integrated for Livestock Linkages	Michael F. Hutjens, UIUC
Illinois Watershed Management Clearinghouse	Richard L. Farnsworth, UIUC
In-Field Management Prescriptions	Donald G. Bullock, UIUC
Interactive Illinois Agronomy Handbook	Robert G. Hoeft, UIUC
On-Machinery Information Management System for Precision Agricultural Operations	Qin Zhang, UIUC
Program Impact and Reporting System Pilot Project	Sarahelen R. Thompson, UIUC
The Community and Economic Development Toolbox	Julie Fesenmaier, UIUC
World Food and Sustainable Agriculture Information on the Web	David W. Onstad, UIUC
Rural Community Development	
FY02 Rural Community Development SRI Leader Support and Coordination	Raymond C. Lenzi, SIUC
Community Development Toolbox	Julie Fesenmaier, UIUC
Rural Development Opportunities: A Research and Outreach Program	Roger J. Beck, SIUC
Rural Enterprise and Alternative Agricultural Development Initiative (READI)	Susan T. Kohler, SIUC
VALUE—Communities through Value-Added Commodities	Burton E. Swanson, UIUC

Swine Odor and Waste Management

FY02 Swine Odor and Waste Management SRI Leader Support and Coordination	Michael Ellis, UIUC
Advances in Aerobic Thermophilic Treatment for Odor Control and Energy Production from Swine Wastes	James W. Blackburn, SIUC
Community Concerns and Citizens' Reaction to Large-Scale Swine Facilities in Illinois	Ann E. Reisner, UIUC
Cost-Effective Catalytic Methods for Odor Reduction in Swine Facilities	Richard I. Masel, UIUC
Dispersion Modeling and Source Characterization	Allen L. Williams, UIUC
FY02 Swine Odor and Waste Management SRI Leader Contingency Funding and Equipment	Michael Ellis, UIUC
Gravity Solid–Liquid Separation with Continuous Solids Removal System	Ted L. Funk, UIUC
Industry Communications and Information Delivery	Michael F. Hutjens, UIUC
Illinois Odor and Nutrient Control Proving Center (ION-PC)	Gerald L. Riskowski, UIUC
Instrumental Measurement of Swine Odor Components	Keith Cadwallader, UIUC
Integration of Nutritional Approaches to Reduce Nitrogen and Phosphorus Excretion in Swine Production	David H. Baker, UIUC
Legal Issues in Swine Odor and Waste Management	Margaret R. Grossman, UIUC
Odor Offensiveness: Qualitative and Quantitative Identification of Odor-Significant Volatiles in Swine Facilities	M. Susan Brewer, UIUC
On-Farm Demonstration of a Solid–Liquid Separation System for Swine Slurry	Paul M. Walker, ISU
Systems Design and Management and Economic Modeling	Gay Y. Miller, UIUC
Thermochemical Conversion of Swine Manure to Produce Fuel and Reduce Odor and Waste 4—Catalyst Identification	Yuanhui Zhang, UIUC
Transferring On-Farm Composting Technology for Swine Waste to Illinois Producers	Paul M. Walker, ISU
Variable Rate Technology Slurry Applicator	Ted L. Funk, UIUC
Various Capacity Aerodynamic Dedusters: Year 3—Development and Evaluation of a Large Concentric Deduster in a Swine Building	Yuanhui Zhang, UIUC

