2003

Annual Report, 2003

University of Arkansas, Fayetteville. Dale Bumpers College of Agricultural, Food and Life Sciences. Dept. of Biological and Agricultural Engineering

2003 Annual Report

Department of Biological and Agricultural Engineering

UNIVERSITY of ARKANSAS
1871

Engineering for Life!
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UNIVERSITY OF ARKANSAS
DIVISION OF AGRICULTURE

Dale Bumpers College of Agricultural, Food, and Life Sciences

COLLEGE OF ENGINEERING
OMNIA SUPERARE INGENIO
UNIVERSITY OF ARKANSAS

2003 Annual Report

Department of Biological and Agricultural Engineering

Lalit R. Verma, Head

Arkansas Agricultural Experiment Station

Gregory J. Weidemann, Associate Vice President for Agriculture-Research

Cooperative Extension Service

Ivory W. Lyles, Associate Vice President for Agriculture-Extension

University of Arkansas Division of Agriculture

Milo J. Shult, Vice President for Agriculture

Dale Bumpers College of Agricultural, Food & Life Sciences

Gregory J. Weidemann, Dean

College of Engineering

Ashok Saxena, Dean

University of Arkansas

John A. White, Chancellor
Bob Smith, Vice Chancellor and Provost

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FOREWORD

This annual report describes the outstanding accomplishments of the Department of Biological and Agricultural Engineering faculty, staff, and students in 2003. Our mission is to *develop and disseminate biological engineering knowledge through teaching, research, and technology transfer that will maximize the professional value of biological engineers to the clients they serve in biological, agricultural, environmental, biomedical, or value-added bioprocess engineering enterprises whether in private practice, government service, industry, or education.*

I am pleased to report that our new science-based undergraduate program in Biological Engineering has established a sound foundation and is attracting bright young minds interested in Food and Bioprocess, Ecological, Bioresource, and Pre-Med/Biomedical Engineering concentrations. There are presently 12 faculty members in research and teaching at Fayetteville, four extension engineers in Little Rock, and one at the Northeast Research and Extension Center in Keiser. We added a new faculty member in 2003 dedicated full-time to Biomedical Engineering. Labs for Biomedical Engineering are being completed at the Engineering Research Center.

We received accreditation from ABET in 2003 for another six years for the Biological Engineering program. We are continuing with two retreats a year and meetings with the BAE Advisory Board and Academy Members. The summer retreat focuses on academic programs and the winter retreat is a comprehensive annual program review.

It was a matter of great pride for the BAE faculty when our student team won first place in the Senior Design Competition at the 2003 International ASAE Meeting in Las Vegas. Four new members were added to the Arkansas Academy of Biological and Agricultural Engineering in January of 2004.

It is great to have a wonderful faculty, staff, students, and friends supporting the mission and goals of the department. We welcome your comments or suggestions to further improve our programs to better serve our clientele.

Lalit R. Verma, Ph.D., P.E.
Professor and Department Head

Biological and Agricultural Engineering Teaching, Research, and Outreach

- Willie Dillahunty, James Geurtz, and Clay McDaniel won first place for their senior design project in the AGCO Student Design Competition, at the 2003 ASAE meeting in Las Vegas.
- Biological Engineering was accredited for the next 6 years by ABET.
- The department has 96 undergraduates enrolled and 28 graduate students.
- Graduate programs were changed to Biological Engineering this past fall. This will match with the undergraduate program in Biological Engineering.
- Hired our first full-time Biomedical Engineering professor Dr. Mahendra Kavdia.
- Dr. Em Ward, M.D., was hired as half-time Adjunct Assistant Professor to help with the Biomedical Engineering Program.
- Dr. Sreekla Bajwa has been elected the regional director of the central region of ASPRS, the Geospatial Society for Photogrammetry and Remote Sensing.
- Dr. Indrajeet Chaubey has been elected Vice-Chair of SW-21, the technology committee on Hydrology.
- Established the Joel T. Walker Memorial Scholarship.
- BAEG Academy inducted four new members; David Cowart, Joe Faddis, Dennis Gardisser, Eugene Snawder.
- Initiated research on precision management of cotton soils by detecting and mapping compacted soil areas.
- Dr. Lalit Verma was named “Outstanding Engineer 2003” by the Arkansas Section of American Society of Agricultural Engineering at their annual meeting in Little Rock.
- Department faculty and Extension Engineers attended a special training on MatLab. The department is considering using this as a basic tool incorporated into the undergraduate program.
- Worked with farmers, county extension agents and industries across Arkansas to develop precision agriculture technologies for their particular needs, while exposing them to the precision agriculture concept.
- Continued development of water based extraction process for the milk thistle model system. These are developing processes to detect valuable compounds in bioenergy crops that could be extracted prior to the firing step.
- Extracting compounds from energy crops, such as mimosa and serecia, and examining their oxygen radical capacity absorbance (ORCA) potential.
- Continuing work on lycopene extraction from watermelon flesh.
- Working to establish multidisciplinary, multi-institutional research team for image acquisition and processing, numerical modeling, and clinical testing.
- Developing a Masters program in the field of Biomedical Engineering.
- Continuing to monitor and model acquired bacterial resistance to medical antibiotics in water ecosystems.
- Investigating the interface between biological and abiological materials at nanoscale. Also designing and fabricating a novel microfludic pump actuated by biomolecular motors.
- Working to design the DNA oligonucleotide building blocks for DNA-based computers and nanotechology. Developing a new methodology for genome-enabled diagnostic systems.
- The Precision Ag team is working towards acquiring a set of high resolution equipment geo-spatial data acquisition applied to agriculture, anthropology, environment, geosciences, etc.

- Conducting research to determine the main-stem node number of the last effective boll population in UNR and wide-row cotton as grown in a range of typical field environments.
- Developing precision agricultural technology for managing soybean cyst nematode in Arkansas by the application of precision agriculture technology to design and manage site-specific production constraints in southern soybean production systems.
- Determine the optimum timing for the final irrigation of cotton based on crop monitoring.
- Continuing work towards improving cotton irrigation practices and recommendations in Arkansas.
- Identifying cotton plants response to water stress as a change in canopy temperatures and investigate the possibility of using that information for precise irrigation scheduling.
- Improving yield and yield stability for irrigated soybean.
- Working to develop an on-line NIR sensor for quantifying beef quality.
- Identify pesticide pollution in La'Anguille watershed in Arkansas Delta caused by the heavy agricultural pesticide usage and model the risk of pollution to surface water bodies using GIS and water quality modeling tools.
- Developing precision farming technology for developing sub-soiling guidelines in Arkansas. Avoiding sub-soiling in a field can save up to $15 per acre.
- Working to test and validate optical sensing technology for plant nitrogen estimation and management rice.
- Developing a nutrient management decision system for the Eucha Basin.
- Developing animal waste management strategies and management tools that optimize efficient, environmentally friendly utilization of nutrients, compatible with sustained land and water quality. Develop nutrient treatment processes in engineered and natural systems for management of manures and other wastes.
- Demonstrate the greenway approach for preservation and restoration of ecological integrity of urban streams.
- Develop, implement, and evaluate a decision support system (DSS) for developing comprehensive watershed nutrient management strategies and water model with a stakeholder-driven, risk- based nutrient management and water conservation decision process, using economic and water quality data validation.
- Differentiating runoff contributing areas from pastures for phosphorus management.
- Develop and improve research infrastructure for the study of bio-regenerative life support systems, mainly focused on low pressure plant growth chambers to simulate greenhouse conditions on the Moon or Mars.
- Organize the water quality data collected by various agencies involved with monitoring the Beaver Lake watershed into a GIS-linked database.
- Design, test, and evaluate systems for storing, treating and utilizing animal waste, particularly poultry litter, including development of alternate uses for litter and for management of litter application to minimize non-point source pollution.
- Optimizing BMPs, water quality, and sustained agriculture in the Lincoln Lake watershed.
- Working to address water quantity and quality problems in Arkansas.

SIGNIFICANT ACCOMPLISHMENTS IN 2003

- Continued to develop an electrochemical method to inactivate *Listera monocytogenes* and aerobic bacteria in chilling brine.
- Continuing work in Biocatalysis Technology by realizing the hidden biocatalytic potentials of the vast natural abundance of untapped microorganisms in conjunction with industrially and medically relevant biotransformations.
- Developing immuno-electrochemical and optical biosensing methods based on capillary bioseparator/ bioreactors for separation of target bacteria from food samples and enzymatic amplification.
- Working to create a reliable, effective technique for developing fissure-resistant rice varieties.
- Improving chemical application efficiency by agricultural chemical applications.
- Developing environmentally relevant biotechnology to degrade recalcitrant pollutants.
- Continuing extractions of flavonoligans from milk thistle.
- Helping producers develop long-term management strategies to control insect populations.
- Developing impedance immunosensors for rapid detection of live *Escherichia coli O157:H7*, *Salmonella Typhimurium*, and *Listeria* monocytogene in food products.
- Detect health beneficial compounds in bioenergy crops and their corresponding biological activity.
- Continued work on water irrigation management for water, labor, and cost savings.
- Working to protect the air, water, and soil from contamination in areas where relatively large quantities of chemical mixes are prepared and loaded for field distribution.
- Provide harvest equipment recommendations that improve profit and meet Arkansas growers needs, i.e., reduce harvest operations cost, harvest delays, and field losses of corn, cotton, grain sorghum, soybeans, and wheat.
- Investigate the components in gin waste that may foster fires in tall gin waste piles and attempt to identify if there are marketable components that have not yet been identified.
- Taught rescue personnel better techniques in Farm Accident Rescue “hands-on” training (2-days) to help them get victims to an emergency room during the golden hour.
- Provide seeding equipment recommendations that meet Arkansas growers needs, i.e., achieve rapid emergence of corn, grain sorghum, rice, soybeans, wheat and cotton, in no-tillage and reduced tillage environments.

Tenured and Tenure-Track Faculty

Sreekala Bajwa, *Assistant Professor*
B.S.Ag.E., 1991, Kerala Agriculture University, Tavanur, India; M.S.Ag.E., 1993, Indian Institute of Technology, Kharagpur, India; Ph.D., 2000, Univeristy of Illinois at Urbana-Champaign. Precision agricultural machinery and equipment, sensors and controls, remote sensing for crop monitoring and soil characterization, GIS, GPS, and decision support systems.

Danielle Julie Carrier, *Associate Professor*
B.S., 1984, M.S., 1986, Ph.D., 1992, McGill University, Canada. Effect of agricultural production systems on phytonutrient or "health beneficial compounds" with emphasis on drying and extraction of vegetable and medicinal plant crops.

Indrajeet Chaubey, *Assistant Professor*
B.Tech, 1991, Agricultural Engineering, University of Allahabad, India; M.S.B.A.E., 1994, University of Arkansas; Ph.D., 1997, Oklahoma State University. Nonpoint source pollution control and modeling, development and assessment of best management practices to minimize nonpoint source pollution, effect of land use on sediment, nutrient and metal transport, interaction of terrestrial and aquatic processes affecting water quality and linking these processes to develop integrated watershed management technology, and application of geographic information systems in natural resource management.

Thomas A. Costello, *Associate Professor*
B.S.Ag.E., 1980, M.S.Ag.E., 1982, University of Missouri; Ph.D., 1986, Louisiana State University. Plot and field scale studies to quantify impacts of land application of animal manure on surface water quality; broiler litter management and its effects on air quality (for birds and workers), building energy consumption, bird performance and the final value of the litter as a fertilizer, energy conservation and environmental control in poultry houses. Projects include development of heat exchangers, fogging systems, and systems for reduction of ammonia concentrations.

Dennis Gardisser, *Associate Head Extension, Research Professor*
B.S., 1979, M.S., 1981, Ph.D., 1992, University of Arkansas. Extension education programs related to engineering aspects of agricultural chemical applications (pesticides, plant nutrients, and other biological products), processing (including on farm storage, drying, and handling of grain), fencing and other aspects of animal confinement or movement control, educational leadership and coordination of precision agriculture, GPS and GIS. Liaison: agricultural aviators, commercial chemical applicators, chemical application equipment dealers, grain drying and processing entities, fencing, precision agriculture, crop commodity groups, and regulatory agencies.

Carl Griffis, *Professor*
B.S.Ch.E., 1963, M.S.Ch.E., 1965, Ph.D., 1968, University of Arkansas. Applications of computers and microcircuitry for monitoring and control of biological processes in food processing, quality, and safety.

Gary Huitink, *Research Associate Professor*
B.S., 1969, M.S., 1971, Iowa State University. Education and consulting on engineering aspects of farm tractors and implements, energy topics (biodiesel, reduced tillage, etc.) yield monitors and reduced-tillage equipment and harvesting equipment, cotton gins, and farm safety.

Mahendra Kavdia*, Assistant Professor*
B.Tech., 1992, M.Tech 1995, Indian Institute of Technology, Ph.D. 2000, Oklahoma State University. Experimental and computational research of nitric oxide and reactive oxygen species specifically applied to the endothelium function and diabetes research, in vitro drug delivery, in vetro experimental system design, statistical analysis, mammalian cell culture techniques, microscopy, spectrophotometry, radio-immuno assays, enzyme-based assays, mathematical modeling of reaction and transport, and biological control.

Jin-Woo Kim, *Assistant Professor*
B.S., 1986, Seoul National University, B.S., 1991, University of Iowa, M.S., 1994, University of Wisconsin, Ph.D., 1998, Texas A&M University. Biotechnological/biochemical engineering, including process analysis and optimization, bioreactor design, biological remediation of environmental toxins; conversion of renewable biological wastes to high value products, and biocatalytic potential of microbes.

Yanbin Li, *Professor*
B.S., 1978, Shenyang Agricultural University, China, M.S.Ag.E., 1985, University of Nebraska, Ph.D., 1989, Pennsylvania State University. Developing biosensors and engineering methods for food safety and sanitation, specifically, description of bacteria in poultry meat and processing water, and rapid detection of bacteria in food products.

DEPARTMENTAL RESOURCES

Faculty

Otto J. Loewer, *Professor, Director UAEDI, P.E., ASAE Fellow*
B.S., 1968, M.S., 1970, Louisiana State University, M.S., 1980, Michigan State University, Ph.D., 1973, Purdue University. Computer simulation of biological systems; grain drying, handling and storage systems.

Marty D. Matlock, *Associate Professor*
B.S., 1984, M.S., 1989, Ph.D., 1996, Oklahoma State University. Nonpoint source nutrient loading effects on waterbodies and developing engineering design parameters for using constructed ecosystems as treatment systems.

Rong Y. Murphy, *Research Associate Professor*
B.S., 1982, M.S., 1984, Tiajin Institute of Light Industry, China, M.S.FDSC, 1989, M.S.Ch.E., 1991, Ph.D., 1992, University of Arkansas. Thermal processing and food safety of meat products with emphasis in thermal process validations, microbial lethality kinetics, and physical, chemical, thermal, and transport properties during meat thermal processing.

G. Scott Osborn, *Assistant Professor*
B.S., 1984, M.S.Ag.E., 1987, University of Kentucky, Ph.D., 1994, North Carolina State University. Heat and mass transfer coupled with kintetics of biological reactions; design of equipment and processes to control biological systems; and modeling of biological processes. Application areas include: control of rice fissuring through genetic manipulation, ecological engineering, oxygenation of wastewater and natural water bodies, biomechanics, food engineering and biomedical engineering.

Phil Tacker, *Research Associate Professor*
B.S., 1979, M.S., 1982, University of Arkansas. Development and management of soil and water resources for row crop and horticulture crop production in the state. Work with drainage, irrigation, water resource development and management and water quality (domestic and irrigation), irrigation system design, selection and operation using soil and water management variables for determining drainage and irrigation requirements, determining proper irrigation scheduling, monitoring irrigation pumping, and controlling pumping costs. Develop and maintain professional and cooperating relationship with agencies involved in soil and water resource development and management.

Karl VanDevender, *Research Associate Professor*
B.S., 1985, M.S., 1987, Mississippi State University, PhD. 1992, University of Arkansas. Development and implementation of statewide Extension programs in livestock and poultry waste management, liquid and dry. Develop curricula and training materials for educational programs in collection, storage, and land application of waste to prevent contamination of surface and groundwater. Work with other UA personnel to develop and demonstrate manure storage, treatment, and utilization practices that address environmental, production, and economic considerations. Develop and maintain positive working relationships with other government agencies and industries.

Lalit R. Verma, *Professor and Department Head, P.E., ASAE Fellow*
B.Tech, 1972, Agricultural University, India, M.S., 1973, Montana State University, Ph.D., 1976, University of Nebraska. Administration.

Earl Vories, *Professor*
B.S., 1981, M.S., 1983, University of Arkansas, PhD., 1987, University of Tennessee. Optimal water-management strategies and water requirements for crop production on the Mississippi Delta in Arkansas, and the climatic properties of the region.

Adjunct Faculty:

Simon Ang *(Ph.D., 1985, Southern Methodist University) Professor, Electrical Engineering, University of Arkansas.*
Robert R. Beitle *(P.E., Ph.D., 1993, University of Pittsburgh) Associate Professor, Chemical Engineering, University of Arkansas.*
Edgar C. Clausen *(P.E., Ph.D, 1978, University of Missouri-Rolla) Professor, Chemical Engineering, University of Arkansas.*
Russell J. Deaton *(Ph.D., 1992, Duke University) Associate Professor, Computer Science and Computer Engineering, University of Arkansas.*
Brian E. Haggard *(Ph.D., 2000, Oklahoma State University) Assistant Research Professor, USDA-ARS-PPPSR.*
Terry Howell *(Ph.D., 1999, University of Wisconsin-Madison) Assistant Professor, McKee Foods, Inc.*
Neil Ingels *(Ph.D., 1967 Stanford University) Professor, Stanford University Medical Center.*
Em Ward *(Ph.D., 2002, University of Arkansas) Assistant Professor, Biomedical Engineering, University of Arkansas.*
Jim Wimberly *(M.S., 1982, Louisiana State University) Assistant Professor, Organic Resources Management.*
Wade Yang *(Ph.D., 1997, University of Saskatchewan,) Assistant Professor, Alabama A&M University.*

Professional and Academic

Ray Avery, Program Technician I

Brandon Beard, Research Specialist I

Justin Calhoun, Technical Support Specialist

Chad Cooper, Program Associate I

Cynthia Corbitt, Administrative Office Supervisor

Paul DeLaune, Post Doctroral Associate

Tammie Edrington, Administrative Assistant

Virginia Glass, Accountant

Doug Kratz, Technical Support Specialist

Betty Martin, Program Tech I

Robert Morgan, Project/Program Manager

John Murdoch, Program Tech II

Sara Seabolt, Secretary

Xiaoli Su, Post Doctoral Research Associate

Katie Vaughn, Program Tech I

Lyndall Watkins, Research Assistant

Stephanie Williamson, Research Specialist

Liju Yang, Post-Doctoral Associate

Faculty and Staff Honors and Awards

The following members of our department were recognized during the last year for their contributions to the University or their profession.

- Dr. Yanbin Li received an Arkansas Alumni Association outstanding research award. Recognized as a "Master Collaborator" for his service to the Department of Biological and Agricultural Engineering.
- Vijay Garg was awarded the WR Thomas Scholarship from the College of Engineering. The scholarship carries a stipend of $8,000.
- Tammie Edrington received the University of Arkansas Employee of the Quarter Award.

Staff Changes/Retirements

- Ken Shelby retired from the department after 31 years of dedicated service to the department.
- Jalene Ramsey has retired from the department after 15 years of dedicated service to the department.
- John Murdoch joined our staff as Research Specialist II, he works at the Design Studio.

