



Illinois Council on Food and Agricultural Research

2004

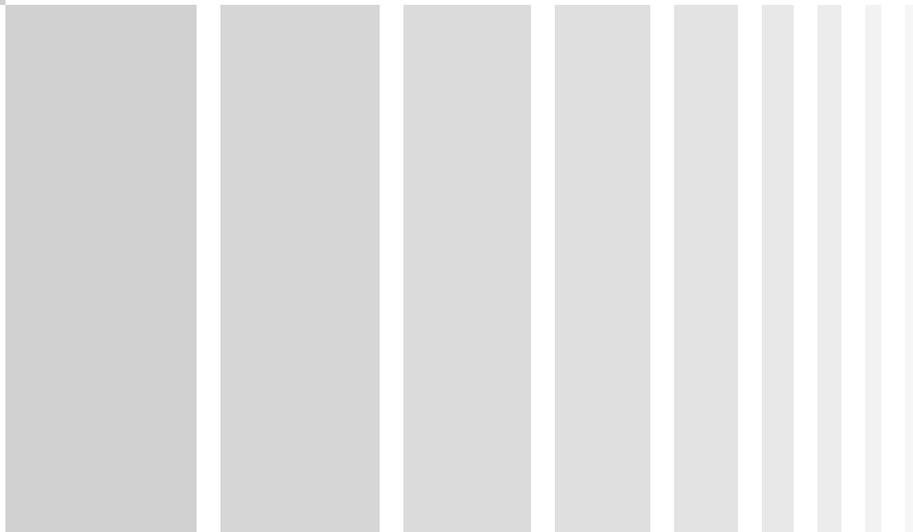
**A Partnership for
Illinois Food and
Agriculture**





OUR MISSION

The mission of the Illinois Council on Food and Agricultural Research (C-FAR) is to advance profitable, consumer-sensitive, environmentally sound food, agricultural, and related systems by securing funding for relevant research and outreach and fostering public participation in program guidance.



A PARTNERSHIP FOR ILLINOIS FOOD, AGRICULTURAL, AND RELATED SYSTEMS

The Illinois Council on Food and Agricultural Research (C-FAR) is a statewide coalition organized to support relevant, high-quality research and related outreach programs for Illinois' food, agricultural, and related systems. C-FAR was founded in December 1993 as a nonprofit association to address the critical need to increase state funding for food, agricultural, and related research, and to provide public input into setting research priorities, and thus ensure the success of Illinois' number one industry.

C-FAR is an unprecedented partnership of the private sector, State of Illinois officials, university administrators, and researchers, all working toward the same goal: to conduct and enhance research that will benefit Illinois' food, agricultural, and related industries; consumers; and ultimately Illinois' economy.

State of Illinois
Food, Agricultural, and Related Sectors
Consumers
Research Partners
University of Illinois at Urbana-Champaign
Southern Illinois University at Carbondale
Illinois State University
Western Illinois University
Other Research Entities

C-FAR research funding is provided by the State of Illinois. C-FAR gratefully acknowledges the State of Illinois for these financial investments. The investments are enabling advancements for Illinois' food and agricultural systems and contributing to the economic vitality of our state.

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MESSAGE FROM C-FAR

Greetings,

As Illinois citizens, we are fortunate. From the world-renowned, beautiful skyline and infinite cultural attractions of Chicago to the majestic flowing countryside of agriculture production, we enjoy a unique diversity in our state. Though varied in our culture and landscape, we are a people blessed with being citizens of a state with many rich attributes.

Intertwined throughout this diversity is the fact that Illinois' food, agricultural, and related sectors are a very significant, if not the most significant, economic engine in the state. These sectors have an

impact on the lives of every Illinois citizen, everyday. While those of us professionally engaged in this important segment of our state's economy realize this is a tremendous responsibility, we embrace the responsibility with vigor. The dedication of industry professionals and other stakeholders is inspiring. For example, the volunteerism displayed by the men and women with a vested interest in our state's food, agricultural, and related systems is a testimonial to their dedication to making Illinois stronger. This volunteerism is clearly evident within C-FAR.

As Illinois commits to maintaining its leadership position in the national and international food and agricultural markets, we will continue to look to be a strong partner with the State of Illinois in ensuring a viable and vibrant research program. Such a foundation of sound research will provide for future prominence.

As we stand shoulder-to-shoulder with the State of Illinois, we will continue to place a key priority on our accountability measures and on investing in research that responds to stakeholder needs and opportunities. We further pledge to engage stakeholders in a meaningful manner and to uphold the principles of the C-FAR appropriation's guiding legislation. Finally we will continue to take full advantage of every outreach mechanism possible to ensure that our state's citizens and economy are the beneficiaries of the State of Illinois' investment in food, agricultural, and related research.

This 2004 Annual Report captures how we are fulfilling these priorities and pledges. We encourage your review of its content.

Together, as a team of partners, we will continue to seize full advantage of the many rich attributes of this great state.

Sincerely,



Alan Puzey
Chairman of the Board



Craig A. Wagenecht
Executive Administrator



2004 HIGHLIGHTS

Annual Meeting

4 C-FAR held its 2004 Annual Meeting of the Membership on February 17 at the Northfield Inn, Suites & Conference Center, in Springfield. The meeting was well attended by members from across the state. The C-FAR membership elected three individuals to serve on the seven-person board of directors: Larry Fischer, Alan Puzey, and Stephen Scates. The five working groups met to elect chairs and vice chairs to serve in 2004. A highlight of the meeting was the presentation of the 2004 Donald A. Holt Achievement Award. The award was presented to the *farmdoc* research team, which was honored for its work to develop Web-based resources and decision tools to assist agricultural decision makers. Also during the meeting, members heard summary presentations given by research leaders of the five C-FAR strategic research initiatives (SRIs) which ended in June 2003.



Chairman Alan Puzey recognizes retiring board member Carol Keiser at the C-FAR 2004 Annual Meeting for her longtime service and commitment to C-FAR.

Semi-Annual Meeting



Jeanne Harland, Human Nutrition and Food Safety Working Group chair, introduces Dr. Andrzej Bartke of the SIU School of Medicine (center) and Dr. Todd Winters of the SIUC College of Agricultural Sciences (right), who discussed their C-FAR research with working group members at the semi-annual meeting.

C-FAR held its 2004 Semi-Annual Meeting at the Northfield Inn, Suites & Conference Center, in Springfield, on August 24. During the general meeting of the membership, members revised the C-FAR bylaws to extend the terms of service of working group chairs and vice chairs. Working group chairs and vice chairs will serve two-year terms, with a two-term limit. The terms of service for research committee members were also extended to two-year terms with a two-term limit. These changes were made to provide greater consistency for the working groups and the research committee. The C-FAR mission statement was revised to a shorter, more concise description of the mission of the association. Additional highlights included special remarks by C-FAR's four partner university leaders and presentations by guest researchers during the working group meetings. Following discussions with researchers, the working groups reviewed their research focus areas to update and clarify research priorities.

C-FAR Day at Western Illinois University



Research chemist Mary Phippen (right) displays a *Cuphea* breeding line being developed for improved agronomic and oil traits during C-FAR Day at Western Illinois University.

C-FAR held its fourth annual C-FAR Day on November 16 at Western Illinois University. This special event highlighted C-FAR-funded research initiatives taking place at the university. C-FAR Day provides an opportunity for C-FAR members to visit with researchers and learn firsthand about their research activities. WIU faculty described key outcomes and impacts of their C-FAR research in areas including alternative crop development, food safety initiatives, and organic crop systems. Following the faculty presentations, attendees toured a seed-cleaning laboratory for alternative crops and the university's Allison Organic Farm.

WHO'S WHO

2004 Board of Directors and Staff

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Board of Directors



Alan Puzey
CHAIRMAN OF THE
BOARD, FAIRMOUNT



David Downs
VICE CHAIRMAN OF
THE BOARD, ALLERTON



Fred Bradshaw
SECRETARY-TREASURER,
GRIGGSVILLE



Larry Fischer
MEMBERSHIP CHAIR,
QUINCY



Nels Kasey
RESEARCH CHAIR,
PARIS



Karen Little
RESEARCH VICE CHAIR,
PLEASANT PLAINS



Stephen Scates
DIRECTOR,
SHAWNEETOWN

Staff



Kraig A. Wagenecht
EXECUTIVE
ADMINISTRATOR



LeAnn M. Ormsby
COMMUNICATIONS
DIRECTOR

Additional C-FAR Staff

Rhonda Hunter
ADMINISTRATIVE ASSISTANT

Gloria Buhrmester
SECRETARY

Arena Jackson
SECRETARY

2004 Working Group Leadership

Expanding Agricultural Markets



Dan Kelley
CHAIR, NORMAL



Heather Hampton+Knodle
VICE CHAIR, FILLMORE

Rural Economic Development



Kae Hanks
CHAIR, GALESBURG



Carl Neubauer
VICE CHAIR, DOWNS

Agricultural Production Systems



Molly Ann Godar
CHAIR, ROCHESTER



Anne Builta Crider
VICE CHAIR,
ARROWSMITH

Human Nutrition and Food Safety



Jeanne Harland
CHAIR, LAFAYETTE



Jim Fraley
VICE CHAIR,
COOKSVILLE

Natural Resources



Byford Wood
CHAIR, BREESE



Dale Crawford
VICE CHAIR, SULLIVAN

2004 MEMBERS

Organizational Members

- 8 Association of Illinois Soil and Water Conservation Districts
Audubon Council of Illinois
Central Illinois Golf Course Superintendent's Association
Champaign County Farm Bureau
Dairy Management Inc.
DuPage County Farm Bureau
GROWMARK
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 Corn Growers Association
Illinois Corn Marketing Board
Illinois Dietetic Association
Illinois Farm Bureau
Illinois Farm Business Farm Management Association
Illinois Farm Credit Services
Illinois Farmers Union
Illinois Fertilizer and Chemical Association
Illinois Forage and Grassland Council
Illinois Grape Growers and Vintners Association
Illinois Lamb & Wool Producers
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
Illinois Society of Professional Farm Managers & Rural Appraisers
Illinois Soil Testing Association
Illinois Soybean Association
Illinois Soybean Program Operating Board
Illinois Specialty Growers Association
Illinois State Grange
Illinois State Horticultural Society
ISU Agriculture Alumni Association
Illinois State Veterinary Medical Association
Illinois Stewardship Alliance
Illinois Sustainable Agriculture Society
Illinois Thoroughbred Horsemen's Association
Illinois Turfgrass Foundation
Illinois Wheat Association
Institute of Food Technologists, Chicago Section
Kane County Farm Bureau
Kankakee County Farm Bureau
Knox County Farm Bureau
Macoupin County Farm Bureau
Madison County Farm Bureau
Mason County Farm Bureau
Mercer County Farm Bureau
Midwest Association of Golf Course Superintendents
Midwest Dairy Association
Orr Agricultural Research Center
Rural Partners
Sod Growers Association of Mid-America
Southeastern Illinois Sustainable Agriculture Association
SIU College of Agricultural Sciences Alumni Society
The Chicago Farmers
UIUC College of Agricultural, Consumer and Environmental Sciences Alumni Association
UIUC College of Veterinary Medicine Alumni Association
Warren-Henderson Farm Bureau

Affiliate Members

Central Illinois Agricultural Research Farms
Environmentally Correct Concepts
Greene Farm Management Services
Illinois Crop Improvement Association
Illinois Department of Natural Resources
Illinois Finance Authority
Illinois Forestry Development Council
Illinois State Geological Survey
ISU Department of Agriculture
Illinois State Water Survey
Lake Vermilion Water Quality Coalition
National Center for Food Safety and Technology
Sangamon County Soil and Water Conservation District
Shawnee Community College
SIUC Center of Excellence for Soybean Research, Teaching, and Outreach

SIUC College of Agricultural Sciences
SIUC Department of Agribusiness Economics
SIUC Department of Animal Science, Food and Nutrition
SIUC Department of Forestry
SIUC Department of Plant, Soil and Agricultural Systems
SIUC Fisheries and Illinois Aquaculture Center
The Nature Conservancy in Illinois
UIS Institute for Legal and Policy Studies
UIUC College of Agricultural, Consumer and Environmental Sciences
UIUC College of ACES Information Technology and Communication Services
UIUC College of Veterinary Medicine
UIUC Department of Agricultural and Biological Engineering
UIUC Department of Agricultural and Consumer Economics
UIUC Department of Animal Sciences

UIUC Department of Crop Sciences
UIUC Department of Food Science and Human Nutrition
UIUC Department of Human and Community Development
UIUC Department of Natural Resources and Environmental Sciences
UIUC Department of Veterinary Biosciences
UIUC Department of Veterinary Clinical Medicine
UIUC Department of Veterinary Pathobiology
WIU Department of Agriculture
WIU Department of Dietetics, Fashion Merchandising, and Hospitality

Individual Members

In addition to the Organizational and Affiliate members and all of their representatives, there were 135 Individual members who supported food, agricultural, and related research in Illinois via C-FAR in 2004.

COMMITTEES

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Research Committee

The purpose and charge of this committee is to

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

Committee members:

Nels Kasey, chair; Karen Little, vice chair; Susan Adams; Mary Buckles; Constance Locher Bussard; Wally Denzer; Pat Dumoulin; Paul Gebhart; Molly Ann Godar; Kae Hanks; Jeanne Harland; Carl Hopphan; Steve Kasten; Dan Kelley; Heather Hampton+Knodle; Carl Neubauer; Albert "Pete" Peter; Lee Anne Roach; Wendell Shauman; Walt Townsend; and Byford Wood.
Ex-officio: Andrew Baker; George Fahey; Patrick O'Rourke; Steven Pueppke; John Russin.

Legislative Committee

The charge of this committee is to

- monitor all legislative activity, state and federal, that may have an impact on C-FAR or its mission and objectives
- develop recommendations for Council or Board approval
- implement and execute plans

Committee members:

Jack Erisman, chair; Fred Bradshaw; Constance Locher Bussard; David Downs; David Erickson; Wally Furrow; Carl Hopphan; Carol Keiser; Scott Lay; Karen Little; Alan Puzey; Stephen Scates; William Whiteside; and Terry Wolf. *Ex-officio:* Herman Bodewes.

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 considered by the C-FAR membership at the annual meeting.

Committee members:

Terry Wolf, chair; Shannon Allen; Allan Aves; Bill Campion; Charlie Grotevant; 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:

Dennis Thompson, chair; Rick Dean; Don Doehring; Paul Galligos; Pam Hansen; Neal Merchen; and Bert Princen.

RESEARCH PARTNERS

University of Illinois at Urbana-Champaign



Robert A. Easter, Dean
COLLEGE OF AGRICULTURAL, CONSUMER
AND ENVIRONMENTAL SCIENCES



**Steven G. Pueppke, Associate Dean
for Research**
COLLEGE OF AGRICULTURAL, CONSUMER
AND ENVIRONMENTAL SCIENCES



**George C. Fahey, Jr., Assistant
Dean, Research Leadership-C-FAR**
COLLEGE OF AGRICULTURAL, CONSUMER
AND ENVIRONMENTAL SCIENCES

Southern Illinois University at Carbondale



Gary L. Minish, Dean
COLLEGE OF AGRICULTURAL SCIENCES



**John S. Russin, Associate Dean
for Research and Personnel
Administration**
COLLEGE OF AGRICULTURAL SCIENCES

Illinois State University

Patrick D. O'Rourke, Chair
DEPARTMENT OF AGRICULTURE



Western Illinois University

Andrew J. Baker, Interim Chair
DEPARTMENT OF AGRICULTURE



RESEARCH PROGRAMS

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In 1995, the Illinois General Assembly passed the Food and Agriculture Research Act, the enabling legislation that provides the framework for C-FAR funding and research activity. In FY04, Governor Rod R. Blagojevich and the Illinois General Assembly appropriated \$5.0 million to C-FAR (note: the FY04 appropriation was reduced by a 2% reserve, resulting in the appropriation being reduced from \$5 million to \$4.9 million). The FY05 C-FAR appropriation is \$3.5 million.

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 Illinois' food and agricultural industry and consumers.

University Internal Programs

In accordance with the Food and Agriculture Research Act (the C-FAR appropriation's enabling legislation), the majority of research funds are allocated on a percentage basis to Illinois' four food and agriculture research universities: the 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, agriculture, and related communities and consumers as defined by the C-FAR membership.

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 External Competitive Grants Program is designed to encourage and support research efforts from state agencies and organizations outside of the four universities. The program solicits RFPs from nonprofit research entities throughout 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. Proposal review follows a two-step process. The first step is a request for and review of pre-proposals. C-FAR working group members evaluate pre-proposals based on relevance to C-FAR research focus areas, potential outcomes and benefits to stakeholders, and dissemination plans. The second step involves inviting principal investigators of top-ranking pre-proposals to submit full proposals. Full proposals undergo scientific review and evaluation.

STRATEGIC RESEARCH INITIATIVE PROGRAM

In 1998, the C-FAR membership established the Strategic Research Initiative (SRI) Program to implement a targeted, multidisciplinary, and multi-institutional team approach to addressing major concerns and opportunities for Illinois' food, agricultural, and related industries and consumers. Currently, there are three initiatives which began in FY04. The following are summaries of FY04 progress reports submitted by the principal investigators of these initiatives.

Biomass Energy Crops for Power and Heat Generation in Illinois: Diversifying Cropping, Improving Energy Security, and Benefiting the Environment

Dr. Stephen Long, a professor of crop sciences at the University of Illinois at Urbana-Champaign, provides leadership for a multidisciplinary team of researchers working to provide Illinois with the foundation and technology leadership for the large-scale cultivation of biomass crops. He is assisted by Emily Heaton, also from the Department of Crop Sciences at the UIUC. In this five-year SRI, researchers are focusing on the use of *Miscanthus*, a perennial rhizomatous grass, as a potential renewable energy source for Illinois and profitable alternative crop for Illinois producers.

Principal Investigators

Stephen P. Long, Crop Sciences and Plant Biology

Tony E. Grift, Lei F. Tian, Yuanhui Zhang, Agricultural and Biological Engineering

Madhu Khanna, Agricultural and Consumer Economics

German A. Bollero, Jack M. Widholm, Crop Sciences

Anne Heinze Silvis, Human and Community Development

Mark B. David, Jack A. Juvik, Gregory F. McIsaac, Thomas B. Voigt, Michelle M. Wander, Natural Resources and Environmental Sciences

University of Illinois at Urbana-Champaign

Field Trials

To generate material for field trials, *Miscanthus* plants were vegetatively propagated in the greenhouse. One hundred plants were divided to produce 20,000 plantlets between August 2003 and June 2004. In June, 16,000 plantlets were used to establish large-scale (0.5 acre) plots in an experimental design that included *Miscanthus* planted alone, *Miscanthus* planted into hairy vetch, a switchgrass plot, and a corn/soybean rotation plot. All other species were established by seeding. The treatments were arranged in a randomized complete block design with four replications. Two more replications will be added in 2005.

In addition to the large-scale plots that will serve as a "field laboratory," small-scale comparisons (10 x 10 m plots) of *Miscanthus* and switchgrass were established in May and June 2004 at four sites around Illinois. These new plots, located in Brownstown, Orr, Havana, and Fairfield, have the same experimental design as plots established in 2002 at DeKalb, Urbana, and Dixon Springs, and will help to determine variation in biomass crop production under different site conditions. At the three older sites, *Miscanthus* has grown to over 12 ft. in its third year and based on stature is expected to out yield switchgrass by the factor of two observed in the winter 2003-2004 harvest. Yields for Urbana in 2004 are about 23 dry tons per acre. This is considerably more than projected from European studies of the crop. It may reflect the very favorable growing conditions of 2004, but emphasizes the need for trials over a few years and multiple sites to establish the potential of the crop in Illinois. Twenty of the bales from the switchgrass and *Miscanthus* 2003-2004 winter

harvest have been left in the field, and mass loss with time is being measured. If bales can be left in the field without significant weight loss then this will avoid any need for long-term covered storage either on farm or at the power generation station.

In a complimentary project, large (0.5 acre) plots of *Miscanthus*, switchgrass and corn/soybean were established at the Dudley Smith Farm in Christian county. Two replications were planted in June 2004 to be followed by two more replicates in 2005. *Miscanthus* plant material was dug directly from a demonstration plot planted at the Farm in 2002 and transplanted to establish the new plots. Due to small plantlet size, initial *Miscanthus* emergence at Brownstown, Orr, Havana, and Fairfield ranged from 40% to 90%. These plots were successfully replanted to the desired planting density in July and August 2004.

These efforts will provide the critically important baseline data needed to predict the productivity of *Miscanthus* and switchgrass at different locations, soil types and topographies in Illinois. It will also establish large scale plots (10 acres) that will provide stands for improving harvest technology and material for test burns at electrical power generation stations.

Miscanthus Breeding and Improvement

A collection of 30 lines of the parent species *Miscanthus sinensis* have been obtained and established in a nursery on the South Farms of the University of Illinois. This work will provide for genetic diversity and the basis for breeding higher yielding and better adapted forms of *Miscanthus x giganteus* for Illinois.

Development of Genetic Engineering Techniques

Researchers obtained a number of *Miscanthus* plants in small pots in the greenhouse in July 2003. Most of the plants were divided after two months and placed in larger pots in order to induce flowering. Once flowering was initiated all immature inflorescences have been removed, surface sterilized and placed on a culture medium that contains 3 mg/l 2,4-dichlorophenoxyacetic acid (2,4-D) as the growth regulator. The cultures are grown at 27-28°C in the dark and many of the explants form white embryogenic callus that should be able to proliferate by selective subculturing. This callus does produce green shoots in the light on a regeneration medium that contains 2mg/l benzyladenine but no 2,4-D. Researchers will next place these shoots in rooting medium without any growth regulator to get whole plants to pot in the greenhouse. These plants will be grown to maturity to observe the morphological phenotype and determine if flowering occurs. Thus, the first goal of obtaining *Miscanthus* callus that will regenerate plants has been attained. A transformation system will provide a basis for introduction of traits such as disease and pest resistance.

Soil Carbon and Gas Emissions

Baseline soil samples were collected from all sites where *Miscanthus* and switchgrass were seeded in spring 2004. Soils have been processed (air dried, split into samples for current and future use). Preliminary analyses are being conducted. These efforts will provide the critically important baseline needed to evaluate the long term impact of biofuels on the soil resource, in particular addition of organic matter and carbon sequestration, needed to quantify the potential of these crops in earning Carbon Credits for farms.

Water Resource Implications

The water resource study was started in the fall of 2004. In preparation for the water research study, access tubes for determining soil water content in the newly established *Miscanthus* plots were installed in the summer of 2004.

Propagation and Eradication of *Miscanthus x Giganteus*

In 2004, researchers began several propagation and eradication studies. First, during the autumn, winter, and spring of 2003-2004, dormant *Miscanthus* plants were obtained from southern Illinois and rhizome divisions were used in greenhouses to propagate more than 900 plants. Eight hundred of these plants were field planted in the spring at the Landscape Horticulture Research Center in Urbana in 8 blocks of 100 plants each. These blocks will be used in future propagation and eradication studies. During the autumn, winter, and spring of 2004-2005, researchers will continue to propagate additional plants in the greenhouses for planting in 2005.