Food Safety

FY02 Food Safety SRI Leader Support and Coordination	Jeannette M. Endres, SIUC
Bacterial Pathogen Content of Organic Food Fertilizer Produced from Aerobic Thermophilic Treatment of Swine Waste	James W. Blackburn, SIUC
Characterization of *Shigella boydeii* Serotype 18 Survivability, Including Fresh Produce	Hans P. Blaschek, UIUC
Development of Model HACCP Programs and Implementation Strategies for Food Service	Hea-Ran L. Ashraf, SIUC
Engineering Aspects of Processing of Foods	V.M. Balasubramaniam, Illinois Institute of Technology
Food Safety Curricular Materials for Schools	Martha Barclay, WIU
Medical School Food Safety Educational Curriculum	Pamela L. Moriearty, Southern Illinois School of Medicine
On-Farm HACCP	Peter B. Bahnson, UIUC
Planning for a Food-Safe Community	Ray Cooke, Springfield Department of Public Health
Presence and Level of *Salmonella* and *Campylobacter* in Chicken Parts from Traditional, Free-Range, and Pasture-Produced Poultry Sold at the Retail Market	Patricia K. Welch, SIUC
Simple Test for Primary Producer to Detect *Salmonella*	James M. Slauch, UIUC
The Economic Impact for Producers and Consumers Arising from Feedgrade Antibiotic Use in Pork Production	Gay Y. Miller, UIUC
Using Large-Scale Gene-Expression Analysis to Address Human-Food Safety Concerns about the Consumption of GMO Products	William J. Banz, SIUC

Water Quality

FY02 Water Quality Leadership SRI Leader Support and Coordination	James D. Westervelt, George F. Czapar, UIUC
Additional Studies to Improve Quantification of the Water and Nitrogen Balances on the Water Quality SRI/BMP Field Site	Robert J.M. Hudson, UIUC
Atmospheric Ammonia Concentration Measurements	Gary J. Stensland, Illinois State Water Survey
Chemical Transport Process Variability in a Tile-Drained Field	Timothy R. Ellsworth, UIUC
Decision Support for Water Quality Planning in Multiple-Ownership Watersheds	Jeffrey R. Beaulieu, SIUC

Effect of Time and Rate of N Application on Nitrate Contamination of Surface Water	Robert G. Hoeft, UIUC
Enhancement of Water Quality and Farm Income: Decision Support for Riparian Management Systems	Jean C. Mangun, SIUC
Evaluation and Development of Soil Biogeochemical Process Models for Tile-Drained Fields	Robert J.M. Hudson, UIUC
Evaluation of N Management Practices on Corn Yield and the Environmental Fate of N	Robert G. Hoeft, UIUC
Factoring Crop N Accumulation into Budgets of N Mass Balances	Fred E. Below, UIUC
Flow and Transport in Shallow Subsurface Drainage Systems	Richard A.C. Cooke, UIUC
Long-Term Changes in Agricultural Soil N and C Pools	Mark B. David, UIUC
Mass Balance	Mark B. David, UIUC
Modeling Hydrology, Sediment, and Agricultural Chemicals in Illinois Watersheds	Deva K. Borah, UIUC
Optimal Uniform and Variable Rate of N Application to Improve Water Quality	Madhu Khanna, UIUC
Shallow Groundwater Flow and Mass Flux of Nutrients (Nitrogen and Phosphorous) in the Big Ditch Watershed (A)	Edward Mehnert, Illinois State Geological Survey
Spatially Aggregated Approaches to Modeling Nitrogen Dynamics in Tile-Drained Watersheds	Gregory F. McIsaac, UIUC
Statewide Mass Balance Model for Estimating Allowable N Application Rates	Stephen P. Wente, UIUC
Supplemental In-Field Denitrification	Richard A.C. Cooke, UIUC
The Role of In-Stream Processes in the Cycling of Dissolved Nitrogen (A)	Mark B. David, UIUC
The Role of In-Stream Processes in the Cycling of Dissolved Nitrogen (B)	Karl W.J. Williard, SIUC
Understanding and Modeling the Hydrology of Tile-Drained Watersheds	Prasanta K. Kalita, UIUC
Watershed Monitoring in Support of WQ-SRI Data-Collection Needs	Laura L. Keefer, Illinois State Water Survey
Watershed-Scale N Balance: Fertilizer N Input	Gregory F. McIsaac, UIUC
WQ-SRI Outreach and Data Repository	Mark B. David, UIUC

C-FAR: An Investment for Illinois' Number One Industry

The food and agriculture industry is vital to the livelihood and health of Illinois citizens and to the economic prosperity of our state. The marketing of Illinois' agricultural commodities generates more than $9 billion annually. Agriculture-related industries, such as farm machinery manufacturing, food processing, agricultural real estate, and the production and sale of value-added food products, contribute billions of dollars more each year to the state's economy. From the financial growth of agriculture-related businesses to the economic development and enhancement of the quality of life in rural communities, the food and agriculture industry is a top priority for Illinois.