Advisory Board

2003-2004 Members

Stan Andrews, Renfroe Engineering
David Beasley, North Carolina State University
Billy Bryan, Professor Emeritus, UA
Dennis Carman, Retired USDA/NRCS
Steven Danforth, Agri Process Innovations
Fred Fowlkes, Retired Entergy, Inc.
Michael Freer, Tyson Foods
John Langston, Retired Arkansas CES
Jeff Madden, Riceland Foods
Stanley Reed, Stanley E. Reed Farm
Wesley Ritter, Halliburton
Michael D. Shook, Agri Process Innovations
Randy Young, ASWCC

Academic Advisory Committee

2003-2004 Members

Stan Andrews, Renfroe Engineering
Michael Freer, Tyson Foods
Fred Fowlkes, Retired Entergy, Inc.
Floyd Gunsaulis, Charles Machine Works
Jeff Madden, Riceland Foods
Stanley Mathis, USDA/NRCS
Chris Pixley, UA Graduate Student
Bruce Westerman, Mid-South Engineering

BAEG Academy Charter Members

Stanley B. Andrews, B.S. (90), M.S. (93)
John L. Bocksnick, B.S. (76), M.S. (78)
Billy B. Bryan, B.S. (50)
Wesley F. Buchele, M.S. (51)
Dennis K. Carman, BS (73)
William L. Cooksey, B.S. (79)
Steven D. Danforth, B.S. (80)
Michael W. Freer, B.S. (85), M.S. (88)
Alan D. Fortenberry, B.S. (72), M.S. (77)
Fred G. Fowlkes, B.S. (68), M.S. (77)
Carl L. Griffis, BS (63), MS (65), PhD (68)
Floyd R. Gunsaulis, B.S. (88), M.S. (90)
John P. Hoskyn, B.S. (60), M.S. (64)
Michael D. Jones, BS (67), MS (68)
Dayna King, B.S. (85), M.S. (88)
John L. Langston, BS (71), MS (73)
Otto J. Loewer, BS (68), MS (70), PhD (73)
Jeffery D. Madden, B.S. (88)
Ralph A. Mashburn, BS (58)
Stanley A. Mathis, B.S. (84)
Robert W. Newell, BS (54)
Albert H. Miller, B.S. (55), M.S. (57) Posthumously
Stanley E. Reed, B.S. (73)
Bill R. Ridgway, B.S. (88)
David Wesley Ritter, B.S. (79), M.S. (81)
Richard M. Rorex, B.S. (78), M.S. (81)
Michael D. Shook, B.S. (82)
Jamal Solaimanian, B.S. (83), M.S. (85), Ph.D. (89)
Freddie C. Stringer, B.S. (70)
Albert E. "Gene" Sullivan, BS (59)
Paul N. Walker, BS (70), MS (71), PhD (74)
Bruce E. Westerman, B.S. (90)
Robert W. White, BS (72), MS (76)
J. Randy Young, B.S. (71), M.S. (75)

Honorary Members

Harold S. Stanton, BS (50), MS (53)
H. Franklin Waters, BS (55) *Posthumously*

BAEG Academy Members

Class of 2003

Joe D. Faddis, B.S. (67)
Dennis R. Gardisser, B.S. (79), M.S. (81), Ph.D. (92)
Eugene H. Snawder, B.S. (69)
David "Gail" Cowart, B.S. (60)

DEPARTMENTAL RESOURCES

Facilities

Old Main is located on the University of Arkansas Campus.

The City of Fayetteville

- Northwest Arkansas has seen a 60% growth in employment.
- Fayetteville has 3,600 acres of parks and fun for the entire family.
- Northwest Arkansas is home to some of the largest employers in the nation, such as Wal-Mart, Tyson and J.B. Hunt.
- Fayetteville enjoys four distinct seasons, with no extremes of hot or cold weather. The average temperature are 37 degrees Fahrenheit in January and 78 degrees Fahrenheit in August. The average relative humidity is 55% and the average annual precipitation is 44 inches of rain and six inches of snow.
- Fayetteville was ranked one of the “Top 15 places to reinvent yourself”.

Downtown Farmers Market

University of Arkansas

- The University of Arkansas is ranked as one of America’s 100 Best College Buys and by *The Princeton Review* as one of The Best 331 Colleges.
- The campus stretches over 420 acres of land upon a former hilltop farm, overlooking the Ozark Mountains to the south, and showcasing 167 buildings - old and new. Visitors are always impressed by the beauty of our campus.

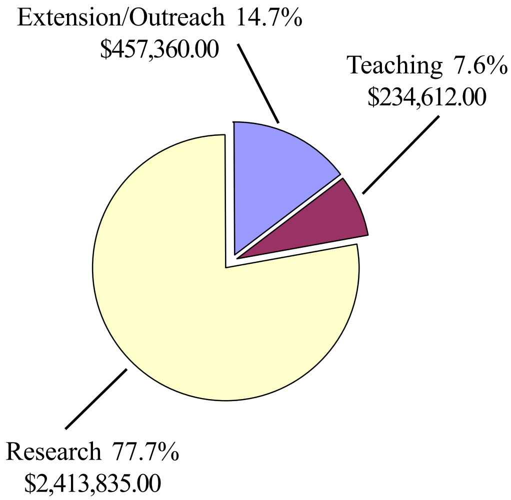
Senior walk stretches over five miles on campus where every graduates name is engraved in the concrete sidewalk.

Department Facilities

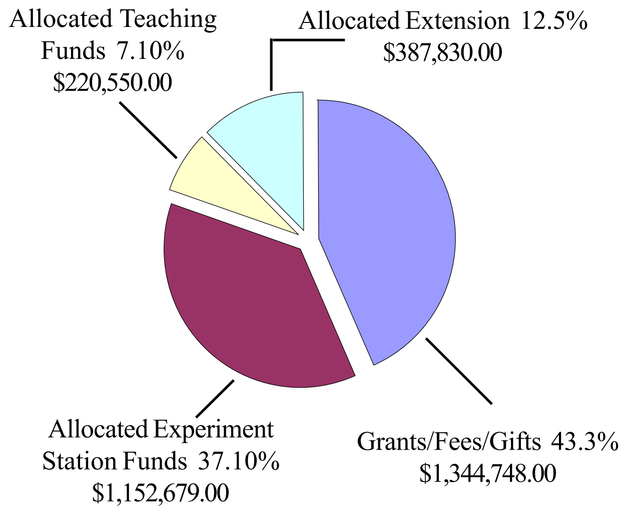
- Department facilities are located in Engineering Hall, adjacent to the Bell Engineering building. We also have research and lab facilities located north of campus at the Agriculture Research and Extension Center.
- The department has laboratory facilities for thermal processing, food safety, machine vision, biosensors and bioinstrumentation, precision agriculture, biomedical engineering, water resources, biotechnology, biomechanical, bioreactor, and GIS.

Total Expenditures, July 1, 2002 to June 30, 2003 - $3,105,807.00

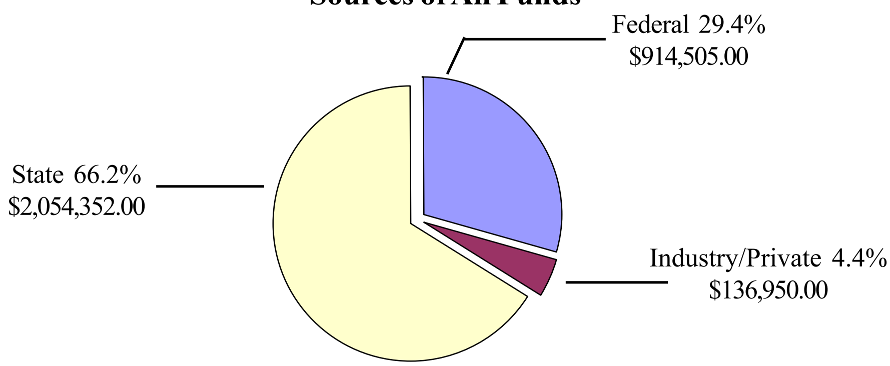
Expenditures by Program Area



Sources: Allocated vs. Grants/Fees/Gifts

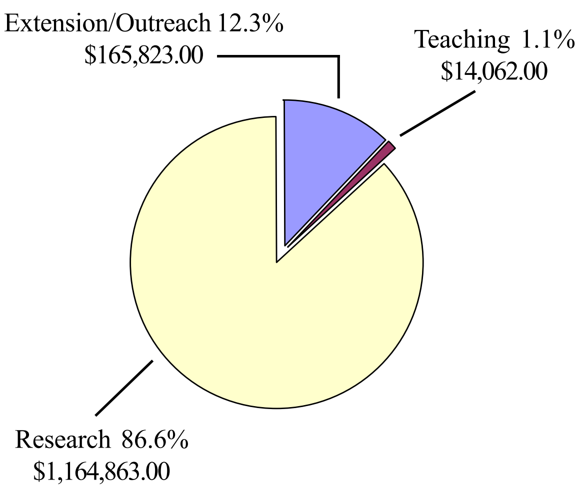


Sources of All Funds

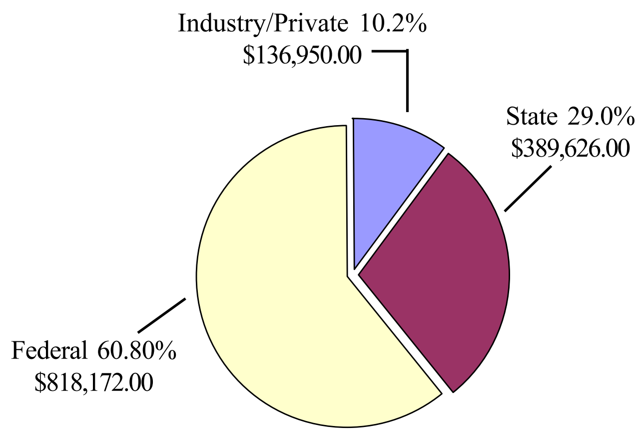


Grants/Fees/Gifts - $1,344,748.00

Expenditures by Program Area



Sources: Allocated vs. Grants/Fees/Gifts



Undergraduate Program

Foreword

Biological Engineers improve people's lives today and help assure a sustainable quality of life on Earth for tomorrow. They create solutions to problems by coupling living systems (human, environmental, food, and microbial) with the tools of engineering and biotechnology. Biological engineers improve human health through biomedical engineering; ensure a safe, nutritious food supply and create critical, new medicines through food and bioprocess engineering; secure a healthy and safe environment through ecological engineering; and create tools to manage agriculture, the environment, and the products of biotechnology through bioresource engineering.

Biological Engineering is an ABET accredited program leading to the B.S. degree. M.S. and Ph.D. degrees are also offered. The curriculum is under the joint supervision of the dean of the College of Engineering and the dean of the Dale Bumpers College of Agricultural, Food and Life Sciences. The Bachelor of Science in Biological Engineering degree is conferred by the College of Engineering and is granted after the successful completion of 128 hours of approved course work.

The educational objectives of the Biological Engineering program are to produce graduates who:

1. Effectively apply engineering to biological systems and phenomena (plants, animals, humans, microbes, and the environment) with demonstrated proficiency in basic professional and personal skills.
2. Are well prepared for future challenges in biological engineering, life-long learning, and professional and ethical contributions to society through sustained accomplishments.

Areas of Concentration

The four areas of concentration in biological engineering are:

Biomedical/ PreMed Engineering – an overview of instrumentation, physiological modeling, biomechanics, biomaterial replacement in the body, rehabilitation engineering, and assistive technology for the disabled. This area is excellent preparation for medical, veterinary, or dental school as well as for graduate programs in biomedical engineering.

Bioresource Engineering – remote sensing, application of computer and satellite technology for managing agriculture, designing machines to interface with living systems.

Ecological Engineering – removing and preventing pollution of the environment, improving and maintaining high water quality, balancing competing interests for natural resources, stream restoration.

Food and Bioprocess Engineering – food processing, developing new products from biomaterials, biotechnology, bioinformatics, proteomics, using bacteria to produce products, extracting nutrients and drugs from natural products.

Each student is required to complete 12 semester hours of approved electives in his or her area of concentration. Six of these hours must be from the biological engineering design elective courses. The remaining 6 hours are classified as technical electives and consist mainly of upper-division courses in engineering, mathematics, and the sciences as approved by the student's advisor. The department maintains a list of approved electives.

For more information visit our web site at http://www.baeg.uark.edu or contact:

Biological and Agricultural Engineering
Phone: 479-575-2351
Email: baeg@engr.uark.edu

Bachelor of Biological Engineering Graduates of 2003

Raymond S. Avery
Dylan P. Carpenter
Rachel A. Davis
William Harlan Dillahunty
James R. Geurtz
Christopher Matthew Long
Clayton W. McDaniel
Mark E. Orlicek

Biological and Agricultural Engineering Scholarships

J.A. Riggs Tractor Scholarship: Tyler Gipson, Adam Jokerst, Noel Lawrence, Patrick Petree, Brian Schaffer, and Tanya Welihinda

John W. White Scholarship: Adam Jokerst

Staplcotn Scholarship: Leslie Bartsch

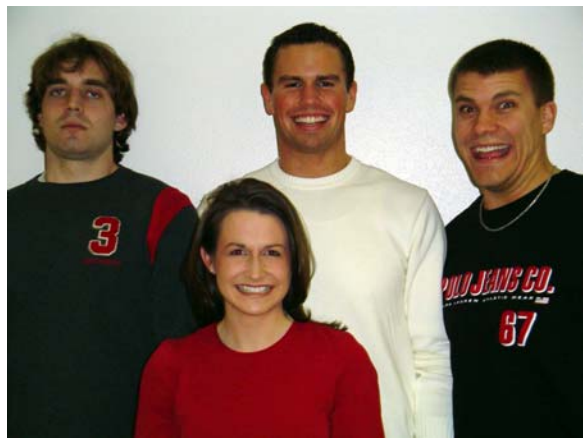
Xzin McNeal: Dylan Ballard, Jack Bourne, Leslie Mooney, Brian Schaffer, David Buckley, Eric Wright

Departmental Scholarship: Krystal Arington, Noel Lawrence, Andrea Ludwig, Drake McGruder, Leslie Mooney, Brian Schaffer, Cory Scott, Krista O'Connor, Jeffery Burns, Tyler Gilbert, Toni Peacock

Billy Bryan Scholarship: Patrick Taylor, Carlese Thompson, Jessica Temple

Biological Engineering Student Club

Officers for 2003-2004
President - Drake McGruder
Vice President - Andrea Ludwig
Treasurer - Tyler Gipson
Secretary - Kyle Kruger



Alpha Epsilon

Officers for 2003-2004
President: Abani Kumar Pradhan
Treasurer: Sumit Sen
Secretary: Sunny Wallace
Faculty Advisor: Dr. Sreekala Bajwa

Biological and Agricultural Engineering Curriculum - 128 Credits

Freshman

Fall Semester		Spring Semester	
BENG 1012 - Biological Engineering Design Fundamentals I	2	BENG 1022 - Biological Engineering Design Fundamentals II	2
GNEG 1122 - Introduction CAD	2	ENGL 1023 - Technical Composition II	3
ENGL 1013 - Composition I	3	CHEM 1123 - University Chemistry II	3
CHEM 1103 - University Chemistry I	3	CHEM 1121L - University Chemistry II Lab	1
MATH 2554 - Calculus I	4	MATH 2564 - Calculus II	4
Humanities/Social Studes Elective	3	BIOL 1543 - Principles of Biology	3
		BIOL 1541L - Principles of Biology Lab	1
	17		**17**

Sophomore

Fall Semester		Spring Semester	
BENG 2612 - Quantitative Biological Engineering Design I	2	BENG 2622 - Quantitative Biological Engineering Design I I	2
PHYS 2054 - University Physics I	4	BENG 3712 - Engineering Properties of Biological Materials	2
MATH 2574 - Calculus III	4	PHYS 2074 - University Physics II	4
MBIO 2013 - General Microbiology*	3	MEEG 2003 - Statics	3
MBIO 2011L - General Microbiology Lab	1	MEEG 2403 - Thermodynamics	3
Humanities/Social Studies Elective	3	CHEM 2613 - Organic Physiological Chemistry**	3
		CHEM 2611L - Organic Physiological Chemistry Lab	1
	17		**18**

Junior

Fall Semester		Spring Semester	
BENG 3722 - Biological Process Engineering I	2	BENG 3732 - Biological Process Engineering I	2
ELEG 2103 - Electronic Circuits	2	BENG 3803 - Mechanical Design in Biological Engineering	2
ELEG 2101L - Electronic Circuits Lab	1	BENG 4103 - Instrumentation in Biological Engineering	3
MEEG 2103 - Dynamics	3	MEEG 3013 - Mechanics of Materials	3
CHEM 3813 - Introduction to Biochemistry	3	CVEG 3213 - Hydraulics or MEEG 3503 - Mechanics of Fluids	3
MATH 3404 - Differential Equations	4		
	16		**14**

Senior

Fall Semester		Spring Semester	
BENG 4813- Senior Biological Engineering Design I	3	BENG 4822- Senior Biological Engineering Design I I	2
BENG Design Elective	3	BENG Design Elective	3
Technical Electives	3	Technical Electives	3
Humanities/Social Studies Electives	6	Humanities/Social Studies Electives	6
	15		**14**

The above section contains the list of courses required for the Bachelor of Science in Biological Engineering degree and a suggested sequence. Some courses are not offered every semester so students who deviate from the suggested sequence must pay careful attention to course scheduling and course prerequisites.

*Students in the Pre-Medical focus area must see faculty advisor for alternate scheduling and elective course requirements.

**Pre-Medical students must take CHEM 3603/3601L, Organic Chemistry I and CHEM 3613-3611L, Organic Chemistry instead of CHEM 2613/2611L, Organic Physiological Chemistry. This requires special scheduling of courses beginning in the first sophomore semester.

Areas of Concentration

Each student is required to complete 12 semester hours of approved electives in his or her area of concentration. Six of these hours must be from the biological engineering design elective courses. The remaining 6 hours are classified as technical electives and consist mainly of upper-division courses in engineering, mathematics, and the sciences as approved by the student's advisor. The department maintains a list of approved electives.

The areas of technical concentration and the recommended elective courses for each are listed here. Note that additional Biological Engineering Design Elective courses (beyond the 6 hours required) may be taken to satisfy Technical Elective requirements.

Biomedical Engineering/Pre-Med

Design Electives:
BENG 4113, Risk Analysis for Biological Systems
BENG 4123, Biosensors & Bioinstrumentation
BENG 4623, Biological Reactor Systems Design
BENG 4403, Control Environmental Structures

Technical electives:
CHEM 3613, Organic Chemistry II
CHEM 3611L, Organic Chemistry II Lab
ZOOL 2404, Comparative Vertebrate Morphology or ZOOL 2443/2441L, Human Anatomy
BIOL 4234, Comparative Physiology or ZOOL 2213/2211L, Human Physiology
BIOL 2533/2531L, Cell Biology
MBIO 4233, Microbial Genetics
KINS 3353, Mechanics of Human Movement

Bioresource Engineering

Design Electives:
BENG 4113, Risk Analysis for Biological Systems
BENG 4123, Biosensors & Bioinstrumentation
BENG 4703, Food and Bioprocess Engineering

Technical electives:
BENG 4803, Precision Agriculture
MEEG 3103, Mechanisms
MEEG 3113, Vibrations & Machine Dynamics
MEEG 3123, Design Stress Analysis
MEEG 4123, Finite Element Methods in Mechanical Engineering
INEG 4533, Application of Machine Vision

Ecological Engineering

Design Electives:
BENG 4903, Natural Resources Engineering
BENG 4913, Bio-Environmental Engineering
BENG 4923, Nonpoint Source Pollution Engineering
BENG 4623, Biological Reactor Systems Design
BENG 4113, Risk Analysis
BENG 4403, Control Environmental Structures

Technical electives:
CVEG 3243, Environmental Engineering
CVEG 4243, Environmental Engineering Design
CSES 2203, Soil Science
CSES 4043, Environmental Impact and Fate of Pesticides
BENG 4803, Precision Agriculture
GEOG 4543, Geog Information Systems
ENSC 4033, Water Quality Analysis

Food and Bioprocess Engineering

Design Electives:
BENG 4113, Risk Analysis for Biological Systems
BENG 4123, Biosensors & Bioinstrumentation
BENG 4623, Biological Reactor Systems Design
BENG 4703, Food and Bioprocess Engineering

Technical electives:
FDSC 4304/4300L, Food Chemistry
FDSC 4124/4120L, Food Microbiology
FDSC 3103, Principles of Food Processing
CHEM 3453/3451L, Elements of Physical Chemistry
MEEG 4413, Heat Transfer
CHEG 4423, Auto.Process Control

TEACHING PROGRAM

Graduate Programs

Foreword

The Department desires that each of its graduate students receive a broad educational experience. This experience includes social as well as intellectual development and will lead, we hope, to increased maturity. An additional part of the development process occurs through service to others. Certainly, course work is primary, but social activities, the exploration of the unknown and the exchange of ideas with fellow students and faculty are also part of the total educational experience. Students are encouraged to become involved in all departmental functions including teaching, research, extension, and social activities so that they may obtain the best possible education. The core of graduate education in Biological Engineering lies in obtaining technical expertise in an area of specialization. Specifically, the objectives of the Biological Engineering graduate program are for its students to:

1. Develop the ability to comprehend and apply engineering principles in order to solve problems in research, development, and design.
2. Obtain sufficient understanding of the mathematical, physical and biological sciences for comprehension of literature in these and related fields.
3. Acquire the skills required to use appropriate equipment, including instruments and computers, in solving problems in their areas of interest.
4. Achieve the technical competence necessary to teach college level courses and conduct an adult education program (such as in Cooperative Extension).