In another greenhouse study, rhizome size (2, 4, or 6 nodes per rhizome) was evaluated to determine the most efficient size for *Miscanthus* propagation. A total of 53.3% of the 2-node rhizomes, 75.6% of the 4-node rhizomes, and 64.4% of the 6-node rhizomes survived and grew. This study will be repeated in 2005-06.

In a final study, the ability of rhizomes to tolerate three low temperatures for storage prior to planting was evaluated. This study will also be repeated in 2005-06 and longer storage durations will be examined.

Economic Analysis

A *Miscanthus* productivity simulation model was used to simulate the yield from *Miscanthus* in various counties of Illinois. The model uses detailed data about climatic conditions, soil moisture, precipitation, temperature, solar radiation, frost dates, and potential evapotranspiration to estimate biomass yield at a 2000m by 2000m ground resolution. Analysis shows that *Miscanthus* yield in Illinois would range between 12 and 17 dry tons per acre even under water limiting conditions. To examine the profitability of growing *Miscanthus* instead of row crops such as corn, soybean, wheat, and pasture, crop budgets were developed for these crops for each county. Since the price of *Miscanthus* would depend on transportation costs to users, investigators obtained data on electricity plant locations in Illinois. They then computed distances from the center of each county to the nearest power plants. This will be used to estimate demand and price received by farmers in each county for growing *Miscanthus*. This data will be used to examine which counties are likely to find it most profitable to grow *Miscanthus*. A model is now in place to predict *Miscanthus* yields for Illinois; this will be tested against the trial yields as the actual data becomes available.

Social Acceptability of Energy Crops

To measure probable grower interest in energy crop production, a survey instrument was developed and pilot-tested with producers and reviewed by scientists familiar with the specifics of production, handling, and marketing of fuel crops. With input from these sources, the survey instrument was finalized and is ready for use in several venues.

Illinois Livestock Integrated Focus Team (IL LIFT)

Dr. Michael Hutjens, a professor of animal sciences at the University of Illinois at Urbana-Champaign, leads a multidisciplinary, multi-institutional research team to address the economic and social challenges facing Illinois' livestock industry. The four-year SRI focuses on livestock facility siting in Illinois; using Illinois byproduct feeds in livestock feeding programs; pasture-based forage systems to sustain Illinois livestock producers; and animal identification for enhanced food quality and monitoring livestock health.

Principal Investigators

Michael F. Hutjens, Animal Sciences

Larry L. Berger, Geoffrey E. Dahl, Animal Sciences

Ted L. Funk, Agricultural and Biological Engineering

Peter D. Goldsmith, Agricultural and Consumer Economics

Richard A. Vogen, Agricultural, Consumer and Environmental Sciences

Richard L. Wallace, Veterinary Medicine
University of Illinois at Urbana-Champaign

Justin Sexten, University of Illinois Extension

Phillip R. Eberle, Agribusiness Economics
Southern Illinois University at Carbondale

Livestock Facility Siting in Illinois

The data collection portion of this study includes surveying a randomly selected sample of Illinois farms that are identified as concentrated animal feeding operations (CAFOs). The on-farm survey instrument has been designed and has been pilot tested with a selected audience. Researchers have compared their knowledge of producers' traditional practices with the requirements of state and federal regulations, and they have crafted the survey to address whether the traditional practices run counter to regulatory requirements. The survey instrument examines the completeness and on-farm use of the written manure management plan, the actual physical management of the facility, the producer's knowledge of regulations, and the facility's sustainable capacity.

Specific goals are:

- to compare a facility's written manure management plan (if existent) with the actual physical operation of the facility, to assess producers' attitudes about the goals and value of the planning process, and to identify challenges that producers face in meeting the new USEPA regulations for 2006
- identify shortcomings in facility operation regarding regulatory compliance
- estimate the cost (dollar amount) for Illinois producers to meet the new USEPA regulations by the 2006 deadline

The project will assess producers' awareness and understanding of regulations; determine whether current farm management practices are sustainable in light of the future regulatory climate; and see whether

current management practices put surface water quality at risk.

The National Pollutant Discharge Elimination System permit requires extensive records of manure production and land application. Those records will have to withstand routine scrutiny by regulators; and the detail, if supplied faithfully, would allow inspectors many opportunities to check on the farm's compliance with regulations. During the research project, lagoon-loading rates will be crosschecked with records of manure production and land application to identify inherent weaknesses in how Illinois facilities manage lagoons. A major part of the survey will be to identify manure storage capacity, and whether there is an endemic shortage of capacity that threatens the surface waters of the state.

The Illinois Department of Agriculture, Illinois EPA, and state office of USDA-NRCS are rapidly reaching agreement on a set of University of Illinois Extension Manure Management Plan (MMP) forms. These forms, if filled out by a CAFO manager, will simultaneously satisfy requirements of all three agencies. This research project will use the University of Illinois Extension MMP form set as the baseline for determining the level of compliance and gaps in recordkeeping that may exist on each farm surveyed.

Using Illinois By-Product Feed in Livestock Feeding

Dr. Randy Shaver of the University of Wisconsin has been contacted concerning the use of his program FeedVal on the IL LIFT website. This will allow for economic comparisons using Illinois base feeds that contain such ingredients as soybean meal, corn, animal fat, dicalcium phosphate, and limestone.

A list of publications, research reports, and presentations representing the most current information on feeding distillers grains to livestock has been compiled. Several of these sources of information are on websites managed by other universities. These will be cross-linked to the IL LIFT website to give producers access to the latest available science-based information. The University of Missouri has a website where price information is updated weekly. Most of the major Illinois producers of distillers grains participate in that website. Initially, that may be the most efficient means for Illinois livestock producers to get current distillers grains prices in Illinois.

Jim Endress, a farm business educator with University of Illinois Extension, has worked with Badger State Energy Ethanol Plant in Monroe, Wisconsin to establish the variation in the nutrient profiles of different ingredients produced by that plant. Means, standard deviations, minimums, and maximums of approximately 30 different nutritional components in distillers dried grain with solubles, distillers wet grain with solubles, distillers solubles, and wet cake have been collected over time. This information will be available to give producers a reference point as to the normal variation that occurs in byproduct feeds.

Using Illinois Forages Based on Pasture Based System

Plant and economic grazing results have been collected at the University of Illinois (U of I) Dudley Smith Farm, Schuette Corporation Beef Farm, and Becherer Sheep Farm from November 2003 to summer 2004. Becherer Sheep Farm grazed animals for a total of 19,582 grazing days from November 1, 2003 to May 15, 2004, with cost ranging from 5 cents per day to 9 cents per day depending upon plant species grazed compared to costs of 17 to 22 cents a day for confinement sheep feeding of hay and corn. Becherer Farm marketed over \$38,000 worth of lambs from 35 acres in 2003. On the U of I Smith Farm, 63 beef cows were grazed from November 1, 2003 to April 13, 2004 (164 grazing days) on 1.14 acres of turnips and spring oats, and 1.14 acres of corn residue per cow at a cost of 78 cents per day. In previous years the feed cost was 45 to 50 cents per day, but extreme mud and ice during

winter months increase the need to feed supplemental hay and corn. These results indicates a savings per cow ranging from \$77 to over \$200 in comparison to confinement operations where the normal cost to feed hay per day ranges from \$1.25 for low quality grass hay to \$2.50 for free choice high quality alfalfa. Data are being analyzed for the Schuette Beef Farm.

Two pasture walks have been held on the Becherer Sheep Farm with a total of over 50 participants attending. A field day was held at the U of I Dudley Smith Farm with over 125 participants. Additional field days have been planned for the U of I Dudley Smith Farm, Schuette Beef Farm, Becherer Sheep Farm and Southern Illinois University Dairy Farm.

A PDF file has been prepared and placed on www.traill.uiuc.edu/pasture.net for the Becherer Sheep farm and one is in progress for the U of I Dudley Smith data. Formal presentations have been presented at eight meetings with over 400 participants in two states.

Animal Identification for Enhanced Food Quality and Monitoring Livestock Health

Dummy chips were manufactured by collaborators in the Micro and Nanotechnology Laboratory at the University of Illinois, and technical details of insertion of those chips into mice used as a research model have been addressed. Ten presentations on the "US Animal Identification Plan" were presented around Illinois as a part of the annual Dairy Days series. Links are now active between the University of Illinois Food Security Initiative website and IL-TRAILL with specific reference to animal identification information.

Water Quality with a Focus on Total Maximum Daily Loads

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This three-year initiative continues efforts of the former water quality SRI with a new focus on total maximum daily loads (TMDLs). Dr. George Czapar, a University of Illinois Extension educator, leads a team of investigators from across the state to develop a scientific basis for nutrient standards in the surface waters of Illinois and to assist in the appropriate development and implementation of standards for TMDLs. The research team works closely with the Illinois Environmental Protection Agency, the Illinois Department of Agriculture, and the Metropolitan Water Reclamation District of Greater Chicago.

Principal Investigators

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Spatial and Temporal Relationships between Biotic Integrity of Illinois Streams, Dissolved Oxygen, and Nutrients

During May to June 2004, researchers conducted a statewide sampling of 142 stream sites from a variety of stream and land use types that receive agricultural and urban runoff and wastewater effluents. Measurement of dissolved oxygen (DO) concentration and percent saturation, pH, conductivity, turbidity, and temperature were recorded. All water sample analyses have been completed including nutrients (all species of nitrogen and phosphorus), sestonic chlorophyll-a, dissolved organic carbon, and silica. This sampling represented high flow conditions and all sites were sampled again in September to October 2004 to investigate these same parameters during low flow.

Also, during the statewide sampling, twenty-six streams were sampled for macroinvertebrates and periphyton chlorophyll-a. In each of these streams, macroinvertebrates were collected with a 500- μ m mesh dip net in each major habitat (e.g., riffle, run, pool) in proportion to availability. Approximately half of the macroinvertebrate samples have been sorted and identified. For periphyton, researchers collected representative rocks from the sediment, scraped a known area, and measured chlorophyll-a.

To better understand the relationship between habitat and water quality, a physical habitat analysis was performed based on USEPA Rapid Bioassessment Protocols. Researchers hope to find a reproducible link between biotic integrity and nutrient and chlorophyll-a concentrations that will assist Illinois Environmental Protection Agency (IEPA) in developing TMDLs.

In cooperation with Southern Illinois University (SIU) and Metropolitan Water Reclamation District of Greater Chicago (MWRDGC), a total of 14 sites that are gauged are being monitored intensively for water quality parameters as previously described as well as periods of continuous DO measurements. Water sampling of several sites near Urbana was initiated in October 2003. Currently, five sites are being monitored on a weekly basis with greater frequency during storm events. Researchers at MWRDGC are monitoring biweekly at five sites in the Chicago area that are influenced by urban runoff and sewage discharge. They are providing extensive support by instrumenting each site for continuous DO measurements as well as conducting the laboratory analyses for all water samples. Researchers at SIU are monitoring monthly at four sites where two are agriculturally impacted and two receive urban runoff. Both MWRDGC and SIU are also selecting several high flow events that will be sampled with greater frequency. These sites will allow researchers to further examine the role of hydrology in controlling the development of algal biomass and the depletion of DO as well as the temporal correspondence among nutrient concentrations, chlorophyll-a, and DO.

Effects of Phosphorus Mediated Through Algal Biomass in Illinois Streams

An extensive analysis of three historical data sets was performed in collaboration with IEPA to look for relationships between nutrients and biota in Illinois streams. The three data sets used were IEPA's Ambient Water Quality Monitoring Network (AWQMN) data set, Illinois Department of Natural Resources' stream fish community data set, and Illinois Natural History

Survey's mussel data set. Multiple regression models showed strong relationships between nutrient concentrations and fish and mussel species richness. Both fish and mussels species richness declined with increasing average concentrations of ammonia and total phosphorous.

Ten sampling sites were established in Little Kickapoo Creek, where much of the project's research effort will occur. Research at Kickapoo is keyed to a new sewage treatment plant serving the area. Preliminary sampling in 2003 included collection of water column nutrient samples, fish community sampling (electrofishing), and qualitative mussel surveys at the 10 sites. More intensive sampling commenced in early summer 2004. Concrete substrates were deployed at the 10 sites for algal colonization; periphyton on these substrates is being collected along with water column nutrient samples on a biweekly basis.

Fourteen sampling sites on streams in the Rock, Kaskaskia, Vermilion, and Illinois river drainages were chosen from the 202 sites in the IEPA AWQM network for intensive periphyton and nutrient sampling. Deployment of concrete substrates and sampling at these sites began in June 2004 and will continue through 2005. The sites are sampled every week to capture temporal variation in nutrients and algal development. Both temporal and spatial (site-to-site) aspects of the response of biota to nutrients will be examined in developing models of nutrient effects.

Seasonal Dynamics of Nutrients, Algae, and Dissolved Oxygen in Agriculturally Dominated Headwater Streams: the Link Between Land-Use and Water Quality

In 2004, researchers sought to determine annual patterns in dissolved nutrient concentrations with an emphasis on conditions during flood events. By combining data, researchers have been able to piece together a three-year data set on physicochemical parameters of these two streams. The dissolved nutrient concentrations (ammonia, nitrate, nitrite, and dissolved reactive phosphorous) have been studied weekly for three years. Using an automated sampling device, water has been collected during storm events on an hourly basis. Researchers have also started to assess fluctuations in total phosphorous during 2004. This data is necessary to understand when phosphorous and nitrogen are being loaded into the system, and when and if these times correspond to periods of high algal biomass which may cause diurnal dissolved oxygen fluctuations.

Changes in physical parameters and flow are being assessed in these two streams. Rating curves have been developed to convert water level data into discharge. Using these data, the mass loss rates of nitrogen, phosphorous, and sediments both on a weekly basis and also during flood events can be calculated. Seasonal dynamics in dissolved oxygen, conductivity, turbidity, temperature, pH and redox have been documented using Hydrolab units. These data allow researchers to develop an understanding of the seasonal changes of dissolved nutrients and diurnal dissolved oxygen and gain insight into the levels of algal biomass that link increased nutrient levels to large fluctuations in diurnal dissolved oxygen.

Also in 2004, researchers sought to assess annual patterns in algal biomass on the substrata and determine if algae were limited by either nitrogen or phosphorous levels during any time. Using nutrient diffusing substrata, it has been shown that the amount of algal biomass is well above what is considered nuisance levels even in what is considered one of the lower nutrient systems in central Illinois. There appears to be weak nutrient limitation during some periods of the year, but the full data set is still being examined.

Other headwater streams in the Mackinaw River and other headwater streams in the region with similar soils and geology are being sampled. Rather large differences have been found in nutrient concentrations in head water streams of the Mackinaw River. Diurnal oxygen dynamics in these systems are being monitored to determine if the low oxygen conditions observed in Bray Creek and Frog Alley are representative of other headwater streams. Researchers are also in the process of sampling algal biomass and the response to nutrient amendments during the periods identified from previous studies in Frog Alley and Bray Creek.

These data have documented several patterns important to understanding the relationship between nitrogen and phosphorus, algal biomass, and dissolved oxygen: (1) the large amounts of phosphorous brought into the system from the surrounding fields during flood events when phosphorous is either resuspended from stream sediments or from direct inputs have been documented; (2) during much of the year total phosphorous levels are rather low relative to nitrate in this system; and (3) even though there are low levels of dissolved reactive phosphorous in the water column, the algae are seldom nutrient limited.

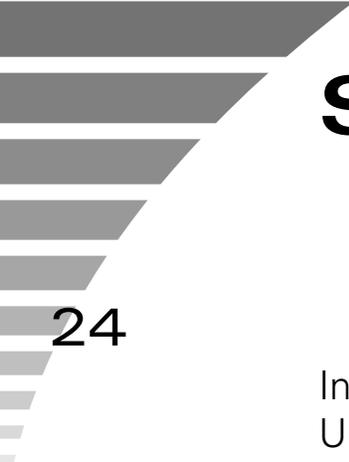
The Impact of Sediments on the Potential Bioavailability of Phosphorus in Illinois Streams

Sieved stream sediment samples were collected at Court Creek, North Creek, and Spoon River sampling stations in October 2003. These samples have been analyzed for mineralogy, specific surface area, and total element concentrations. These sediments have also undergone selective chemical extractions to determine phosphorus forms and their ability to sorb added phosphate has been determined.

The routine, bi-weekly sampling at these same stations commenced in April and has continued uninterrupted. The continuous monitoring instruments (for temperature, dissolved oxygen (DO), conductivity, and pH) were deployed at these same stations in May. Light and dark benthic flux chambers (to assess the extent of P release from stream sediments) have been designed and deployed.

Following are some initial results from the project:

- Selective chemical extractions of stream sediments suggest that about 80% of the total phosphorus is associated with Fe-oxides in the bed sediments at the stations and about 20% is present as apatite, an insoluble calcium phosphate mineral. Negligible amounts of phosphorus were associated with carbonate minerals or as organic phosphorus species.
- The ability of stream sediments to sorb added phosphate follows the order: North Creek is greater than Court Creek which is greater than Spoon River.
- Stream flows at the sites were generally below longer-term mean flows between mid-April and mid-May, but since then, stream flows have generally been greater than mean values.
- For most sampling dates, bioavailable phosphorus has been nearly equal to dissolved reactive phosphorus (DRP) which suggests that particulate forms of phosphorus are not bioavailable to a significant extent. However, the higher-flow events at our Spoon River station are an exception. For those samples, the bioavailable phosphorus fraction was significantly greater than DRP which indicates that some particulate phosphorus is bioavailable during higher flow events at this station.
- The continuous monitoring data indicate that diurnal swings in temperature, pH, and DO are greater at the Court Creek and North Creek stations than at the Spoon River station.
- To date, suspended chlorophyll-a concentrations have generally been greater at our Spoon River station (8-47 µg/L) than at the Court and North Creek stations (4-18 µg/L).



SENTINEL PROGRAM

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Introduced in 1999, the C-FAR Sentinel Program at the University of Illinois at Urbana-Champaign was initiated to take advantage of windows of opportunity to conduct research that address C-FAR priorities. Sentinel projects are multi-investigator and multi-departmental, with most crossing college boundaries and bringing together investigators from a variety of disciplines. In 2004, this program comprised seven creative, problem-solving research initiatives.

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

Principal Investigators

Stephen P. Long, Crop Sciences and Plant Biology

Donald R. Ort, Crop Sciences and USDA-Agricultural Research Service

Evan H. DeLucia, Plant Biology

With contributions from sixteen investigators representing the Departments of Animal Sciences, Crop Sciences, Entomology, Food Sciences and Human Nutrition, Natural Resources and Environmental Sciences, and Plant Biology as well as the Illinois State Water Survey and USDA-Agricultural Research Service

The 2004 experiment on the 80-acre site was the largest experiment to date. Four 70-ft diameter FACE (Free-Air Concentration Enrichment) rings elevating carbon dioxide (CO₂), four elevating ozone, and four elevating both gases in combination to predicted levels for 2040–50 were operated in soybean plots together with four further control rings. Eight further plots, four elevating CO₂ and four controls, were added to the adjacent corn field. The facility successfully maintained these elevations to a high degree of precision from crop emergence to harvest.

The 50% increase in CO₂ increased yield by almost 20%, and the increase in ozone decreased yield by 20%. Although not fully analyzed, it is clear that elevation of CO₂ partially offsets the damage caused by elevated ozone. The results show that a very significant loss of competitiveness on world markets is likely to occur, given that ozone levels are not rising in South America, unless resistant germplasm is developed. The increase in ozone decreased photosynthesis, accelerated senescence and crop maturation, and resulted in fewer pods,

fewer seeds per pod and smaller seeds. CO₂ and ozone both decreased water loss by the soybean crop by 16% and 11% respectively, suggesting that by 2050 significantly less water will be lost to the atmosphere. This may benefit crops on well drained soils. However, it would also affect regional climates by lowering water transfer to the atmosphere, increasing soil surface temperatures, and increasing drainage to rivers. These changes would increase the risk of flooding and nitrogen losses to the rivers system. Ozone lowered the yield of all soybean germplasm tested. Although there was variation between genotypes, there was no evidence that recent cultivars were any more tolerant of ozone than the elite Chinese lines.

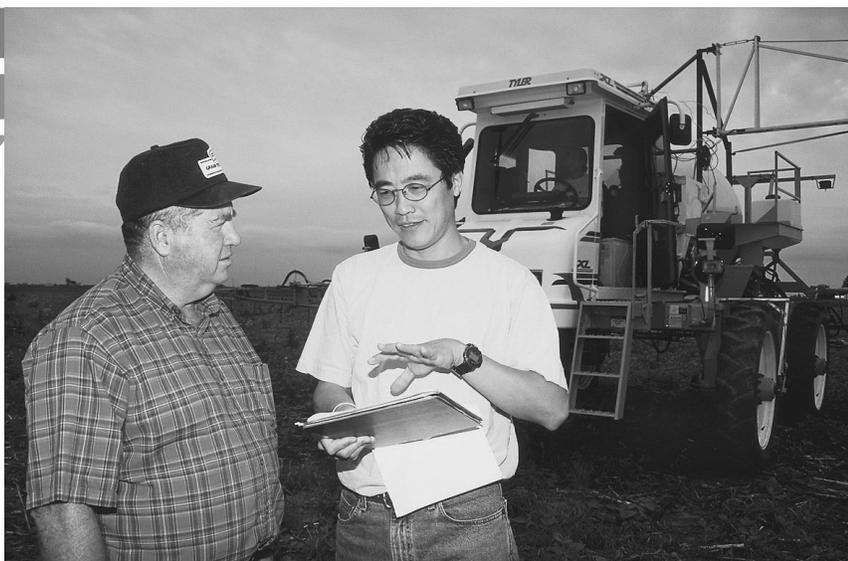
The results confirm that simple field selection is not leading to improvement of ozone tolerance in soybean, and that there is an urgent need to develop breeding programs under conditions of elevated ozone. In 2002, elevated CO₂ also increased photosynthesis and yield in corn (on average by 10%), but had no effect on yield in 2004. The difference appears to be that there was little rainfall in the first half of the 2002 growing season. Corn evaporates less water under elevated CO₂ and so soil moisture remained higher in 2002 allowing a higher final yield. In 2004, rainfall and soil moisture was high throughout the growing season. The results suggest that while soybean yield is increased by rising CO₂, corn yields are only increased in dry years.

Over 500 individuals visited the SoyFACE facility during 2004, ranging from high school groups to two agritourism groups from Brazil to the director of the National Science Foundation and the deputy director of the Illinois Department of Agriculture. Six graduate students who based a substantial portion of their thesis research on work with



SoyFACE successfully gained their degrees during the year. Major research papers from the project have been published in leading peer-reviewed journals. The Agronomy Society of America and Crop Science Society of America devoted a morning of their joint annual meeting to a series of 10 presentations on SoyFACE. Researchers from over 40 universities and research organizations in 15 different countries and four continents participated in SoyFACE research in 2004.

Existing funding, including C-FAR support, was leveraged to obtain additional external funds to expand the project was provided in 2004. The additional support came from: ADM (carbon dioxide); Pioneer Hi-Bred (Seed), BASF (finance for a drought sub-treatment), Argonne National Laboratory and USDA-ARS (additional equipment); DOE, USDA-NRI, and IALC (four competitive federal research grants). Most importantly, the Department of Energy has awarded \$3,000,000 for genomics research within SoyFACE over the next three years, and the Institute of Genomic Biology has selected SoyFACE as the focus for one of its seven research themes. Estimated value of this additional external support in the past year is \$1.56 million.