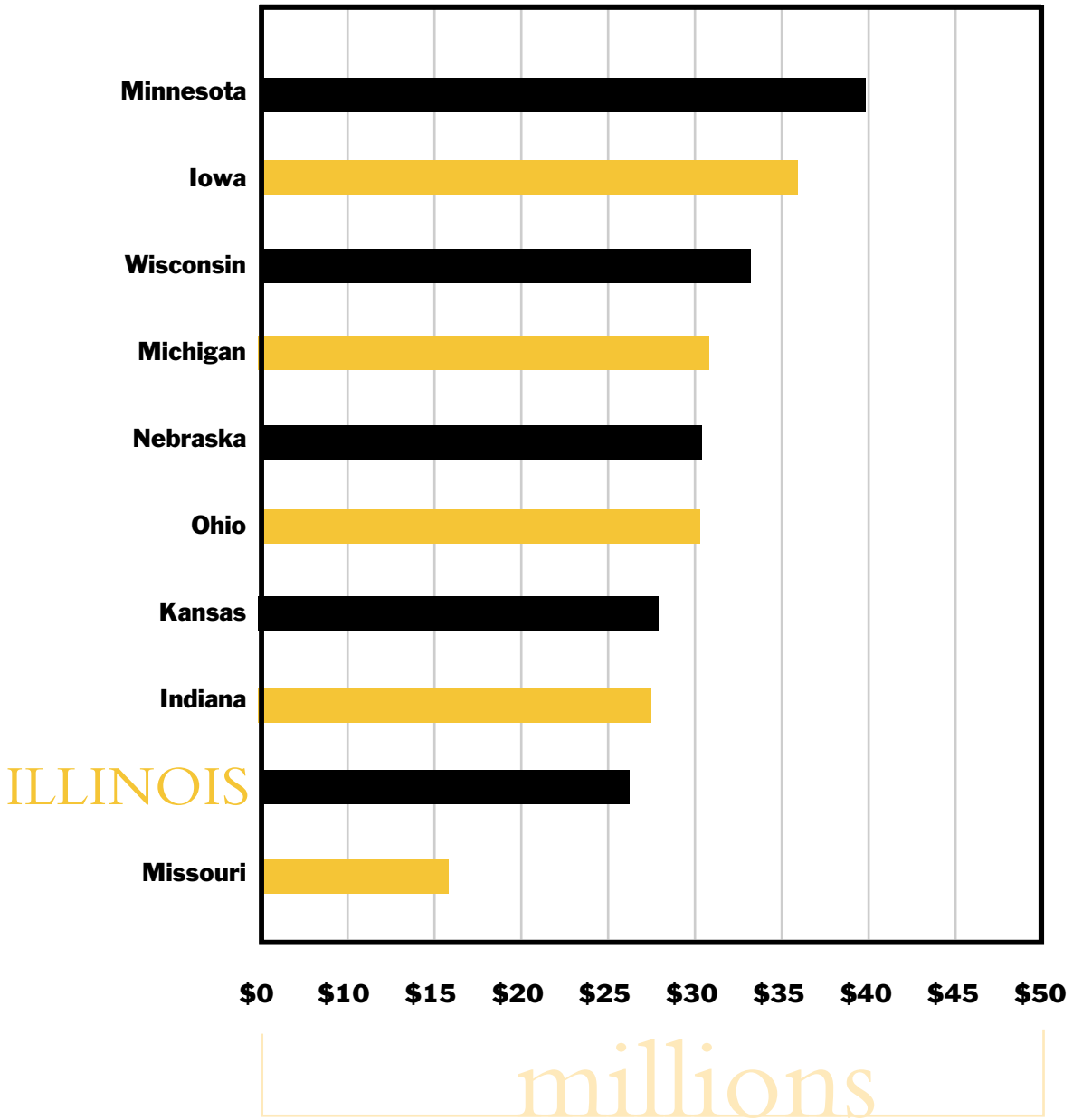
- One million Illinois workers are employed in the food and fiber system, ranking Illinois as one of the top states in reliance on agriculture.
- Illinois is a national leader in the production of corn, soybeans, and livestock. It usually ranks among the top five states in cash income, crop cash receipts, and total value of farm real estate.
- Food processing is the state's number two manufacturing activity, adding almost $13.4 billion annually to the value of Illinois' raw agricultural commodities.
- Illinois ranks number one among all states in the production of ethanol.
- New and expanded agricultural enterprises, including such ventures as value-added agribusinesses and the production of specialty crops, are allowing Illinois to capture greater revenue from agricultural commodities.
- Millions of bushels of corn and soybeans are exported every year to other states and other countries.