In the attainment of the above objectives, the graduate student will combine courses in Biological Engineering, other engineering fields, physical sciences, mathematics, statistics and biological sciences in developing his or her program of study. The advanced degrees, except for the non-thesis option, are primarily research degrees awarded for significant creative research or design accomplishment, and not for the completion of a specified number of courses. Therefore, the program concentration is on a significant thesis or dissertation problem completed under the supervision of members of the graduate faculty. This is not to say that the course work is unimportant. Certainly, strong course support is essential if the thesis or dissertation problem is to be properly addressed.

Degree Requirements

Master of Science in Biological Engineering

Students will be admitted to the Biological Engineering program upon admission by the Graduate School and acceptance by one of the Department Faculty with graduate school status of level II or higher. The student will not be admitted to the M.S. program until engineering competence has been demonstrated. Engineering competence can be demonstrated by satisfying one of the following criteria:

a. Receipt of a B.S. degree in engineering from an ABET accredited program or equivalent.

b. Students whose undergraduate work was not in engineering will be required to pass the following courses including the appropriate prerequisites:

1. MEEG 2403 Thermodynamics
2. MEEG 3503 Mechanics of Fluid
3. BENG 3712 Engineering Properties of Biological Materials
4. MEEG 2003 Statics, or MEEG 4413 Heat Transfer, or ELEG 2103 Electronic Circuits
5. MEEG 2031 Dynamics, or BENG 3722 Biological Processing Engineering, or BENG 4103 Instrumentation in Biological Engineering
6. One of the 4000 level BENG design courses

Master of Science in Engineering

The requirements for admission to the Master of Science in Engineering program within the Department of Biological and Agricultural Engineering are the same as those for the Master of Science in Biological Engineering as described above.

Doctor of Philosophy

Admission to the departmental aspect of the Ph.D. program depends strongly on the judgment of the individual professor. Unless the candidate has a Master of Science degree in Engineering with a thesis, however, the following admission criteria apply.

a. Students with a B.S. degree in engineering from an ABET accredited program may be considered for Ph.D. program based on their excellent academic records and/ or outstanding research experience. The Departmental Graduate Committee will make a specific recommendation to the Department Head.

b. Students with both B.S. and M.S. degrees not in engineering will be required to demonstrate engineering competence equivalent by:

- either passing all deficiency courses (listed above under Master of Science in Biological Engineering)
- or upon approval by the Departmental Graduate Committee, passing a qualifying examination constructed administered by the Committee.

Students with a Non-Engineering B.S. degree will not be considered for directly starting a Ph.D. program. Instead, they need to start a M.S. program first. Exceptions must be approved by the Departmental Graduate Committee and the Department Head.

All students should be aware that they cannot practice engineering without a professional engineer (PE) license and they may not be able to obtain a PE license without possessing an ABET accredited B.S. degree in Engineering or the equivalent.

Current Graduate Students in Biological and Agricultural Engineering

Student	Degree	Advisor	Student	Degree	Advisor_
Ray Avery	M.S.	Brian Haggard	Johnny Mason	M.S.	Sreekala Bajwa
Dylan Carpenter	M.S.	Jin-Woo Kim	Ashish Mishra	M.S.	Sreekala Bajwa
Willie Dillahunty	M.S.	Tom Costello	Robert Morgan	Ph.D.	Marty Matlock
Sujit Ekka	M.S.	Marty Matlock	Abani Pradhan	Ph.D.	Yanbin Li
Eylem Mutlu	Ph.D.	Indrajeet Chaubey	Debabrata Sahoo	M.S.	Indrajeet Chaubey
Vijay Garg	Ph.D.	Indrajeet Chaubey	Sumit Sen	M.S.	Indrajeet Chaubey
Amber Gosnell	M.S.	Carl Griffis	Senthil Subramaniam	M.S.	Julie Carrier
Prahlad Jat	Ph.D.	Scott Osborn	Omar Trujillo	Ph.D.	Carl Griffis
Jayarani Kandaswamy	M.S.	Sreekala Bajwa	Madhukar Varshney	Ph.D.	Yanblin Li
Inoka Kodikara	M.S.	Jin-Woo Kim	Katie Vaughn	M.S.	Julie Carrier
Subodh Kulkarni	Ph.D.	Sreekala Bajwa	Sunny Wallace	Ph.D.	Julie Carrier
Ju-Seok Lee	Ph.D.	Jin-Woo Kim	Kati White	Ph.D.	Indrajeet Chaubey
Zhihui Liu	Ph.D.	Yanbin Li	Liju Yang	Ph.D.	Yanbin Li
Xiaole Mao	M.S.	Yanbin Li			

Degrees Conferred in 2003

Student	Degree	Advisor	Thesis/Disseration Title
Rami Al-Haddad	M.S.	Yanblin Li	Interdigitated Microelectrode Array Based Impedance Biosensor for Detection of *E.Coli 0157:H7*.
Danielle Carbonnet	M.S.	Scott Osborn	A Finite Difference Model for Predicting Sediment Oxygen Demand in Streams.
Madhukar Varshey	M.S.	Yanblin Li	Chemiluminiscence Fiber Optic Biosensor Coupled with Immunomagnetic Separation for the detection of *Salmonella Typhimurium* in Foods.
Katie Vaughn	M.S.	Julie Carrier	Extraction of Lycopene From Watermelon Using Supercritical Fluid Extraction.
Sunny Wallace	M.S.	Julie Carrier	Extraction of Flavanolignans From the Seeds of *Silybum Marianum*.
Liju Yang	Ph.D.	Yanblin Li	Impedance Biosensors for Rapid Detection of Foodbourne Pathogens.

Students in Other Programs Advised by BAE Faculty

Student	Degree	Advisor	Graduate Program
Dilek Auston	Ph.D.	Scott Osborn	Food Science
Brandon Beard	M.S.	Rong Murphy	Food Science
Malissa Davidson	M.S.	Rong Murphy	Poultry Science
Liju Duan	Ph.D.	Julie Carrier	Chemical Engineering
Mike Duren	M.S.	Earl Vories	Agronomy
Byungchul Kim	Ph.D.	Yanbin Li	Food Science
William Little	M.S.	Sreekala Bajwa	Electrical Engineering
Chuan Luau	M.S.	Julie Carrier	Chemical Engineering
Taraq Osaili	Ph.D.	Rong Murphy	Food Science

Biological Engineering Courses

BENG1012 Biological Engineering Design Fundamentals I (FA) (Formerly BAEG 1012, First offered Summer 2002). Introduction to the profession of Biological Engineering. Basic engineering methodologies, including analysis and design, as applied to biological systems. Introduction to problem solving and data analysis utilizing computers. Group activities and team design efforts. Lecture 1 hour, laboratory 3 hours per week. Corequisite: BENG 1010L.

BENG1010L Biological Engineering Design Fundamentals I Laboratory (FA) (Formerly BAEG 1010L, First offered Summer 2002). Corequisite: BENG 1012.

BENG1022 Biological Engineering Design Fundamentals II (SP) (Formerly BAEG 1022, First offered Summer 2002). Continuation of BENG 1012. Emphasis on applying computer tools to problem solving and engineering design with biological systems. Lecture 4 hours per week. Prerequisite: BENG 1012.

BENG2103 Electronic Applications in Biological Systems (IR) Basic circuit theory and introductory applications of DC circuits, AC circuits and electro-mechanical components in actuating, monitoring and controlling processes involving biological materials. Lecture 2 hours, laboratory 3 hours per week. Corequisite: BENG 2100L.

BENG2100L Electronic Applications in Biological Systems Laboratory (IR) Corequisite: BENG 2103.

BENG2612 Quantitative Biological Engineering I (FA) (Formerly BAEG 2612, First offered Summer 2002). A systems engineering approach to quantifying bio-energetics, growth and the interface between organisms and the physical environment, including energy balances, mass balances, solar energy and psychrometics. Initiation of two-semester team design project involving design of life support for an enclosed
biological system, such as a growth chamber or bio-reactor. Pre- or Corequisite: PHYS 2054. Prerequisite: BIOL 1543 and BIOL 1541L and BENG 1022.

BENG2622 Quantitative Biological Engineering II (SP) (Formerly BAEG 2622, First offered Summer 2002). Continuation of BENG 2612. Introductory biological engineering design of life support systems that produce food, energy or other biological products. Completion of two semester design project, including construction, testing and evaluation. Analysis using descriptive statistics, regression, engineering economics. Integrates social concerns, ethics, safety and aesthetics using soft systems concepts. Prerequisite: BENG 2612.

BENG3712 Engineering Properties of Biological Materials (SP) Measuring and predicting the physical, chemical, and thermal properties of biological materials necessary for the analysis and design of production and processing systems. Prerequisite: PHYS 2054.

BENG3722 Biological Process Engineering I (FA) Applications of the principles of microbial kinetics and heat transfer to the analysis and design of biological engineering processes. Biological engineering processes will encompass examples in the realms of food and bioprocess, bioenvironmental, biomechanical and biomedical engineering. Lecture 1 hour, laboratory 3 hours per week. Pre- or corequisite: MBIO 2013. Corequisite: BENG 3720L. Prerequisite: MEEG 2403 or CHEG 2313.

BENG3720L Biological Process Engineering I Laboratory (FA) Corequisite: BENG 3722.

BENG3732 Biological Process Engineering II (SP) Continuation of BAEG 3722. Continued applications of the principles of microbial kinetics and heat and mass transfer to the analysis and design of biological engineering processes such as food and bioprocess, bioenvironmental, biomechanical and biomedical engineering. Lecture 1 hour, laboratory 3 hours per week. Corequisite: BENG 3730L. Prerequisite: BENG 3722.

BENG3730L Biological Process Engineering II Laboratory (SP) Corequisite: BENG 3732.

BENG3803 Mechanical Design in Biological Engineering (FA, SP) (Formerly BAEG 3803, First offered Summer 2002). Engineering principles, selection, and design of mechanical components and systems for equipment used in biological, food and agricultural industry; combined stress analysis, materials, fasteners, power transmission and components, power hydraulics, pneumatics, atomization. Lecture 2 hours, laboratory 3 hours per week. Pre- or corequisite: MEEG 3013. Corequisite: BENG 3800L. Prerequisite: MEEG 2013.

BENG3800L Mechanical Design in Biological Engineering Laboratory (FA, SP) (Formerly BAEG 3800L, First offered Summer 2002). Corequisite: BENG 3803.

BENG4103 Instrumentation in Biological Engineering (SP) (Formerly BAEG 4103, First offered Summer 2002). Theory and advanced applications of analog circuits, digital circuits, and commercial instruments involving biological materials. Lecture 2 hours, laboratory 3 hours per week. Corequisite: BENG 4100L. Prerequisite: BENG 2103 (or ELEG 2103 or ELEG 3903).

BENG4100L Instrumentation in Biological Engineering Laboratory (SP) (Formerly BAEG 4100L, First Offered Summer 2002) Corequisite: BENG 4103.

BENG4113 Risk Analysis for Biological Systems (FA, Odd years) Principles of risk assessment including exposure assessment and dose response, and risk management. Methods of risk analysis modeling and simulation with computer software. Applications of risk analysis in animal, food and environmental systems. Prerequisite: MATH 2564 and MBIO 2013.

BENG4123 Biosensors & Bioinstrumentation (SP) Principles of biologically based sensing elements and interfacing techniques. Design and analysis methods of biosensing and transducing components in bioinstrumentation. Applications of biosensors and bioinstrumentation in bioprocessing, bioenvironmental, biomechanical and biomedical engineering. Lecture 2 hours, laboratory 3 hours per week. Corequisite: BENG 4120L. Prerequisite: MBIO 2013 and BENG 4103.

BENG4120L Biosensors & Bioinstrumentation Laboratory (SP) Corequisite: BENG 4123.

BENG4403 Controlled-Environment Structures for Biological Systems (IR) Environmental, structural and functional requirements of buildings, with emphasis on confinement systems for commercial animal and plant production. Analysis of heat and mass balances which incorporate physiological input of the organisms. Psychometrics and solar energy principles. Design of ventilation, heating and cooling systems. Simple structural design with wood components. Pre- or Corequisite: MEEG 3013. Corequisite: BENG 4400L. Prerequisite: MEEG 2403.

BENG4400L Controlled-Environment Structures for Biological Systems (IR) Corequisite: BENG 4403.

BENG450V Special Problems (1-4) (FA, SP) Selected problems in biological engineering are pursued in detail. Prerequisite: senior standing.

BENG451VH Honors Thesis (1-6) (FA, SP, SU) Prerequisite: Honors candidacy.

BENG452V Special Topics in Biological Engineering (1-4) (IR) Special topics in biological engineering not covered in other courses. May be repeated.

BENG4623 Biological Reactor Systems Design (FA, Even years) Extension of principles of microbial growth kinetics and transport phenomena to the design of biological reactor systems used in biological engineering. Reactor systems using specialty microbial biomass (activated sludge) for substrate utilization as well as biomass and product formation. Application areas such as bioremediation, bioprocessing and organic (food/animal) waste treatment. Pre or corequisite: CHEM 3813. Corequisite: BENG 4620L. Prerequisite: BENG 3732.

BENG4620L Biological Reactor Systems Design Laboratory (FA, Even years) Corequisite: BENG 4623.

BENG4703 Food & Bioprocess Engineering (SP, Even years) Basic engineering principles involved in the design of systems for handling, conditioning, and storage of agricultural materials. Lecture 2 hours, laboratory 3 hours per week. Corequisite: BENG 4700L. Prerequisite: BENG 3732 or CHEG 3143 or MEEG 4413.

BENG4700L Food & Bioprocess Engineering Laboratory (SP, Even years) (Formerly BAEG 4700L, First offered Summer 2002). Corequisite: BENG 4703.

BENG4803 Precision Agriculture (FA, Odd years) Introduction to precision Agriculture, benefits, spatial variability within a field, zone concept, site-specific management. Spatial data collection: sensors, GPS, yield monitoring, remote sensing. Knowledge discovery from data: data processing, neural networks, genetic algorithms, use of GIS. Decision support systems. Variable-rate technology: real-time and mapbased systems, variable-rate machinery, smart controls. Evaluation: Yield mapping, economic analysis. Prerequisite: MATH 1213 and basic computer skills, descriptive statistics.

BENG4800L Precision Agriculture Laboratory (FA, Odd years)

BENG4813 Senior Biological Engineering Design I (FA) (Formerly BAEG 4813, First offered Summer 2002). Design concepts for equipment and processes used in biological, food and agricultural industries. Initiation of comprehensive two-semester team-design projects; defining design objectives, developing functional/mechanical criteria, standards, reliability, safety, ethics and professionalism issues. Design mechanisms, solid modeling, consideration of vibrations using computer-aided techniques. Lecture 2 hours, laboratory 3 hours per week. Corequisite: BENG 4810L. Prerequisite: BENG 3803.

BENG4810L Senior Biological Engineering Design I Laboratory (FA, Even years) Corequisite: BENG 4813.

BENG4822 Senior Biological Engineering Design II (SP) (Formerly BAEG 4822, First offered Summer 2002). Continuation of BENG 4813. Design concepts for equipment and processes used in biological and agricultural industries. Completion of 2-semester team design projects. Construction, testing, and evaluation of prototypes. Written and oral design reports. Discussion of manufacturing methods, safety, ergonomics, analysis/synthesis/ design methods as appropriate for particular design projects. Laboratory/design 4 hours per week. Prerequisite: BENG 4813.

BENG4903 Bioenvironmental Engineering (FA, Odd years) (Formerly BAEG 4903, First offered Summer 2002). Engineering principles for the design of systems for utilization of surface water and ground water. Includes frequency analysis of rainfall, infiltration, runoff, evapotranspiration, hydraulic control structures, ground water pumping, drainage and irrigation. Lecture 2 hours, laboratory 3 hours per week. Corequisite: BENG 4900L. Prerequisite: CVEG 3213 or MEEG 3503.

BENG4900L Bioenvironmental Engineering Laboratory (FA, Odd years) (Formerly BAEG 4900L, First offered Summer 2002). Corequisite: BENG 4903.

BENG4913 Bio-Environmental Engineering (SP, Even years) Engineering principles for the design of systems for the biological treatment and utilization of organic by-products from animal and crop production and food and crop processing. Design of best management practices to protect bio-environmental resources by minimizing non-point pollution (off-site movement of sediment, nutrients and other constituents) and by minimizing nuisance odors associated with land applied organic residues, inorganic fertilizers and pesticides. Emphasis on economic utilization of beneficial components of typical wastes. Lecture 2 hours, laboratory 3 hours per week. Pre- or Corequisite: BENG 4903 or CVEG 3223. Corequisite: BENG 4910L.

BENG4910L Bio-Environmental Engineering Laboratory (SP, Even years) Corequisite: BENG 4913.

BENG4923 Non-Point Source Pollution Engineering (SP, Odd years) Engineering principles involved in assessment and management of nonpoint source (NPS) pollution. Effect of NPS pollution on ecosystem integrity. Use of GIS/ mathematical models to quantify extent of pollution. Design/implementation of best management practices. Discussion of Total Maximum Daily Load (TMDL) principles and processes. Lecture 2 hours, laboratory 3 hours per week. Corequisite: BENG 4920L. Prerequisite: CVEG 3213 or MEEG 3503.

BENG4920L Non-Point Source Pollution Engineering (SP, Odd years) Corequisite: BENG 4923.

BENG500V Advanced Topics in Biological Engineering (1-6) (FA, SP, SU) (Formerly BAEG 500, First offered Summer 2002). Special problems in fundamental and applied research. Prerequisite: graduate standing.

BENG5103 Advanced Instrumentation in Biological Engineering (SP, Even years) Applications of advanced instrumentation in biological systems. Emphasis on updated sensing and transducing technologies, data acquisition and analytical instruments. Prerequisite: BENG 4103.

BENG5100L Advanced Instrumentation Laboratory (SP, Even years) Corequisite: BENG 5103.

BENG5113 Agricultural Remote Sensing and GIS (FA, Even years) Introduction to passive and active remote sensing, remote sensing systems, optical radiation models, sensor models, data models, spectral transforms, spatial transforms, correction and calibration, geo-rectification, classification, vegetative indices. Introduction to GIS, spatial interpolation, spatial modeling. Applications in agriculture, variable rate technology, hydrologic modeling, yield monitoring, crop modeling. Prerequisite: GEOL 4413.

BENG5110L Agricultural Remote Sensing and GIS Laboratory (FA, Even years)

BENG5123 Imaging and Rapid Analysis of Biological and Agricultural Material s (FA, Odd years) Techniques of imaging and non-invasive analyses of biological and agricultural materials. Covering spectral sensing (x-ray, UV, VS, IR), optics, image processing, recognition, on-line monitoring and vision-based controls. Applications to automated food/fruit inspections, defect/contaminant detection, and characterization of food non-food materials in real-time on processing lines. Prerequisite: BENG 4103.