Developing an Agricultural Remote Sensing Program at University of Illinois

Principal Investigator

Lei Tian, Agricultural and Biological Engineering

A library of spectral signatures of soybean crop and different weed species has been collected. Researchers are working to (1) distinguish weeds from soybean crop using remote sensing and spectro-radiometer data, and map spatial variation in weed density from the remote sensing data; and (2) differentiate between grass and broadleaf species of weeds, and map the spatial distribution of each category of weeds.

Hyperspectral remote sensing imagery was collected over a soybean field in central Illinois before canopy closure. Estimates of percent vegetation cover were generated through the processing of RGB (red, green, blue) digital images collected on the ground with an automated crop mapping system. A comparative study was completed to test the ability of broad-band, narrow-band, and derivative-based vegetation indices to predict percent soybean cover at levels less than 70%.

To add more data, a very high resolution real-time remote

sensing system was developed for crop/weed indices studies (www.age.uiuc.edu/remotesensing/RealtimeRS.htm). Remote sensing image data is collected every hour in an experimental field. An unmanned Aerial Vehicle (UAV) remote sensing system has been developed to be used in this growing season. The helicopter used in the UAV experiment can carry a payload of about twelve pounds (sensors and instrument) in the field operation. High spatial and temporal resolution data are collected in the field. The experiments are designed to eliminate the errors caused by natural lighting conditions and the limitation in remote sensing data collection processes. Preliminary data has shown very promising results in increasing the accuracy of the sensing system. Weed plots have been prepared for the high-resolution system.

With the newly developed equipment, researchers provided unique remote sensing data collection and data processing services to other researchers and producers. Papers were presented and displays held in national and international conferences including ASAE, ASPRS, Precision Ag, CIGR, and WEC2004. Researchers are working closely with similar research labs at other universities

and with government agencies such as NASA and USDA. ILARS has also developed a very good co-operative relationship with other research institutes and private companies in Asia, Europe, and South America. Several local, domestic, and international visiting scholars have been hosted in ILARS. A cooperative project (with Northeast Agricultural University, China) has been sponsored by Chinese Ministry of Science and Technology to develop crop management tools based on remote sensing technology. Faculty and graduate student exchange plans have been setup under this project.

Transgenic Swine Program



Principal Investigators

Matthew B. Wheeler, Walter L. Hurley, Animal Sciences

Sharon M. Donovan, Food Science and Human Nutrition

Progress has been made towards obtaining a patent for the IGF-I transgenic animals and further characterizing the α -LA and IGF-I lines of transgenic animals. Researchers have obtained a new U.S. patent entitled "Animal Expressing Exogenous IGF-I in Their Milk." The following

describes research activity over the past year.

IGF-I Transgenic Swine

Effect of a Short-term Fast on Intestinal Disaccharidase Activity and Villus Morphology of Piglets Suckling IGF-I Transgenic Sows

The objective of this study was to investigate the effect of milk-borne IGF-I on piglet intestinal morphology and disaccharidase activity following a short-term fast utilizing transgenic sows that over-express IGF-I in milk. Following farrowing, litters were normalized to 10 piglets. On day 6, piglets suckling IGF-I transgenic sows (TG) and piglets suckling control sows (CON) were randomly assigned to three treatments: fed piglets (0 hours), which remained with the sow until euthanized, or fasted piglets, which were removed from the sow 6 or 12 hours prior to euthanasia on day 7. Serum IGF-I and IGFBP were measured and intestinal weight, length, protein and DNA content, disaccharidase activity, and villus morphology were also assessed. Piglets fasted for 12 hours lost weight relative to piglets fasted 0 or 6 hours. Intestinal weight (g/kg BW) of piglets fasted 6 or 12 hours was less than piglets fasted 0 hours. When intestinal weight was normalized by length (g/cm) an interaction between transgenic IGF over-expression and fasting was observed. Piglets suckling TG sows maintained similar intestinal weight/length at 0, 6, and 12 hours, whereas piglets suckling CON sows lost intestinal weight/length over time. Serum IGF-I did not differ between CON and TG but was lower at 12 hours compared to 0 hours. Serum IGFBP-4 was lower at both 6 hours and 12 hours compared to 0 hours, whereas IGFBP-1 increased with longer fasting time. Jejunal villus height

and width were greater at 6 and 12 hours compared to 0 hours. Crypt depth differed between all groups and increased over time. Disaccharidase activity was unaffected by fed state, however piglets suckling TG sows had greater jejunal LPH and sucrose activities than CON piglets. In summary, intestinal weight, villus morphology, and serum IGFBP-1 and IGFBP-4 were significantly different from fed piglets within 6 hours of fasting, whereas after 12 hours, serum IGF-I and body weight change were also significantly different from fed piglets. Thus, the duration of food deprivation prior to euthanasia should be considered when designing experiments to assess intestinal development or the IGF axis, as the magnitude of differences between the fed and fasted state may exceed those expected due to the experimental treatment.

Impact of Mammary Specific Transgenic Overexpression of IGF-I on Pig Milk Composition and Yield

IGF-I regulates lactation by stimulating mammary mitogenesis, inhibiting apoptosis, and partially mediating the effects of growth hormone on lactogenesis. Herein, lactation performance during first and second parity was assessed in transgenic swine (TG) that over-expressed human IGF-I in milk under the control of the bovine α -lactalbumin promoter, regulatory regions, and signal peptide coding sequence. Milk samples were collected throughout lactation (farrowing at day 24) from TG sows and non-transgenic littermates (CON) and IGF-I, IGF-II, and IGFBP determined. Colostral IGF-I content was 26-fold greater in IGF sows (range 228 to 1600 ug/L) than CON (36 \pm 17.8 ug/L) and was 60-fold in mature milk. There was no effect

of parity on milk IGF-I content. Milk IGF-II concentrations were unaffected by IGF-I overexpression. Low molecular weight IGFBP (IGFBP-2 and/or -5) were significantly higher in the milk of IGF vs. CON in the early postpartum period and in milk collected after weaning. Milk yield, determined by weigh-suckle-weigh, was similar in TG and CON as was litter weight gain. Milk nutrient composition was not affected by IGF over-expression. Thus, mammary specific transgenic over-expression of IGF-I significantly increased milk IGF-I and IGFBP content, but did not impact lactation performance possibly due to its targeted secretion into milk.

ALPHA-LACTALBUMIN Transgenic Swine

Effect of Increased Suckling Intensity on Daily Milk Yield for Yorkshire Sows with One of Two Genotypes: Control and Transgenic for Bovine Alpha-lactalbumin

The objective of the present study was to determine the effects of over-expression of a mammary-specific transgene, bovine α -lactalbumin, and suckling intensity on milk production in sows and the resultant piglet growth of litters suckling these transgenic sows. Lactational response to increased nursing stimulation was determined by fostering Yorkshire litters either the same age (day 0) or seven days older (day 7) than sow lactational age to sows either non-transgenic (C) or transgenic for bovine α -lactalbumin (bALA). Twenty first parity Yorkshire sows were

allocated between four treatments (bALA-d0, bALA-d7, C-d0, C-d7) dependent on sow genotype and age of litter fostered. Litters were standardized at 10 piglets each and fostered to subject sows at 36 hours postpartum. All day 0 and day 7 litters were equal in litter weight within age groups. Sow milk yield (kg) was determined by the weigh-suckle-weigh method on days 6, 9, 12, 15, and 18 postpartum. Mean total milk yield of sows with day 7 foster litters (7.9 kg/d) was significantly greater than milk yield of sows with day 0 foster litters (6.9 kg/d). bALA-transgenic sows with day 7 foster litters (bALA-d7) produced significantly more milk than anticipated based on results from other treatments, where as a significant interaction existed between genotype and day of foster. The bALA-transgenic treatment with day 7 foster litters resulted in a 31% increase in milk produced as compared to the combined mean of remaining treatments. The bALA-transgenic treatment produced a significant increase in milk yield from day 0 to day 7 of 2.0 kg/d (28%) as compared to a 0.3 kg/d (4%) increase in milk yield for control sows under increased suckling intensity. First parity bALA-transgenic sows produce more milk and are more able to respond to increased milk removal by a resultant increase in milk production than control sows under equivalent conditions. Similarly, piglets suckling bALA-transgenic sows gained weight faster than piglets suckling control sows.

Illinois Center for Soy Foods



Principal Investigators

Keith R. Cadwallader, Barbara P. Klein, Food Science and Human Nutrition

Soy food sales in the United States reached \$4 billion in 2003, increasing steadily at the rate of 10% annually. Continued growth is dependent on availability of new products, consumer familiarity with the array of soy foods in the marketplace, and acceptability of those products in the U.S. and globally. The stated goal of the Illinois Center for Soy Foods (ICSF) is to promote consumption of soy foods, which would benefit growers, processors, and consumers in Illinois. The ICSF continues to implement research, training, and outreach projects to stimulate further soy foods sales growth.

New markets for soyfoods include the food service sector, particularly in school and other institutional settings. Concerns for the increase in childhood obesity have stimulated the development of soy foods targeted to elementary school populations. Recipes developed by ICSF are being introduced and tested as

part of the "*iSoy: A Better School Lunch*" program. This study is being done in collaboration with the Illinois Soybean Program Operating Board and ADM. Four school districts representing the demographics of the state of Illinois are participating. In conjunction with the research, a prototype education program based on sound education principles called "Food is Elementary" will be adapted to inform school children of good nutrition and positive eating habits that include soy.

ICSF continues with development of improved prototype soy-fortified products suited for American diets. Three cookbooks in the Soy in American Kitchen series have been published and are marketed online. The fourth cookbook, "*Soy for the Last Minute Chef*," is in press. The annual Soy Foods Tasting event increases consumer awareness about how soy foods can play an important role in daily diets. Targets for the soy tasting include decision makers for institutional food services, restaurant operators, dietitians, and food industries. *Soy Source*, a retail "store" in Bevier Hall on the UIUC campus, continues to feature new soy foods during the school year. ICSF participates in trade shows, as well as health related events such as the "Food, Fun and Fitness" expo held at Navy Pier.

Educational and outreach efforts continued to be a high priority for the ICSF. Short courses related to soy flavor, product development, and nutritional benefits of soy are part of the continuing effort to reach both U.S. and foreign markets. Working with the World Initiative for Soy in Human Health (WISHH), ICSF has conducted workshops for

private voluntary organizations and government agencies from the US and other countries. ICSF personnel spoke at schools, community organizations, and national and international food science and dietetics meetings about the health benefits of soy and the ease of using it, as well as research studies. Outreach programs were held in the field for international audiences in Botswana, Haiti, Honduras, Kenya, Mozambique, and Senegal on how to add soy to local diets. The Center has also provided research and technical services to several companies on problems related to extrusion and dairy analogues.

A Soy Foods Managed Research Area (MRA) was established. The mission of the Soy Foods MRA is to connect the Illinois Soybean Program Operating Board with leading food scientists, nutritionists, and other researchers in an effort to promote the further development and consumption of soy foods through targeted research areas. The first MRA meeting introduced the iSoy school lunch program. Preparations for a forum on "Obesity Management: The Role of Soy" in May of 2005 are well advanced. The forum will assess the state of understanding of how soy foods can help in addressing the national crisis of obesity.

Researchers have had continued success in receiving grants for research related to soy foods. During 2004, the Center received external financial support of more than \$750,000 from the federal government and the soybean industry. Researchers also continue their success in obtaining industry funds from food ingredient companies, as well as the Midwest Food Manufacturing Alliance. Collaboration with ADM in the areas of food product development and education about soy foods continues. The consumer research and education

facility in the National Soybean Research Center has been completed and is the focal point for education and research on soy foods. The Center's website, at www.soyfoodsillinois.uiuc.edu, remains a resource for consumers interested in soy foods. The site provides information on a wide variety of soy products.

Manipulation of Photoperiod to Enhance the Sustainability of Illinois Dairy Farms



Principal Investigators

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Richard L. Wallace, Veterinary Medicine and University of Illinois Extension

Gary D. Schintkey, Agricultural and Consumer Economics and University of Illinois Extension

Management of photoperiod (the duration of light a cow is exposed to each day) in dairy cattle is a profitable tool for producers in many economic situations. Properly implemented, photoperiod technology leads to immediate milk production responses, requires little capital investment, and has a quick

asset turnover. These features make the investment particularly attractive to help producers meet the current challenges and improve long term viability of the Illinois dairy industry. This project emphasizes a combination of outreach education and applied research to demonstrate, optimize, and develop novel photoperiod management techniques, and thereby facilitate widespread awareness and adoption of photoperiod technology on dairy farms in Illinois.

Outreach activity in the last year included presentations made at numerous industry sponsored events that reached at least 300 dairy producers and allied industry representatives in the Illinois-Iowa-Minnesota-Wisconsin region and the World Dairy Expo in Madison, WI; seminars given to veterinarians for continuing education credit in California, Vermont and Guelph, Canada; a week-long seminar series was provided to 200 dairy producers in Ontario, Canada sponsored by Ontario DHIA; and invited presentations were given to veterinarians and allied professionals at the Penn-State Nutrition Conference, Pacific-Northwest Animal Nutrition Conference, and the Tri-State Dairy Nutrition Conference. Coupled with those presentations were numerous symposium proceedings articles.

Information on photoperiod management is available at any time at the revised photoperiod website at www.traill.uiuc.edu/photoperiod. The site includes data summaries, installation instructions, and worksheets for estimating installation costs and economic benefits. Information on light design for dry cow barns was recently added. The site continues to have high activity. Using key

words “dairy” and “photoperiod” the site continues to rank first on the search engines Google, Hotbot, Lycos, Yahoo, AOL, and others.

As in previous years, researchers estimated stakeholder interest in the general area of research using results of a survey in *Hoard's Dairyman*. For the third year, use of photoperiod management was over 30% of the responding herds. This is a national survey that reaches a broad group of producers across the U.S. The results indicate that dairy producers are using the technology and suggest that new findings in this area would be of interest.

As for applied research, the first field study testing the viability of photoperiod management in Illinois ran the last two years on commercial farms. This study involved pairs of farms of similar production and management levels; within each pair one farm installed lighting and is applying long day treatment to the lactating herd and the other herd serves as a control of no treatment. Milk production, herd health, and implementation costs were followed for six months. Researchers are continuing to summarize the results. A second study examining the impact of photoperiod manipulation to speed heifer growth and eventual entry into the milking herd has been summarized and a manuscript is being prepared for submission to the *Journal of Dairy Science*.

Creating Niche Market Opportunities in Animal Feeding for Small Farmers with Soybeans

Principal Investigators

Neal R. Merchen, George C. Fahey, Jr., Animal Sciences

The central goal of this project is to identify soybean processing techniques that will add value to soybean meal as a feedstuff for poultry and swine. By identifying soybean processing conditions that could increase soybean meal amino acid digestibility and/or minimize soybean meal phytate phosphorus content, more nutrient-efficient diet formulations for pigs and poultry and less phosphorus supplementation would be required in feed formulations, resulting in less phosphorus excretion by the animal, positively impacting the environment. By developing soybean meal with benefits specific to swine and/or poultry feeding, it is anticipated that increased opportunities will arise for processing plants to furnish “species specific” soybean meal.

Work has focused on two linked yet different aspects of the project (1) feedstuff modifications and feeding trials, and (2) outreach activities. Animal science researchers work with soybean meal samples processed under tightly controlled conditions at the pilot plant at Texas A&M University.

Soybean meal samples from soybeans processed with varying residence times through alteration of the bed depths during the desolventizing/toasting process were analyzed to determine if amino acid digestibility by pigs and roosters was affected. Preliminary results indicate no differences

in total essential amino acid digestibilities, but higher total nonessential amino acid digestibilities for bed depths of 7 or 8 inches when fed to swine.

Samples for examining phytate phosphorus variation were manufactured by varying extractor residence time from 45 to 60 and 90 minutes times, and were analyzed for composition and quality. The soybean meal phytate phosphorus concentrations decreased slightly as residence time increased from 45 to 90 min., but were still higher than that of soybean meal prepared from low phytate soybeans. Both increased heat processing and genetic selection for low-phytate content resulted in increased bioavailability of phosphorus in SBM for chicks, increasing bioavailability from 38.8 to 65.6% when extraction time increased from 45 to 90 min. This was still less than for soybean meal prepared from low phytate soybeans (85.8%).

When fed to cecetomized roosters, lysine digestibilities were highest when the extraction time was 45 min. (87.6% vs. 83.0%), with no consistent effect being observed for other amino acids. Additionally, soybean meal samples from 55 U.S. processing plants were collected and analyzed for amino acids, fat, and oligosaccharides. Soybean meal prepared in northern maturity zones had lower amino acid, verbascose, and raffinose concentrations than soybean meal prepared in central or southern maturity zones.

Amino acid digestibility and true metabolizable energy (TME) in poultry were determined for seven solvent extracted soybean meals (SBM) that contained no contaminants, 1 or 3% gums,

.05% or 1.5% soapstock, 2% weeds and trash, or 6% of all contaminants. These values were then compared to a roasted soybean sample. The presence of contaminants had no effect on amino acid levels and digestibility. The addition of gums and soapstock generally increased TME. The amino acid digestibility of roasted soybeans was lower than the solvent-extracted SBM; however, the TME of the roasted soybeans was higher than for solvent extracted SBM.

As regards the agricultural economics component, animal enterprise models are being finalized and readied for use. Recommendations from the animal trials are forthcoming.

Frazier Barnes & Associates provides linkages with soybean producer groups interested in the possible advantages of producing specialized soybean meal products for animal feeding in small scale processing plants. As research results indicate potential advantages for swine or poultry feeding when using meal produced using modified processing conditions, these identified producer groups will be better prepared to capture the value of working within a niche market. These groups will be mainly interested in the biodiesel component, with the soybean meal being of secondary interest. Additionally, synergies between biodiesel production and ethanol production exist, and it remains to be seen how this possibility will be received by producer groups.

The data resulting from the research will be best made available to the animal feeding industry and the public via the internet. A website was

developed and is gradually being populated with information ranging from general soybean processing information to specific databases of soy nutrition information that will be of interest to the animal feeding industry.

Practicing nutritionists need reliable information on the nutritional value of soybean meal in order to capture its full value. The site provides the latest data, derived from research sponsored by ISPOB through the Soy/Swine Nutrition Research Program and by Illinois C-FAR through the Soy in Animal Nutrition Database program. A series of charts were developed showing the results on an as-fed basis and as a dry matter basis. Chart comparisons include general composition information, total amino acids, percentage standardized digestibility of amino acids, standardized digestible amino acids, percentage apparent digestibility of amino acids, apparent digestibility of amino acids, carbohydrates and minerals. Included with the charts is linked terminology and definitions. The charts are available from www.traill.uiuc.edu//sand.

To provide a tool for feed industry and public understanding of solvent extraction, an interactive Soybean Processing and Extraction diagram is available on the internet. This animated website shows the path soybeans take in a typical solvent extraction plant. This includes steps through Direct Extraction, Meal Handling, Pre-press Preparation, and Solvent Extraction. Images and descriptions of equipment appear along each step of the way towards processing whole soybeans into soybean meal for livestock consumption. This is available at http://sand.traill.uiuc.edu/soyprocessing/soyprocessing_content.html.

[traill.uiuc.edu/soyprocessing/soyprocessing_content.html](http://www.traill.uiuc.edu/soyprocessing/soyprocessing_content.html).

The research team works in parallel with economic and outreach teams to ensure that this project will result in tangible outcomes. These outcomes will hopefully improve domestic marketing channels for soybeans while supporting and benefiting the swine and poultry industries with better information about species-specific diets containing soybean meal.

Plant Disease Molecular Diagnostic Initiative

Principal Investigators

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Researchers sought to acquire equipment to aid in the rapid detection of plant pathogens. Funds were used to purchase a Zeiss microscope to speed the counting of soybean cyst nematodes, a microplate reader that can perform high-throughput immunological and DNA quantification assays, and two ABI sequence detection systems that can quickly quantitate pathogen DNA.

The microscope from Zeiss is being used for soybean cyst nematode counting. The high-speed microplate reader has been used to process over 20,000 immunological assays that detect fungal toxins in plant tissues. Researchers are using the reader for high-speed determination of DNA concentration for DNA-based pathogen detection. The ABI 7900HT sequence detection system, which performs real-time polymerase chain reaction (PCR)

to detect pathogen DNA, is now operational. In fact, it has been so heavily used, a second real-time PCR machine (ABI 7000) was purchased. The real-time PCR has been used to detect fungal, nematode, and viral DNA in plant tissues. Researchers have also been able to detect plant gene expressing induced by plant pathogens. The 7900 instrument has greatly improved the sensitivity and speed of DNA-based pathogen assays. Several conventional PCR assays that detect plant pathogens have been converted into real-time PCR assays, called TaqMan assays, and have proven to be 100 times more sensitive. Researchers are now able to detect brown stem rot (BSR) of soybean caused by *Philophora gregata*, Aphanomyces root rot (ARR) of alfalfa caused by *Aphanomyces eutieches*, as well as *Fusarium solani f.sp. glycines*, which causes sudden death syndrome in soybean. The

ability to detect these fungal plant pathogens allows researchers to investigate the biology, ecology, and infection processes of these poorly understood pathogens. Such knowledge will be essential to improve integrated management of these diseases.

The real-time PCR machine has also been a boon for our research on detecting virulent soybean cyst nematodes (SCN) (nematodes capable of infecting resistant soybean plants). In one project, we have been using the ABI7900 to add DNA markers to a newly developed genetic linkage map for the soybean cyst nematode. The ability to map any SCN virulence gene marker to the SCN genome is essential for map based cloning of these virulence genes.

In other experiments, TaqMan assays have been used to test putative SCN virulence genes. In this project researchers have determined the frequency of

these genes in SCN populations growing on resistant and susceptible plants and have been able to predict some of the parasitic ability of SCN. Ultimately, this real-time PCR assay for SCN virulence will allow us to rapidly predict SCN virulence to commonly grown resistant soybean varieties. The ability to quickly predict SCN virulence and monitor these populations over time will allow us to advise growers on which SCN resistant soybean varieties to grow to control the nematode. The ability to rotate SCN resistant soybean will prevent the build up of highly virulent SCN populations and help preserve SCN resistant soybean germplasm.

Overall, this initiative is showing benefits to farmers, plant breeders, and researchers studying plant pathogens.

INTERNAL AND EXTERNAL RESEARCH PROJECTS

Projects supported through the university internal programs and the External Competitive Grants Program are funded for one, two, or three years. No-cost extensions can be granted if unforeseen circumstances arise. Support is provided on a fiscal year basis (July 1 through June 30). The following sections provide a report on the internal and external research projects that were completed in 2004, as well as a listing of the research projects that were funded in FY05. Although projects are listed under given categories, they often span multiple research areas and interests.

CROPS

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

European resistance to genetically modified organisms (GMO) products has reduced farm incomes by billions of dollars in the U.S. since 1997. It is important to demonstrate that commercial GMO corn is broadly equivalent to non-GMO corn in all aspects except the new gene. One way to achieve this is to show that metabolite (chemical) variation between non-GMO hybrid cultivars exceeds variation between GMOs and non-GMOs. This research has the potential to reduce the negative impression of GMOs among corn consumers and expand markets overseas. Equivalence is one of the key principals required to sell GMOs and one of the key areas that opponents of biotechnology cite as being inadequately studied to date.