C-FAR members extend their appreciation and gratitude to Governor George H. 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. This support has increased Illinois' rank among states in funding of food and agricultural research from 26th in 1995 to 15th in 2000.

Illinois must maintain a strong commitment to developing and advancing its food and agricultural industry in order to capture future opportunities and remain competitive in the ever-changing world market. While the trend of Illinois' investment in food and agricultural research has been on an upward slope, the investment relative to other Midwestern states is lower than desired (see the chart on page 95). This relative lag indicates a need for additional funding in food and agricultural research.

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

Comparison of U.S. Midwestern Agricultural States' Annual Research Expenditures (FY00)



Source of this data is the Inventory of Agricultural Research, USDA/CREES (land grant institutions), which reflects FY00 expenditures (not appropriations) of state funds for food and agricultural research by land grant institutions. The Illinois figure includes both C-FAR-appropriated funds and other general revenue funds as appropriated by the State of Illinois.

Summary of FY01 Expenditures and Obligated Funds

External Competitive Grants Program 4,045,503

Expenditures 2,306,613

Obligations 1,738,840

Internal Programs 10,792,066

Expenditures 6,311,330

Obligations 4,480,736

Strategic Research Initiatives 7,518,437

Expenditures 5,128,660

Obligations 2,389,777

Program and Administrative Obligations 25,157

Illinois Department of Agriculture Fee 50,000

Member Expense Account 130,147

Total FY01 Expenditures and Obligated Funds $22,561,310

Expenditures $13,926,750

Obligations $8,634,560

Note: The total FY01 expenditures and obligated funds are higher than the FY01 appropriation because a portion of funds from the previous fiscal year are typically obligated for investment in the subsequent year.

Summary of FY02 Allocations

External Competitive Grants Program 2,239,853*

Internal Programs 7,580,000

Strategic Research Initiatives 5,000,000

Illinois Department of Agriculture Fee

($50,000, or ½ of 1% of the total appropriation, whichever is less) 50,000

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

Total FY02 Allocations $15,019,853

* *An additional $19,853 (from unexpended funds in the FY01 1% Member Expense Account) was allocated to the FY02 External Competitive Grants Program by agreement with the Illinois Department of Agriculture.*

C-FAR FY01 Expenditure Summary: Internal Programs

(July 1, 2000 through June 30, 2001)