BENG5613 Simulation Modeling of Biological Systems (FA, Even years) Application of computer modeling and simulation of discrete discrete-event and continuous-time systems to solve biological and agricultural engineering problems. Philosophy and ethics of representing complex processes in simplified form. Deterministic and stochastic modeling of complex systems, algorithm development, application limits, and simulation interpretation. Emphasis on calibration, validation and testing of biological systems models for the purposes of system optimization, resource allocation, real-time control and/or conceptual understanding. Prerequisite: AGST 4023 or STAT 4003 or INEG 4333.

BENG5703 Design and Analysis of Experiments for Engineering Research (IR) Principles of planning and design of experiments for engineering research. Propagation of experimental error. Improving precision of experiments. Analysis of experimental data for optimal design and control of engineering systems using computer techniques. Lecture 2 hours, laboratory 3 hours per week. Corequisite: BENG 5700L. Prerequisite: INEG 4333.

BENG5700L Design and Analysis of Experiments for Engineering Research Laboratory (IR) Corequisite: BENG 5703

BENG5713 Food Product and Process Development (FA, Odd years) Multidisciplinary approaches for developing new food products and processes, in the context of an industry-sponsored project. Group dynamics and interpersonal skills. Factors that influence product and process development. Analysis and modeling applied to

BENG5613 Simulation Modeling of Biological Systems (FA, Even years) Application of computer modeling and simulation of discrete discrete-event and continuous-time systems to solve biological and agricultural engineering problems. Philosophy and ethics of representing complex processes in simplified form. Deterministic and stochastic modeling of complex systems, algorithm development, application limits, and simulation interpretation. Emphasis on calibration, validation and testing of biological systems models for the purposes of system optimization, resource allocation, real-time control and/or conceptual understanding. Prerequisite: AGST 4023 or STAT 4003 or INEG 4333.

BENG5703 Design and Analysis of Experiments for Engineering Research (IR) Principles of planning and design of experiments for engineering research. Propagation of experimental error. Improving precision of experiments. Analysis of experimental data for optimal design and control of engineering systems using computer techniques. Lecture 2 hours, laboratory 3 hours per week. Corequisite: BENG 5700L. Prerequisite: INEG 4333.

BENG5700L Design and Analysis of Experiments for Engineering Research Laboratory (IR) Corequisite: BENG 5703

BENG5713 Food Product and Process Development (FA, Odd years) Multidisciplinary approaches for developing new food products and processes, in the context of an industry-sponsored project. Group dynamics and interpersonal skills. Factors that influence product and process development. Analysis and modeling applied to food process design. Lecture 1 hour, laboratory 6 hours per week. Corequisite: BENG 5710L. Prerequisite: BENG 4703.

BENG5710L Food Product and Process Development Laboratory (FA, Odd years) Corequisite: BENG 5713.

BENG5723 Engineering Methods for Food Safety (FA, Even years) Principles of engineering methods applied to food and safety and sanitation. Discussion of thermal, chemical, electrical pasteurization or sterilization in food processing. Demonstration of monitoring and detecting techniques for food safety, including image analysis, biosensors and modeling. Lecture 3 hours per week. Prerequisite: BENG 4103 and FDSC 4124 (or equivalent).

BENG5733 Advanced Biological Process Engineering (FA, Odd years) Applications of the principles of bioprocess/biochemical engineering to microbiological and biomedical problems. Topics include applied enzymology, metabolic engineering, molecular genetics and control, and bioinformatics in addition to classical applied enzyme and cell-growth kinetics and advanced bioreactor design. Prerequisite: BENG 3732 or CHEG 5531.

BENG5801 Graduate Seminar (FA) Reports presented by graduate students on topics dealing with current research in agricultural engineering. Prerequisite: graduate standing.

BENG5903 Water Quality Modeling and Management (SP, Odd years) Processes and methodologies associated with surface water quality modeling, investigation of management processes based on modeling results. Process from simple steady-state spreadsheet models (to understand aquatic biosystems modeling) to complex GIS-based dynamic models. Develop calibration and validation statistics for model applications. Students will develop a semester project that integrates their skills and knowledge in parameterizing, calibrating, and validating water quality models for environmental applications. Prerequisite: BENG 5613.

BENG5913 Bioremediation and Biodegradation (SP, Odd years) Environmentally-relevant biotechnology using organisms to remove or metabolize environmental pollutants through microbial degradation and phytoremediation of recalcitrant compounds. Benefits as well as potential costs of environmental applications of biotechnology will be evaluated.

BENG5923 Nonpoint Source Pollution Control and Modeling (SP, Even years) Control of hydrologic, meteorologic, and land use factors on nonpoint source (NPS) pollution in urban and agricultural watersheds. Discussion of water quality models to develop NPS pollution control plans and total maximum daily loads (TMDLs), with consideration of model calibration, validation, and uncertainty analysis. Prerequisite: BENG 4903 or CVEG 3223.

BENG5933 Environmental and Ecological Risk Assessment (SP, Even years) Process and methodologies associated with human-environmental and ecological risk assessments. Environmental risk assessments based on human receptors as endpoints, addressing predominantly abiotic processes. Ecological risk assessments based on non-human receptors as endpoints. Approach using hazard definition, effects assessment, risk estimation, and risk management. Application of methods to student projects to gain experience in defining and quantifying uncertainty associated with human perturbation, management and restoration of environmental and ecological processes. Prerequisite: BENG 4113.

BENG600V Master's Thesis (1-6) (FA, SP, SU) Prerequisite: graduate standing.

BENG6713 Advanced Properties of Biological Materials (IR) An advanced treatment of the physical, thermal, and electromagnetic properties of food and other biological materials. Special emphasis on the microscopic bases for physicochemical properties. Modeling of material properties and behavior. Lecture 2 hours, laboratory 3 hours per week. Corequisite: BENG 6710L. Prerequisite: graduate standing.

BENG6710L Advanced Properties of Biological Materials Laboratory (IR) Corequisite: BENG 6713.

BENG700V Doctoral Dissertation (1-18) (FA, SP, SU) Prerequisite: candidacy.

Computational Biology and Tissue Engineering

Mahendra Kavdia, Assistant Professor, Biological and Agricultural Engineering, UAF

Objective:

Nitric Oxide (NO) Biotransport: NO plays key role in numerous physiological functions including endothelium-derived relaxation, platelet inhibition, smooth muscle proliferation, neurotransmission and host defense. The overall objective of the proposed research is to use computational modeling and in vitro experiments to improve our understanding of the interactions among NO, oxygen (O_2), superoxide (O_2^-), peroxynitrite ($ONOO^-$), thiols, and transition metals in blood and tissue.

Accomplishments:

In vascular wall, most of the bioavailable NO is believed to derive from endothelial cells nitric oxide synthase (eNOS). Recently, neuronal NOS (nNOS) has been identified as a source of NO in the vicinity of microvessels and has been shown to participate in vascular function. Thus, NO can be produced and transported to the vascular smooth muscle cells from (a) endothelial cells and, (b) perivascular nerve fibers, mast cells and other nNOS containing sources. A detailed computational model of NO diffusion-reaction in a cylindrical arteriolar segment was formulated. The model quantified the relative contribution of these NO sources and the smooth muscle availability of NO in a tissue containing an arteriolar blood vessel. The results indicate that a source of NO derived through nNOS in the perivascular region can be a significant contributor to smooth muscle NO.

Computer Model of Palatal Growth

Em Ward, Adjunct Assistant Professor, Biological and Agricultural Engineering, UAF

Objectives:

Establish multidisciplinary, multi-institutional research team for image acquisition and processing, numerical modelling and clinical testing. Submit proposal to NIDCR (June 2004).

Accomplishments:

Complete team tentatively in place, including faculty from CVEG, BENG, UAMS (Arkansas Children's Hospital), and the Army Core of Engineers. Preliminary literature search partially completed. Initial task assignments made in primary areas.

Desktop Urinary Pathogen Detection Device

Em Ward, Adjunct Assistant Professor, Biological and Agricultural Engineering, UAF

Objectives:

Obtain external funding for the exploratory development of a portable, rapid detection system for common urinary pathogens.

Accomplishments:

Received priority score of 247 from NIBIB with very encouraging comments. Submitted revised application (March 1, 2004).

Master of Science in Biomedical Engineering

Em Ward, Adjunct Assistant Professor, Biological and Agricultural Engineering, UAF

Objectives:

Develop courses and collaborative teaching and research efforts supporting a Biomedical Engineering graduate program. Secure funding for facilities, equipment and faculty. Receive students in Fall 2004.

Accomplishments:

Development of six graduate level courses for the Biomedical Engineering curriculum. Dr. Ward is responsible for three: Biomedical Engineering Research Internship (BENG 5223), Tissue and Cell Engineering (BENG 5233) and Biomaterials (BENG/MEEG 5243). Submitted proposal to Dean Saxena for Tissue Engineering Laboratory. Ongoing dialogue with UAMS faculty regarding panels, seminars, exchanges and site visits.

Monitoring and Modeling Acquired Bacterial Resistance to Medical Antibiotics in Water Ecosystems

Scott Osborn, Assistant Professor, Biological and Agricultural Engineering, UAF
M.D. Matlock , Associate Professor, Biological and Agricultural Engineering, UAF
J. Valentine (UAMS, ACH); Professor of Pediatrics and Pharmacology, University of Arkansas for Medical Sciences, Arkansas Children's Hospital, Little Rock
J.W. Kim, Assistant Professor, Biological and Agricultural Engineering, UAF
B. Haggard, Assistant Research Professor, Biological and Agricultural Engineering, UAF
R. Beitle, Associate Professor, Chemical Engineering, UAF
I. Chaubey, Assistant Professor, Biological and Agricul tural Engineering, UAF
J. Carrier, Associate Professor, Biological and Agricultural Engineering, UAF
Y. Li, Professor, Biological and Agricultural Engineering, UAF

Objectives:

This project is a collection of several sub projects that seek to create tools to determine the exposure of bacteria to antibiotics in natural water ecosystems. These tools will be used to help discover if this exposure contributes to the reduction of the effective life of specific antibiotics for treating human disease through resistance acquired in the natural water ecosystem. This project has been further focused in 2003 to investigate the effects of oxygen on antibiotic residual/organism interaction in the aquatic ecosystem. Before reaction kinetics can be determined representing these interactions, tools for determining and monitoring the oxygen profile in sediment must be created. Also, an experimental method for controlling oxygen concentration in the ecosystem must be available.

The specific sub-objectives are:

1) Create a mass transfer/ bioreaction kinetics model for estimating oxygen concentration throughout the sediment as a function of sediment type, SOD, depth; and water velocity, temperature and BOD.
2) Create a technique for oxygenating the aquatic ecosystem to be used as an experimental control to determine the relative effects of oxygen on bioreactions affecting the concentration of antibiotic residuals and process to bioconcentrate and transfer resistance throughout aquatic organisms.

Accomplishments:

SOD model successfully created and verified against SOD chambers on one stream. Predicted SOD values were within 10% of chamber-based measured values. Model determined SOD independently from chamber measurements and no calibration or curve fitting was done to determine model parameters. Two refereed article published; several professional meeting presentations, abstracts and papers given on the SOD model; MS student, Danielle Charbonnet completed work on this project. Portable Water Ecosystem Oxygenator continued in development. A field-scale prototype was design, built and tested. Optimal operating parameters were experimentally determined. A release of the intellectual property for the device to the inventors was obtained and the process for assigning IP to U of A system initiated. Technology transfer for the device was initiated in partnership with Virtual Incubation Corp. of Fayetteville through BlueinGreen, LLC created specifically to license the device and raise capital to conduct further testing and transfer the technology to appropriate industries. Disclosure of the device was written and proposed to University of Arkansas. Two proposals for funding to support work on the oxygenator were submitted (one not funded, other is pending).

Nano-Biotechnology

Jin-Woo Kim, Assistant Professor, Biological and Agricultural Engineering, UAF
Russell Deaton, Professor, Computer Science and Computer Engineering, UAF
Ajay Malshe, Associate Professor, Mechanical Engineering, UAF
Steve Tung, Assistant Professor, Mechanical Engineering, UAF

Objectives:

1) Investigating the interface between biological and abiological materials at nanoscale; 2) and designing and fabricating a novel microfluidic pump actuated by biomolecular motors.

Accomplishments:

Nano-biotechnology is Bio-Inspired Nanoscale Science and Engineering for designing, fabricating, and utilizing nanometer scale (1 — 100 nm) structures as probes of the structural and functional properties of biological macromolecules, as biosensors, as central components of diagnostic and therapeutic approaches, and as tools to revolutionize agricultural and food systems, all with the intent to increase the functionality of bio-assays while reducing device footprint. The challenges are substantial, such as the diversity of material systems and their limited compatibility with biological systems, and a lack of understanding of biological and physical phenomena at nanometer-scale dimensions, yet the potential for important intellectual and technological payoffs underscores the need for solutions to the challenges.

One of the researches in my laboratory includes developing and understanding interface between the biotic world and abiotic world in nanometer scale. We seek to study the interface between DNA and gold for the purpose of making electronic devices that can manipulate DNA states including DNA hybridization. Ultimately, the goal of this research is to build and characterize the first Biologically Active Microelectronic Memory device. The developed method will lead to the development of a new family of micro/nanominature analytical devices capable biomolecular detection. The potential applications include bio/nano-sensing of medical diseases, pathogens, and environmental toxins. I have ongoing collaboration on the research with Dr. Ajay Malshe of Mechanical Engineering and Dr. Russell Deaton of Computer Science and Computer Engineering at the University of Arkansas.

Another area of focus is in the field of BioInspired Micro-Electro-Mechanical System (MEMS). In recent years, micro- and nano-fluidics have aroused considerable interest due to its potential groundbreaking impact on a wide range of science and engineering disciplines. In particular, the integration of bio- and abiosystems at micro- and nano-scales is the main focus of current research and development work in microfluidics because mastering of micro- and nano-scale fluid transport can dramatically improve the performance of biochemical analysis through significant reduction in the amount of fluids and reagents used during the tests. High performance microfluidics devices are needed to successfully develop a high-efficiency microfluidics system. Micro-electromechanical system (MEMS) technology is a precision manufacturing technique by which various microfluidics devices can be fabricated for diverse applications. Currently, many MEMS-based microfluidics devices and systems are being developed. Among them, however, the main challenge is the development of actuation mechanisms that is both efficient and reliable for micro/nano flow manipulation. Currently, we are investigating the realization of the next generation basic building blocks to address this issue through designing and testing “durable” cellular motors based self-powered microfluidics systems, utilizing tethered *Escherichia coli* cells for flow propulsion and control, that are important in various biological, chemical, genomic, and proteomic applications. Cell, flagella motor, and related cell “components” are some of the well engineered parts by nature over millions of years and instead of reinventing the wheels, the research offers an excellent opportunity to integrate such pre-engineered micro and nano bio-components into micro and nano transportation systems.

Nucleic Acid Technology

Jin-Woo Kim, Assistant Professor, Biological and Agricultural Engineering, UAF
Russell Deaton, Associate Professor, Computer Science and Computer Engineering, UAF
Junghuei Chen, Associate Professor, Biochemistry, the University of Delaware

Objectives:

Designing the DNA oligonucleotide building blocks for DNA-based computers and nanotechnology. Developing a new methodology for genome-enabled diagnostic systems.

Accomplishments:

DNA has several properties that make it attractive as a construction material for computers and structures on a nanometer scale. With the tools of molecular biology, DNA is easily manipulated in the test tube, can be produced in great quantities of specified size and sequence, and is relatively stable and long-lasting. Most importantly, the reaction in which short, single-stranded duplexes can be used to program the computation or to direct the self-assembly of the nanostructure. In addition, because of the massive parallelism of the reactions in the test tube, DNA computers have the potential to solve difficult problems efficiently. DNA computers also provide an intimate interface to the biological world for in vitro or in vivo sensing and processing of biological signals.

One of area of focus in my laboratory is DNA word design for computation. I have an ongoing collaboration on the research with Dr. Russell Deaton of Computer Science and Computer Engineering at the University of Arkansas. We are currently conducting research on designing the DNA oligonucleotide building blocks for DNA-based computers and nanotechnology.

We are also investigating a new methodology for genome-enabled diagnostic systems using DNA computing. The method accesses the wealth of information within the genomes of the untapped microbiota in nature to reveal their hidden biocatatytic potentials, and to access the genomic information of microorganisms at population through community scales to assess the impact of humans and non-human biota on an ecosystem. Using DNA computing, the storage of genomic information and discovery of sequence patterns is done in vitro. The protocol will be capable of learning DNA sequences in vitro from the microorganisms to which it is exposed, discovering similarities and differences in vitro between input and learned, memory molecules, and detecting hidden

biocatalytic potentials as well as ecological changes from the genomic information of all microorganisms, known or unknown, in a sample. By processing genomic information in vitro rather than *in silico*, the advantages are massively parallel sampling of the input DNA, ability to work with unknown organisms and sequences, and massively parallel recall and matching of DNA sequence content to detect changes in ecosystems. This research also is complementary to the following two focus areas [biocatalysis technology and environmental biotechnology] by providing a route to expand the investigation of ~ biocatalysts to untapped pools of microorganisms in the environment via traditional methods, accelerating the development of biocatalysts for applications in the pharmaceutical, chemical, and food industries, and environmental remediation. The proposed memory would also provide a better diagnostic tool for ecological monitoring that provides a holistic view of the genomic status of an ecosystem. In addition, the research would move toward medical diagnosis and in vitro analysis of gene expression patterns.

Acquisition of a High Accuracy/Resolution Landscape and Structure Characterization System (HARLS-CS) for Anthropology, Archaeology, Architecture, Biology & Geosciences

Fred Limp (PI), Director, Center for Advanced Spatial Technology, UAF
Sreekala Bajwa, Assistant Professor, Biological and Agricultural Engineering, UAF

Objectives:

The project was aimed at acquiring a set of high resolution equipment geo-spatial data acquisition applied to agricuture, anthropology, environment, geosciences, etc.

Accomplishments:

We have acquired several of the proposed items including a horizontal scanner, total station GPS unit, an elevated platform, etc. We are currently in the process of acquiring a digital camera, a multispectral camera with attitude controlled mount for remote sensing, and a spectro-radiometer for spectral data collection.

Adaptation of COTMAN for Use in UNR Cotton

Owen Gwathmey (PI), WTES, Jackson, TN;
Earl Vories, Professor, Biological and Agricultural Engineer ing, UAF
Bill Molin, USDA-ARS, Stoneville, MS;
Jack Reed, MSU, Starkville, MS;
Keith Edmisten, NCSU, Raleigh, NC;
Tom Cothren, TAMU, College Station, TX.

Objective:

To determine the main-stem node number of the last effective boll population in UNR and wide-row cotton as grown in a range of typical field environments.

Accomplishments:

Late-season crop management with COTMAN depends on identification of the last effective boll (LEB) population. An objective of this study was to improve adaptation of COTMAN by determining the LEB in UNR cotton (10-inch rows or less) in a range of typical field environments, as compared to wide-row cotton. A 3-year study was conducted in AR, MS, NC, TN and TX with replicated UNR and wide-row plots. Growth and development were monitored with COTMAN. First-position blooms were tagged with date and NAWF at anthesis. Tagged bolls were hand-picked, counted, and weighed by NAWF for each plot. Plots were also mechanically harvested for lint yield. Boll 'effectiveness' was evaluated by NAWF in terms of boll frequency, size, contribution to yield, and earliness. Data were statistically analyzed with NAWF data nested within row spacings. In UNR, more first-position seedcotton came from NAWF= 3 and 4 in AR, NC, and TN; from NAWF=4 in MS; and from NAWF= 5 to 8 in TX; than from other NAWF. In UNR, only 20 to 40% of first-position yield was accumulated up to and including NAWF= 5, except in TX (2003). Results suggest that in UNR, the LEB was set higher on the plant than NAWF=5 in most environments.