This research demonstrated that the commercial GMO corn is equivalent in content and metabolite profiles to non-GMO corn. It was learned that some transgenes (e.g., the *gdhA* gene) can cause broader changes in corn (and other crops) that are not equivalent to variations among non-GMO corn hybrids. Researchers showed how these gross changes in chemical content have broad impacts upon herbicide tolerance, yield, yield stability, drought tolerance, and feed and forage quality that can be exploited to increase farm incomes.

A C-FAR External Competitive Grants project

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

A new mineralizable organic nitrogen (N) soil test has been developed at the University of Illinois that reportedly can identify fields that are responsive compared to those non-responsive to fertilizer N when planted to corn. This soil test, referred to as the Illinois Soil Nitrogen Test (ISNT), determines primarily amino sugar-N in the soil. If the test proves to be successful, it potentially could save producers a significant amount of unneeded N fertilizer. The purpose of this research is (1) to identify soil sampling conditions that may be important for soil test accuracy and usefulness, and (2) to determine amounts of fertilizer N that are needed to augment varying soil test levels so that the optimum amount of soil N plus fertilizer N is available for corn and less remains in the soil to possibly degrade water quality. The research methods employed involved the application of incremental rates of fertilizer N in regions of low, medium, and high ISNT values in grower fields and then determining the corn response to fertilizer N in each soil test environment. Ideally, little or no fertilizer N should be needed for soils with high ISNT levels but greater amounts of N would need to be applied to soils with low ISNT values.

The ISNT appeared to have reasonably good success in identifying fields unlikely to give a corn yield response to fertilizer nitrogen. Following three years of study, this research showed that with ISNT values in excess of 220 ppm-N, little yield benefit was derived from fertilizer N applications, especially in fields that had a recent history of manure application. The greatest limitation of the test appeared

to be its inability to accurately predict amounts of fertilizer N to apply when ISNT values were less than 220 ppm-N. Other factors or variables appeared to be more important in determining corn response to fertilizer N than the amount of N detected by the ISNT. Another aspect of this research was the finding that ISNT levels do vary significantly when the same sites are sampled on a month-by-month basis. Larger fluctuations were observed in soils with a history of manure application compared to soils with a history of no manure application. More critical studies on the causes for ISNT temporal changes are needed, as well as precautions that may be necessary in sample handling.

A C-FAR External Competitive Grants project

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Green Stem: A New Disease Threatening Illinois Soybean

Delayed maturity of soybean, also known as "green stem," is a problem of increasing importance in Illinois. In addition to harvesting difficulties, lower yields and reduced seed quality are common in fields under high incidences of green stem. Past research in other states has indicated that green stem can be caused by insects, environment, viruses, pesticides, or a multitude of other factors. In Illinois, a survey of bean leaf beetles and plants exhibiting virus symptoms revealed that

bean pod mottle virus (BPMV) was present in over 70% of affected plants and in 100% of the beetles. There was also a strong correlation between the green stem symptoms and frequency in isolating BPMV. During this process, several strains of BPMV were collected that consistently provided a range of symptom severity on susceptible soybean varieties. These strains can be grouped according to causing mild, intermediate, or severe symptoms on susceptible soybean varieties. There are few management options for BPMV and green stem. The best long-term option is the identification or development of resistant varieties. The goals of this research were to monitor symptom development and yield loss caused by Illinois strains of BPMV in fields and screen houses and to evaluate soybean germplasm for resistance to these BPMV strains.

A greenhouse frame measuring (30m-long by 12m-wide) was constructed in a production field and was covered with an insect screen to keep virus vectors from influencing the results. This system was built to evaluate the effects of BPMV on soybean health. Six strains of BPMV were individually inoculated in separate plots containing a susceptible variety. The virus strains were inoculated at three different soybean growth stages (V2, VR and R4). Only the two severe strains of the virus were capable of reducing soybean yield. Four of the six isolates were capable of reducing seed quality and producing symptoms of green stem. Timing of inoculation did not matter for the two severe strains; however the intermediate strains had to be inoculated early to produce green stem

symptoms. A repeat of this study was conducted in the final year of the project; however drought conditions limited foliar symptoms and the ability to evaluate the differences between the virus strains. Over sixty soybean lines were evaluated for resistance to BPMV. This included parental germplasm and elite soybean lines. None of the lines tested were immune to the virus with all lines showing at least mild symptoms of the virus. However, ten lines had very mild symptoms. These lines included parental soybean lines of the SIU program as well as recent cultivars that had been released from breeding programs at SIU and UIUC. Populations were developed from crosses with the parents that exhibited mild symptoms. Those populations are at various stages of yield testing but have not been tested for reaction to BPMV.

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Impact of Southern Root-Knot Nematode and Soybean Germplasm Development in Illinois

Root-knot nematodes (RKN), *Meloidogyne spp.*, are some of the most destructive soybean pathogens in the world. Each year they are responsible for over \$200 million in soybean yield loss in the United States. There are two species important in soybean production that can occur in Illinois. *Meloidogyne hapla*, the northern root-knot nematode, can cause damage to soybean, however rotation with

corn and other non-host crops keep population densities below damage thresholds. *Meloidogyne incognita*, the southern root-knot nematode, causes greater damage to soybean than *M. hapla* and all rotational crops grown in Illinois are hosts for this pathogen. Several fields were identified in southern Illinois that were infested with *Meloidogyne incognita*, the southern root-knot nematode, in 2000. The goals of this project were to (1) evaluate commercial and public varieties to identify those that are most resistant, (2) develop resistant germplasm adapted to northern latitudes, (3) quantify population dynamics throughout the growing season and over winter, and (4) evaluate the impact of RKN on soybean yield in a northern environment.

Over 250 commercial varieties were screened for resistance to *M. incognita*. Less than 15% of the varieties were resistant. Soybean varieties that were developed at SIUC were also screened for resistance to this pathogen. Three varieties were identified with resistance and are currently available to soybean producers through seed companies in southern Illinois. Soybean populations were developed by crossing northern (susceptible) and southern (resistant) germplasm and were evaluated for resistance to *M. incognita*. Several lines were identified with resistance and are at various stages of yield testing. The population dynamics of *M. incognita* were studied at an infested field in Carmi, Illinois. Population densities of *M. incognita* were not detectable in early spring. However, in June through August the nematode densities were

at their highest for the entire year. For most treatments, the nematode densities went from 0 (not-detected) to a high of 4,500 juveniles/100 cc soil. Starting in September, the nematode populations quickly began to decline. This field study has been repeated at another location and similar results were found. Sampling for *M. incognita* should be conducted from June through September. In these same field studies, yield loss for the susceptible variety exceeded 70%. For the SIUC resistant varieties, yield loss was not as severe; it was 12%.

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Increase Capability to Measure and Modify Soybean Seed Composition and Functionality in Foods

The true economic value of the soybean is derived from the quality and the amount of protein in the form of amino acids, oil in the form of fatty acids, sugars, and other constituents such as isoflavones and cancer-fighting compounds. However, farmers are typically paid for only the weight of the soybeans, not the true value of the crop. As the demand by consumers for specific attributes grows, there are opportunities for producers to earn additional value by responding to those specific needs. Publicly available testing procedures that allow rapid, non-destructive, and low-cost measurement, are essential for farmers to maximize their potential earnings in such settings.

The objective of this research was to develop calibrations using Fourier Transform Near Infrared (FT-NIR) spectroscopy in order to measure 16 amino acids, five fatty acids, sugars, and three distinct isoflavone groups in soybean seeds.

FT-NIR calibration models were developed for the total of the three forms of three isoflavones. The calibration for daidzein had a coefficient of correlation (*r*) of 0.85, root mean square error of prediction (RMSEP) of 295 ppm and ratio of standard deviation of reference values and RMSEP of the prediction (RPD) of 1.6. The validation model for the total genistein had a *r*-value of 0.88, RMSEP of 269 ppm and RPD of 1.9; whereas the validation model for total glycitein had a *r*-value of 0.73, RMSEP of 82 ppm and RPD of 1.4. The isoflavone calibration for total isoflavones is now being used for screening of soybean germplasm collections and new samples have been added to the calibration since the project ended.

Calibrations for fifteen amino acids: aspartic acid, threonine, serine, glutamic acid, proline, glycine, alanine, valine, isoleucine, leucine, tyrosine, phenylalanine, histidine, lysine, and arginine were developed. The FT-NIR calibration models obtained *r*-values ranging from 0.45 to 0.91, RMSEP values from 0.08 to 0.32% db, and RPD values from 1.0 to 2.6.

Validation models for five fatty acids showed a wide range of *r*-values (0.49 to 0.87), RMSEP (0.39 to 3.46% of total oil), and RPD (1.0 to 1.9). The results indicate that the FT-NIR calibration and validation models developed for ground soybean seeds are suitable for the determination of oleic, linoleic, and linolenic

acid content. The application of FT-NIR to the determination of palmitic acid and stearic acid needs refinement. However, a new use for these calibrations has emerged. They are also useful for measuring fatty acid composition going into blends of soybean oil used for biodiesel. Being able to quickly measure the fatty acids with FT-NIR could potentially enable predicting lubricity and particulate emissions for a particular blend of biodiesel.

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Alternative Crops Breeding and Production Program for Western Illinois

The objective of this project was to develop a breeding and production research program aimed at introducing and developing alternative crops for the Midwest region. In collaboration with the National Center for Agricultural Utilization Research, this program has focused on evaluating and improving alternative crops through breeding and production practices. Crops of particular interest have included Cuphea, common milkweed, Niger, and Kenaf.

Variety development and production guidelines for *Cuphea* have been developed for the Midwest region. *Cuphea* seed oil contains large amounts of fatty acids, such as lauric and capric acid, which provide soaps and detergents with their cleaning power. Currently, the U.S. soap industry gets half of these fatty acids from the petroleum industry and the other 50% from imported coconut and palm kernel oils. In 2002, the U.S. imported 1,325 million pounds of coconut and palm kernel oil valued at \$526 million. The development of improved varieties and production guidelines for *Cuphea* adapted to the Midwest growing conditions will offer a tremendous advantage for Illinois growers. An estimated 8 million acres of production would be needed to meet 50% of the lauric acid market demand.

Production guidelines have also been developed for common milkweed. Currently, milkweed seed floss is being used as a non-allergenic fill to replace imported duck and goose downs in comforters. There is a 1-2 million dollar business making pillows and comforters from milkweed floss. An attractive feature of the milkweed plant is that the pods, seeds, and organic matter can also be useful and profitable. Seed is currently selling for \$75/lb and is used for prairie restoration and butterfly farms. The seed meal has been shown to be a strong nematicide, controlling nematodes. Green foliage is even being baled and sold to butterfly farms for raising monarch butterflies. Milkweed seed oil is rich in vitamin E and could open potential markets for skin moisturizers. The profit potential of milkweed has been estimated at \$2,700 per acre for

floss production alone. This would certainly be very attractive to most farmers, especially for a perennial crop.

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***Miscanthus X Giganteus:* An Adapted Biomass Crop for Permaculture, Air and Soil Enhancement**

Ninety-nine percent of the electricity generated in Illinois comes from fossil fuel or nuclear sources. Energy crops grown on Illinois farms could supplement this with home grown electricity. Thorough reviews of crop types found perennial rhizomatous grasses to be most efficient at producing high yields for low farm inputs. Of this type of grass, two stand out: *Miscanthus* (*Miscanthus x giganteus*) and switchgrass (*Panicum virgatum*). Using a computer model of *Miscanthus* production developed in Europe and climate data from the Illinois State Water Survey, researchers predicted *Miscanthus* yields would range from 11-18 t/ac in Illinois—much higher than the 6 t/ac that switchgrass typically yields in comparable parts of the U.S. This project was designed to foster the use of natural resources in Illinois by (1) testing the hypothesis, via production trials in three locations, that *Miscanthus* will be productive under Illinois conditions, and more so than switchgrass; (2) establishing a collection and characterizing different forms of *Miscanthus*; (3) optimizing crop cultivation and furnishing a sounder basis for economic

analysis of grower costs; (4) establishing demonstration plots throughout Illinois to provide outreach focus points; and (5) providing information to growers, energy producers, and others on markets, incentives, and opportunities for the introduction of *Miscanthus* in Illinois through e-based and traditional outlets.

Information available in the peer-reviewed literature was used to compare yields of *Miscanthus* and switchgrass that received varying amounts of growing degree days, nitrogen fertilizer, and water.

Miscanthus always yielded more than switchgrass over the range of all inputs examined. On average, *Miscanthus* yielded 5 t/acre more than switchgrass, but there are some growing conditions (low water, high nitrogen) that may close this gap. Field trials proved *Miscanthus* to be productive in Illinois. *Miscanthus* yields in 2004 were 14.4, 24.6 and 19.6 t/acre at the northern, central and southern sites, respectively. The year 2004 was the third annual harvest following planting. European studies show this to be the stage when the crop has matured and maximal annual yield has been achieved. From these studies, similar yields should be expected for the next 10-25 years. *Miscanthus* yielded significantly more and, on average, twice as much as switchgrass at all locations.

Economic analysis of *Miscanthus* versus a corn/soybean rotation shows *Miscanthus* to be more profitable when considered over 10 years and without subsidies for either system. Assuming a modest *Miscanthus* yield of 14 t/acre and \$30/ton *Miscanthus*, corn yields of 160 bu/acre and soybean yields of 50 bu/acre at December 2003 prices, the

Miscanthus system has a net profit of \$2,900/acre while the corn/soy system has a net loss of \$900/acre. Energy production capacity from *Miscanthus* is substantial. If only 20% of the agricultural area in Illinois were used to produce this crop and burnt in direct combustion for electricity generation, it could meet 100% of the state's electricity demand.

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Agricultural Pests and Pesticides: Background for Decision-Making

This project was established to generate new data and develop educational materials on pesticides and pest management for the agricultural-urban-consumer interface. Its objectives were refined to focus on solving a serious, developing problem in apple insect management: the simultaneous loss of insecticides to regulatory restrictions, the evolution of resistance in a key pest (the codling moth), and increasing consumer concern over pesticide residues on foods. Because of codling moth resistance to organophosphate

and certain other insecticides, infestations of apples at harvest resulted in losses of greater than 80 percent despite numerous, well-timed applications of insecticides in several orchards scattered across southern Illinois, and the problem was spreading. An 80 percent loss in fresh apple sales represented up to \$4,000 per acre losses in revenue for these orchards and jeopardized the jobs of hundreds of seasonal employees who work in the Illinois apple industry.

In field trials conducted in Union County and at the University of Illinois orchard near Urbana, several new reduced-risk insecticides were effective for codling moth control. Where organophosphate resistance had not already developed, effective alternatives included the insect growth regulators Intrepid (methoxyfenozide) and Rimon (novaluron), the neonicotinoids Assail (acetamiprid) and Calypso (thiacloprid), and the pyrethroids Danitol (fenpropathrin) and Warrior (lambda-cyhalothrin). Where organophosphate resistance was established, Assail, Calypso, and Rimon were very effective, but Intrepid, Danitol, and Warrior were not. The reduced-risk insecticides Avaunt (indoxacarb), Esteem (pyriproxyfen), and SpinTor (spinosad) were only moderately effective and not good enough for commercial apple production systems.

Applications of the codling moth sex pheromone, codlemone, in twist-tie dispensers (Isomate C-Plus), hand-applied small droplets in combination with permethrin (Last Call CM), and sprays through conventional orchard sprayers (Check Mate CM-F) were effective for mating disruption and reduction in fruit damage in Illinois or elsewhere in the region where resistance had not resulted in high populations of codling moth. Where population densities were high, mating disruption was ineffective.

These findings allow apple growers to choose effective control practices against codling moth—populations that are organophosphate-resistant or not—in Illinois or Midwest conditions. Careful selection of codling moth management practices is essential because controlling this pest costs \$200-300 per acre in apples in Illinois and is absolutely necessary in most orchards to prevent near total loss of a crop with a farm-gate harvest value of over \$5,000 per acre.

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ANIMALS

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Determining the CLA Production Capacity of Ruminant Diets

Development of health-friendly, conjugated linoleic acid (CLA)-enhanced beef and milk will help ameliorate the negative public perception of beef and milk, and thereby aid in increasing per capita consumption of beef and milk. Increased consumption of beef and milk not only improves revenue for beef and dairy farmers, but also helps improve the domestic market for corn and soybeans. However, consistent production of CLA-enhanced beef and milk is limited because there is no adequate method for predicting the CLA producing potential of ruminant diets. Development of a valid prediction model for ruminal CLA production would allow farmers to consistently produce CLA-enhanced beef or milk. Marketing of these products will improve public perception of beef and milk, which will increase revenues to Illinois livestock and grain farmers and improve the sustainability of Illinois agriculture. A goal of this research is to develop a prediction model that will allow beef and dairy producers to evaluate rations for their ability to potentially generate CLA-enhanced meat or milk. Researchers hypothesize that given a thorough understanding of the factors that affect ruminal biohydrogenation, a prediction model can be developed that will accurately estimate the ruminal pool of CLA and trans-11 octadecenoic acid (TOA) that will be available for incorporation into meat and milk.

A series of in vitro experiments were conducted that examined the primary factors of lipid level and source along with forage level and source. The major outcomes were that the source and level of lipid in the diet are still the determining factors on overall CLA and transvaccenic acid (TVA) formation in vitro. The inclusion of an unsaturated oil or fat product in

the diet substantially increases the production of CLA and TVA during in vitro fermentation. While oil inclusion beyond 4% of the diet dry matter increased formation of all CLA and C18:1 fatty acids isomers, the rate of fatty acid biohydrogenation and total NDF digestion were significantly decreased. Therefore, efforts to increase CLA production capacity of ruminant diets should focus on limiting primary sources of unsaturated fatty acids (e.g. soybean oil) to 4% of diet dry matter. Within the 4% limits, the results indicated that source of unsaturated fatty acids did not significantly affect the rate of biohydrogenation, which suggested that the multiple sources of unsaturated fatty acids would likely have similar effects on CLA and TVA production. The prediction model is still being refined but provides a good jumping off point for on-farm estimation of the CLA production capacity of ruminant diets.

A C-FAR External Competitive Grants project

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Economics of Grazing Stocker Cattle as a Sustainable Alternative to Row Crops

The goal of this project was to test the hypothesis that an intensively managed stocker grazing system could produce profits competitive with a traditional row crop farming system on high quality farmland in western Illinois. Incorporation of profitable grass-based farming would provide diversity in the

economic base of western Illinois agricultural production, lower overall input costs particularly for machinery and fossil fuels, provide for recycling of soil nutrients, reduce the use of herbicides, and provide year-round ground cover.

A successful stocker grazing model was developed that provides western Illinois agricultural producers with a profitable and environmentally friendly enterprise that could compliment and provide diversification to crop farming operations. This project consisted of three trials over a three year period involving a total of 225 head of cattle weighing approximately 560 pounds each. Pastures consisted of alfalfa-orchardgrass, perennial ryegrass-white clover-endophyte free fescue, and endophyte friendly tall fescue (Max Q) fertilized with 120 pounds of nitrogen per year in two applications. Average stocking rate, total grazing days per year, animal daily gain, and total yearly beef production per acre were 2.28 animals per acre, 167, 2.13 pounds, and 850.3 pounds.

Total production costs including amortization of fencing, water system, and seeding establishment, labor, fertilizer, machinery, interest, farm overhead, and animal costs for interest, marketing, health, and minerals were \$228.98 per acre. Assuming a value of gain at \$0.50 per pound generates revenue of \$425.15 per acre leaving a return to the land resource of \$196.17. Illinois FBFM data from 2002 and 2003 for high quality soils in western Illinois show average revenue, expense, and return to land of \$408, \$281.50, and \$126.50 for corn and \$299.50, \$207.00, and \$92.50 for soybeans. Potential constraints are value of gain risk from unexpected short term price

changes and seasonally poor performance during the months of July and August. Value of gain variation is affected by price relationships among various weight classes of feeder cattle and general market fluctuations in the feeder cattle market. Market risk could be mitigated by using the grazing program as part of an overall system with long term ownership of cattle. Incorporating high quality warm season forages into the grazing system or supplemental feeding would improve animal gains during the summer slump but was not tested in these trials.

A C-FAR External Competitive Grants project

Kenneth O. Nimrick, John P. Carlson,
Agriculture

Western Illinois University

Dean R. Oswald, University of Illinois
Extension

Public Promotional Efforts for Dairy Industry vs. Structural Changes in the Dairy Industry

Research objectives were to (1) identify and evaluate expansion programs that have been employed to attract new producers and expand output of current producers, and (2) evaluate the forces of structural change (size of dairy animals; productivity; cost of production; milk demand; number, size and age of processing plants; population density; regulatory environment; land use alternatives; etc) on milk production trends.

To accomplish the first objective, researchers identified expansion programs used by a number of states that were classified as generic programs for any business or agricultural enterprise and dairy

specific programs. To accomplish the second objective, researchers directly elicited from producers ratings of factors important to dairy expansion in their location, including promotion programs. States included were Idaho, Illinois, Iowa, Kansas, New Mexico, Ohio, South Dakota, and Wisconsin.

Milk producers rated 42 factors as to their contribution to dairy expansion in their area. These factors were categorized into seven groups that were then ranked by producers as to their importance for dairy growth. The categories in order of importance were:

- (1) market for dairy farm products
- (2) resource availability and prices
- (3) family and community ties
- (4) structure of the dairy industry
- (5) regulatory environment
- (6) community support and services
- (7) public sector promotion and support

The order or rankings varied by size of dairy operation. Small dairies ranked family and community ties second, whereas large dairies ranked regulatory environment as second. The results suggested that economic and social factors outweigh public promotion and support as important reasons for dairy growth, but extension service and university research within the public promotion category were rated as having a positive impact. Extension service received the tenth highest rating. Assistance in obtaining licenses and permits, and guaranteed loans also had positive ratings, but less than extension and university research. Dairy operators who expanded or who have large operations rated guaranteed loans high. Large operations also rated labor training programs very positive. Tax breaks and dairy recruitment activities

were rated neutral to negative, but producers who relocated did rate recruitment activities high.

Illinois dairy operators perceived a number of items that were less positive than other states. The regulatory compliance items, land prices, utility cost, and climate were rated lower compared to most of the other states. Thus, Illinois milk producers have perceived themselves having economic disadvantages with respect to land and utilities; and environmental and business disadvantages with respect to climate and regulatory compliance. These perceptions should be further evaluated to determine the extent to which they are limits on dairy growth in Illinois.