Actual Fiscal Year Expenditures*							
C-FAR Research Focus Areas	**Expenditure Areas**	**UIUC**	**SIUC**	**ISU**	**WIU**	**Per Legislation**	**TOTALS**
Expanding Agricultural Markets	Equipment	131,589	2,434	4,495	0		**$138,518**
	Materials/Supplies	62,856	97	849	0		**$63,802**
	Personnel	450,595	26,539	19,897	0		**$497,031**
	Services/Contracts	92,942	15,368	1,317	0		**$109,627**
	Transportation	34,881	1,419	231	0		**$36,531**
Rural Economic Development	Equipment	10,437	7,111	0	11,294		**$28,842**
	Materials/Supplies	8,996	3,725	0	4,011		**$16,732**
	Personnel	245,819	31,697	27,984	38,635		**$344,135**
	Services/Contracts	29,893	12,988	154	5,153		**$48,188**
	Transportation	12,938	2,477	42	2,133		**$17,590**
Agricultural Production Systems	Equipment	364,642	162,856	51,102	304		**$578,904**
	Materials/Supplies	308,099	27,547	3,756	6,252		**$345,654**
	Personnel	1,335,185	155,953	31,449	23,155		**$1,545,742**
	Services/Contracts	263,009	54,934	9,783	4,707		**$332,433**
	Transportation	63,315	13,050	826	133		**$77,324**
Human Nutrition and Food Safety	Equipment	15,381	52,576	0	0		**$67,957**
	Materials/Supplies	96,164	24,254	0	0		**$120,418**
	Personnel	457,137	130,235	0	0		**$587,372**
	Services/Contracts	48,959	21,420	0	0		**$70,379**
	Transportation	12,411	1,864	0	0		**$14,275**
Natural Resources	Equipment	39,522	0	148	2,366		**$42,036**
	Materials/Supplies	82,929	410	74	8,436		**$91,849**
	Personnel	533,455	24,760	7,401	74,307		**$639,923**
	Services/Contracts	35,905	5,500	95	10,478		**$51,978**
	Transportation	14,071	0	933	1,764		**$16,768**
Subtotals		4,751,130	779,214	160,536	193,128		**$5,884,008**
Indirect Costs		0	0	8,340	9,941		**$18,281**
Research Support		86,391	52,394	7,113	3,442		**$149,340**
C-FAR Administrative Office**		212,955	28,567	10,388	7,791		**$259,701**
1% Member Expense		N/A	N/A	N/A	N/A	130,147	**$130,147**
IDOA Fee		N/A	N/A	N/A	N/A	50,000	**$50,000**
Awards/Obligated Funds for FY02 Research		4,253,746	29,434	115,255	82,301		**$4,480,736**
Total FY01 Expenditures and Obligated Funds		**$9,304,222**	**$889,609**	**$301,632**	**$296,603**	**$180,147**	**$10,972,213**

* FY01 Achievement Award expenditures are included in the figures in this table.

** A balance of $13,962 in the C-FAR Administrative Office account was carried forward to FY02.

C-FAR FY01 Expenditure Summary: External Program

(July 1, 2000 through June 30, 2001)

Actual Fiscal Year Expenditures							
C-FAR Research Focus Areas	**Expenditure Areas**	**UIUC**	**SIUC**	**SIU**	**WIU**	**Other Entities***	**TOTALS**
Expanding Agricultural Markets	Equipment	1,945	22,707	0	0	0	**$24,652**
	Materials/Supplies	6,763	14,218	0	0	0	**$20,981**
	Personnel	54,046	108,155	0	0	21,825	**$184,026**
	Services/Contracts	7,302	66,316	0	0	20,361	**$93,979**
	Transportation	7,240	6,332	0	0	3,554	**$17,126**
Rural Economic Development	Equipment	3,074	1,859	0	0	4	**$4,937**
	Materials/Supplies	12,783	338	0	0	1,116	**$14,237**
	Personnel	129,047	138,902	0	0	2,762	**$270,711**
	Services/Contracts	15,965	7,541	0	0	2,064	**$25,570**
	Transportation	9,454	1,677	0	0	1,198	**$12,329**
Agricultural Production Systems	Equipment	19,056	5,816	0	0	0	**$24,872**
	Materials/Supplies	33,271	76,483	27,850	0	0	**$137,604**
	Personnel	133,195	189,870	5,040	0	0	**$328,105**
	Services/Contracts	45,190	88,099	1,260	0	0	**$134,549**
	Transportation	13,435	13,012	0	0	0	**$26,447**
Human Nutrition and Food Safety	Equipment	1,003	6,409	0	0	0	**$7,412**
	Materials/Supplies	42,463	8,269	0	0	10,999	**$61,731**
	Personnel	152,451	52,744	0	0	7,074	**$212,269**
	Services/Contracts	22,523	10,756	0	0	177	**$33,456**
	Transportation	5,913	8,070	0	0	112	**$14,095**
Natural Resources	Equipment	5,313	18,686	16,199	3,928	1,500	**$45,626**
	Materials/Supplies	32,263	10,555	17,762	3,055	5,132	**$68,767**
	Personnel	168,044	23,178	38,129	26,109	44,298	**$299,758**
	Services/Contracts	61,340	4,609	50,020	861	1,718	**$118,548**
	Transportation	14,742	2,569	1,226	0	939	**$19,476**
Subtotals		997,821	887,170	157,486	33,953	124,833	**$2,201,263**
Indirect Costs		0	84,720	9,602	3,133	7,895	**$105,350**
Awards/Obligated Funds for FY02 Research		973,659	532,285	1,586	27,755	203,605	**$1,738,890**
Total FY01 Expenditures and Obligated Funds		**$1,971,480**	**$1,504,175**	**$168,674**	**$64,841**	**$336,333**	**$4,045,503**