Application of precision agriculture technology to define and manage site-specific production constraints in southern soybean production systems

John Rupe, Professor, Entomology, UAF
Sreekala Bajwa, Assistant Professor, Biological and Agricultural Engineering, UAF
Rick Cartwright, Professor, Dept. of Scrop, Soil, & Environmental Sciences, UACES, Little Rock, AR
Terry Krikpatrick, Professor, Dept. of Crop, Soil, & Environmental Sciences, UACES, Hope, AR
Subodh Kulkarni, Graduate Student, Biological and Agricultural Engineering, UAF

Objectives:

The project was aimed at developing precision agriculture technology for managing soybean cyst nematode in Arkansas.

Accomplishments:

Soybean cyst nematode (SCN) is a serious problem in all soybean growing areas within the USA. The soybean plants often show no symptoms but yield reduction can go up to 100% in severely affected areas. Even mild levels of nematode reduce the grain yield by up to 10-15 bushels acre. In the first of year of this project, we have conducted field experiments at two fields, one at Pine Tree Experiment Station in Colt, and another at a producer's field in Prairie

County called Hartke field. Pine Tree field had 3 treatments, a SCN susceptible variety (Hutcheson), Hutcheson + aldecarb, and a resistant variety, Anand. The treatments were replicated 5 times resulting in 15 strip plots. The Hartke field had two treatments, Hutcheson and Anand. Hartke field did not develop significant levels of SCN in 2003. The pine tree field showed the effect of treatments. At harvest cyst numbers were highest in Hutcheson plots, followed by Hutcheson+aldecarb. Anand field showed no cysts at the time of harvest. This experiment shows that resistant cultivar is the best method to control SCN. Due to the relatively low yield of resistant varieties, there is opportunity for site-specific variety planting to manage SCN. The experiment will be repeated in one field in 2004, with the whole field planted with susceptible cultivar, Hutcheson. This will enable us to map the distribution of SCN within the field that will aid site-specific management in 2005.

Determining the Optimum Timing for the Final Furrow Irrigation on Cotton Based on Crop Monitoring

Earl Vories, Professor, Biological and Agricultural Engineer ing, UAF
Tina Teague, Agricultural Research, Arkansas State University
Jeremy Greene, Extension Entomologist, Southeast Research Extension Center
William Robertson, Cotton Specialist, Cooperative Exten- sion Service
Phil Tacker, Research Associate Professor, Biological and Agricultural Engineering, UAF
Joel Faircloth, formerly Cotton Specialist, Macon Ridge Experiment Station, Winnsboro, LA;
Bobby Phipps, Cotton Specialist, Delta Research Center, Portageville, MO;
Chris Sansone, Assoc. Professor and Extension Entomolo gist, Texas Cooperative Extension, San Angelo, TX;
Tommy Doederlein, Extension IPM Agent, Texas Coopera tive Extension, Lamesa, TX.

Objectives:

The objective of this research is to determine the optimum timing for the final irrigation on cotton based on crop monitoring. Ten irrigation studies were conducted in four states (MO, AR, LA and TX) during the 2003 growing season to investigate the response to late-season irrigation. Two were not completed and data from one were not yet available. Only one mid-South study showed significant differences in cotton yield with late-season irrigation. Efforts were begun to combine the studies from different locations and years. On drip-irrigated cotton, yields were not affected by shutting the water off as early as 400 DD60 after NAWF=5,

Accomplishments:

Plans for next year include an earlier treatment. A new study, conducted using a center pivot system utilizing LEPA technology, indicated that terminating LEPA irrigation at 400 DD60 past NAWF=5 or before is too soon. Additional studies are planned.

Improving Corn Irrigation Practices and Recommendations in Arkansas (Year 3/3)

Earl Vories, Professor, Biological and Agricultural Engineer ing, UAF
Phil Tacker, Research Associate Professor, Biological and Agricultural Engineering, UAF
Jason Kelley, CSES, CES;
Jeremy Ross, Area Agronomy Specialist, Crop, Soil, and Environmental Sciences, Cooperative Extension Service

Objectives:

1. Develop a new crop coefficient curve for irrigation scheduling of corn.
2. Determine whether the corn crop coefficient curve needs to be adjusted for maturity of the particular hybrid being grown.
3. Field test the resulting Irrigation Scheduler program for corn.

Accomplishments:

Field studies were conducted at NEREC and corn verification fields. Three hybrids of different relative maturities were planted early April on 38” rows at NEREC. The drip irrigation system was operated from June 1 until July 24 at rates of 100% and 60% of the estimated evapotranspiration (ET), along with a nonirrigated check. Restricted surface drainage impacted early-season growth and no significant yield differences were observed. The irrigation system worked well at allowing the application of precise amounts of water. Irrigation data and observations

Improving Cotton Irrigation Practices and Recommendations in Arkansas (Year 3/3)

Earl Vories, Professor, Biological and Agricultural Engineer ing, UAF
Phil Tacker, Research Associate Professor, Biological and Agricultural Engineering, UAF
Tina Teague, Agricultural Research, Arkansas State University
Derrick Oosterhuis, Distinguished Professor, Crop, Soil, and Environmental Sciences, UAF
Kelly Bryant, AECD, Southeast Research Extension Center

Objectives:

1. To develop a new crop coefficient curve for computerized irrigation scheduling.
2. To devise a system of in-season adjustments to the irrigation scheduling program.
3. To develop a crop-based indicator compatible with COTMAN data collection to predict the need to irrigate cotton.

Accomplishments:

A study was conducted at NEREC to validate the crop water use function for cotton in the Arkansas Irrigation Scheduler, with subsurface drip irrigation to precisely control the water applied. Wet soil conditions delayed planting and frequent rains prevented the development of excessive soil water deficits and little difference was observed in the yield, earliness of fiber quality in the study. A second study at NEREC, dealing with furrow irrigation timing, was also impacted by rain and significant yield or quality effects were not observed.

Improving cotton irrigation recommendations in Mid-South

Sreekala Bajwa, Assistant Professor, Biological and Agricultural Engineering, UAF
Earl Vories, Professor, Biological and Agricultural Engineering, UAF

Objectives:

The research objective is to identify cotton plant's response to water stress as a change in canopy temperatures and to investigate the possibility of using that information for precise irrigation scheduling. This approach is expected to save the amount of water used for irrigation while using the water more effectively based on the needs of the plants.

Accomplishments:

The project commenced on January 2004. Currently we are developing experimental design for conducting an irrigation experiment with different levels of water applica tions so as to generate water stress in cotton plants. We will be monitoring canopy temperature and soil moisture tension on a continuous basis. Soil electrical conductivity data for the experiment field was measured with a VERIS system. Infrared thermocouples were acquired for canopy temperature measurement. Both spectral data and remote sensing data will be collected during July-August period for quantifying moisture stress in cotton.

Improving Yield and Yield Stability for Irrigated Soybean (year 3/3)

E. D. Vories, Professor, Biological and Agricultural Engi neering, UAF
P.L. Tacker, Research Associate Professor, Biological and Agricultural Engineering, UAF
L.C. Purcell, Associate Professor, Crop, Soil, and Environmental Sciences, UAF
T.L. Kirkpatrick, Plant Pathology, Southwest Research Extension Center
Moye Rutledge, Professor, Crop, Soil, and Environmental Sciences, UAF
L.R. Oliver, University Professor, Crop, Soil, and Environmental Sciences, UAF

Objectives:

To investigate methods for improving yield and yield stability of irrigated soybean, allowing more profitable production for Arkansas conditions. Specific objectives include:

1. Determine the optimum timing of the final irrigation on soybean.

2. Determine whether soil moisture in some Arkansas soils is naturally recharging by the start of the next cropping season.
3. Determine whether irrigation management can compensate for some of the damage caused by soybean cyst nematode.
4. Refine, extend and validate the relationships used in the irrigation scheduling program.
5. Conduct on-farm irrigation demonstrations with interested county agents and producers.

Accomplishments:

Field studies under Obj. 1 were conducted at NEREC and SEBES. At SEBES, yields were not significantly different for a treatment with irrigation as recommended versus one additional irrigation. At NEREC more treatments were included; however, some treatments could not be made due to rainfall, and little could be concluded from the limited data. Soil moisture wells (Obj. 2) are currently being installed. The nematode study (Obj. 3) employing microplots to allow for more control was completed, and preliminary results suggested more frequent watering might help salvage yield. Image analysis was used to test an assumption for soybean water use in the Irrigation Scheduler program (Obj. 4). On-farm demonstrations included working with producers on: border irrigation; hipped row irrigation of drilled soybeans; irrigation scheduling; furrow irrigation; and using irrigation tubing to provide multiple inlet irrigation to a levee-irrigated field.

Online NIR technology to quantify beef quality

Sreekala Bajwa, Assistant Professor, Biological and Agricultural Engineering, UAF
Jason Apple, Associate Professor, Dept. of Animal Sciences, UAF
Jean-Francois Meullenet, Associate Professor, Dept. of Food Science, UAF
Jayarani Kandaswami, Graduate Student, Biological and Agricultural Engineering, UAF

Objectives:

The project goal is to develop an online NIR sensor for quantifying beef quality. Specific objectives are to quantify tenderness of beef stakes with NIR data, and to predict tenderness of aged beef from NIR observations within 72 hours postmortem. A second objective is to predict fat and cholesterol content in ground beef patties.

Accomplishments:

We have conducted one set of experiment to estimate fat and cholesterol in ground beef patties. The first trial of this experiment included 8 levels of fat from 0-35% at 5% increments. The different fat levels were obtained by mixing lean and fat tissues. Each batch or treatment consisted of 30 patties, whose NIR reflectance spectra were collected immediately after they were made. Five of the patties were selected randomly for measuring pH, moisture, and fat. Ten patties from each batch were randomly selected for cooking. The patties were cooked until the inside temperature reached 71^{0}F. NIR reflectance of cooked patties was measured by slicing them into half and measuring the reflectance with an ASD Spectra-radiometer. The cooked patties were send to meat processing lab to test for cholesterol levels. Preliminary data analysis showed significant difference between the NIR reflectance of patties with different fat levels. The data will be further analyzed using chemometrics to model fat and cholesterol contents based on NIR reflectance. A second experiment is being carried out to test the capability of NIR technology for estimating beef tenderness. Sample beef stakes were collected and the NIR reflectance of raw stakes were measured within 72 hour of slaughter. The stake samples are then cooked and tested for their shear strength, which is a measure of tenderness, using WB shear test and razor blade shear test. The data will be analyzed and the preliminary results will be used to attract funding from Beef Council and USDA.

Pesticide Pollution Risk Assessment and Mitigation Training in Arkansas Delta

Sreekala Bajwa, Assistant Professor, Biological and Agricultural Engineering, UAF
Dennis Gardisser, Associate Head Extension, Research Professor, Biological and Agricultural Engineering, UAF
Indrajeet Chaubey, Assistant Professor, Biological and Agricultural Engineering, UAF
Vibhav Srivastav, Graduate Student, Biological and Agricultural Engineering, UAF

Objectives:

The research objectives were to identify pesticide pollution in La'Anguille watershed in Arkansas Delta caused by the heavy agricultural pesticide usage, and model the risk of pollution to surface water bodies using GIS and water quality modeling tools. The knowledge gained through the study will be used to train stakeholders on pesticide pollution mitigation.

Progress:

The project started on October 2003. In the short time period, we have acquired some equipment (computer) and software (PCI Geomatics), and initiated geo-spatial data acquisition. A landsat data for spring 2003 was ordered through Arkansas View program. Data on water shed boundary layers, and commercial applicator location was already obtained. GIS data on soil hydro-geological properties were ordered from NRCS through GIS lab

Precision Farming Technology for Developing Subsoiling Guidelines in Arkansas

Sreekala Bajwa, Assistant Professor, Biological and Agricultural Engineering, UAF
Gary Huitink, Research Associate Professor, Biological and Agricultural Engineering, UAF
Subodh Kulkarni, Graduate Assistant, Biological and Agricultural Engineering, UAF

Objectives:

The goal of the research is to evaluate precision technologies such as VERIS and remote sensing for identifying and mapping soil compaction levels in an agricultural field. Information on field soil compaction can be used for developing subsoiling guidelines in cotton agriculture in Arkansas. Avoiding subsoiling in a field can save up to $15 per acre.

Accomplishments:

Field experiments were conducted in Arkansas Agricultural Experiment Station (AAES) field in Fayetteville, and a grower's field in Forrest City in 2003. Fayetteville field experiment included 4 treatments of different levels of compaction, and 4 replications. Forrest city field had 2 treatments, subsoiled and not subsoiled, and 3 replications. Data collected from Forrest City field include COTMAN data, soil compaction with a cone penetrometer, apparent electrical conductivity with a VERIS machine, and lint yield with a yield monitor. Data collected from Fayetteville field included soil compaction, canopy reflectance with a spectro-radiometer, plant population, and final lint yield. One set of remote sensing data was col lected for Fayetteville field and 3 sets of remote sensing data was collected for Forrest City field.
Preliminary data analysis showed that yield was not significantly ($p > 0.05$) correlated to field compaction. Soil electrical conductivity showed very high correlation ($r > 0.9$) with soil compaction in both fields. There was also significant difference between the germination at the compacted vs non-compacted fields in Forrest City. Additional analysis has to be performed with the crop response to compaction monitored through remote sensing. A paper on research findings was presented at the 2003 Beltwide cotton conference.

(CSES). SWAT has been selected for preliminary water quality analysis. The next step will be to classify Landsat image into landcover classes for water quality modeling, and to calibrate SWAT model for L'Anguille watershed.

Remote sensing to detect moisture and SDS stresses in soybean

Johnny Mason, Graduate Student, Biological and Agricultural Engineering, UAF
Sreekala Bajwa, Assistant Professor, Biological and Agricultural Engineering, UAF
John Rupe, Dept of Entomology, UAF

Objectives:

The overall goal of this research is to develop a method to detect the type, severity, and spatial distribution of sudden death syndrome (SDS), soybean cyst nematode (SCN) and water stresses in a soybean crop from remotely sensed data.

Accomplishments:

Experiments were conducted at plot scale and microplot scale in summer of 2002 and 2003. Microplot experiment included 5 varieties, and 4 treatments. The four treatments were control, SDS inoculated, SCN inoculated, and SDS+SNC inoculated. The plot-scale experiment included four varieties, 4 water treatments, and two SDS treatment (inoculated or uninoculated). Nematode counts were made at the beginning and the end of the season. Hyperspectral canopy reflectance data was collected on a weekly basis in 2002 and bi-weekly basis in 2003. Initial data analysis showed several wavelengths as significant in detecting SDS stress.

The project was terminated in August 2003 as our graduate assistant left this program and we were unable to find a replacement for the training grant. Two papers were presented on the outcomes of this research.

Site-specific Sensing and Precision Management of Plant Nitrogen in Rice Crop

Sreekala Bajwa, Assistant Professor, Biological and Agricultural Engineering, UAF
Rick Norman, Professor, Crop, Soil, & Environmental Sciences, UAF
Ashish Mishra, Graduate Student, Biological and Agricutural Engineering, UAF

Objectives:

The research objectives were to test and validate optical sensing technology for plant nitrogen estimation and management in rice.

Accomplishments:

Field experiments were conducted at RREC in Stuttgart, AR in summer 2002, and in Pine Tree Experment Station in Colt, AR in 2003. Experimental design included 6 different nitrogen rates of 0, 30, 60, 90, 120, and 150 lbacre. The 2002 study included two rice varieties Wells and Cocodrie. In 2003, experiments were conducted with only Wells variety, but a mid-season application of 0 and 45 lb acre were made on the plots. Data was collected on rice reflectance, biomass, and tissue nitrogen content in both years. In 2004, rice moisture content was also measured. Data analysis showed that tissue and plant nitrogen were highly correlated to rice reflectance. Tissue nitrogen showed higher correlation with final rice yield, and plant reflectance than plant nitrogen or nitrogen yield. We have identified, 400, 500, 676, and 700 nm as most indicative of nitrogen stress in rice. These bands mainly correspond to pigment absorption caused by various pigments such as chlorophyll, carotenoids, and xanthophylls. A paper on the research finding will be presented at the 2003 ASAE annual meeting. A paper was presented on this research. A manuscript is under preparation.

Systems of Controlling Air Pollutant Emissions and Indoor Environments of Poultry, Swine, and Dairy Facilities

Thomas A. Costello, Associate Professor, Biological and Agricultural Engineering, UAF
Jim Wimberly, President, Foundation for Organic Resources Management
Frank Jones, Research Professor and Extension Section Leader, Cooperative Extension Service
G. Tom Tabler, Project Manager, Center of Excellence for Poultry Science, UAF

Objectives:

1) To quantify and describe the processes of air pollutant emissions from poultry, swine and dairy facilities, with emphasis on ammonia and other gaseous nitrogen compounds generated from poultry production housing and litter storage and treatment facilities.

2) To design, test and evaluate systems for achieving indoor environmental conditions within poultry, swine and dairy production facilities, with emphasis on methods to optimize air quality and decrease fuel costs.

Accomplishments:

Efforts are continuing in the evaluation of commercial prototype litter to energy systems, with the goal being to heat poultry buildings using poultry litter as a fuel. A new demonstration project was initiated to test a furnace built by an Arkansas manufacturer (Lynndale, Inc., Harrison, Ark, project described in a separate report). Tests will include laboratory as well as on-farm measurements. There is a potential for significant fossil fuel energy consumption by poultry growers to be offset by manure/ litter combustion. Use of litter as an energy source has the extra environmental benefit of decreased phosphorus runoff associated with manure applications to land in sensitive watersheds dominated by poultry production.

A Nutrient Management Decision Support System for the Eucha Basin

Marty Matlock, Associate Professor, Biological and Agricultural Engineering, UAF
Indrajeet Chaubey, Assistant Professor, Biological and Agricultural Engineering, UAF
Brian Haggard, Assistant Professor, Biological and Agricultural Engineering, UAF
Dan Storm, Professor, Biosystems and Agricultural Engineering, Oklahoma State University, Stillwater Oklahoma
Mike Smolen, Coordinator, Biosystems and Agricultural Engineering, Oklahoma State University, Stillwater Oklahoma
Will Focht, Director, Environmental Institute, Oklahoma State University.

Objective:

The goal of this project is to develop a watershed nutrient management decision support system (DSS) for developing comprehensive watershed nutrient management strategies for both agricultural and urban landscapes. This DSS will provide a risk-based approach to identifying all substantial nutrient sources within watersheds at field, farm, and watershed scales over daily-to-annual time periods, and will incorporate site-specific terrestrial, atmospheric, and hydrologic components of nitrogen and phosphorus nutrient cycles. Processes that act to remove nutrients from the watershed will be quantified using ecosystem models and bio-indicators. We will integrate risk-based decision-making theory with geographic information system (GIS)-based watershed modeling (Surface Water Assessment Tool, or SWAT) and reservoir modeling (CE-QUAL-W2) to create a decision support system that links land use practices with reservoir water quality. We will use SWAT as the watershed model backbone for the DSS and link it with a risk-based scenario generator. The DSS will integrate a GIS ecosystem model with a stakeholder-driven risk-based nutrient management decision process, using bio-indicators and water quality data for validation. We will accomplish this goal by completing the following objectives:

1. Develop a GIS ecosystem model decision support system (DSS) to provide risk-based information on sources and fate of nutrients within watersheds (terrestrial and aquatic).
2. Develop a stakeholder input and advisory structure to guide the development and implementation of the risk-based DSS.
3. Develop seasonal external phosphorus load thresholds for Lake Eucha using in situ algal bioassays and a reservoir model.
4. Evaluate the effectiveness of the nutrient management DSS in the Eucha Basin and develop management alternatives for implementation.

We have developed initial stakeholder strategies, and are completing the first phase of modeling efforts. We will be collecting field data and convening stakeholder meetings this year.

Animal Manure and Waste Utilization, Treatment and Nuisance Avoidance for Sustainable Agriculture

Marty D. Matlock, Associate Professor; Biological and Agricultural Engineering, UAF
Thomas A. Costello, Associate Professor; Biological and Agricultural Engineering, UAF
Indrajeet Chaubey, Assistant Professor; Biological and Agricultural Engineering, UAF

Objectives:

1) To develop animal waste management strategies and management tools that optimize efficient, environmentally-friendly utilization of nutrients, compatible with sustained land and water quality.