A C-FAR External Competitive Grants project

Phillip R. Eberle, C. Matthew Rendleman, William C. Peterson,
Agribusiness Economics

Clint Milliman, formerly of
Agribusiness Economics

Southern Illinois University at
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Livy Coe, USDA-NRCS

Kenneth E. Griswold, Cooperative
Extension

Penn State University (formerly of
ASFN at SIUC)

Developing Replacement Gilts for Increased Reproductive Efficiency

The purpose of the experiment was to evaluate the effect of gilt development diet on the estrus and ovulation response to pubertal induction with PG600. Methods that could improve selection and maturation of replacement females would have great benefits for

swine breeders. New information suggested that increasing available amino acids to gilts when energy was not limiting, could enhance the pubertal response. Researchers evaluated three diets differing in their lysine (and all other amino acids) to digestible energy ratio. The diets were calculated to contain moderately high (0.9), moderate (0.75) and low (0.6) ratios of lysine (g) to digestible energy. The diets were fed to gilts from 100 until 175 days of age. The gilts (PIC-C-22 crossbred terminal line gilts) were fed to maximize growth and approximate maximal intake for age and weight. Gilts were weighed weekly, backfat and loin eye area determined at 115, 145, and 175 days and blood analyzed for insulin at day 145. At 175 days of age, all gilts received an injection of PG600. Gilts were exposed to a mature boar and checked for estrus using fenceline contact once daily for one week. Reproductive tracts were collected 20 days after the injection and assessed for CL and follicles.

Results indicate that the high lysine diets improve growth rate and loin eye area after six weeks on the diets. The high lysine diets that meet or exceed recommendations positively influence body weight, growth rate, and loin eye area and body composition. These growth and carcass responses are also related to improved estrus expression but lower ovulation rate. This suggests an important role for lysine intake in controlling reproduction in replacement gilts, but that lowered lysine could be used for managing gilt development without detrimental effects on fertility. This information has been shared with producers to provide them with management options for

their particular types of gilts and replacement procedures.

Robert V. Knox, Animal Sciences
University of Illinois at
Urbana-Champaign

Probiotics as an Alternative to Antibiotics in the Diet of Weaning Pigs

The swine industry is an important livestock enterprise in the state of Illinois with cash receipts from pigs amounting \$1.95 billion in 1998. Nationally this figure amounted to \$26.55 billion in 1998. Small improvements in feed efficiency and health of pigs by decreasing dependence on antibiotic prophylaxis can make a large impact on profitability.

The application of antibiotic or antimicrobial feed additives to enhance growth rate and feed efficiency is widely practiced in the swine industry. There are serious limitations to continued use of antibiotic prophylaxis, namely increased potential for colonization of the gut by pathogenic bacteria and the spread of antibiotic resistance in the wider environment. This research concerns the development of alternative strategies to reduce dependence on dietary antibiotics using probiotic organisms in order to enhance swine health and performance and result in environmentally and socially acceptable and safe production systems. By definition a probiotic is a live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance. They may be mono- or mixed cultures of viable microorganisms (lactic acid and other bacteria, or yeasts, applied as dried cells or in a fermented

product). Upon ingestion, probiotics exhibit a beneficial effect on the health of the host by improving the properties of its indigenous microbiota. It is postulated that the addition of probiotics can support the development and maintenance of a well-balanced intestinal microbiota in weaning pigs. Furthermore, it is postulated that a combination of bacteria will be more effective than a monoculture in growth promotion and colonization resistance against enteric pathogens. It is also possible that growth heterogeneity in piglets fed diets without growth promoting levels of antibiotics can be reduced by inclusion of probiotics and that probiotic therapy can lead to the reduction in intestinal load and fecal shedding of antibiotic-resistant Salmonella.

The stability of the fecal bacterial populations in weaning piglets was studied using classical cultivation techniques after introduction of an exogenous *Lactobacillus reuteri* strain MM53 in conjunction with bacitracin additions. Piglets (n=24) were assigned to six treatment groups in a crossover experiment designed to examine the effects of bacitracin and *L. reuteri* amendments. Treatment groups were: A—control (non medicated); B—control (medicated period I); C—test (medicated period I and *L. reuteri* addition periods I and II); D—test (medicated and *L. reuteri* addition period I only); E—test (*L. reuteri* additions periods I and II); and F—test (*L. reuteri* additions periods I only). Dosed animals received 2.5×10^{10} CFU antibiotic-resistant *L. reuteri* MM53 every other day. Fresh fecal samples were collected

and analyzed for total anaerobes, lactobacilli, and *L. reuteri* counts. Total anaerobic counts ranged from 1.54×10^{10} to 1.36×10^{12} CFU/g feces for all treatment groups. Total lactobacilli for all treatment groups ranged from 2.90×10^8 to 2.67×10^{11} CFU/g feces. No antibiotic-resistant colonies were detected in control groups (A and B). *L. reuteri* MM53 counts ranged as follows: group (C) 2.55×10^4 to 3.68×10^7 ; (D) 2.12×10^5 to 1.47×10^6 ; (E) 2.75×10^5 to 5.24×10^7 ; and (F) 2.11×10^4 to 1.76×10^5 CFU / g feces. Weight change per week indicated that piglets in both groups B and E had the same relative weight gain performance. These similarities in performance of B and E indicate that introduction of bacteria such as *L. reuteri* may potentially produce the same weight gain performance as that of sub-therapeutic levels of antibiotics. This has important swine production and food safety implications for producers and consumers of pork.

A C-FAR External Competitive Grants project

Roderick I. Mackie, Animal Sciences
University of Illinois at
Urbana-Champaign

Increasing Wool Value Through Producer Cooperatives & Niche Markets

Goals of this project included: (1) to investigate cooperative types and business structures to allow producers to join together to add value to wool, and (2) to compare and evaluate alternative and value-added products and markets to determine the feasibility and economics for Illinois producers.

The Illinois Value-Added Wool Producers Cooperative, Inc. was formed with 12 producer shareholders. The cooperative has developed corporate bylaws and articles of incorporation have been filed with the State of Illinois. Cooperative members are currently investigating wool uses, product development methods, and marketing methods to further attain project goals. A blanket marketing study is underway to evaluate consumer needs and cost.

A field evaluation was conducted using wool filters to reduce odors in swine buildings. The filter types and combinations used reduced the odor intensity of the exhaust air from 270 to 251 OU/m³ or 8% odor reduction. The overall reduction in ammonia concentration was 0.1 ppm or approximately 8%. Results suggest that the wool filters will not reduce odor and ammonia levels greatly enough to consider commercial production.

Researchers investigated the use of raw wool for field application in Illinois. It was determined that raw wool should be chopped by smaller than 2" × 2" for blow-in applications. Wool was tested under dry and wet conditions. Dry wool will not be blown away when wind speed is lower than 9.6 mph; at 20 mph wind speed, about 20% is blown away. Under wetted conditions (three times of water in mass) there is no blow-away at 30 mph.

The insulation value of wool was also investigated. Mattress type raw wool has better insulation value than the blow-in with minimal compaction. However, the insulation levels of both types of wool are much lower than fiberglass.

A C-FAR External Competitive Grants project

Dean R. Oswald, University of Illinois
Extension
A. Richard Cobb, Animal Sciences
University of Illinois

Meeting Community Standards to Improve Siting of Livestock Facilities

The purpose of the research was to help livestock businesses adapt to the changing environment concerning the siting or expansion of larger scale livestock facilities in Illinois. The goal was to use a review of livestock regulations, processes, and experiences over the last eight years to address the fundamental gap between the legal standard and the community standard. This gap has been identified as a major reason for the inability of the industry to achieve its growth targets. The research would then describe the gap, introduce the concept of industry legitimacy, outline the impacts of lost legitimacy, and then prescribe steps to ameliorate the problem.

In studying the gap between community and legal standards it was found that little scientific information existed as to the impact of livestock facilities on their communities. There was much anecdotal information but no scientific analysis as to whether concentrated animal feeding operation (CAFO) impacts were positive or negative, nor a methodology for measuring this critical issue. Much of the impasse between the industry and stakeholders and the industry's legitimacy rests on differing views as to livestock's real impacts on

their communities. Therefore, to address the stated goal concerning community standards, research was conducted first to see if in fact there was impact. Once knowing how CAFOs impact their communities, there would be objective scientific information that would provide an important component for the study about community standards. Two projects were conducted from the original work plan, one to determine if in fact there was impact and the second to make recommendations about how to manage the impact.

A C-FAR External Competitive Grants project

Peter D. Goldsmith, Agricultural and Consumer Economics

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Molecular Pathogen Detection for Herd Health and Food Safety

The purposes of this project were to expand the capabilities of a centralized molecular-based facility for the identification and characterization of economically important animal pathogens and to apply molecular-based methodologies to assist in field investigations of emerging or emergency disease problems and disease monitoring. During the first year, a fully functional Molecular Diagnostic Facility (MDF) in the University of Illinois Veterinary Diagnostic Laboratory (VDL) was established. The second year enabled the expansion of nucleic acid based assays performed in the MDF, including:

- (1) an improved protocol for Mycoplasma detection by DNA

amplification and its speciation by restriction fragment length polymorphism

- (2) quantitative polymerase chain reaction for detection of *Leptospira interrogans*
- (3) a reverse transcription polymerase chain reaction (RT-PCR) protocol for the detection of porcine respiratory and reproductive syndrome virus (PRRSV)
- (4) sequencing of PRRSV diagnostic cases
- (5) a real-time RT-PCR (qRT-PCR) for the detection of PRRSV and bovine viral diarrhea virus

Both qRT-PCR assays are valuable tools for biosecurity (i.e., prepurchase screening) and are especially valuable for examination of porcine semen for PRRSV prior to use. In addition to these significant animal pathogens, the MDF is able to perform DNA amplification for *Listeria monocytogenes*, *Salmonella*, *Campylobacter* spp., *Streptococcus equi*, *Clostridium perfringens* toxin typing, *E. coli* virulence genes, and pseudorabies virus. Another significant component currently employed by the MDF is RiboPrinting® for the characterization of microbial pathogens. Thus, the VDL has established a focused animal health and food safety program in Illinois for the rapid identification and characterization of known animal disease pathogens.

The long-term and continuing benefits of this Molecular Diagnostic Facility program are multifaceted, including the improved productivity from the early detection of pathogens and the monitoring of intervention programs, the improved maintenance of the marketability of Illinois agriculture food commodities, and the identification of emerging

pathogens. The value of research knowledge gained through these efforts will, in turn, be of benefit by providing information to assist in improving intervention programs. In addition, the officers and Executive Board of the American Association of Veterinary Laboratory Diagnosticians are coordinating the development of cooperative agreements with the National Veterinary Services Laboratory and the Animal Plant Health Inspection Service division of the USDA to develop rapid, sensitive, and specific molecular-based detection procedures in university and state veterinary diagnostic laboratories for diseases that might be confused with foreign animal diseases. The University of Illinois VDL MDF will be a part of these cooperative agreements. Several of the bacterial pathogens are of zoonotic concern and the ability to rapidly identify them and characterize virulence factors would be part of this effort. Consequently, the MDF has a central role in maintaining animal health for Illinois residents as well as contributing to the health and safety of Illinois citizens through monitoring and detecting foodborne and waterborne pathogens including potentially zoonotic agents.

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FOODS

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Assessing the Role of Health Benefits in the Consumption of Soy-Based Foods

Clinical research in the past decade has demonstrated that soy-based foods provide various health benefits relative to chronic diseases such as osteoporosis, heart disease, and cancer. In 1999, the Food and Drug Administration (FDA) recognized such health benefits and permitted food companies to use health claims on soy-based food that contains a minimum of 6.25 grams (i.e., one-fourth of the daily recommended level) of soy protein per serving. The primary goal of this research is to assess the impact of medical research findings and regulatory confirmation on the development of the soy food market. Specifically, researchers examined whether consumers' perceived knowledge of the health benefits of soy food influences two consumer decisions: (1) whether to participate in the soy food market and (2) the quantity of soy food consumed.

Estimated results establish that perceived soy health knowledge affects both the likelihood of soy food purchase and the quantity of soy food consumed. Individuals with high soy health knowledge are more likely to participate in the soy market and, when they participate, consume soy food more often compared to those with low soy health knowledge. General health knowledge affects soy consumption behavior indirectly via its influence on perceived soy health knowledge. Consumers with high health knowledge are likely to be more knowledgeable about the health benefits of soy proteins when compared to consumers with low health knowledge, thereby increasing

the likelihood of participating in the soy market and the frequency of consuming soy food. Thus, the health motivation affects soy consumption behavior directly and indirectly via soy-specific health knowledge.

The estimated impact of soy health knowledge was considerably weaker when compared to those of perceived taste and convenience. Perceived unappetizing taste is the most important factor unfavorably shaping consumer behavior toward soy foods. Perceived inconvenience reinforces such unfavorable behavior. Knowledge of soy health benefits only partially offsets these negative perceptions and behavior toward soy food.

In summary, estimated results indicate that enhanced knowledge of soy health benefits will increase the probability of market participation from less than 30 percent (with medium soy health knowledge) to about 50 percent (high soy health knowledge), while increasing soy consumption frequency from about 10 times per month (with medium soy health knowledge) to over 20 times (with high soy health knowledge). The impact of perceived improved taste is more dramatic, increasing market participation rate by 40 percent and soy consumption frequency by 29 times per month between neutral to positive perceptions about the taste of soy food.

A C-FAR External Competitive Grants project

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Southern Illinois University at Carbondale

Dietary Genistein and NMU-Induced Tumor Growth in a Postmenopausal Animal Model

In this study, researchers sought to examine the effects of genistein on tumors that have already developed. A chemical carcinogen, 1-methyl-1-nitrosourea (MNU), was chosen to induce mammary tumors in intact female rats. MNU induces various types of breast cancer tumors located in a variety of areas in the mammary gland. After tumors developed, the rats would be ovariectomized to remove the ovarian source of estradiol. Because the ovaries in these animals would be removed it will reduce the amount of circulating estrogen to a similar level as that of post-menopausal women. It is important to point out that these animals will still have a estrogen produced in the adrenals similar to that observed in postmenopausal women. Therefore, this study would enable a better understanding of the interaction between dietary genistein and various types of mammary tumors (estrogen-dependent and estrogen-independent).

Animals were ovariectomized after mammary tumor development and were then placed into one of three treatment groups. Treatment groups included: positive-control (OVX+ estradiol implant), genistein (OVX+ dietary genistein), and negative-control (OVX alone). Tumors were distinguished as malignant or benign by histopathological examination of each tumor. Tumors were further characterized as either estrogen-dependent or independent using immunohistochemistry to identify the presence of both estrogen receptor alpha and the progesterone receptor. Genistein in the diet at 750 ppm

increased the weight of estrogen-dependent adenocarcinomas in the ovariectomized rats compared to the negative-control animals. Genistein also resulted in a higher percentage of proliferative cells in the tumors when compared to the negative-control animals which had no supplemental estrogen. This research has been published in the journal, *Carcinogenesis*.

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Matthew A. Wallig, Veterinary Pathobiology

University of Illinois at Urbana-Champaign

Effects of Extruded Fiber on Digestibility and Gastrointestinal Characteristics

Dietary fiber plays an important role in human health. Increasing fiber consumption can help control type 2 diabetes, aid in large bowel function, decrease blood cholesterol, decrease the incidence of obesity, and decrease tumor formation in the gastrointestinal (GI) tract. If GI and nutritional changes that occur when consuming fiber are determined, recommendations concerning the optimal fiber profile for disease prevention and specific disease states may be forthcoming from this research. The overall goal of the research was to determine the effects of extrusion processing on the fiber profile of selected fiber sources and to measure how these effects altered digestion and intestinal characteristics in pigs as a model for humans.

Two types of experiments were conducted to determine the effect of extrusion conditions on chemical composition and in

vitro and in vivo digestibilities of high fiber food ingredients (barley grits, corn meal, oat bran, soybean flour, soybean hulls, wheat bran). Extrusion conditions altered crude protein, fiber, and starch concentrations of ingredients. In vitro digestion demonstrated that different extrusion conditions and different fiber containing ingredients had different effects on digestion and production of short-chain fatty acids (SCFA) from the ingredients. Altering ingredients to contain more resistant starch and soluble fiber seemed to be effective in increasing production of SCFA, which positively influence colonic health. Increasing soluble fiber also seems to be important in attenuating blood glucose (positive for diabetic individuals) and reducing concentrations of blood cholesterol. Thus, using extrusion conditions that will increase resistant starch and soluble fiber would be speculated to produce results that would be beneficial to human health.

When the processed fiber sources were fed to pigs, decreasing the insoluble:soluble fiber ratio resulted in an increase in digestibility, probably because of increased fermentation in the large bowel. An increase in digestibility was also seen when pigs were fed processed soybean hulls compared to processed wheat bran. Generally, the nature of the fiber source did not affect digestion of protein or amino acids, a desirable outcome. Although further work is needed to provide definitive recommendations, it would appear that processing fiber sources in ways that increase resistant starch and soluble fiber concentrations produce effects on fermentation and digestion

characteristics that are believed to be beneficial to humans consuming fiber.

Neal R. Merchen, George C. Fahey, Jr., Animal Sciences

University of Illinois at Urbana-Champaign

Effects of Soy Protein Feeding on Diabetic Nephropathy

Type 2 diabetes mellitus is rapidly reaching epidemic proportions in the U.S. and other countries with westernized lifestyles. It is now estimated that at least 16 million Americans have diabetes, with approximately 90-95% suffering from type 2. Among the numerous complications associated with this disease, diabetic nephropathy (kidney disease) contributes to approximately 35.8% of all new cases of end-stage kidney disease. Therefore, therapies to prevent or treat diabetic nephropathy are warranted. In patients with diabetes, elevations in urinary albumin excretion (UAE) indicate morphological and functional anomalies in the kidney. Therefore, UAE is commonly measured to aid diagnosis and to monitor progression of diabetic nephropathy. Dietary protein restriction has long been known to reduce UAE and has been the conventional treatment for diabetic nephropathy. Recently, some interest has been directed towards the manipulation of dietary protein quality, specifically by replacing animal protein with soy protein. The aim of this study was to determine the qualitative and quantitative effects of dietary protein on the progression of diabetic nephropathy in a type 2 diabetes mellitus animal model.

Twenty-four diabetic and 24 control mice were fed ad libitum 1 of 4 different diets (20% casein, 20% soy protein, 12% casein, or 12% soy protein). In diabetic mice, a 20% casein diet was found to increase urinary albumin excretion to macroalbuminuric levels, while a 20% soy protein diet led to no major changes in urinary albumin excretion. Low protein diets (12%), independent of protein type, decreased urinary albumin excretion to low microalbuminuric levels. The data from this study show that diets rich in soy protein prevent an increase in UAE, suggesting slower development of diabetic nephropathy. Thus, the replacement of casein with soy protein, especially for higher protein intake, may offer a new treatment option for the prevention of diabetic nephropathy. Researchers found that at low protein intake, replacing casein with soy protein did not lead to any significant benefit beyond the kidney protective effect seen with protein reduction. However, protein reduction is often not a practical solution, due to poor compliance and the risk of malnutrition. Thus, the use of soy protein at higher intake levels may offer a more viable alternative.

John W. Erdman, Kelly A. Tappenden,
Food Science and Human Nutrition
University of Illinois at Urbana-
Champaign

Gene-Expression Screen to Determine Anti-Obesity Effects of Soybean Diets

Diet has always played a vital role in supporting health. In modern society, the leading causes of illness and death are

chronic diseases. For example, heart disease, cancer, strokes, and diabetes are among the top killers in the U.S. Every year, heart disease alone accounts for 41% of deaths in the U.S. with an estimated \$274.2 billion spent on medical costs. Foods containing bioactive components are receiving increased attention. Soybean products contain numerous bioactive phytochemicals. Furthermore, soy products exert specific physiological effects when ingested. For example, soy compounds can ameliorate some cardiovascular risk factors, postmenopausal osteoporosis and hot flashes, diabetes, obesity, cancer, kidney disease, allergies and other chronic diseases. Further investigation of these beneficial effects of soy foods on chronic disease risk reduction is complementing the existing research on the established health effects of soy protein.

The effects of soy protein, soy phytoestrogens, and other soy phytochemicals on human health have become a major focus for this research team. Large-scale gene-expression analysis to help pinpoint key molecular connections regulating the effect of soy phytochemicals on health and disease would be a logical extension of research. Accordingly, the objective of this study is to investigate the effects of soy phytochemicals on gene-expression in a preclinical obese rats model. The ultimate objective is to pinpoint key molecular connections regulating the effect of soy phytochemicals on disease biology, which in turn will improve therapeutic strategies targeted at these individual disease states.

This project will have direct connection to improved nutrition,

improved human health, and expanding markets for Illinois agriculture. Previous work done by these researchers and existing research on soy foods will be extremely helpful in positioning the soy industry as a key player in the rapidly growing functional foods industry.

William J. Banz, David Allan
Higginbotham, Animal Science, Food
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Southern Illinois University at
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Isolation and Characterization of Agronomic Antimutagens and Human Cancer Cell Growth Suppressors

Cancer is a disease primarily induced by DNA damage and may, to some extent, be a preventable disease. One component of cancer prevention may be the use of diet supplements of agronomically-derived chemoprotectants. This research focused on commercial processing products and by-products of important Illinois crops such as corn and soybean as a source of antimutagens, anticarcinogens, and human tumor cell suppressors. The goals of this research were to

- (1) chemically fractionate corn and soybean processing products and by-products and isolate samples for testing
- (2) develop and calibrate a micro-method to determine the antioxidant capacity of corn and soybean by-product chemical fractions
- (3) analyze the corn and soybean fractions for their antioxidant capacity

- (4) analyze fractions of crop processing products for antimutagenic/anticarcinogenic activity against carcinogens using a genomic DNA damage assay
- (5) analyze chemical fractions of corn or soybean processing products for their ability to suppress the relative growth rates of human cancer cells
- (6) purify and chemically characterize each identified chemoprotective corn or soybean agent

Researchers developed a new microplate antioxidant assay that allows for the use of small amounts of test agent with many concentrations and replicates. This assay proved highly useful in analyzing many chemical fractions isolated from commercial processing products generated during soybean oil and corn ethanol production. Innovative molecular biological tools were integrated to systematically analyze corn and soybean by-products and isolate agents that repress carcinogen-induced genomic DNA damage in mammalian cells and/or suppress the growth rate of human tumor cells. Researchers structurally identified a series of chemoprotective soybean saponins that repressed the DNA-damaging activity of arylamine carcinogens. It has recently been reported that soybean saponins and isoflavones also repressed spontaneous DNA damage in mammalian cells. The antioxidant activity of all major soybean isoflavones were determined and related to their molecular structure. Three corn ethanol by-product chemical fractions were isolated that appear to be polyphenolics and have up to 100 times the antioxidant activity of vitamin E. One of these fractions significantly repressed spontaneous oxidative damage to genomic DNA in

mammalian cells. This research identified a series of chemical fractions of crop processing products that have the ability to repress genomic DNA-damaging activity of dietary carcinogens and reactive oxygen species. These data demonstrate that value-added chemoprotective agents are present in commercial agronomic processing by-products. The commercialization of these agents could both reduce the aggregate costs involved in the generation of products such as corn ethanol and lead to agents that may protect the public health.

Michael J. Plewa, Elizabeth D. Wagner, Crop Sciences
University of Illinois at Urbana-Champaign

Genistein Induces Thymic Atrophy: A Potential Human Health Risk?

This work examined the effects of genistein and daidzein on mouse thymus and immune system. Soy is clearly a desirable and healthful food for humans in the vast majority of situations. However, initial results showed that genistein at fairly high levels could produce thymic atrophy, and in this work researchers directly analyzed the effects of genistein given both by injection and in the diet on immune function, and tested the hypothesis that genistein could act as an inhibitory agent on immune function in vivo.