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

C-FAR FY01 Expenditure Summary: Strategic Research Initiatives

(July 1, 2000 through June 30, 2001)

Actual Fiscal Year Expenditures							
Strategic Research Initiative	**Expenditure Areas**	**UIUC**	**SIUC**	**ISU**	**WIU**	**Other Entities***	**TOTALS**
Information Systems and Technology	Equipment	46,045	0	0	0	0	**$46,045**
	Materials/Supplies	26,428	0	1,393	0	1,948	**$29,769**
	Personnel	536,364	12,186	82,306	0	11,558	**$642,414**
	Services/Contracts	9,671	138	590	0	0	**$10,399**
	Transportation	9,956	10	1,011	0	148	**$11,125**
	Coordination	50,798	N/A	N/A	N/A	N/A	**$50,798**
Rural Community Development	Equipment	1,975	17,486	0	2,750	0	**$22,211**
	Materials/Supplies	16,318	21,510	0	4,433	0	**$42,261**
	Personnel	178,298	446,293	0	62,204	0	**$686,795**
	Services/Contracts	76,623	60,210	0	12,013	0	**$148,846**
	Transportation	19,140	26,534	0	6,146	0	**$51,820**
	Coordination	N/A	54,088	N/A	N/A	N/A	**$54,088**
Swine Odor and Waste Management	Equipment	123,828	2,573	50,731	0	0	**$177,132**
	Materials/Supplies	82,006	11,956	203	0	15,342	**$109,507**
	Personnel	524,079	70,881	20,089	0	8,232	**$623,281**
	Services/Contracts	42,482	6,106	19,011	0	0	**$67,599**
	Transportation	22,949	310	39	0	0	**$23,298**
	Coordination	87,138	N/A	N/A	N/A	N/A	**$87,138**
Food Safety (including allocation to Functional Foods)	Equipment	(1,536)	29,486	0	3,512	674	**$32,136**
	Materials/Supplies	55,950	24,084	0	2,678	6,877	**$89,589**
	Personnel	305,766	102,543	0	46,272	35,035	**$489,616**
	Services/Contracts	39,607	39,861	0	13,840	20,700	**$114,008**
	Transportation	8,629	13,879	0	4,703	82	**$27,293**
	Coordination	N/A	81,693	N/A	N/A	N/A	**$81,693**
Water Quality	Equipment	229,767	12,608	0	0	0	**$242,375**
	Materials/Supplies	52,743	7,694	0	0	0	**$60,437**
	Personnel	571,610	112,786	0	0	0	**$684,396**
	Services/Contracts	145,651	25,651	0	16,484	0	**$187,786**
	Transportation	31,647	5,781	0	95	0	**$37,523**
	Coordination	58,004	N/A	N/A	N/A	N/A	**$58,004**
Subtotals		3,351,936	1,186,347	175,373	175,130	100,596	**$4,989,382**
SRI Review Panel**		N/A	N/A	N/A	N/A	N/A	**$0**
Indirect Costs		0	104,298	9,555	17,511	7,914	**$139,278**
Awards/Obligated Funds for FY02 Research		1,940,796	259,578	57,759	27,466	104,178	**$2,389,777**
Total FY01 Expenditures and Obligated Funds		**$5,292,732**	**$1,550,223**	**$242,687**	**$220,107**	**$212,688**	**$7,518,437**

* Other entities are the American Farmland Trust, Illinois Restaurant Association Education Foundation, Iowa State University, Purdue University, National Center for Food Safety and Technology at the Illinois Institute of Technology, and the Springfield, Illinois, Department of Public Health.