2) To develop nutrient treatment processes (physical, chemical, biological) in engineered and natural systems for management of manures and other wastes.

Accomplishments:

Poultry waste impacts on water quality are being addressed using computer-aided management tools and by developing alternatives to land application. Decision support systems (DSSs) are currently being developed. A preliminary Nutrient Management Decision Support System has been outlined and is being integrated into a study watershed. This DSS uses a watershed-level model to predict nutrient transport within watersheds. The accuracy of model predictions has been studied as a function of input data resolution. For sediment, nitrate, and total phosphorus predictions, minimum DEM data resolution ranged from 30 to 300 m; whereas, minimum land use and soils data resolution ranged from 300 to 500 m.

Once calibrated and validated, the DSS may assist watershed managers in selecting an optimal approach to protecting and enhancing ecosystem health and meeting expected uses of water resources by the public, agriculture and industry. Management plans which include alternatives to land application of animal manures will help decrease nutrient loadings to streams and lead to improvements in water quality.

Demonstration of Greenway Development To Protect Ecological Services in Urban Streams

Luanne Diffin, City of Rogers, Arkansas
Marty Matlock, Associate Professor, Biological and Agricultural Engineering, UAF
Robert Morgan, Graduate Student, Biological and Agricultural Engineering, UAF
Marc Nelson, Assistant Professor, Arkansas Water Resources, UAF

Objective:

The objective of this project is the demonstration of a greenway approach for preservation and restoration of ecological integrity of urban streams. This project will demonstrate the greenways approach in the Blossom Way arm of Osage Creek Greenway, located between Dixieland Drive and 26th Street in Rogers, Arkansas. The measure of success in technology transfer will be the participation of stakeholders in regional meetings (at least 20), participation in the educational curriculum by secondary and higher education (at least 100 students total), and participation in regional and national workshops (at least 150 total). Inputs from the participants in the stakeholder meetings and workshops will be incorporated in the greenway design and restoration plans. Finally, technical success of the implementation of the plan will be assessed based on stabilized stream peak flow and stage events, reduced sediment transport, and improved ecological services in the stream reach.

We have completed collection of field data and formulation of the stakeholder group. We have met with officials and developed design and construction strategies. We developed curricula for undergraduates and high school students in collaboration with Ms. Elleen Hutchison, a teacher at the Rogers High School. Construction of the greenway began in October, 2003.

Development of a decision support system and data needs for the Beaver Lake watershed

I. Chaubey, Assistant Professor, Biological and Agricultural Engineering, UAF
M. Matlock, Associate Professor, Biological and Agricultural Engineering, UAF
T.A. Costello, Associate Professor, Biological and Agricultural Engineering, UAF
B.E. Haggard, Assistant Research Professor, Biological and Agricultural Engineering, UAF
K.L. White, Graduate Student, Biological and Agricultural Engineering, UAF
S. Formica, Environmental Preservation Division, Arkansas Department of Environmental Quality

Objectives:

(a) organize the water quality data collected by various agencies involved with monitoring the Beaver Lake watershed into a GIS-linked database;

(b) develop a decision support system (DSS) (beta version) with limited scenario analyses to quantify effect of land management on stream and lake water quality; and

(c) outreach to Arkansas Soil and Water Conservation Commission, Arkansas Department of Environmental Quality, and BLWP on using the DSS and the GIS-linked water quality database.

Accomplishments:

A common database containing water quality and watershed data has been created. A significant progress has been made in creating the DSS. The beta version of the DSS will be released in April 2004.

Development of an integrated water conservation – water quality program in the Arkansas Delta

I. Chaubey, Assistant Professor, Biological and Agricultural Engineering, UAF
M. Matlock, Associate Professor, Biological and Agricultural Engineering, UAF
E. Vories, Professor, Biological and Agricultural Engineer ing, UAF
J. Popp, Assistant Professor, AEAB, UAF
T.A. Costello, Associate Professor, Biological and Agricultural Engineering, UAF
P. Tacker, Research Associate Professor, Biological and Agricultural Engineering, UAF

Objectives:

Our goal is to develop, implement, and evaluate a decision support system (DSS) for developing comprehensive watershed nutrient management strategies and water conservation. The DSS will integrate a GIS ecosystem model with a stakeholder-driven risk-based nutrient management and water conservation decision process, using economic and water quality data for validation. The DSS will have education and extension components that will be used to better inform policy makers in developing the most equitable regional water quality improvement strategies. We will accomplish this goal by completing the following objectives:

1. Quantify linkages among water use, water conservation, water quality, and ecosystem response at various geographic scales (farm to watershed scale).
2. Develop comprehensive cost-benefit analyses of the water conservation and water quality management practices to optimize row-crop agricultural production and water quality improvement.
3. Develop a GIS ecosystem model decision support system (DSS) to provide analyses of alternative agricultural practices, their effects on water quality, and associated economic and environmental benefits.
4. Develop education/demonstration programs to educate stakeholders (farmers, extension agents, state and federal agencies) on linkages among farm level activities and watershed scale water quality response.

Accomplishments:

This is a three year project started in September 2003. We have selected fields for instrumentation. The field instrumentation will be completed by May 2004.

Differentiating Runoff Contributing Areas from Pastures for Phosphorus Management

I. Chaubey, Assistant Professor, Biological and Agricultural Engineering, UAF
B.E. Haggard, Assistant Research Professor, Biological and Agricultural Engineering, UAF
T.A. Costello, Associate Professor, Biological and Agricultural Engineering, UAF
K.L. White, Graduate Student, Biological and Agricultural Engineering, UAF

Objectives:

(a) Develop and test a field-scale methodology to measure the location of different runoff-contributing areas from pastureland; and

(b) Relate the spatial variability of field runoff in pastureland to hydrologic, topographic, and soil characteristics.

Accomplishments:

We have built surface runoff sensors and subsurface saturation sensors to delineate runoff contributing areas from a landscape. The sensors have been installed in three fields at the Savoy Experimental watershed.

GIS database development and watershed modeling in the Arkansas Priority watersheds

I. Chaubey, Assistant Professor, Biological and Agricultural Engineering, UAF
M. Matlock, Associate Professor, Biological and Agricultural Engineering, UAF
T.A. Costello, Associate Professor, Biological and Agricultural Engineering, UAF

Objectives:

Prepare basic GIS data needed for the 9 priority watersheds in Arkansas to model watershed response
Calibrate SWAT model for hydrology and apply SWAT model to make watershed response predictions
Train ASWCC personnel on use of GIS data and model
Develop and publish user manual to use GIS data and SWAT model
Host GIS data base, and models in the Biological and Agricultural Engineering Watershed Modeling Laboratory.

Accomplishments:

A watershed modeling laboratory has been developed with the funding from this project. This laboratory currently supports research of a Ph.D. student, a Post Doctoral Research Associate and a Research Technician. We have completed the watershed modeling for three watersheds.

Growth Chambers for Bio-Regenerative Life Support

Thomas A. Costello, Associate Professor, Biological and Agricultural Engineering, UAF
G. Scott Osborn, Assistant Professor, Biological and Agricultural Engineering, UAF
William Dillahunty, Undergraduate Student, Biological and Agricultural Engineering, UAF
James Geurtz, Undergraduate Student, Biological and Agricultural Engineering, UAF
Clay McDaniel, Undergraduate Student, Biological and Agricultural Engineering, UAF
John Sager, Agricultural Engineer, Kennedy Space Center, NASA
Ray Wheeler, Plant Physiologist, Kennedy Space Center, NASA

Objectives:

1) To develop and improve research infrastructure for the study of bio-regenerative life support systems, mainly focused on low pressure plant growth chambers to simulate greenhouse conditions on the Moon or Mars.

2) To develop and improve hardware and software for the control of experiments in bio-regenerative life support, including plant growth chambers and bio-reactors used to investigate human life support for long-term space missions.

Accomplishments:

Long-term space missions, such as the establishment of outposts on Mars or the moon, will require bio-regenerative life support systems. Because of the high cost of transporting clean water, oxygen and food, long-term missions require recycling the by-products of life—including human wastes, food wastes and exhaled carbon dioxide. Controlled plant growth chambers provide astronauts with a system which can utilize these by-products to grow food, capture and utilize nutrients, condense clean water and generate oxygen. Bio-regenerative life support will essentially utilize greenhouses on a planetary outpost to help sustain the astronauts with a minimum of transported inputs other than energy. Controlling plant growth micro-environments to insure the life-sustaining productivity will require computer-based instrumentation and components for lighting, heating, cooling, chamber pressure and gas composition control.

Biological engineers have established expertise in providing micro-environmental control for terrestrial (Earth) biological systems, such as greenhouse crops and poultry/livestock rearing facilities. Faculty and student efforts were recently initiated to focus that expertise on bio-regenerative life support, in collaboration with engineers and scientists at NASA's Kennedy Space Center (KSC). Biological engineering faculty have been working with student teams (most recently in BENG 4813/4822, Senior Biological Engineering Design I, II, a required capstone design sequence in the B.S. in Biological Engineering program) to develop plant growth chambers which could be used to test crops in an environment similar to a Mars greenhouse. Students designed, built and tested a hypobaric growth chamber in 2002-2003 at the Biological Engineering Research Laboratories in Fayetteville. The UA faculty adviser connected the students with NASA contacts that were developed while working at KSC during the summers of 2002 and 2003. The students designed a low pressure growth chamber to simulate plant growth conditions at a Mars outpost.

During faculty fellowships in 2002 and 2003, UAF faculty have contributed expertise in biological systems controls. Indoor environmental control technologies were applied to plant growth chambers used by NASA to study bio-regenerative life support. Control algorithms were developed to control chamber humidity using vapor pressure rather than relative humidity as the process variable. A digital PID algorithm was tested that used multiple regression in time to predict trends in vapor pressure to allow anticipatory adjustments to both the humidifier and de-humidifier. A fuzzy logic algorithm was also tested. The algorithms were implemented using autonomous programmable logic controllers. The PID algorithm improved humidity control compared to the existing commercial controller.

Faculty expertise has been utilized to update growth chamber controls and monitoring systems at KSC. Students are contributing exploratory design projects to help develop technology needed to grow food on Mars. Biological engineering student design teams working with NASA placed third nationally in the 2001, and first nationally in 2003 at the ASAE National Student Design Competition. Continued collaborations between NASA and UA faculty and students will help to inspire our next generation of explorers, on earth and in space.

Engineering Design and Evaluation of Animal Waste Management Systems in Arkansas

Thomas A. Costello, Associate Professor, Biological and Agricultural Engineering, UAF

Indrajeet Chaubey, Assistant Professor, Biological and Agricultural Engineering, UAF

Frank Jones, Research Professor and Extension Section Leader, Cooperative Extension Service

G. Tom Tabler, Project Manager, Center of Excellence for Poultry Science, UAF

Objective:

1) To design, test and evaluate systems for storing, treating and utilizing animal waste, particularly poultry litter, including development of alternate uses for litter and for management of litter application to minimize nonpoint source pollution.

Accomplishments:

Computer models have been explored as a means to assess the impact of land applied animal waste and to evaluate the effectiveness of various best management practices (BMPs). The impact of poultry litter applications on water quality was studied using the Soil and Water Assessment Tool (SWAT) model. The resolution of the input data set used with SWAT was hypothesized to affect the quality of the model predictions. The resulting uncertainties of SWAT model estimates of sediment, nitrate nitrogen (NO3-N), and total phosphorus (TP) transport were compared for various levels of input data resolution (measured hydrologic, meteorologic, watershed characteristics and water quality data from Moores Creek watershed in Washington County, Arkansas). The SWAT model output was most affected by input DEM data resolution. For sediment, NO3-N, and TP predictions, minimum DEM data resolution ranged from 30 to 300 m; whereas, minimum land use and soils data resolution ranged from 300 to 500 m. A demonstration project has been initiated to test and evaluate a biomass-fired furnace that uses poultry litter as a fuel to provide space-heat for broiler houses (project described separately). A litter-fired furnace manufactured by Lynndale, Inc (Harrison, Ark.) will be tested at the UA Engineering Research Center, Fayetteville, Ark., and the UA Applied Broiler Research Facility, near Savoy, Ark. Testing will provide measures of furnace efficiency, emissions, labor requirements, and demonstrate the extent of litter incineration and ash production.

Many poultry farmers located in sensitive watersheds are looking for alternative ways to utilize poultry litter. Use of the litter combustion technology could help offset land applications of manure and decrease the loading of nutrients into streams and lakes. When litter is applied to pastures and hay fields, the SWAT model and other computer-based management tools can be used to select strategies that minimize runoff of nutrients.

Optimizing BMPs, Water Quality, and Sustained Agriculture in the Lincoln Lake Watershed

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T.A. Costello, Associate Professor, Biological and Agricultural Engineering, UAF
K. VanDevender, Research Associate Professor, Biological and Agricultural Engineering, UAF
M.A. Nelson, Assistant Professor, Arkansas Water Resources
K. Teague, Cooperative Extension Service
M. Gross, Cooperative Extension Service

Objectives:

(1) Develop an integrated watershed management plan by incorporating a process of public participation, issue identification, and consensus building,

(2) Collect chemical and biological stream and Lincoln Lake water quality data to determine the improvement in water quality as a result of previously implemented BMPs and to indicate problems that should be the focus of future BMP implementation,

(3) Perform a GIS-based integrated assessment of resource allocation, BMP effectiveness and BMP needs that can sustain long-term agricultural production in the watershed while maintaining environmental quality, and

(4) Organize field trips/demonstration of stakeholders, farmers, and state agencies to educate them on the integrated watershed management process and linkages between farm-level production and water quality.

Sustainable Agriculture and Water Resources in Arkansas: A bioenvironmental engineering solution

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M. Matlock, Associate Professor, Biological and Agricultural Engineering, UAF
T.A. Costello, Associate Professor, Biological and Agricultural Engineering, UAF
E. Vories, Assistant Professor, Biological and Agricultural Engineering, UAF
B.E. Haggard, Assistant Research Professor, Biological and Agricultural Engineering, UAF

Objectives:

The overall goal of this project is to address water quantity and quality problems in Arkansas. We have identified three specific needs that will be addressed in this project.

1. Estimation of water budget and ET measurement to accurately predict crop water requirements in Arkansas Delta
2. Quantification of external P load threshold for drinking water quality management in the Beaver Lake
3. Quantification of pharmaceutical and antibiotic residuals in streams in Northwest Arkansas.

The following objectives will be accomplished in this project

1. Quantify linkages among water use, water conservation, water quality, and ecosystem response at various geographic scales (farm to watershed scale).

2. Develop seasonal external P load thresholds for Beaver Lake using in situ bioassays.

3. Measure and assess concentrations of pharmaceutical and antibiotic residuals in water samples from northwest and north-central Arkansas streams.

4. Disseminate information to state/federal agencies, stakeholders, and other interested groups.

This project will supplement another ongoing project titled "Development of a Decision Support System and Data Needs in the Beaver Lake watershed" funded by the USEPA under 319 (h) program. All the data collected will become part of the Decision Support System. The two projects will thus work synergistically and provide a much stronger tool for water quality management.

Accomplishments:

This is a three year project that started in September 2003. We have selected sites for data collection which is scheduled to start in May 2004.

Use of hyperspectral imaging in lake water quality modeling

I. Chaubey, Assistant Professor, Biological and Agricultural Engineering, UAF

V. Garg, Graduate Student, Biological and Agricultural Engineering, UAF

Objectives:

1. To acquire Hyperspectral and water quality data for Beaver Lake.

2. To model water quality from remote sensing image.

3. To parameterize and initiate lake water quality models using spatially distributed water quality inputs in a GIS format.

Accomplishments:

We have been collecting remotely sensed water quality data for the Beaver Lake. In addition, ground-truthing data are also collected to develop models for water quality determination using remotely sensed data.

A Model for Pathogen Lethality and Heat/ Mass Transfer of Meat Thermal Processing

R.Y. Murphy, Research Assistant Professor, Biological and Agricultural Engineering, UAF

Objectives:

Cooking serves as the primary means of eliminating pathogens in ready-to-eat meat products and protecting the public from foodborne disease. Inadequate cooking is a major contributing factor that leads to outbreaks of foodborne illness. Since 2001, millions of pounds of ready-to-eat meat products have been recalled due to inadequate cooking. Currently, there are no standard operation procedures that help food processors to collect scientific data required to demonstrate the effectiveness of their cooking processes. The goal of this project was to help food processors effectively control their cooking process and eliminate pathogens from ready-to-eat meat products. Based on the fundamentals of cooking processes, in this research, we determined the effect of various elements on pathogen destruction and developed a tool to predict pathogen lethality that correlated cooking time with product temperature for all thermal processes, including hot water cooking, steam cooking, smoking, frying, and convection cooking.

Accomplishments:

The model provides scientific basis for process validation by achieving statistical process controls. The model also helps federal regulatory agencies in monitoring and reviewing a thermal process. Only through a better understanding of the commercial operations and knowledge of the effect of operating conditions on food safety, product quality, and yield will it become possible to successfully control meat and poultry thermal processes based on scientific knowledge. The development of this model was based on real products in commercial systems and the model was validated using real products under commercial processing conditions in prototype commercial systems.

An Electrochemical Method to Destroy Pathgenic Bacteria in Brine Chilling Water for Cooked Poultry and Meat Products

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Michael Slavik, Professor, Poultry Science, UAF
Carl Griffis, Professor, Biological and Agricultural Engineering, UAF
Betty Swem, Research Specialist, Poultry Science, UAF
Zhihui Liu, Graduate Assistant, Biological and Agricultural Engineering, UAF

Objectives:

1. To develop an electrochemical method to inactivate *Listeria monocytogenes* and aerobic bacteria in chilling brine.
2. To design and construct the electrochemical treatment chamber and optimize the parameters.
3. To evaluate the electrochemical method with industrial samples in both laboratory and pilot plant scale tests.

Accomplishments:

A laboratory-scale flow-through electrochemical treatment system was designed and constructed and the effects of the parameters (current level, waveform, residence time and chamber diameter) on inactivation of *L. monocytogenes* were studied. The results indicated that the treatment at 5 A current level, with 0.75 inch chamber, for 3 s residence time reduced *L. monocytogenes* in initial brine (0 h) and used brine (20 h) by 5.95 and 1.8 log CFU/ml, respectively. There was no significant difference in *L. monocytogenes* reduction between pulsed and non-pulsed waveforms. Measured values of absorbency, chlorine, and pH of the brine slightly increased after treatments. This laboratory-scale treatment system was also evaluated for its efficacy to inactivate *L. monocytogenes* in recirculated brine for chilling thermally processed poultry and meat products. An average D-value of 1.61 min in the storage tank was achieved even at 7 mA/cm^3 current level with the fresh brine (t = 0 h). For the used brine (t = 20 h), the average D-value was 2.5 min in the treatment chamber at a current level of 35 mA/cm^3, and increased to 9.4 and 61.2 min at current levels of 17.5 and 7 mA/cm^3. Different materials including platinum, titanium and glass carbon were investigated for different design of electrodes in their shapes (rod, pipe or plate) and dimensions (both diameter and length). The laboratory-scale electrodes and treatment chambers have been designed and constructed and the microbial testes are being conducted to determine the bacteria destruction rate. A pilot-plant-scale electrode and treatment chamber were designed and constructed based on the results of the laboratory-scale tests. The pilot-plant electrochemical treatment system is being tested using a portable brine chiller provide by ALKAR Inc.

This project is leading to an innovative antimicrobial technology for treatment of food processing water, specifically low temperature chilling brine. This cost-effective flow-through system can be applied to the control of bacterial contamination during chilling food products. The results of this project will provide the food processors with a new, cost-effective method to destroy *L. monocytogenes* in brine chiller water to minimize product recalls, extend recirculating time of brine chilling water and solve the environmental problem related to discharging high concentration salt water. Consequently, consumers will have safer cooked poultry and meat products.