This research demonstrated that genistein can induce thymic atrophy, suppress humoral and cell-mediated immunity, and induce apoptosis of thymic cells when administered at high

concentrations by injection. Dietary genistein was less potent in this regard, even though genistein administered in the diet at levels that mimic those seen in humans under certain nutritional conditions (e.g., human infants fed soy formula) did produce demonstrable thymic and immune changes. Equol, the major metabolite of genistein, was less potent in this regard, and did not produce thymic atrophy at physiological concentrations in vivo. There results indicate that there should be concern about effects of genistein on immune and non-immune endpoints in human populations exposed to high genistein levels (particularly soy-fed infants), although there appears to be less of a risk from equol, which is several fold less potent on both immune and non-immune endpoints and would not be likely to produce significant biological effects in human populations at the levels typically seen in these individuals.

Paul S. Cooke, Veterinary Biosciences
University of Illinois at Urbana-Champaign

An Evaluation of the Safety of a Genetically Modified Corn: A Porcine Model

A transgenic corn variety has been developed at Southern Illinois University at Carbondale whereby an *E. coli* gene encoding glutamate dehydrogenase (gdhA) has been placed into the corn genome. The gene enables the transgenic corn to increase the efficiency of nitrogen uptake and, perhaps, utilization. By using a transgenic crop that has not been available commercially,

researchers had the opportunity to track the presence of this gene through both surgically modified pigs and young pigs in an effort to evaluate the potential of the gene to survive digestion and/or be conclusively found in the organs and tissues. Thus, the safety of the ingestion of genetically modified corn was investigated, and can be used as a model for human transgenic crop ingestion. The objectives of the studies were to (1) detect if any of the transgene was present in ileal digesta and feces of pigs fed diets containing a transgenic corn, and (2) investigate if the transgene was detectable in the tissues and digesta of young pigs fed transgenic corn.

In older, surgically modified pigs, the transgene was not detected in either ileal digesta or fecal material. In the young pig transgenic DNA was detected in 71.43% of the stomach samples and 1.79% of the small intestine samples, however transgenic DNA was not detected in the large intestine, white blood cells, plasma, liver, or muscle. These data suggest transgenic DNA began degradation in the stomach and was degraded beyond detection by the large intestine. Furthermore, transgenic DNA could not be detected in the tissues of pigs fed diets containing the transgenic DNA.

These findings support the use of transgenic corn for livestock production and consumption, as targeted transgenic DNA was present, if at all, at levels below our detection limits. Therefore, the potential safety concern regarding transgenic crop use in animal production appears to be limited in scope. This research has garnered international interest; few studies have been

designed to adequately assess the safety concern in this regard. This is increasingly important when considering current trade limitations with respect to transgenic crops.

A C-FAR External Competitive Grants project

Gary A. Apgar, Karen L. Jones, Animal Science, Food and Nutrition

David L. Lightfoot, Plant, Soil and Agricultural Systems

Southern Illinois University at Carbondale

Kenneth. E. Griswold, Cooperative Extension Penn State University (formerly of ASFN at SIUC)

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

Consumer concerns have increased with the growing number of reported foodborne illnesses and food product recalls. It has been well documented that ionizing irradiation can effectively reduce or remove microbial contaminants in meat products and extend product shelf stability in the process. Literature reports indicate a significant increase in shelf life (samples exhibiting less than 105 CFU/g for total plate count) from 16 days to 8 weeks when chicken breast meat was irradiated at a dose of 3 kilogray. Similar results have been reported with other chicken and lamb meat. Therefore, one would expect similar results in other red meat products. The overall goal of this project was to add to the body of evidence concerning the cost of irradiation using a business simulation model. Fully cooked and cured ham was the product used in this modeling

approach. The model simulated three business approaches including X-ray irradiation, Cobalt 60 irradiation, and irradiation using contract services through an off-site operator. This research is especially important as the Food and Drug Administration has not approved irradiation of processed meats but is seeking additional research to assess its impact on the product safety, quality, and cost.

Results with specific operating, investment, and volume assumptions indicate that irradiation of sliced boneless ham using an X-ray irradiator would be a profitable business for annual throughputs of 100, 150, and 200 million pounds per year, but not, however, for a throughput rate of 50 million pounds per year. A business implementing a Cobalt-60 irradiator would be profitable even at the lowest throughput of 50 million pounds annually. The highest net present value was generated by the 200 million pound rate using Cobalt-60 irradiation. Furthermore, contracting with an off-site company was profitable for throughput rates of 150 and 200 million pounds per year. Specific costs estimates were \$0.04, 0.02, 0.015, and 0.01 per pound for 50, 100, 150, and 200 million pounds annually, respectively for the X-ray system. The Cobalt-60 system resulted in cost estimates of \$0.02, 0.015, 0.01, and 0.008 per pound for 50, 100, 150, and 200 million pounds annually, respectively. Contracting services resulted in costs of \$0.06 per pound for 50 and 100 million pounds annually and \$0.05 per pound for 150 and 200 pounds annually. The cost of \$0.06 per pound for contracted services

resulted in negative revenue values based on the present business simulation model.

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Pasteurizing Fruit Juices with a Resonant Macrosonic Synthesis Pasteurizer

The juice industry in Illinois consists primarily of small and mid-sized operations. Many such juice producers cannot afford the expense of pasteurizing their juice products. For example, among 77 cider producers in Illinois, only about 30% of them sell pasteurized juices. Each year, however, there are about 16,000 to 48,000 cases of foodborne illness caused by fruit and vegetable juices in the United States. Recent juice-related outbreaks have raised public concern about the microbial safety of juice. Present pasteurization techniques apply thermal energy to destroy foodborne pathogens and hence cause inevitable quality degradation. Recently developed nonthermal technologies, such as high pressure processing (HPP) and pulsed electric field (PEF) processing, can achieve the

desired microbial inactivation rate while maintaining good product quality. These technologies, however, are usually expensive, especially for small and mid-sized juice producers in Illinois. There is a need to develop an appropriate juice pasteurization technique that can ensure juice safety by achieving the targeted microbial reduction and provide better quality retention while remaining affordable to small and mid-sized juice producers. In this project, the feasibility of using power ultrasound to inactivate foodborne pathogens was studied.

Microbial inactivation tests with *Shigella* (four strains), *Listeria monocytogenes* (eight strains), and *E. coli* K12 and *E. coli* O157:H7 were conducted at sublethal (sonication) and lethal (thermosonication) temperatures. Sonication tests with *Shigella boydii* at low temperatures have demonstrated that acoustic power levels have an important effect on inactivation rates. The D-values of *S. boydii* at acoustic power densities of 1.43, 0.85, and 0.49W/mL were 3.66, 4.36, and 8.78 min, respectively when the temperatures were < 38°C. Ultrasound treatments with *E. coli* K12 in apple cider at 40, 45, 50, 55, and 60°C were conducted, while for *L. monocytogenes* the temperatures were 20, 30, 40, 50, 55, and 60°C. For *L. monocytogenes* 10403S, inactivation in apple cider caused

by sonication at 50, 55, and 60°C are 1.6-, 1.5-, and 2.4-fold higher compared to thermal treatment at the same temperatures. In *E. coli* K12 inactivation tests, sonication increased inactivation rate by 8.2-, 4.2-, and 1.2-fold at 50, 55, and 60°C, respectively. At 60°C, to further increase inactivation rate, low pressure (2–5 atmospheric pressure) needs to be introduced into the sonication system to increase the cavitation activity. Sonicating apple cider for 5 min at 60°C followed by a 6 hrs of storage did not have recoverable cells detected, which indicated that a mild ultrasound treatment can be used to injure and partially kill microbes and the remaining pathogenic organisms will die off during storage. Quality analysis showed that ultrasound treated apple cider did not change titratable acidity and pH. Color values of ultrasound treated samples were close to that of raw apple cider. The research findings of this project demonstrated the technical feasibility of using power ultrasound as an alternative food safety intervention for securing microbial safety of apple ciders.

A C-FAR External Competitive Grants project

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VALUE-ADDED INITIATIVES



Building Supply Chains Linking Illinois Livestock Producers with Urban Markets

Chicago is one of the three largest markets for specialty foods in the country. According to the 2000 census, 65% of Illinois' population resides in Chicago and the surrounding six suburban counties. A large number of consumers with higher than average income and above average meat consumption make an especially attractive market for producers of meat products. In addition, the culturally diverse population of the Chicago area creates unique opportunities for niche marketers. Project goals included:

- (1) the identification of practical models for building regional marketing alliances between producers and food retailers
- (2) the identification of research-based technology that has the potential to economically improve consistency and quality of meat products
- (3) the development of web-based resources that can more efficiently link rural livestock producers to urban markets

A major outcome from the project was the successful development of a web-based marketing resource called MarketMaker. MarketMaker has had over 475,000 hits in the first 17 months of operation. Nearly 100 producers have listed their products on the site. The site includes information on over 38,000 businesses involved in the food industry. Consumer data related to six different demographic characteristics can be mapped to locate markets. Full census profiles for geographic markets can also be located.

Characteristics of regional meat marketing alliances were studied

during a pilot project that assembled a quality-driven supply chain to market beef products to high end markets in Chicago. An Illinois beef producer cooperative was formed and a branded beef product (Illinois Crown Beef) was developed to sell specification beef directly to independent grocers. This program has been functioning for nearly two years and has allowed the investigators first-hand experience in the process of developing, marketing, and implementing a branded meat program. The investigators' knowledge gained from this experience has been used (1) to advise new and existing clients working on similar branded food programs, (2) to form the basis for our follow-up project focusing on meat processors and retail meat managers, and (3) to expand and focus IDEA's (Initiative for the Development of Entrepreneurs in Agriculture) effort to educate entrepreneurial farmers and agribusiness personnel on the concept of investing in brand equity.

A C-FAR External Competitive Grants project

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Larry L. Berger, Douglas F. Parrett, Animal Sciences

Peter D. Goldsmith, Agricultural and Consumer Economics
University of Illinois at Urbana-Champaign

Origin-Based Branding of Illinois Commodities

Think of California wines, Florida orange juice, Idaho potatoes, and Wisconsin cheese. These are all states that effectively brand a commodity-like product and, as

a result, benefit from a stronger market, higher pricing, and easier marketing. What products could Illinois producers most effectively brand with an Illinois-origin brand, and how can this be done?

For the first part of this project, individual interviews and surveys were conducted to better understand the possible commodities that producer consortiums (or even individual producers) could effectively brand. For the second part of the project, best practices of branding across the country were examined to determine what would be most effective for various commodities. Nine commodities were found to have at least 1/3 of the interviewed population strongly agreed they would be potentially beneficial to brand. These included soy, corn, pork, beef, popcorn, soy milk, apples, milk, and eggs. For representative commodities (soy, milk, beef, eggs, etc.), best practices studies were developed to be made available for those commodity boards to provide to their members.

In addition, a more complex treatment of this topic has been written. The book, "Marketing Nutrition," will be published early in 2005 by the University of Illinois Press.

A C-FAR External Competitive Grants project

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University of Illinois at Urbana-Champaign

Koert van Ittersum, Management

Georgia Tech University (formerly of Business Administration at UIUC)

Continuous Production of Butanol from Corn and Recovery by Gas Stripping

Butanol is an important industrial chemical which can be produced by fermentation from agricultural products such as corn using hyper butanol producing strain *Clostridium beijerinckii* BA101 developed at the University of Illinois. Compared to the current popular fuel additive, ethanol, butanol is more miscible with gasoline and diesel fuel and has a higher energy content. Production of butanol is hampered due to cost ineffective recovery by distillation. For this reason we investigated recovery of butanol by gas stripping, a process which does not require expensive chemicals or membranes. Additionally, with this process, gases that are used to recover butanol are produced within the system.

Efficient recovery of butanol from a fermentation broth of *C. beijerinckii* BA101 was achieved using gas stripping. Four types of reactor systems were used for this purpose: (1) batch reactor, (2) concentrated feed batch reactor, (3) fed-batch reactor, and (4) continuous reactor. All of the four systems have proved to be economical for butanol production and recovery. These studies have resulted in a number of publications and the process of butanol production and recovery is being scaled up for possible commercialization.

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United States Department of Agriculture

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Enhancing Value of Corn by Fermentation to Butanol and Removal by Extraction

The objective of the project was to produce butanol from corn and recover the butanol from the fermentation broth by extraction. Butanol is toxic to the cells of *Clostridium beijerinckii* that produce it. The maximum concentration that can be achieved in the fermentation broth is less than 25-33 g/L (total acetone butanol ethanol or ABE). Recovery of butanol (or ABE) from fermentation broth by traditional distillation is energy intensive. Recovery of butanol by extraction has been reported to be a cost effective technique. Project goals were:

- (1) the evaluation of the effect of extraction solvent (oleyl alcohol) on growth of *C. beijerinckii* and butanol production
- (2) the production of butanol and separation by extraction
- (3) scale up of butanol production from corn to 2L batch bioreactor
- (4) the production of butanol from corn in fed-batch bioreactor

C. beijerinckii BA101 is a hyper butanol producing strain which has an industrial potential and was particularly suitable for this study.

Oleyl alcohol was used to study its affect on cell growth of *Clostridium beijerinckii* BA101 and butanol production. It was observed that oleyl alcohol does not inhibit cell growth of this culture. It has also been confirmed that oleyl alcohol does not extract glucose or nutrients from the fermentation medium. Further, studies were performed on production and removal of butanol by extraction in 100 mL reactors. Results suggested that ABE production was increased by 32% and

glucose utilization was increased by 14%. It was also possible to reuse treated oleyl alcohol. The recovered oleyl alcohol resulted in higher ABE production and glucose consumption. However, problems such as formation of emulsion which caused an oleyl alcohol separation problem were experienced. Further studies on scaling up to a 2 L batch reactor are being planned. Initial studies on fed-batch fermentation and recovery have been unsuccessful. However, further attempts with modified reactor designs are being planned.

A C-FAR External Competitive Grants project

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Advanced but Affordable Composites from Agricultural By-Products

The overall goal of the project is to develop technology in which abundant and renewable agricultural resources of Illinois will be converted into advanced but affordable bio-composites for the transportation industry. Specifically, researchers are attempting to develop economically competitive, but environmentally friendly, agro-composites for interior and

exterior parts for transportation vehicles. These materials will be developed from Illinois crops, i.e., soybeans, wheat, corn, and agricultural fibers like kenaf.

Various starches and kenaf fibers were obtained from Illinois crops. The kenaf fibers were thoroughly cleaned and were separated into three fractions, i.e., the core pith, inner woody fiber, and outer bark fiber. The fractionated kenaf fibers were subjected to physical structural and chemical structural measurements to ascertain their suitability for composite formulation. Their suitability for high temperature performance was gauged by conducting thermal measurements at $50^{\circ}\text{C} < T < 500^{\circ}\text{C}$. Harnessing the results, researchers were able to formulate composites from pure kenaf, as well as from kenaf and various polymerized starches. A series of composites were fabricated from kenaf and soybean byproducts, corn byproducts, and wheat byproducts. The formulated composites were subjected to various mechanical tests to evaluate their performance.

Scanning electron microscopy results on kenaf suggest that the core pith consists of a highly porous structure largely made of parenchymatous cells while the woody part is also porous, consisting of fibers and vessel members. The outer bark of kenaf has a fibrous structure and consists of thick and long fibers. The spectroscopic measurements on these three fractions indicate no significant differences on the chemical structure, though the physical attributes of the pith, woody part, and bark fibers do suggest that these structural attributes can be exploited to formulate composites. Differential scanning calorimetry (DSC) data

under an inert environment at $30^{\circ}\text{C} < T < 475^{\circ}\text{C}$ show two endothermic peaks at 103°C (82 J/g) and 367°C (87 J/g) and an exothermic peak at around 280°C for both inner and outer kenaf fibers. The first endothermic peak is indicative of bulk water's evaporation, while the second endothermic peak implies that kenaf undergoes depolymerization and degradation reactions at around 360°C .

Thermal experiments under oxygen gas show strong exothermic peaks at 320°C (-3995 J/g) and 422°C (-1790 J/g) for both inner and outer kenaf fibers. Results suggest that kenaf starts to undergo oxidation at around 220°C with a reaction peak at about 320°C . Thus, kenaf is a suitable fiber material to formulate transportation composites. The thermal gravimetric and differential thermal analysis measurements on both inner and outer kenaf fibers at $30^{\circ}\text{C} < T < 525^{\circ}\text{C}$ reinforce the conclusions drawn from DSC experiments. Researchers evaluated how to process the kenaf fibers to formulate composites and how to optimize the processing steps by conducting high temperature in-situ diffuse reflectance Fourier transform infrared measurements on kenaf fibers. Results suggest that four distinct phases of the structure can be recognized at $25^{\circ}\text{C} < T < 500^{\circ}\text{C}$, i.e., Phase I: $25^{\circ}\text{C} < T < 250^{\circ}\text{C}$, Phase II: $250^{\circ}\text{C} < T < 325^{\circ}\text{C}$, Phase III: $325^{\circ}\text{C} < T < 370^{\circ}\text{C}$, and Phase IV: $370^{\circ}\text{C} < T \leq 500^{\circ}\text{C}$. Therefore, to shift the phase diagram it was felt that composites be formulated at $T < 275^{\circ}\text{C}$ under high pressure.

A series of composites were developed from various fractions of kenaf at $150^{\circ}\text{C} < T < 250^{\circ}\text{C}$. The formulated composites

were subjected to microscopic examination to ascertain when the lignin undergoes polymerization and how this reaction can be manipulated to enhance the strength of the composites. Results suggest that lignin material diffuses to the surface of the fibers at around 200°C , and this reaction is completed by 230°C . Higher temperatures than 230°C under high pressure start to degrade the polymeric characteristics of lignin negating any potential benefits. The composites fabricated from kenaf outer bark fibers manifest strong dependence on the temperature of formulation. The flexural strength increases from 2.38 MPa to 5.8 MPa depending on the formulation temperature. However, this result should be contrasted with the composites formulated from kenaf inner fibers where the strength ranged from 13.5 MPa to 35.2 MPa, again depending on the formulation temperature. These results are very significant and show great promise since a commercial polymer had not been added to the composites yet the materials' strength was high. Future work will include developing polymers from soybeans, corn, and wheat and combining them with procedures developed for fibers to form high-strength transportation materials.

A C-FAR External Competitive Grants project

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

The objectives of this research are to examine processing parameters of agricultural bio-solid wastes to produce vermicompost, using vermicompost as a media amendment for floriculture and nursery crops, and demonstrate the potential of vermicomposting agricultural bio-solids to produce a value added product from organic waste. Methods include the use of small scale vermicompost reactors that would be suitable for use by Illinois agricultural producers.

Researchers are evaluating the processing of sequentially sampled beef manure wastes through the year with earthworms and creating a value-added product called vermicompost. The first phase of this project was to evaluate pre-processing parameters of the manure prior

to placing it in the vermicompost reactors. The pre-processing of the beef manure included using the raw manure, raw manure mixed with peat moss in a 5 to 1 ratio, and the mixed manure pre-composted for 14 days. The quantity of manure added to the reactors was also evaluated. The reactors had a surface area of 0.12 square meters and manure wastes were added at rates of either 3.3 L/square meter every day or 6.6 L/square meter every two days. The pre-composted material added every day resulted in greater worm activity compared to the other treatments. This resulted in the potential of processing 100 L of beef manure wastes per month for each square meter of vermicompost reactor surface area.

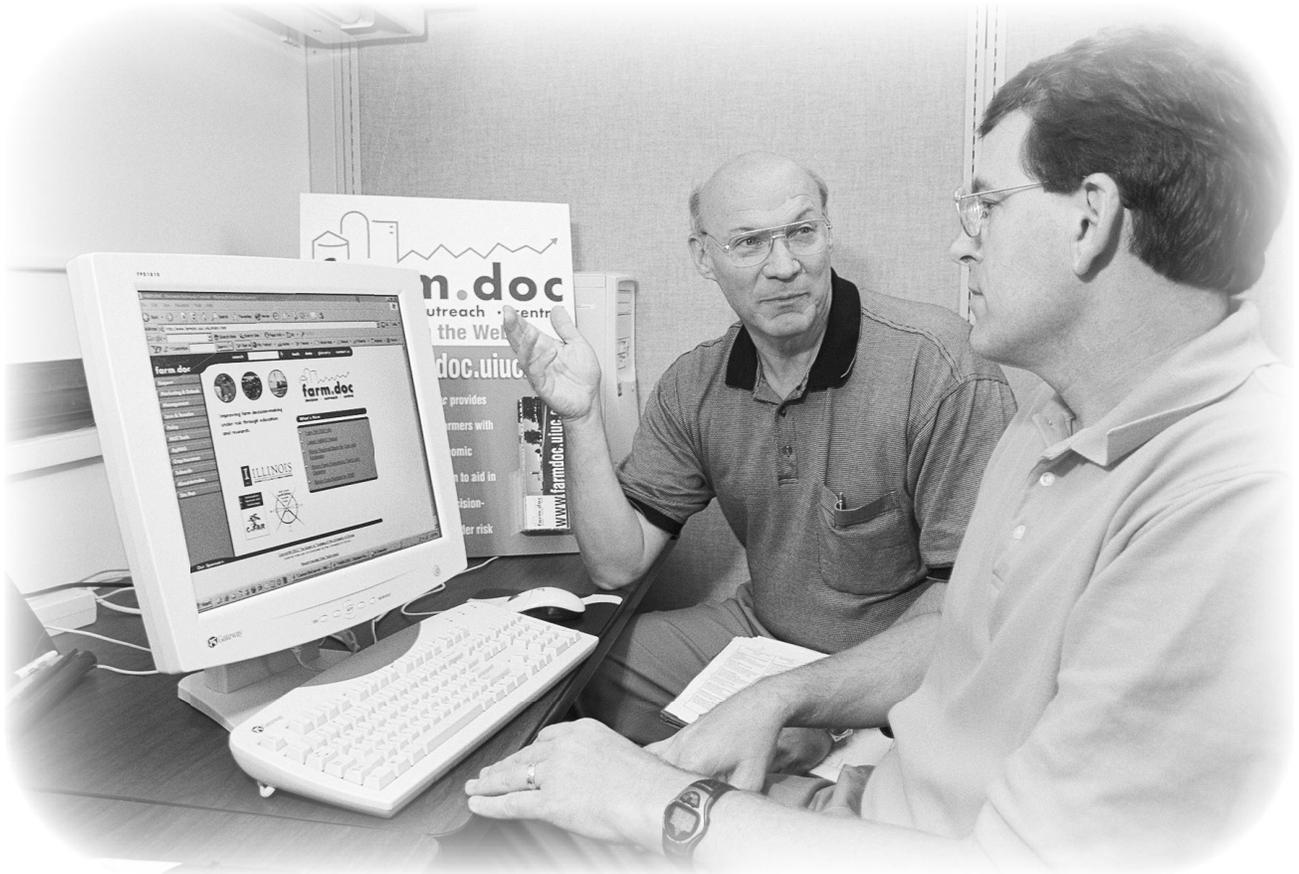
The results of the finished material indicate there are differences in physical properties of vermicompost produced from beef manure sequentially sampled through the year. Differences exist in percentage of air volume,

percentage of volumetric moisture, total porosity, and water holding capacity. There was no defined pattern for these differences as to date of sampling. Clarifying whether these differences will have an effect on plant growth is important to ornamental greenhouse and nursery growers. Uniformity of composted materials is crucial for acceptance by commercial growers. More work is required to determine if these differences will have an impact on plant growth and this will be addressed in the second phase.