** The SRI Review Panel account has a balance of $11,195.

C-FAR FY02 Allocations Summary Report

(July 1, 2001 through June 30, 2002)

C-FAR Research Focus Areas	Internal Grant Programs					External Competitive Grants Program	Strategic Research Initiatives	Per Legislation	TOTALS
	UIUC	SIUC	ISU	WIU	Internal Totals				
Expanding Agricultural Markets	503,280	82,000	0	0	585,280	452,745			**$1,038,025**
Rural Economic Development	382,267	29,912	39,475	111,140	562,794	401,493			**$964,287**
Agricultural Production Systems	2,944,732	337,000	48,600	14,569	3,344,901	658,399			**$4,003,300**
Human Nutrition and Food Safety	1,334,516	110,860	46,277	0	1,491,653	366,614			**$1,858,267**
Natural Resources	673,231	25,000	99,606	75,654	873,491	360,602			**$1,234,093**
Strategic Research Initiatives							5,000,000		**$5,000,000**
Food Safety $800,000									
Info Systems and Technology $825,000									
Rural Community Development $975,000									
Swine Odor and Waste Mgmt. $1,250,000									
Water Quality $1,150,000									
Research Support	104,000	57,900	0	5,500	167,400				**$167,400**
Research Discretionary	25,185	157,807	43,264	1,080	227,336				**$227,336**
Indirect Costs	N/A	N/A	13,861	10,370	24,231				**$24,231**
C-FAR Administrative Office	227,889	30,571	11,117	8,337	277,914				**$277,914**
Achievement Award	20,500	2,750	1,000	750	25,000				**$25,000**
1% Member Expense	N/A	N/A	N/A	N/A	N/A			150,000	**$150,000**
IDOA Fee	N/A	N/A	N/A	N/A	N/A			50,000	**$50,000**
TOTALS	**$6,215,600**	**$833,800**	**$303,200**	**$227,400**	**$7,580,000**	**$2,239,853***	**$5,000,000**	**$200,000**	**$15,019,853***

* An additional $19,853 from unexpended funds in the FY00 1% Member Expense Fund was allocated to the FY01 External Program.

Websites to watch:

C-FAR **WWW.ILCFAR.ORG**

Information Systems and Technology SRI	**web.aces.uiuc.edu/sriit**
Rural Community Development SRI	**www.siu.edu/~i-farrm**
Swine Odor and Waste Management SRI	**sowm.outreach.uiuc.edu**
Food Safety SRI	**www.siu.edu/~foodsafe**
Water Quality SRI	**web.aces.uiuc.edu/sriwq**
NAT Tools for Good Health	**www.nat.uiuc.edu** ***For analyzing diet and food choices.***
farm.doc	**www.farmdoc.uiuc.edu** ***Provides farmers with decision-making information and analysis tools.***
Illinois TRAILL	**il-traill.outreach.uiuc.edu** ***Organizes livestock research, information, and expert services.***
Interactive Agronomy Handbook	**web.aces.uiuc.edu/iah** ***Databases and online resources complement handbook.***
Pest Management & Crop Development Bulletin	**www.ag.uiuc.edu/cespubs/pest** ***Provides scouting reports, management advice, and decision-aid tools.***
Illinois IPM Online	**www.ipm.uiuc.edu** ***An environment for learning about integrated pest management.***
Illinois Watershed Management Clearinghouse	**web.aces.uiuc.edu/watershed** ***Helps groups create and implement a plan to address local watershed issues.***
Illinois World Food and Sustainable Agriculture Program	**web.aces.uiuc.edu/wf** ***Covers world food issues and related agricultural and natural resource implications.***
Community Development Toolbox	**www.ag.uiuc.edu/~lced/cfarsriit.html** ***Addresses rural needs for data analysis.***

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