Biocatalysis Technology

Jin-Woo Kim, Assistant Professor, Biological and Agricultural Engineering, UAF
Robert Beitle, Associate Professor, Chemical Engineering, UAF
Ed Clausen, Professor, Chemical Engineering, UAF
Tonya L. Peeples, Chemical and Biochemical Engineering, University of Iowa

Objectives:

Realizing the hidden biocatalytic potentials of the vast natural abundance of untapped microorganisms in conjunction with industrially and medically relevant biotransformations.

Accomplishments:

The use of biocatalysts in the industrial processes for the production of novel chemicals and pharmaceuticals has enormous potential. Biocatalysts exhibit exquisite catalytic power — high selectivity and environmental friendliness — unmatched by conventional catalysts. However, limited access to microbial genome information and gene products restricts biocatalyst screening to a few known microorganisms. In fact, a high proportion of extant species have never been investigated. Traditional culturing methods limit analysis to those that grow under laboratory conditions. A very high proportion of microbial species are currently "unculturable", and an estimated 1-10% of bacteria and 0.1-1% of archaea are known and available for scientific research. This leaves a vast amount of untapped resources for the discovery of novel biocatalysts.

To this end, we are investigating the hidden biocatalytic potentials of the vast natural abundance of untapped microorganisms in conjunction with industrially and medically relevant biotransformations. In particular, organisms that thrive in extreme environments are of interest in the production of highly stable enzymes and in the development of innovative bioprocesses. Individual organisms may live at temperatures near boiling or under high pressures, in the presence of high salt or in highly acidic environments. Most of these extremophiles belong to a recently defined domain of microbes known as the Archaea. Much of these works require evaluations of microbial physiology using molecular biology, microbiology, classical cellular physiology, and bioprocess design as tools of discovery. In addition, substantial works at

Capillary Electrochemical/optical Biosensors for Rapid Detection of Pathogenic Bacteria in Poultry and Meat Products

Yanbin Li, Professor, Biological and Agricultural Engineering, UAF
Xiaoli Su, Graduate Student, Biological and Agricultural Engineering, UAF
Byungchul Kim, Graduate Student, Food Science, UAF

Objectives:

1. To develop immuno-electrochemical and optical biosensing methods based on capillary bioseparator/bioreactors for separation of target bacteria from food samples and enzymatic amplification.
2. To design and fabricate a prototype biosensor based on the biosensing method to be developed in Objective 1 by assembly the components of sample pretreatment, biosensing devices and electrochemical/optical transducers into an automated instrument.
3. To evaluate the biosensor for detection of *Escherichia coli O157:H7, Salmonella Typhimurium*, and *Listeria monocytogene* in raw and cooked poultry and meat products.

Accomplishments:

A biosensing system, including a capillary column-based bioseparator/bioreactor and a flow injection bienzyme eletrode or spectrophotometer, has been developed for rapid detection of *E. coli O157:H7*. Anti-*E. coli O157:H7* antibodies were chemically immobilized onto the inner wall of the column for use in tests. Samples and enzyme-labeled antibodies were pumped through the column, and the "sandwich" immuno-complexes (immobilized antibody-*E. coli O157:H7*-enzyme-labeled antibody) were formed. Then, different substrates were pumped through the column to obtain the product of enzymatic reaction in the bioreactor. The peak current and the absorbance in 400 nm of the product were measured using an electrochemical detector and an optical detector, respectively. In electrochemical measurement, an amperometric tyrosinase-horseradish peroxidase biosensor in a flow injection system was designed to detect the phenol concentration that is proportional to the cell number of *E. coli O157:H7*. The effects of blocking agent, flow rate, buffer, $MgCl_2$ and pH on detection of *E. coli O157:H7* were investigated.

The biosensor developed can detect *E. coli O157:H7* and *S. Typhimurium* with a working range from 5.0 ´10^1 to 5.0 ´10^6 CFU/ml and the total assay time was less than 1.5 h without any enrichment. The relative standard deviation was 2.0~7.3%. S. *Typhimurium* in milk could be identified with a detection limit of 8.6´10^2 CFU/ml by using electrochemical measurement without any enrichment or pretreatment. *Listeria monocytogenes*, *E. coli O157:H7* and S. Heidleberg did not interfere with the detection of S. *Typhimurium*. The optimum parameters, 2% BSA in 1.0 ´ 10^{-2} M, pH 7.4 PBS as the blocking agent, 0.5 ml/h as the sample flow rate, 1.0 ´ 10^{-2} M $MgCl_2$ and 2.0 ´ 10^{-4} M p-nitrophenyl phosphate in 1.0 M, pH 9.0 Tris buffer as the substrate for the enzymatic reaction and 1.0 ml/h as the substrate flow rate, were determined. The technique has potential for rapid detection of *E. coli O 157:H7* and other pathogenic bacteria by immobilizing specific antibodies onto the inner wall of the capillary column. The biosensor will provide the food industry with more rapid, sensitive and cost-effective method for detection of pathogens in food products, which will assist the industry to ensure

Chemiluminescent Fiber Optical Biosensor for Rapid Detection of *Escherichia coli O157:H7* and *Salmonella Typhimurium* in Food Samples

Yanbin Li, Professor, Biological and Agricultural Engineering, UAF

Steve Tung, Assistant Professor, Mechanical Engineering, UAF

Madhukar Varshney, Graduate Student, Biological and Agricultural Engineering, UAF

Ballaji Venkatesh, Graduate Assistant, Mechanical Engineering, UAF

Objectives:

1. To develop chemiluminescent fiber optic biosensor coupled with immuno-microbeads separation for detection of *Escherichia coli O157:H7* and *Salmonella Typhimurium* in food samples.
2. To design and fabricate a prototype biosensor by assembling the components of sample pretreatment, biosensing devices and optical transducer into an automated instrument.
3. To evaluate the biosensor for detection of E. *coli O157:H7* and *S. Typhimurium* in raw and cooked poultry and meat products and fresh vegetables.

Accomplishments:

A chemiluminescence biosensor, consisting of a chemiluminescence reaction cell, a fiber optic light guide, a luminometer and a data acquisition unit connected to a PC, was developed in conjunction with immunomagnetic separation for rapid detection of *E. coli O157:H7* and *S. Typhimurium*. Magnetic microbeads coated with anti-*Salmonella* antibodies and anti-*Salmonella* antibodies conjugated with horseradish peroxidase (HRP) were added to food samples, and the immuno-reaction was completed in 60 min resulting in a sandwich complex. A magnetic field was applied to collect magnetic beads and the addition of luminol to HRP-conjugated antibodies resulted a chemiluminescence reaction. The signal was collected through a fiber optic light guide, measured with a photometer, and recorded in the data acquisition unit. The chemiluminescence biosensor was specific to *E. coli O157:H*7 in samples containing other bacteria including *S. Typhimurium,* Campylobactor *jejuni* and *Listeria monocytogenes*. The chemiluminescence signal was linear on log scale from 10^2 to 10^5 CFU/ml of *E. coli O157:H*7 in samples. The whole detection could be completed within 1.5 h without any enrichment. The detection limits for ground beef, chicken carcass and lettuce samples were 3.2´10^2, 4.4´10^2 and 5.5´10^2 CFU/ml of *E. coli O157:H*7, respectively. The minimum detection limit of the chemiluminescence biosensor for S. *Typhimurium* was 1.97x10^3 CFU/ml and the range of the detectable signal was from 8.6 to 350 mV for cell numbers from 1.97x10^3 to 1.97x10^6 CFU/ml. Signals for 10^6 CFU/ml of S. *Typhimurium* were at least 97 and 394% higher than the corresponding values for S. enteritidis and four times the signal values for others including S. montevideo, S. california, S. heidlberg, and S. seftenberg respectively. The biosensor response showed a significant difference ($p < 0.05$) between 10^3 CFU/ml *S. Typhimurium* and 10^6 CFU/ml of commonly-occurring bacteria in foods including *L. monocytogenes*, Pseudomonas aeruginosa, Citrobacter freundii, C. *jejuni*, *E. coli O157*, and generic E. *coli*. A regression equation, $y = 0.0262\ x^{5.3833}$, with $R^2 = 0.9723$ was obtained for the calibration curve over the detection range for *S. Typhimurium*. The whole procedure could be completed within 90 min and an automated, compact biosensor could be designed based on this study.

Determining the Physical, Chemical and Genetic Mechanisms Responsible for Fissure Resistance of Rice

Dr. Scott Osborn, Assistant Professor, Biological and Agricultural Engineering, UAF
Shannon Pinson, Ph.D., Research Geneticist, USDA-ARS,

Objective:

The objective of this project is to create a reliable, effective technique for developing fissure-resistant rice varieties. This project will identify and quantify the relationship between important physical and chemical properties of the rice kernel and resistance to field fissuring. The relative importance of the contribution of each physicochemical property to fissure resistance will also be determined. This knowledge on the chemical and physical properties affecting kernel fissuring will allow us to more accurately and efficiently identify and molecularly tag genes affecting resistance to field fissuring. Molecularly tagged genes and evaluation methods developed by this project will allow breeders to more rapidly and consistently develop improved rice varieties as fissure-resistant as the variety 'Cypress'. Furthermore, the knowledge that will be developed on how chemical and physical properties of the rice kernel interact to affect fissure resistance is also expected to reveal chemical pathways and novel genetic combination that can provide milling stability beyond that of Cypress'.

Accomplishments:

Further testing on rice varieties grown in different years was performed. This work supported and provided ndergraduate research experience to five undergraduate students. The minimum amount of rice required to accu rately determine milling yield was reduced from several kilograms to 900 grams by developing a top harvest technique to reduce the variability between rice kernels collected from the field.

The field fissuring mathematical model was refined to predict a "fissuring index" for varieties based on lab tests. The index was compared to field observations for four varieties made over several crop years. The index accu rately predicted fissuring resistance for all four varieties. The index also provided data used to determine the specific physiological mechanisms responsible for providing fissure resistance for each of the varieties tested. This information led to the unexpected discovery of high fissure resistance capabilities within the endosperm of Teqing (this variety as a whole exhibits poor fissure resistance). Also, the effect of shape on fissure resistance is being studied and appears to contribute less to resistance than earlier thought.

Prahlad Jat, a PhD student, was recruited to manage the research on this project and pursue a dissertation topic related to this work. Additional funding to support this work was sought through two proposals (pending).
Two presentations at professional technical meetings were made. One technical paper and one abstract were also published from this work.

Environmental Biotechnology

Jim-Woo Kim, Assistant Professor, Biological and Agricultural Engineering, UAF

Objectives:

Developing environmentally relevant biotechnology to degrade recalcitrant pollutants.

Accomplishments:

Due to their comparatively low cost and generally benign environmental impact, bioremediation technologies offer attractive alternatives and/or supplements to conventional contamination clean-up technologies. The enormous natural capacity and the amazing physiological versatility of microorganisms to degrade organic compounds form the basis for bioremediation. However, many environmental biotechnologies are slower and still operated on "black box" principles, and their performance often lacks efficiency, reliability and predictability. Without accelerating microbially mediated processes, and a clear perspective of the system to be remedied, accompanied by an understanding of the mechanisms and products of biodegradation, it is difficult to apply bioremediation technology for the restoration of contaminated sites with any consistent success. In order to overcome these concerns, more systematic studies to enhance the rate of biodegradation processes are need to facilitate proper design of bioreaction systems and system optimization by mathematical modeling process.

To this end, my laboratory focuses on the research to develop and evaluate engineered bioreaction systems for cost-effective and efficient environmental remediation. In particular, biological remediation of chemical warfare agents and pesticides is of interest. Much of this work requires screening and physiological characterization of microbes that can survive in the presence of pollutants using nucleic acid technology as well as traditional cultivation based methods, design and development of biocatalytic systems, in particular, immobilized cell/ enzyme systems, and their evaluation and optimization through process analysis and mathematical modeling.

Extraction of Flavonolignans from Milk Thistle

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Ed Clausen, Professor, Chemical Engineering, UAF
Gisela Erf, Associate Professor, Poultry Sciences, UAF
Sunny Wallace, Graduate Student, Biological and Agricultural Engineering, UAF
Senthil Subramanian, Graduate Student, Biological and Agricultural Engineering, UAF
Lijun Duan, Graduate Student, Chemical Engineering, UAF
Katie Vaughn, Graduate Student, Biological and Agricultural Engineering, UAF

Objectives:

1. To study the extraction process by characterizing the extraction step and by replacing organic solvents with water.
2. To determine if the addition of milk thistle extracts to cell culture medium in the presence of oxidative stress inducers will at least protect or possibly enhance lipopolysaccharide-induced immunological functions of macrophages (microbicidal and tumoricidal activities), reduce oxidative damage to the cell, and have a sparing effect on cellular antioxidant systems.

Accomplishments:

We are continually developing our water based extraction process on our milk thistle model system. Sunny Wallace has completed her MSc, which focuses on the evaluation of organic solvents at various temperatures for the extraction of the milk thistle compounds. Three publications resulted from her work in Applied Biochemistry and Biotechnology, Journal of Nutraceutical, Functional and Medicinal Foods and Phytochemical Analysis. Senthil Subramanian has started his MSc (Summer 2002) and he is working on replacing the solvent-based pretreatment step by a water process. We anticipate that M Subramanian will graduate in the spring or summer of 2004 and will publish one publications. The PhD student, Liju Duan, has successfully passed his Chemical Engineering preliminary exams and is well on his way of completing his experimental work, consisting of extraction of at temperatures above 100 °C.. He has one publication in Applied Biochemistry and Biotechnolog. We anticipate that he will be finishing in the summer of 2004. Ms Wallace is pursuing a PhD at the University of Arkansas. We have a proposal pending with NIH (1 R21 AT001851-01) aimed at examining the effect of milk thistle extracts on the oxidative stress of the macrophage cultures. This work has started in collaboration with Dr. Erf.

Extraction of Lycopene from Watermelon

Danielle Julie Carrier, Associate Professor, Biological and Agricultural Engineering, UAF
Ed Clausen, Professor, Biological and Agricultural Engineering, UAF
Gisela Erf, Associate Professor, Poultry Sciences, UAF
Luke Howard, Professor, Food Science, UAF
Katie Vaughn, Graduate Student, Biological and Agricultural Engineering, UAF

Objective:

How to best extract lycopene from watermelon pulp and to determine its biological activity.

Accomplishments:

Katie Vaughn has obtained her MSc in December 2003. We are in the process of re-submitting a manuscript to Journal of Food Science. We obtained funding from the Arkansas Bioscience Institute to study the effect of lycopene supplementation on the oxidative stress status of macrophage cultures. Katie is now hired as a Research Associate. We have one group proposal pending with NRI Lycopene-rich Product Development from Watermelon in collaboration with Oklahoma State University and the USDA Lane-Oklahoma research station.

Impedance Immonusensors for Rapid Detection of Pathogens in Food Products

Yanbin Li, Professor, Biological and Agricultural Engineering, UAF
Simon Ang, Professor, Electrical Engineering, UAF
Michael Johnson, Professor, Food Science, UAF
Liju Yang, Graduate Student, Biological and Agricultural Engineering, UAF
Rami Al-Haddad, Graduate Student, Biological and Agricultural Engineering

Objectives:

The overall goal of this research is to develop impedance immunosensors for rapid detection of live *Escherichia coli O157:H7*, *Salmonella Typhimurium*, and *Listeria monocytogene* in food products. The supporting objectives are:

1. To develop impedance immunosensing methods based on interdigitated microelectrodes for microsystem and specific growth medium for differentiation between live and dead cells.
2. To evaluate the impedance immunosensor for detection of *E. coli O157:H7*, *S. Typhimurium,* and *L. monocytogene* in poultry, meat, dairy and vegetable products.

Accomplishments:

Three-electrode electrochemical impedance technique was investigated for detection of *S. Typhimurium* by monitoring the growth of bacteria in selenite cystine broth supplemented with trimethylamine oxide hydrochloride and mannitol. The change in the system impedance during the growth of bacteria was studied using frequency spectral scanning. It was found that the impedance at low frequencies (<10 kHz) mainly came from the double-charged layer capacitance, reflecting the changes at the electrode interface and the adsorption on the electrode surface. While at high frequencies (>10 kHz), the system impedance mainly depended on the medium resistance.

Interdigitated microelectrodes (IMEs) were used in the impedance measurement for detection of viable *S. Typhiumrium* in a selective medium and milk samples. The impedance growth curves, impedance against bacterial growth time, were recorded at 10, 100, 1000 Hz during the growth of *S. Typhiumrium*. The impedance did not change until the cell number reached 10^5-10^6 CFU/ml. Bacterial attachment to the electrode surface was observed using scanning electron microscopy, which was the major contribution to the change in double layer capacitance of the IME, and consequently to the impedance. The detection times obtained from the impedance growth curves at 10 Hz had a linear relationship with the logarithmic value of the initial cell number in the sample. The regression equations for the cell numbers between 4.8 and 5.4 x 10^5 CFU/ml were t_D =- 1.38 Log N + 10.01 and t_D=-1.57 Log N +11.39 in the pure medium and milk samples, respectively, both with R^2= 0.99. The detection times for 4.8 CFU/ml and 5.4 x 10^5 CFU/ml initial cell numbers were 9.33 h and 2.17 h. The detection limit could be as low as 1 cell in a sample. The biosensor being developed in this project would provide the food industry with more rapid, sensitive and cost-effective method for detection of viable pathogenic bacteria in food products for ensuring food safety and food security.

PCR-based Fluorescent Biosensing Methods and Quartz Crystal Microbalance-based Immunosensor for Rapid Detection of Major Pathogens in Food Samples

Yanbin Li, Professor, Biological and Agricultural Engineering, UAF
Michael Slavik, Professor, Poultry Science, UAF
Hong Wang, Research Specialist, Poultry Science, UAF
Xiaoli Su, Graduate Student, Biological and Agricultural Engineering.
Xiaole Mao, Graduate Student, Biological and Agricultural Engineering, UAF

Objectives:

1. To develop a PCR-based fluorescent biosnesing method for rapid detection of *S. Typhymuirum*, *C. jejuni*, *E. coli O157:H7* and *L. monocytogenes* in poultry samples.
2. To develop a quartz crystal microbalance-based immunosensor for rapid detection of *E. coli O157:H7* with a flow-through instrument.

Accomplishments:

A DNA binding fluorescence method based on polymerase chain reaction (PCR) products was evaluated for rapid detection of *Salmonella Typhimurium* in poultry products. Wash water samples of chicken carcasses and ground turkey were inoculated with *S. Typhimurium* to obtain final concentrations of 10^0-10^5 CFU/ml. One ml of

each sample was used to get the DNA template and 5 ml of the sample template was added into 25 ml of SYBR Green PCR Master Mix and two specific *Salmonella* ompC gene primers. The negative control was the same except 5 ml of each wash solution was added instead of 5 ml sample template. The reaction was carried out in a thermocycler. Finally, the fluorescence signal of each PCR product was measured using a fluorometer. The PCR products were also confirmed by ethidium bromide agarose gel, and the DNA concentrations of the PCR products were measured by a filter fluorescence photometer. The results showed that when bacterial cells increased from 0 to 2 CFU/ml, the fluorescence signal increased significantly. The PCR-based fluorescence method could detect the target bacteria in minutes after PCR amplification compared to hours by gel electrophoresis and also could be done at an earlier time during PCR amplification. The detection limit of this method for *S. Typhimurium* in the poultry samples was 2 CFU/ml without any enrichment. In the tests being conducted, similar results have been obtained for detection of C. *jejuni*, E. coli O157:H7 and *L. monocytogenes*.
A quartz crystal microbalance (QCM)-based immunosensor was developed for rapid detection of *Escherichia coli O157:H7*. It was based on the immobilization of affinity-purified antibodies onto a monolayer of 16-mercaptohexadecanoic acid, a long-chain carboxylic acid-terminating alkanethiol, self-assembled on an AT-cut quartz crystal's Au electrode surface with N-hydroxysulfosuccinimide ester as a reactive intermediate. The binding of target bacteria onto the immobilized antibodies decreased the sensor's resonant frequency, and the frequency shift was correlated to the bacterial concentration. The stepwise assembly of the immunosensor was characterized by means of both quartz crystal microbalance and cyclic voltammetry techniques. Three analytical procedures, namely immersion, dip-and-dry and flow-through methods, were investigated. The immunosensor could detect the target bacteria in a range of 10^3-10^8 CFU/ml within 30-50 min, and the sensor-to-sensor reproducibility obtained at 10^3 and 10^5 CFU/ml was 17.9% and 11.3% RSD, respectively. The QCM immunosensor was comparable to Protein A-based piezoelectric immunosensor in terms of the amount of immobilized antibodies and detection sensitivity.