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AGRICULTURAL RELATED STUDIES

58



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

As the number of commercial farming operations continues to shrink and as traditional agribusinesses continue to consolidate, the economic and social vitality of rural communities are becoming ever more dependent upon the creation of small businesses. These businesses are needed to provide employment opportunities for rural residents and tax revenue for local governments to maintain services and infrastructure. Unfortunately, a large percentage of small, rural businesses fail, and while many students graduating from high school indicate that they have a desire to start their own businesses, most are ill prepared to meet the challenges of starting and operating a small business. A sound business education curriculum at the post-secondary level is essential to improve the success rate of young entrepreneurs, and, in many states, the community college system is ideally situated to take a lead role in educating young people in the skills necessary to start and grow small businesses.

Although studies have been conducted to evaluate business curricula at the community college level, there has been little effort made to evaluate the educational background, the business experience, and the attitudes towards entrepreneurship of instructors at the community college level. The target population of this study consisted of the business instructors at 32 community college districts located in downstate Illinois. A traditional three-stage survey method was employed with two

mailings of the survey and a follow-up reminder postcard. A total of 96 of the 112 community college instructors identified returned surveys for a response rate of 85.7%.

The community college instructors responding to the survey were approximately two-thirds male. Almost 60% were 51 years of age or older. Nearly all the instructors were full-time faculty members with a master's degree or Ph.D. Most had significant teaching experience with eighty-three percent having taught for more than 10 years. Over 50% of the instructors had started and operated their own business.

The survey respondents indicated that accounting and general business courses are the most important courses in which potential entrepreneurs should enroll. Small business and marketing courses were also deemed important. The office technology courses were identified as the least important courses for small business managers and operators. Respondents indicated a strong admiration for people that choose to start their own businesses. Ninety-three percent indicated an admiration or strong admiration for entrepreneurs. Nearly all the respondents indicated that they would encourage students to start their own businesses.

Rick C. Whitacre, Agriculture
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Ethanol Policy in the Presence of Other Economic Distortions: Is a Win-Win Policy Change Possible?

Researchers proposed to conduct research that bridged the gaps in the existing literature by estimating the net benefits to society of ethanol use, incorporating both economic and environmental effects. More specifically, the objectives of this research are to (1) estimate the economic costs of varied policies designed to promote ethanol, (2) estimate the environmental effects of an expanded national ethanol program, and (3) search for combinations of fuel and agricultural commodity policies that might lead to "win-win" situations relative to the affects of current policy.

After conducting a thorough literature review on the economic and environmental impact of ethanol policy, researchers developed a preliminary theoretical model of gasoline, gasohol, ethanol, and corn markets, and have begun applying that model in GAMS programs to simulate economic equilibria. The model is a multi-sector equilibrium displacement model, primarily assuming constant-elasticity-of-substitution (CES) functional forms. Much research time has been spent gaining experience with the development and application of such models. To become familiar with the details of current U.S. ethanol policy, research was carried out to write a paper entitled "U.S. Ethanol Policy." Details of the estimated environmental impacts of ethanol policy were also investigated. Researchers remain in the process of gathering data

on the ethanol, petroleum and corn production industries, with which a simulation model will be calibrated. After calibration, the model simulations of environmental impacts will be able to be added. A professor from Konkuk University in Korea will be arriving at UIUC in December 2004 as a visiting scholar. He plans to spend one year collaborating with researchers on whether "win-win" situations exist for U.S. ethanol policy.

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

The overall goal of this project was to implement and release the ProStar Simulator and its associated decision making tools on the Internet for use by farmers (directors), students, and managers and owners of retail fertilizer and chemical businesses in Illinois. These tools include the ProStar Business Simulation, the Web-enabled Variable Rate Fertilizer Application Cost Estimator, and Breakeven Analysis and Profitability Analysis Calculators. These materials are being developed in a manner such that they are user friendly and useful in instructional settings. Contact Dr. O'Rourke (via email at porourke@ilstu.edu) for access information.

Users of these Web-enabled tools will gain knowledge and confidence in their abilities to successfully incorporate economic, financial, and environmental considerations in the successful strategic management of their businesses. There is little question that success in profitably providing farm supply services is crucial to the long run success of such highly competitive businesses. Farm supply businesses that do not adopt applicable strategic management concepts will not be well prepared for successfully competing with those businesses that do.

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NATURAL RESOURCES



Fertilizer Nitrogen Management to Optimize Water Quality

62

The use of nitrogen fertilizers in Illinois corn production is widespread because nitrogen is required for plant growth and most soils do not have sufficient capacity to supply enough nitrogen. The importance of proper nitrogen management as it relates to yield is becoming more critical as environmental concerns about excessive nitrogen fertilization intensify. Lake Bloomington is a major source of drinking water for residents of the Bloomington area; this lake has a history of nitrate concentrations that exceed 10 ppm. The primary objective of this study is to ascertain the influence of corn fertilizer nitrogen management upon the subsequent water quality of Lake Bloomington. The knowledge gained from this study will aid in developing recommendations that deal with fertility and cultural practices that promote the safe stewardship of farmland throughout Illinois while maintaining high quality drinking water.

A field nitrogen (N) study evaluated six agricultural fertilizer management techniques for nitrate-N release via tile drainage; 0 lb N/acre fertilizer N (control), 175 lb N/acre fall-applied anhydrous ammonia (AA), 175 lb N/acre fall-applied AA + N-Serve, 125 lb N/acre spring-applied AA+N-Serve, 175 lb N/acre pre-plant spring-applied AA, and 140 lb N/acre sidedressed AA. Overall, the application of AA in the spring produced similar grain yields to that of the fall-applied treatments. The application of fall-applied AA resulted in tile water that contained more nitrate-N, as compared to the same rate of fertilizer N applied in the spring. In addition, spring-

applied AA increased plant N accumulation. Thus, one method to reduce the nitrate-N of water entering Lake Bloomington is to encourage the application of fertilizer N in the spring. These results need to be verified over a number of years to assess seasonal variability patterns.

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Hydrologic and Water Quality Consequences of Alternative Crop Management

The objectives of this project are to measure water, nitrogen, and phosphorus discharges in subsurface drainage water from four pairs of conventionally and organically managed fields in Central Illinois and to identify relationships that can be used in simulation models to estimate hydrologic and water quality impacts of organic and conventional management practices in a range of soil types and weather scenarios.

This project is a continuation of projects funded by C-FAR, the USDA-Sustainable Agriculture Research and Education Program, and the Illinois Department of Agriculture. Between 1996 and 2001, researchers collected and analyzed approximately 1,900 water samples and since July 2001 (most recent funding cycle), an additional 700 samples were analyzed. Researchers have also maintained continuous flow and weather monitoring equipment at these sites to the present time.

Results are still being analyzed, but based on the available data, average nitrate-nitrogen concentrations in tile drainage water from organically managed fields were

approximately one half as large as the concentrations in water draining from conventionally managed corn-soybean fields in three of four field-by-field comparisons. In the fourth comparison, nitrate concentrations from the two systems were similar. Nitrate concentrations from organically managed fields generally range from 1 to 2 mg N/L when perennial forage or green manure crops are being produced, while concentrations from conventionally managed fields range from 5 to 15 mg N/L. Analysis of the data is continuing and manuscripts will be prepared for publication in peer-reviewed scientific journals. Results suggest that organic crop production has potential for reducing nitrate loss to surface waters through tile drainage.

A C-FAR External Competitive Grants project

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Richard A. C. Cooke, Agricultural and Biological Engineering
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Effects of Tillage, Lime Rate and Timing of Limestone Application on Acid Soils

Since 1982, soil erosion in Illinois has been reduced by approximately 35%. Much of this decline can be traced to the use of reduced tillage and no-tillage systems. However, over time these soils have increased acidity levels, especially deeper in the soil profile if limestone had been surface-applied and not incorporated. The problem is to determine if limestone needs to be incorporated in these systems because the incorporation of

limestone with tillage will increase soil erosion.

After four years of study at three locations, applying limestone to a continuous chisel treatment increased pH in the surface 6 inches. This represents only one-half to two-thirds the depth that the tillage implement ran. Applying limestone to no-till plots (at half-rate) increased the pH mostly in the surface 4 inches at each location. The increase in pH by sampling depth with the rotary tiller was similar to the continuous chisel treatment. The annual application of pelleted lime increased the pH in the surface 2 inches only slightly. Thus far, yield differences for corn and soybeans have been affected only by tillage not lime application. However, soybean yields at Dixon Springs have been significantly reduced (by 14.5% in 2002 and 21% in 2003) with no lime and pelleted lime treatments where pH increases over the past four years was minimum.

Indications are that the inversion of soil to mix lime deeper in the profile provides little benefit over surface application. In Illinois, there are approximately 2 million acres receiving limestone annually. No-till systems occur on 22% of the cropland which means some 450,000 acres of no-till receive limestone annually. Not tilling these soils saves 5-10 tons/acre annual soil loss from erosion, leading to an annual savings of 2-5 million tons of soil in Illinois.

A C-FAR External Competitive Grants project

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Edward C. Varsa, Plant, Soil and Agricultural Systems

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Evaluation of BT Toxin Persistence in Soils

Corn insecticide treatments target the European corn borer, which can reduce yield up to 20%, and the corn rootworm, which can reduce yield up to 45%. Corn that have been genetically modified to contain a gene from the bacterium *Bacillus thuringiensis* (Bt) to produce a toxin that is toxic to these pests is expected to provide better pest control. These crops however, will be profitable to farmers only if negative or non-target effects of genetic alteration are acceptable to the public. Unfortunately such risk assessment studies have lagged far behind the rapidly developing genetically modified (GM) crop industry with increasing acreage covered by these crops. It is important to generate a base of information on the impact of GM crops on agriculture systems and the environment. The goal of this work was to develop the ability to screen soil samples for residual Bt toxin and determine whether Bt toxin is likely to persist in soils in toxic forms when Bt corn is grown using common cultural practices. This work focuses on both Cry1Ab (toxic to European corn borer) and Cry3Bb (toxic to corn rootworm) toxin proteins in Bt crops.

Efforts to develop an Enzyme-Linked Immunosorbent Assay (ELISA) to quantify Bt toxin in soil produced monoclonal antibodies against Cry1Ab. The complex matrix in soil extracts, however, interfered with the assay so researchers adopted commercial ELISA kits for their work. This method recovered 47% of Cry1Ab in soil added as Bt-corn residues indicating possible microbial degradation and/or adsorption and persistence especially by clay and humic substances. 14C-labeled Bt toxin used in laboratory incubations will

allow a comprehensive study of its fate in soils. Attempts at labeling *E. coli* cultures with 14C produced toxin products with activity below the detection limit. A strategy to produce sufficiently labeled toxin will be developed if additional funding becomes available.

Cry3Bb toxin was not detected by ELISAs applied to extracts from soils from YieldGard® Rootworm corn field plots in Urbana, Monmouth, and DeKalb in July and September 2003 sampling. Corn root and above ground tissue toxin varied with time and location. Particularly interesting was that root toxin (0-30cm depth) in all locations decreased by 30% to 80% by late summer. Corn rootworm corn efficacy research in Urbana reported unanticipated high root damage by corn rootworms in the YieldGard® Rootworm hybrid. As larvae emerged later in Bt than non-Bt crops, the question raised was whether the toxin expression diminishes over season compromising root protection? A change in toxin expression was observed in this study, and it affects not only the efficacy of Bt-corn but also the soil input of toxin and its influence on soil environment. This work is continuing with funding from Illinois-Missouri Biotechnology Alliance, and will further the understanding of assay toxin persistence in soils and its effects using insect bioassays, the influence of nitrogen and moisture stresses on toxin input from Bt-corn, and Bt toxin in soil leachates in cornfields.

A C-FAR External Competitive Grants project

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

The purpose of this project was to evaluate the potential of using legumes to enhance remediation of petroleum hydrocarbon contaminated soils and compare it to biofuel-contaminated soils. The goal was to measure the nitrogen fixation rate of legumes grown in petroleum hydrocarbon and biofuel contaminated soils.

Researchers examined petroleum hydrocarbons in place of pesticides because there are over 32,000 oil and gas wells in Illinois from which oil is produced and shipped making this process a prominent threat to contaminate land used for production agriculture. This research has provided valuable information to assist with enhancing bioremediation of land contaminated with hydrocarbons. Results show that nitrogen fixation is severely inhibited in petroleum hydrocarbon contaminated soils, however, soils contaminated with biofuels or fuels made from soybean are much less hazardous to nitrogen fixation. Results from this study show biofuels are more environmentally friendly than petroleum hydrocarbons. This study provides more support for using biofuels. In addition, increasing the use of biofuels could increase the price of Illinois soybeans.

Robert L. Rhykerd, Kenneth D. Smicklas, Agriculture
Illinois State University

Measurement of 3-Dimensional Airborne Particulate Spatial Distribution in Indoor Environments

The objectives of the project were to (1) develop a 3-dimensional (3-D) multipoint particulate sampler suitable for acquiring airborne particle spatial distribution (APSD) data across a full scale room airspace at the same time with minimal disturbances to the room air flow; (2) develop a Volumetric Particle Tracking Velocimetry (VPTV) system suitable for measurement of full-scale 3-D room air flow; and (3) collect paired APSD and VPTV data for the room with typical ventilation systems in animal buildings including conventional and displacement ventilation.

Researchers acquired 3-D data on APSD in a swine building. The multi-point dust sampler was used to measure the APSD in a full-size laboratory room. The sampler, with an array of unique flow control devices developed by the investigators, can obtain particle concentrations at different locations with minimum disturbance to the room air. A full-size Room Ventilation Simulator (RVS) was developed, within which various room configurations and ventilation systems can be evaluated. The RVS is capable of providing -10 to 40 C room air conditions during any time of the year. The RVS is equipped with a dust generation and dispersion system, various particle analyzers (both mass and number concentrations) to allow detailed particulates analysis. Researchers will acquire the air velocity field using a stereoscopic particle imaging velocimetry method. A 3-D VPTV system has

been developed and full room air velocity profiles have been successfully acquired. Although particles behave differently from the air, they are largely affected by the airflow pattern and local air velocity. Thus, an instantaneous air velocity profile is important to the modeling of APSD. APSD and air velocity collected in this study will be invaluable for the development of mathematical models for indoor air quality studies and improvement of ventilation systems.

Yuanhui Zhang, Xinlei Wang, Yigang Sun, Agricultural and Biological Engineering

University of Illinois at Urbana-Champaign

PROJECTS RECEIVING EXTENSIONS

Researchers for the following projects were granted no-cost extensions to complete their research. Requests for no-cost extensions are granted when unforeseen circumstances arise. While the due dates for these projects have been extended, no additional funds were allocated. These projects will be reported on after their new maturity dates in 2005.

A Novel Management Strategy for Prrs Virus in Swine: Reducing Vaccine Failure

FY02 UIUC Internal Program
Tony L. Goldberg, Veterinary Medicine
University of Illinois at Urbana-Champaign

An Integrated Approach to Reduce Pathogen and Nutrients in Runoff from Animal Production Systems

FY01 UIUC Internal Program
Prasanta K. Kalita, Agricultural and Biological Engineering
University of Illinois at Urbana-Champaign

Bioavailability of Low Phytate Soybean Meal for Trout

FY03 ISU Internal Program
Kerry W. Tudor, Agriculture
Illinois State University

Biomarkers to Study Synergy Among Phytochemicals in Prevention of Cancer by AFB

FY02 External Competitive Grants Program
Matthew A. Wallig, Veterinary Pathobiology
University of Illinois at Urbana-Champaign

Determining the Market Potential of Organic Food Production in Illinois

FY03 External Competitive Grants Program
Martha S. Bazik-Rittmueller, University of Illinois Extension

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

FY03 External Competitive Grants Program
Vivak M. Malhotra, Physics
Southern Illinois University at Carbondale

Increasing Butanol Yield by Fermenting Degermed Corn to Benefit Illinois Farmers

FY03 External Competitive Grants Program

Nasib Qureshi, National Center for Agricultural Utilization Research

USDA (formerly of UIUC)

Mass Media Frames and Public Understanding of Agricultural Biotechnology

FY02 UIUC Internal Program

Robert Hughes, Jr., Napoleon K. Juanillo, Jr., Human and Community Development

University of Illinois at Urbana-Champaign

Native Herbaceous Perennials as Alternative Crops for Illinois Nurseries

FY03 External Competitive Grants Program

Janice M. Coons, Biological Sciences Eastern Illinois University

Quorum Sensing in *Pseudomonas Syringae*: New Targets to Control a Plant Pathogen

FY01 UIUC Internal Program

Stephen K. Farrand, Crop Sciences

University of Illinois at Urbana-Champaign

Reducing the Impact of Emerging Iridoviral Diseases on Illinois Aquaculture

FY02 UIUC Internal Program

Tony L. Goldberg, Veterinary Medicine

University of Illinois at Urbana-Champaign

Soy Saponins as Colon Cancer Inhibitors

FY03 External Competitive Grants Program

Keith W. Singletary, Food Science and Human Nutrition

University of Illinois at Urbana-Champaign

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

FY03 External Competitive Grants Program

Robert M. Skirvin, Natural Resources and Environmental Sciences

University of Illinois at Urbana-Champaign

FISCAL YEAR 2005: INTERNAL COMPETITIVE GRANTS PROGRAMS

The FY05 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) focused on supporting ongoing research initiatives and funded the following new projects in FY05.

FY05 Projects

Research Focus: Expanding Agricultural Markets

Examination of Most Influential Factors on Crop Insurance Purchase Decisions of Northern Illinois Farmers

Research Lab Support for Research in Nutrition, Feed, Soils, Waste Materials and Water

Research Focus: Rural Economic Development

Alternative Vegetable Crops: Developing Production Practices and Marketing

New Crops Development

Vermicompost and Horticulture Research Lab Support

Research Focus: Agricultural Production Systems

How Much Domperidone is Needed to Treat Cows Suffering from Fescue Toxicosis?

Performance of Finishing Pigs in Hoop and Confinement Housing during Winter and Summer in a Southern Environment

Research Focus: Human Nutrition and Food Safety

Assessing Intervention Strategies to Insure the Safety of Ground Beef Patties

Does Protein Source Enhance Weight Loss in a Low-Carbohydrate Diet?

Research Focus: Natural Resources

Alternative Nitrogen Fertilization Management for Sustainable Turf Grass Growth

Research Lab Support for Soils, Materials Analysis and Water for Ropp Greenhouse

Principal Investigator

Aslihan D. Spaulding, ISU

Paul M. Walker, ISU

S. Alan Walters, SIUC

Winthrop B. Phippen, WIU

Gary R. Bachman, ISU

Karen L. Jones, SIUC

Gary A. Appgar, SIUC

Bryon R. Wiegand, ISU

David Allan Higginbotham, SIUC

Jorge D. Hernandez, SIUC

Robert L. Rhykerd, ISU

FISCAL YEAR 2005: EXTERNAL COMPETITIVE GRANTS PROGRAM

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In accordance with the Food and Agriculture Research Act, the C-FAR appropriation's enabling legislation, a minimum of 15% of the total C-FAR appropriation (minus fees) is dedicated to an external competitive grants program. This program enabled support to the following projects in FY05.

FY05 Projects

Research Focus: Expanding Agricultural Markets

Expanding Market for Activated Carbon from
Corn-to-Ethanol By-Products

Research Focus: Rural Economic Development

Building Illinois Meat Supply Chains: Analyzing
Processors and Meat Managers

Research Focus: Agricultural Production Systems

Testing and On-Farm Application of Odor Reduction
Technologies for Swine Facilities

Research Focus: Human Nutrition and Food Safety

Clinical Testing of the Anti-Diabetic Effects of
High-Isoflavone Soy Protein

Research Focus: Natural Resources

Evaluation of Offal Composting as an Alternative
to Rendering

Principal Investigator

Massoud Rostam-Abadi,
Illinois State Geological Survey

Darlene S. Knipe,
University of Illinois Extension

Michael Ellis, UIUC

William J. Banz, SIUC

Paul M. Walker, ISU

FISCAL YEAR 2005: 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 agricultural industry and consumers. The SRI research portfolio includes the following initiatives in FY05.

FY05 Projects

Biomass Energy Crops for Power and Heat Generation in Illinois: Diversifying Cropping, Improving Energy Security, and Benefiting the Environment

Agronomic Trials
Water Resource Implications
Economic Analyses
Social Acceptability
Harvesting Technology
Propagating and Eradicating *Miscanthus x giganteus*
Carbon Sequestration and Greenhouse Gas Accounting
Genetic Engineering
Bioconversion

Illinois Livestock Integrated Focus Team (IL LIFT)

Technology Development
Livestock Facility Siting in Illinois
Using Illinois By-Product Feeds in Livestock Feeding Programs
Animal Identification for Enhanced Food Quality and Monitoring
Livestock Health
Pasture Based Forage Systems to Sustain Illinois Livestock Producers

FY05 Projects

Water Quality with a Focus on Total Maximum Daily Loads

SRI Leader Support and Coordination

Seasonal Dynamics of Nutrients, Algae and Dissolved Oxygen in Agriculturally Dominated Headwater Streams
Effects of Phosphorus Mediated through Algal Biomass in Illinois Streams
Spatial and Temporal Relationships between Biotic Integrity of Illinois Streams, Dissolved Oxygen, and Nutrients (Including Controls on Dissolved Reactive and Particulate Phosphorus)
The Impact of Sediments on the Potential Bioavailability of Phosphorus in Illinois Streams

Principal Investigator

Stephen P. Long, UIUC
Mark B. David, UIUC
Madhu Khanna, UIUC
Anne Heinz Silvis, UIUC
Lei Tian, UIUC
Thomas B. Voigt, UIUC
Michelle M. Wander, UIUC
Jack M. Widholm, UIUC
Yuanhui Zhang, UIUC

Michael F. Hutjens, UIUC
Peter D. Goldsmith, UIUC
Larry L. Berger, UIUC

Geoffrey L. Dahl, UIUC
Justin W. Sexten,
University of Illinois Extension

Principal Investigator

George F. Czapar,
University of Illinois Extension

William L. Perry, ISU

Walter R. Hill, Illinois Natural History Survey

Mark B. David, UIUC

Michael L. Machesky,
Illinois State Water Survey

C-FAR RESEARCH REACHING ALL ILLINOIS CITIZENS

Often considered Illinois' number one industry, the state's food and agricultural industry is indeed a very significant economic engine. This industry encompasses a myriad of related sectors such as food processing and the expanding green industry. A quick overview of the industry conveys:

- *The market value of agriculture production in Illinois is \$7.68 billion*
- *Farms cover more than 28 million acres – nearly 80% of the state's total land area*
- *Illinois is a leading producer of soybeans, corn and swine, and because of the state's climate and varied soil types, boasts significant production of several specialty crops and vegetables*
- *In addition to the billions of dollars from agricultural-related marketings, billions more dollars flow into the state's economy from agricultural-related industries*
- *The state's green industry has a direct economic value of \$4.72 billion*
- *The green industry's payroll is \$1.74 billion*
- *The state is home to more than 950 food manufacturing companies*
- *Food processing is the state's number-one manufacturing activity, adding almost \$13.4 billion annually to the value of Illinois' raw agricultural commodities*
- *Chicago is home to the largest rail gateway in the nation, resulting in transportation efficiencies of food and agricultural products*
- *Illinois ranks second nationally in the export of agricultural commodities*
- *About 1.5 million Illinois workers are employed in the food and fiber system*

Sources for the overview and statistics: Illinois Department of Agriculture, Illinois Department of Employment Security, U.S. Department of Agriculture, UIUC Department of Natural Resources and Environmental Sciences report entitled "The Illinois Green Industry," Economic Research Service, U.S. Department of Agriculture

C-FAR research, funded by the State of Illinois, has had an immense impact on the quality of life of Illinois citizens and the economy of the state since the first C-FAR appropriation in FY96. These research investments are unique in that they are guided by Illinois citizens, via the C-FAR membership, to ensure that the most critical research needs of the food, agricultural, and related industries are met. The research spans a wide gamut of areas important to Illinois.

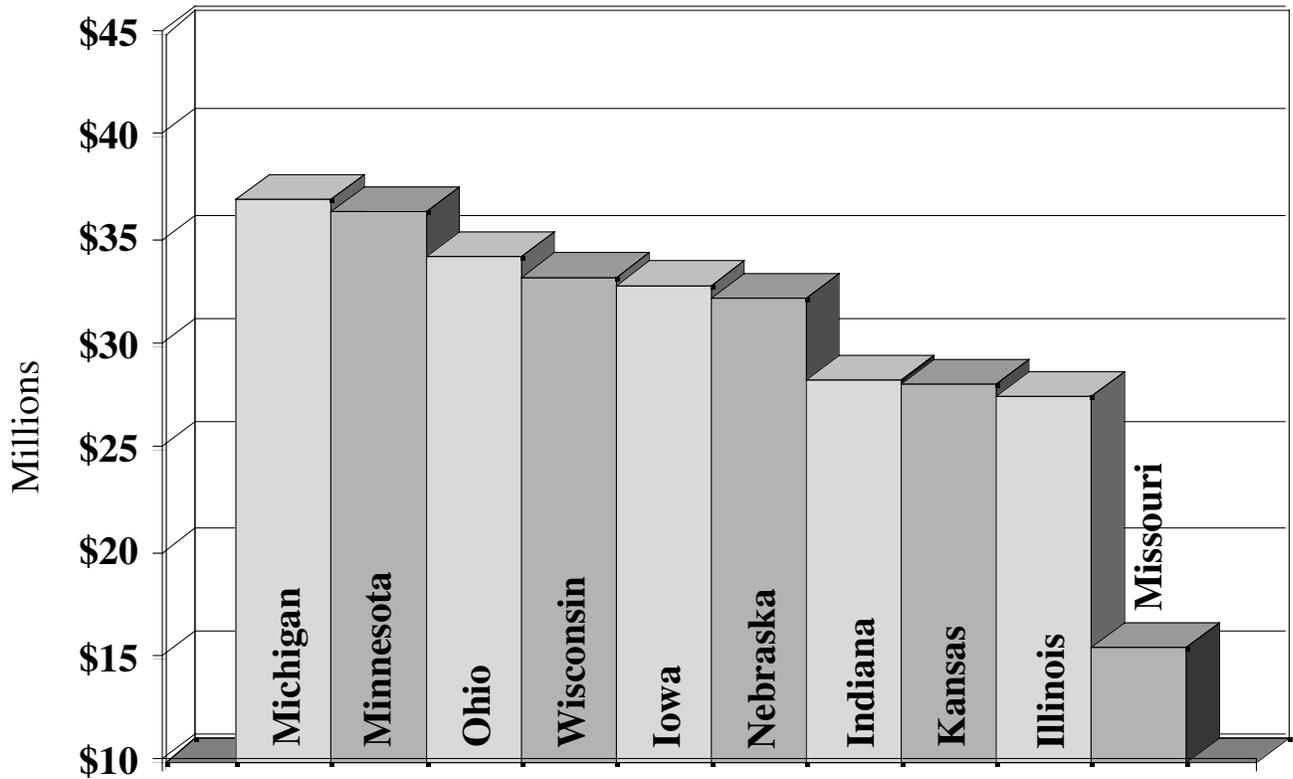
The following highlights are just a few examples of C-FAR-funded research outcomes that either have been commercialized or have otherwise enhanced the life of the people of Illinois.

- To prevent foodborne illnesses in Illinois, Hazard Analysis Critical Control Point (HACCP) training programs have been developed for food service operators, environmental health specialists, small meat-processing facilities, and farms.
- New marketing resources and networks are helping Illinois livestock producers boost their income and better meet consumer demand by providing a greater selection of high-quality meat products. One example is the Premium Beef Project which is linking Chicago independent grocers with downstate beef producers.
- Millions of dollars have been generated in agricultural related sales increases, capital investments, investment and operations capital secured, and loan packages.
- The Illinois Environmental Protection Agency developed a plan to adopt water quality standards for nutrient-related parameters that protect against measurable impacts to the aquatic environment that can be caused by nutrient over-enrichment. The plan states the utilization of C-FAR-funded research as a scientific basis for criteria development.
- Special instruction on how to apply food safety practices in everyday life was provided to over 43,000 students in 1,400 4th–6th grade classrooms in and around Chicago.
- The Illinois Center for Soy Foods promotes the consumption of soy foods, thereby providing benefits to soybean growers, processors, and consumers in Illinois. The center addresses: soy product development, soy consumer acceptance, soy processing technology transfer, and soy education and outreach.
- DNA markers for advanced selection methods for disease resistance have been transferred to the private sector. Utilizing this technology, producers are expected to be able to reduce yield losses associated with soybean cyst nematode and soybean death syndrome by 50% within the next 10 years and improve grower annual income by \$156 million.
- Innovative technologies are being used to recycle livestock and urban waste into value-added compost. A new compost product called “Sweet Earth” is providing added income for farmers.
- A tomato variety has been developed for the delivery of an edible vaccine to protect against one of the most serious respiratory diseases: the respiratory syncytial virus (RSV).

The State of Illinois appropriations for food, agricultural, and related research, via C-FAR, have effectively garnered additional leveraged funding. C-FAR research investments are often utilized as seed funding to establish a particular research program. Once a research program acquires maturity, it is able to attract federal funding, corporate investments, and so forth. Federal funding is the significant share of the leveraged funding achieved. A list of several initiatives follows with the leveraged funding detailed. The leveraged funding amounts are only the initial funding amounts, and it is anticipated that these investments will continue to yield additional leveraged funds in the future.

- Evaluating Corn GMOs for Safety, Equivalence, and Environmental Impact and related projects funded at \$450,424 were leveraged to obtain **\$16.3 million** from the U.S. Department of Agriculture, the National Science Foundation, the Illinois Soybean Program Operating Board, the North Central Soybean Research Program, the United Soybean Board, the Illinois Missouri Biotechnology Alliance, the Illinois Corn Marketing Board, the Frasci Foundation, Pioneer Hi-Bred International, Inc., Monsanto, Syngenta Seeds, Garst Seed Company, Soygenetics, Land O'Lakes, Golden Harvest Seeds, and Access Plant Technology.
- Development of a Post-Menopausal Animal Model for Evaluation of Effects of Soy Isoflavones on Mammary Tumor Growth and related projects funded at \$419,340 were leveraged to obtain an **\$8 million** grant from the National Institutes of Health.
- Research and Discovery Program to Abate the Threats and Harness the Potential of Atmospheric Change to Benefit Illinois funded at \$1.9 million was leveraged to obtain **\$4.1 million** from the U.S. Department of Energy, the U.S. Department of Agriculture, the National Science Foundation, Archer Daniels Midland, Pioneer Hi-Bred, BASF International, Argonne National Laboratory, and Brookhaven National Laboratory.
- Transgenic Swine Program funded at \$642,961 was leveraged to obtain **\$2.7 million** from the U.S. Department of Agriculture, the Biotechnology Research and Development Corporation, the National Science Foundation, and Infigen, Inc.
- Broccoli and Health and other projects funded at \$342,000 were leveraged to obtain a **\$2.5 million** grant from the U.S. Department of Agriculture.
- Innovative Finishing and Marketing Strategies for Small Beef Producers and other projects funded at \$192,000 were leveraged to obtain a **\$2.2 million** grant from the U.S. Department of Agriculture.
- Harnessing the Benefits of an Apple Scab Resistance Gene funded at \$104,400 was leveraged to obtain a **\$1.65 million** grant from the National Science Foundation.
- Farm Decision Outreach Central (farm.doc) funded at \$365,000 was leveraged to obtain **\$1.54 million** from the U.S. Department of Agriculture.
- The Post-Antibiotic Era of Food Production funded at \$90,000 was leveraged to obtain a **\$1.35 million** grant from the National Institutes of Health.
- Neurochemistry of Growth and Leptin funded at \$69,000 was leveraged to obtain **\$1.3 million** and employment of two full-time technicians from the U.S. Department of Agriculture and the National Institutes of Health.

Comparison of U.S. Midwestern Agricultural States' Annual Research Expenditures (FY03)



Source of this data is *Inventory of Agricultural Research, USDA/CREES*, which reflects FY03 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 FY04 Expenditures and Obligated Funds

External Competitive Grants Program		\$1,988,016
Research Expenditures.....	\$1,098,985	
Research Obligations.....	\$887,602	
ScientiPc Reviewers	\$1,429	
University Internal Programs and Other Programs/Accounts		\$5,101,428
Research Expenditures.....	\$3,935,965	
Research Obligations.....	\$1,165,463	
Strategic Research Initiatives Program		\$2,798,979
Research Expenditures.....	\$1,773,524	
Research Obligations.....	\$1,025,455	
ScientiPc Reviewers	\$0	
Illinois Department of Agriculture Fee		\$24,500
1% Member Expense Account		\$31,333
Total FY04 Expenditures and Obligated Funds		\$9,944,256¹
Research Expenditures.....	\$6,808,474	
Research Obligations.....	\$3,078,520	
ScientiPc Reviewers	\$1,429	
IDOA Fee & 1% Member Expense	\$55,833	

¹The FY04 research expenditures are higher than the FY04 appropriation as a portion of funds from the previous fiscal year are typically obligated for investment in the subsequent year.

Summary of FY05 Allocations

External Competitive Grants Program		\$517,125²
(15% of the total appropriation, after IDOA Fee and Member Expense)		
University Internal Programs and Other Programs/Accounts		\$2,093,175
Strategic Research Initiatives Program		\$837,200³
Illinois Department of Agriculture Fee		\$17,500
(\$50,000, or ½ of 1% of the total appropriation, whichever is less)		
1% Member Expense Account (1% of the total appropriation)		\$35,000
Total FY05 Allocations		\$3,500,000

²An additional \$17,667 was allocated to the FY05 External Program due to distributing unexpended funds from the FY04 1% Member Expense Account. Therefore, the total FY05 External Program funding level is \$534,792.

³An additional \$5,806 was allocated to the FY05 Strategic Research Initiative Program due to distributing unexpended funds from a previous SRI. Therefore, the total FY05 SRI Program funding level is \$843,006.

C-FAR FY04 Expenditure Summary: External Competitive Grants Program
(July 1, 2003 - June 30, 2004)

Actual Fiscal Year Expenditures							
C-FAR Research Focus Areas	Expenditure Areas	UIUC	SIUC	ISU	WIU	Other Entities*	TOTALS
Expanding Agricultural Markets	Equipment	0	10,451	0	0	0	10,451
	Materials/Supplies	0	13,441	0	0	0	13,441
	Personnel	23,819	101,282	0	0	0	125,101
	Services/Contracts	7,321	6,080	0	0	0	13,401
	Transportation	1,798	44,850	0	0	0	46,648
Rural Economic Development	Equipment	582	0	0	43,943	0	44,525
	Materials/Supplies	7,722	0	0	8,864	566	17,152
	Personnel	62,263	0	0	31,680	16,798	110,741
	Services/Contracts	30,807	144	0	577	40	31,568
	Transportation	14,646	0	0	3,000	2,969	20,615
Agricultural Production Systems	Equipment	1,025	2,459	0	0	0	3,484
	Materials/Supplies	20,495	8,710	0	0	0	29,205
	Personnel	142,762	65,110	0	0	0	207,872
	Services/Contracts	10,760	364	0	0	0	11,124
	Transportation	11,559	1,785	0	0	0	13,344
Human Nutrition and Food Safety	Equipment	-4,245	288	627	0	0	-3,330
	Materials/Supplies	29,153	7,446	0	0	5,210	41,809
	Personnel	57,857	43,963	500	0	12,701	115,021
	Services/Contracts	8,475	3,687	0	0	0	12,162
	Transportation	1,283	1,044	0	0	148	2,475
Natural Resources	Equipment	9,921	0	0	0	0	9,921
	Materials/Supplies	9,358	1,745	0	0	0	11,103
	Personnel	80,225	32,708	0	0	0	112,933
	Services/Contracts	16,220	13,075	0	0	0	29,295
	Transportation	7,350	4,551	0	0	0	11,901
Subtotals		551,156	363,183	1,127	88,064	38,432	1,041,962
Indirect Cost		0	45,054	0	8,806	3,163	57,023
Scientific Reviewers		N/A	N/A	N/A	N/A	N/A	1,429
Awards/Obligated Funds for FY05 Research		644,295	230,057	0	10,260	2,990	887,602
Total FY04 Expenditures and Obligated Funds		1,195,451	638,294	1,127	107,130	44,585	1,988,016

* Other entities are Eastern Illinois University, Illinois Institute of Technology, and University of Illinois at SpringPeld.

C-FAR FY04 Expenditure Summary: Strategic Research Initiative Program (continued)

(July 1, 2003 - June 30, 2004)

Biomass Energy Crops for Power and Heat Generation in Illinois	Equipment	2,227	0	0	0	0	0	0	2,227
	Materials/Supplies	2,040	0	0	0	0	0	0	2,040
	Personnel	60,462	0	0	0	0	0	0	60,462
	Services/Contracts	4,451	0	0	0	0	0	0	4,451
	Transportation Coordination	4,403	0	0	0	0	0	0	4,403
		N/A	0	0	0	0	0	0	0
Illinois Livestock Integrated Focus Team	Equipment	0	0	0	0	0	0	0	0
	Materials/Supplies	7,863	0	0	0	0	0	0	7,863
	Personnel	35,337	0	0	0	0	0	0	35,337
	Services/Contracts	3,089	0	0	0	0	0	0	3,089
	Transportation Coordination	1,572	0	0	0	0	0	0	1,572
		N/A	0	0	0	0	0	0	0
Water Quality with a Focus on TMDLs	Equipment	16,651	0	5,331	0	0	0	0	21,982
	Materials/Supplies	58,299	0	1,950	0	508	0	0	60,757
	Personnel	80,892	6,866	11,093	0	6,227	0	0	105,078
	Services/Contracts	21,562	0	1,871	0	0	0	0	23,433
	Transportation Coordination	4,519	0	N/A	0	1,240	0	0	5,759
		0	N/A	N/A	0	N/A	0	0	0
Subtotals		1,537,994	112,621	20,245	5,718	83,397	0	1,759,975	
Indirect Cost		0	12,179	0	572	798	0	13,549	
Awards/Obligated Funds for FY05 Research		911,283	69,771	44,169	0	232	0	1,025,455	
Total FY04 Expenditures and Obligated Funds		2,449,277	194,571	64,414	6,290	84,427	0	2,798,979	

(1) The first five SRIs listed above did not receive additional funds in FY04. Amounts shown represent expenditures of funds carried over from previous fiscal years to complete work. The last three SRIs listed above were initiated in FY04.

(2) Other entities are SpringPald (IL) Department of Public Health, Southern Illinois University School of Medicine, and Kent State University.

C-FAR FY04 Expenditure Summary: University Internal Programs and Other Programs/Accounts
(July 1, 2003 - June 30, 2004)

Actual Fiscal Year Expenditures							
C-FAR Research Focus Areas and Programs	Expenditure Areas	UIUC	SIUC	ISU	WIU	Per Legislation	TOTALS
Expanding Agricultural Markets	Equipment	74,102	0	0	0	0	74,102
	Materials/Supplies	15,443	0	915	0	0	16,358
	Personnel	276,501	0	8,000	0	0	284,501
	Services/Contracts Transportation	18,608 24,212	0 0	43 0	0 0	0 0	18,651 24,212
Rural Economic Development	Equipment	1,216	0	1,288	0	0	2,504
	Materials/Supplies	1,081	36	1,376	0	0	2,493
	Personnel	96,657	30,304	20,585	71,988	0	219,534
	Services/Contracts Transportation	7,514 5,056	260 0	419 1,389	23 10	0	8,216 6,455
Agricultural Production Systems	Equipment	102,440	20,360	720	0	0	123,520
	Materials/Supplies	181,481	9,874	444	0	0	191,799
	Personnel	1,087,403	22,614	7,964	0	0	1,117,981
	Services/Contracts Transportation	125,687 25,922	37,448 0	2,405 0	0 0	0 0	165,540 25,922
Human Nutrition and Food Safety	Equipment	8,163	23,041	0	0	0	31,204
	Materials/Supplies	56,213	544	0	0	0	56,757
	Personnel	582,565	15,456	0	0	0	598,021
	Services/Contracts Transportation	43,420 10,444	59,248 0	0 0	0 0	0 0	102,668 10,444
Natural Resources	Equipment	581	0	0	0	0	581
	Materials/Supplies	32,978	0	2,302	0	0	35,280
	Personnel	295,711	0	19,404	0	0	315,115
	Services/Contracts Transportation	30,497 4,925	0 0	1,681 2,793	0 0	0 0	32,178 7,718
Subtotals Indirect Cost Research Support C-FAR Administrative Office Achievement Award 1% Member Expense IDOA Fee Awards/Obligated Funds for FY05 Research		3,108,820	219,185	71,728	72,021		3,471,754
		0	0	4,762	2,694		7,456
		71,980	111,123	2,369	627		186,099
	(included above)	221,938	29,772	10,826	8,120		270,656
	0	0	0	0	0	0	
	N/A	N/A	N/A	N/A	N/A	31,333	31,333
	N/A	N/A	N/A	N/A	N/A	24,500	24,500
	1,099,066	82	38,831	27,484			1,165,463
Total FY04 Expenditures and Obligated Funds		4,501,804	360,162	128,516	110,946	55,833	5,157,261

FY05 C-FAR Allocations Summary Report
(July 1, 2004 - June 30, 2005)

C-FAR Research Focus Areas and Programs	Internal Grants Program					External Competitive Grants Program ⁽¹⁾	Strategic Research Initiative Program ⁽²⁾	Per Legislation	TOTALS
	UIUC (82%)	SIUC (11%)	ISU (4%)	WIU (3%)	Total Internal University Allocations				
Expanding Agricultural Markets	276,000	0	19,150	0	295,150	48,416	N/A	N/A	481,004
Rural Economic Development	0	10,000	16,200	49,092	75,292	86,796	233,552	N/A	469,682
Agricultural Production Systems	690,000	35,000	5,000	0	730,000	144,667	111,029	N/A	1,533,779
Human Nutrition and Food Safety	414,000	20,000	9,053	0	443,053	159,442	N/A	N/A	787,651
Natural Resources	0	15,000	18,008	5,886	38,894	95,471	498,425	N/A	846,230
Scientific Reviewers⁽³⁾	N/A	N/A	N/A	N/A	N/A	0	N/A	N/A	0
Research Support	86,530	121,585	0	0	208,115	N/A	N/A	N/A	141,282
Research Discretionary	36,197	0	2,345	0	38,542	N/A	N/A	N/A	228,600
Indirect Costs	N/A	N/A	3,548	0	3,548	N/A	N/A	N/A	9,988
C-FAR Administrative Office⁽⁴⁾	213,677	28,664	10,423	7,817	260,581	N/A	N/A	N/A	260,581
Achievement Award⁽⁵⁾	0	0	0	0	0	N/A	N/A	N/A	0
1% Member Expense	N/A	N/A	N/A	N/A	N/A	N/A	N/A	35,000	35,000
IDOA Fee	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17,500	17,500
Totals	1,716,404	230,249	83,727	62,795	2,093,175	534,792⁽¹⁾	843,006⁽²⁾	52,500	3,523,473^{(1) & (2)}

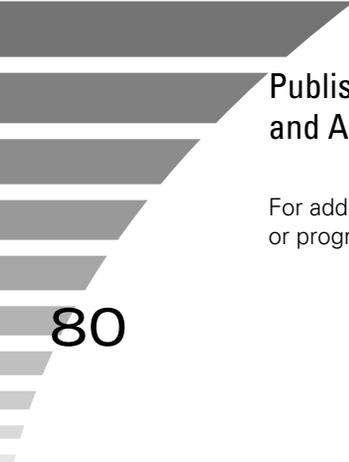
(1) \$17,667 of unexpended funds from the FY04 1% Member Expense Account was allocated to the FY05 External Competitive Grants Program (included in Pfigures above).

(2) \$5,806 of unexpended funds from a previous SRI was allocated to the FY05 SRI Program (included in Pfigures above).

(3) \$4,571 of unexpended funds from the FY04 Scientific Reviewer account will be utilized for FY05. Therefore, no allocation from FY05 funds was necessary.

(4) The FY05 C-FAR administrative ofpce budget is \$313,700. This budget is met with \$260,581 from the FY05 appropriation and \$53,119 of unexpended FY04 funds from this account.

(5) The Achievement Award will not be given in FY05 so that these funds can be directed to ongoing research.



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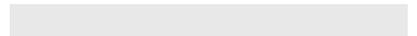
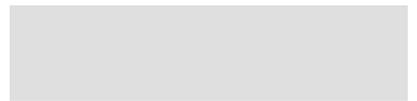
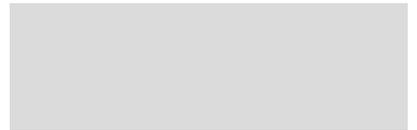
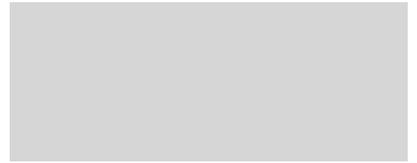
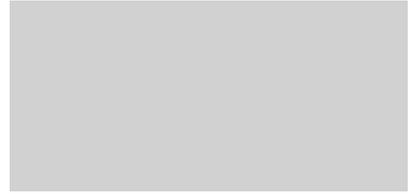
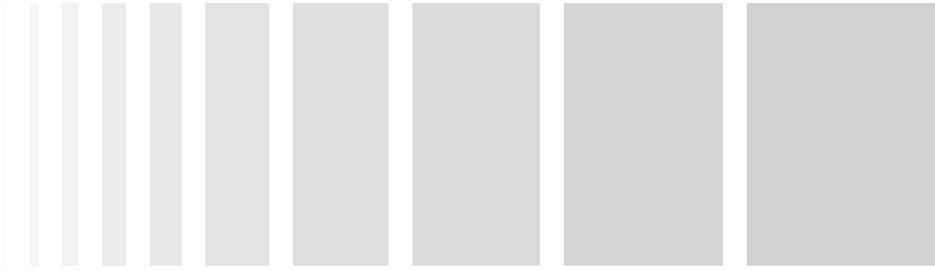
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