Predictive Models and Quantitative Risk Assessment Models for *Salmonella Typhimurium* and *Campylobacter jejuni in* Poultry Production, Processing and Distribtion System

Yanbin Li, Professor, Biological and Agricultural Engineering, UAF
Phil Crandall, Professor, Food Science, UAF
Betty Swem, Research Specialist, Biological and Agricultural Engineering, UAF
Abani Pradhan, Graduate Student, Biological and Agricultural Engineering, UAF

Objectives:

1. To develop predictive models for the survival/growth/death and cross-contamination of *Campylobacter jejuni* and *Salmonella Typhimurium* on eggs, chickens, carcasses and processed meat during production and processing.
2. To develop quantitative risk assessment model for S. *Typhimurium* and *C. jejuni* in a poultry systems.
3. To perform quantitative microbial risk assessment of poultry products based on Monte Carlo simulation using @Risk software.

Accomplishments:

Experiments have been conducted to collect the data for *S. Typhimurium* and *C. jejuni* on chicken skins and in processing water with various conditions (temperature, time, age of water, chlorine level, chemical spray and initial cell concentration). Predictive models have been developed for predicting survival/growth/destruction of *S. Typhimurium* and *C. jejuni* on chicken carcasses and in processing water. A cross-contamination model for poultry chilling process was also investigated. A probability model, P = 1/[1+exp(-y)], was developed based on the data, where P is the probability of an individual chicken drumstick being contaminated after chilling, and y is a linear function of treatment factors, pre-chill incidence, total chlorine level in chill water, and the age of chill water. This model can be used to predict post-chill contamination probability based on the pre-chill incidence and the chlorine level, and, conversely, it can be used to define the pre-chill percent contamination and chlorination requirement for controlling post-chill contamination. A quantitative risk assessment model has been developed based on the collected and reported data using Monte Carlo simulation with Analytica software. The risk model can present the probability of microbial hazards in terms of percentage of contaminated carcasses or pathogen level of each carcass for given processing conditions. The predictive microbial models will provide poultry processors with a powerful tool to analyze the survival/growth/death and cross-contamination of pathogenic bacteria on poultry carcasses and in processing water under various processing conditions. The microbial risk assessment model will assist the poultry processor in their HACCP programs and risk management in a quantitative way. Consumers will benefit from safer poultry products and the society will benefit from reduced foodborne diseases and related medical costs.

Quality and Safety for Thermal Processed Foods

R.Y. Murphy, Research Assistant Professor, Biological and Agricultural Engineering, UAF

Objectives:

The aim of this project is to evaluate commercial processes for ready-to-eat meat and poultry products and determine the factors that affect food safety, product quality, and product yield during cooking, cooling, post cook pasteurization, and storage. Different types and sizes of commercial products, including fillets, formed patties, tenders, nuggets, strips, franks, hams, logs, and various bone-in skin-on products, were studies. The processes that were evaluated include air/steam impingement oven, fryer, smoke house, steam and hot water cooker, various pasteurizer (steam, hot water, and flash), refrigeration system, and freezer. The models are developed to determine the pathogen thermal lethality, thermal profile, and product yield in different cooking systems for different meat and poultry products. Pathogen lethality, water purge, and sensory attributes were determined for fully cooked and vacuum packaged meat and poultry products during post cook pasteurization via steam or hot water.

Accomplishments:

The low infectious dose required for pathogens dictates that successful prevention must focus on reducing, controlling, or eliminating the microorganisms with a HACCP (hazard analysis and critical control point) plan. The results from this research will be applicable to many different thermal food processes and a variety of food products for which pathogen contamination is a significant issue. The results from this research will help to reduce food-borne illness outbreaks and product recalls among ready-to-eat foods, which have cost hundreds of millions of dollars in the industry and forced many small and large U.S. companies out of business.

Searching for Valuable Compounds in Bioenergy Crops

Danielle Julie Carrier, Associate Professor, Biological and Agricultural Engineering, UAF
Ed Clausen, Professor, Chemical Engineering, UAF
Gisela Erf, Associate Professor, Poultry Sciences, UAF
Luke Howard, Professor, Food Science, UAF
Jack Lay, State-Wide Mass Spectrometry Facility, UAF
Rohana Liyanage, State-Wide Mass Spectrometry Facility, UAF
David Bransby, Professor, Agronomy & Soils, Auburn University
Chuan Lau, Graduate Student, Chemical Engineering, UAF

Objective:

To detect health beneficial compounds in bioenergy crops and their corresponding biological activity.

These compounds would be extracted from the biomass before the firing process. Identification of such compounds would add value to existing commodities.

Accomplishments:

In collaboration with Dr. David Bransby of Auburn University, we are extracting compounds from energy crops, such as mimosa, serecia and kudzu and examining their oxygen radical capacity absorbance (ORAC) poten tial. We were able to determine that the major compounds that convey the ORAC activity of the mimosa extract are quercitrin and hesperetin. Two publications are stemming from this work: Applied Biochemistry and Biotechnology and Journal of Food and Agricultural Chemistry. We have We obtained funding from the Arkansas Bioscience Institute to study the effect of mimosa extract on the oxidative stress status of macrophage cultures. This work will be carried out by Lijun Duan as soon as he finishes his Ph.D.

Thermal Process Validation

R.Y. Murphy, Research Assistant Professor, Biological and Agricultural Engineering, UAF

Objectives:

The overall objective of this program is to deliver science-based knowledge and educational programs to industry to enable their employees to make practical decisions in achieving performance standards. Our program focuses on two areas of food operations,

(1) cooking and
(2) post-cook handling.

In our research, products were inoculated with *Salmonella* Senftenberg and *Listeria monocytogenes* and processed in prototype commercial cooking equipment at the University of Arkansas. Factors that affected pathogen lethality under commercial operating conditions were evaluated. Both pathogen process lethality and real time pathogen survival/kill models were established.

In order to better prepare our students to solve the real world food safety problems, we developed a senior level course on thermal processing and food safety.

During the semester, each student was required to complete a project generated from a commercial thermal process. We also developed an on-line training course on pathogen process lethality through the Institute of Food Science and Engineering at the University of Arkansas. This is an internet-based distance-learning program for food safety professionals in industry. In addition, we have offered the workshops on thermal process validations to transfer our research findings to industry.

Accomplishments:

Our program is to help processors to achieve performance standards at the same time to optimize their operations in order to improve product quality and yield. This project will help processors to control and validate thermal processes and document the elimination of pathogens from processed foods. Our research will benefit to entire processed food industry. The information from this project will also be important to government agencies and food scientists. Currently, very limited information is available for directing commercial processes.

EXTENSION PROJECTS

Extension and Outreach Programs

Agricultural Chemical Applications

Dennis R. Gardisser, Research Professor, Biological and Agricultural Engineering, Extension Engineer, Cooperative Extension Service

Objectives:

1. Improve chemical application efficiency - to increase efficacy.
2. Reduce the potential for drift and demonstrate ways to be better environmental stewards.

Accomplishments:

The primary emphasis of this program continues to be making chemical applications safer and more effective. Concepts have been directed at reducing drift, making applications more uniform, and ensuring that chemicals are placed on the target in a form that will enhance the mode of action. A variety of teaching techniques, from hands on field demonstrations to classroom instruction, have been used to convey recommended practices. Over 1,000 aircraft pattern analyses were performed on more than 186 Arkansas aircraft for both spray and granular type applications at eleven agricultural aviation workshops conducted by Extension. Ground application workshops have also been conducted featuring specifically targeted instruction to enhance chemical applications for the following general group categories: ground operated custom applicators, cattlemen, lawn and turf, row crop producers, forestry, research and technology, agricultural chemical development, and marketing groups. In addition, several new concepts have been evaluated and adopted by equipment manufacturers.

Drift reduction demonstrations were conducted at four aerial application workshops again this year to help applicators determine the effects of several different operating parameters. These parameters included: application speed and height, use of drift control agents, nozzle setup and design, and operating pressure. A major effort was made at this year's fly-ins to help aerial applicators correctly calibrate their equipment to help avoid major drift concerns.

Extension has also provided many additional government agencies with guidance and assistance concerning chemical application problems.

Application guidelines were developed and presented as an ongoing part of pesticide license recertification for all types of commercial and private applicators. Arkansas engineers provided leadership during the planning and conducting of a nationwide Drift Educators – PAT conference held in Sacramento, CA.

I continue to provide leadership with the "National Drift Minimization Coalition" and serve as the technology cochair for that group. I served on the new PAASS (Professional Aerial Applicator Support System) content committee and have assisted with that program on numerous phone conferences.

Calibration workshops and application accuracy demonstrations for all types of chemical applications will continue to be a major focus.

Annual ADEQ Regulation No. 5 Annual Refresher Training

Karl VanDevender, Research Associate Professor, Biological and Agricultural Engineering, Extension Engineer, Cooperative Extension Service
Justin Calhoun- Extension Associate, Cooperative Extension Service
Jodie Pennington- Extension Dairy Specialist,
Mike Daniels- Extension Environmental Management Specialist,
Wavey Austin NRCS Environmental Engineer,
Keith Brown ADEQ Manager State Permits Branch Water Division

Objectives:

The Arkansas Department of Environmental Quality's Regulation No. 5 requires all producers that utilize water in the management of their animal manure to be permitted. A requirement of the permit is annual refresher training in the area of manure management. The Extension service is required by the regulation to provide this training. Each year 7 swine, 4 dairy, and 3 poultry meetings are held to satisfy the training requirements of over 450 regulation No. 5 permits. While Extension has the responsibility of providing the meetings, ADEQ, NRCS, Industry groups and other agencies are active participants in the development and presentation of the curriculum. Extension's effort is partially covered by various EPA 319(h) grants.

Progress:

All 14 meetings were held in the spring of 2003 with approximately 700 individuals representing permitted farms, industry personnel, and agency groups attending.

Controlled Ambient Aeration as a Pest Management Strategy in Stored Rice

Terry J. Siebenmorgen, Professor, Food Science, UAF
Frank Arthur, USDA-ARS, GPMRC,
Loyd T. Wilson, Professor, Entomology, Texas A&M University
Dennis Gardisser, Research Professor, Biological and Agricultural Engineering, Extension Engineer, Cooperative Extension Service
Michael Boyd, Entomologist, University of Missouri Delta Research Center.

Objectives:

1. Survey county agents in Texas, Louisiana, Arkansas, and Missouri to determine current rice storage practices on the farm, including: aeration practices, pesticide use practices, and historical predatory insect problems. (Year one)
2. Use controlled ambient aeration in farm-scale bins of rice (in the Southern and Delta rice-growing regions) to reduce insect populations while maintaining rice quality. (Years one and two)
3. Use controller data to generate an actual cost analysis for controlled aeration vs. fumigation (Years one and two)
4. Use climatological data to develop aeration management strategies for stored rice throughout the rice-growing region in the Southern US. (Years two and three)
5. Through extension publications, field days, meetings, web sites, and other venues, provide rice producers, county extension agents, consultants, and other interested parties with recommendations for effective inhibition of insects using controlled aeration. (Year three)

Accomplishments:

Rice producers in all 4 states have been surveyed. Arkansas had 152 completed responses. A region survey summary has not been completed. Rice producers/cooperators were identified in Texas, Missouri, and Arkansas. Bins from cooperators in each of these states were utilized to pursue objectives 1 and 2. Data from these bins is being processed - all still have rice in them or have just recently been emptied. A CES in-service training session was conducted to outline the project and objectives to CES county agents - 57 in attendance.

No formal publications to date. CSREES annual report has been submitted and a poster was developed and exhibited at the RREC field day in August 2002.

Funding: CSREES - ~ $365,000, 3 year project.

Equipment and Techniques for Reduced Tillage and No-tillage (Corn, Grain Sorghum, Rice, Soybeans, Wheat and Cotton)

Gary Huitink ,Research Associate Professor Biological and Agricultural Engineering, Extension Engineer, Cooperative Extension Service
Roger Eason, Director of Pine Tree Experiment Station,

Objectives:

Provide seeding equipment recommendations that meet Arkansas growers' needs, i.e., achieve rapid emergence of corn, grain sorghum, rice, soybeans, wheat and cotton, in no-tillage and reduced tillage environments.

Provide recommendations that will assist in reducing Arkansas growers' costs of grain and cotton production.

Provide recommendations that help Arkansas growers reduce soil loss from their grain and cotton fields in order to reduce sediment loads in streams that drain cropped watersheds, to further the accomplishment of soon-to-be mandated TMDL criteria.

Accomplishments:

Consultation, field days, demonstrations and meetings showed growers practical techniques to improve seeding corn, cotton, rice, soybeans, wheat and grain sorghum. Replicated studies have demonstrated the effectiveness of direct seeding, crop rotation and reduced traffic for these crops; county agents, consultants, growers and others are using these data and recommendations. An estimated two-thirds of the wheat crop and one-third of the soybean crop were direct-seeded (no-tillage). Approximately 1 million acres are now subsoiled annually in Arkansas, using recommendations based on UA research and education. Subsoiling developments pioneered in Arkansas are being imitated in educational efforts in Louisiana, Mississippi, Missouri and Tennessee.

The Cooperative Extension Service has developed guidelines, based on research conducted at the Pine Tree Experiment Station and Cotton Branch Experiment Station. The University of Arkansas Cooperative Extension Service guidelines are available in print and are also published on the Cooperative Extension Service web site.

Farm Safety Programs

Gary Huitink, Research Associate Professor, Biological and Agricultural Engineering, Extension Engineer, Cooperative Extension Service
County Extension Agents, Cooperative Extension Service, University of Arkansas
Andy Guffey, Safety Director, Arkansas Farm Bureau
Jeremy Wesson, Safety Director, Arkansas Farm Bureau
Larry Davis, Safety Director, Southern Ginners Association, Memphis, Tn

Objectives:

The primary thrust is educating rural residents on ways to avoid common hazards.

Teaching rescue personnel better techniques in Farm Accident Rescue "hands-on" training (2-days) to help them get victims to an emergency room during the golden hour.

Accomplishments:

Agriculture is a dangerous work environment; however, farm fatalities in Arkansas have declined from 19 in 1999 down to 10 in 2003 (latest complete UA CES data base). A variety of educational activities have roles in reducing farm injuries and fatalities in Arkansas. As the invited speaker, topics of "Approaches to Teaching Farm Communities to reduce Agricultural Hazards for Youth" and "Managing to Reduce Risks for Gin Workers" were delivered. Over 700 farm owners, managers, workers, gin owners, gin managers, consultants and safety personnel participated in meetings addressing only farm safety issues. Many other production meetings included hazards and safety as one of the topics. Over 250 gin personnel attended one of 3 programs addressing electrocution hazards, serious falls and "managing to reduce risk" conducted jointly by the Cooperative Extension Service and the Southern Cotton Ginners' Association. Both Alabama and Nebraska Extension Services have referenced our "Tornado Safety" fact sheet and many other states have adopted portions of it since it was placed on our web site several years ago. We now have 9 "fact sheets" and 4 videos available for loan posted on our web site.

Arkansas Farm Bureau and the Cooperative Extension Service conduct joint workshops in counties to train EMTs and volunteer fire department personnel efficient accident rescue. Several Arkansas rescue units have acquired air bags, 4-wheel drive vehicles for rescue in remote areas, etc. after our training. They'll prove valuable for logging, backhoe, construction, traffic and other accidents, too. Several states have patterned their rescue training program after the model developed in Arkansas.

Harvest Equipment Selection, Maintenance and Fine-Tuning (Adjustments for Cotton, Corn Grain Sorghum, Rice, Soybeans and Wheat)

Gary Huitink, Research Associate Professor, Biological and Agricultural Engineering, Extension Engineer, Cooperative Extension Service
County Extension Agents, Cooperative Extension Service, University of Arkansas

Objectives:

Provide harvest equipment recommendations that improve profit and meet Arkansas growers' needs, i.e., reduce harvest operation cost, harvest delays and field losses of corn, cotton, grain sorghum, soybeans and wheat.

Provide recommendations that will assist in reducing Arkansas growers' costs of grain and cotton production.

Accomplishments:

Consultation, field days, demonstrations and meetings provided growers practical techniques to improve combine adjustments and measuring field loss of corn, grain sorghum, rice, soybeans and wheat. Storm cells in 4 counties in eastern Arkansas during July 2003 created special problems. Maturing corn was flattened in parts of fields by violent thunderstorm winds. Growers worked with the Extension engineer and Extension feed grain specialist to obtain attachments on their corn heads that effectively harvested both standing and "down" corn. Where standard corn heads on combines were unable to recover the grain during the August – September 2003 harvest, Roll-A-Cone attachments were purchased, installed and utilized. These modifications salvaged almost all of the quality ears and growers were pleased with the technical advice and their purchases.

The University of Arkansas Cooperative Extension Service guidelines for cotton and the grains are available in print and the information on grains are also published on the Cooperative Extension Service web site.

On-Farm Grain Handling and Storage

Dennis R. Gardisser, Research Professor, Biological and Agricultural Engineering, Extension Engineer, Cooperative Extension Service.

Objectives:

1. Improve efficiency of on-farm grain handling systems.
2. Maintain the best grain quality possible during on-farm storage.
3. Help producers develop long-term management strategies to control insect populations.

Accomplishments:

Several producer programs were conducted to discuss general management procedures for those growers utilizing on-farm grain storage and drying. Growers were instructed how to optimize the use of existing facilities, with the primary emphasis being on efficiency and grain quality. Several workshops were conducted with commercial operators to enhance the quality of grain in the end product after storage. These programs were conducted with the cooperative assistance of the peer research group.

Corn production in Arkansas has risen sharply. The high air temperatures associated with harvest time in the Delta present some unique problems. Engineers have investigated batch and continuous flow dryers to enhance the on farm drying programs. Cooperative research projects are ongoing between extension and research faculty to learn the optimum operating characteristics for these dryers under Arkansas conditions for a variety of crop commodities.

I have worked in concert with staff from the Arkansas Department of Corrections and other researchers to develop the most efficient operating guidelines for the Cummins facility. I am participating in a joint research project with food processing engineers and the staff at ADC to investigate alternative ways to control insects in rice storage – other than using chemicals. New controls have been developed to help better analyze energy conservation as well.

Additional information will be distributed to clientele in a timely manner as it is developed in applicable research projects. Plans are to involve more county agent staff, hands-on, with these projects as a training exercise.

Precision Agriculture

Dennis R. Gardisser, Research Professor, Biological and Agricultural Engineering, Enxtension Engineer, Cooperative Extension Service.
Sreekala Bajwa, Assistant Professor, Biological and Agricultural Engineering, UAF
Ahish Mishra, Graduate Student, Biological and Agricultural Engineering, UAF
Suzanne Wiley, GIS Specialist U of A CES - Monticello.

Objectives:

1. Investigate practical potential for practical incorporation of precision agriculture practices.
2. Coordinate efforts of many agricultural disciplines into a practical recommendation for producers.

Accomplishments:

The Arkansas Precision Agriculture Working Group, ARPAWG, was formed to provide an avenue to better organize the many precision agriculture activities. This group has had an initial organization meeting and is developing an Internet web page and a newsletter. A 1/2 time graduate student within the Biological and Engineering department at Fayetteville is serving as the program contact and publisher of the newsletter. Dr. Sreekala Bajwa and I were elected cochairs of ARPAWG and will serve as editors and coordinators for this effort.

One major activity has been to develop training opportunities for Arkansas youth on remote sensing and GIS databases. A regional remote sensing symposium has been planned for Arkansas in February 2003.Agricultural chemical applicators have expressed a keen interest in utilizing GIS databases from GeoStor in their management schemes. This database will help them identify and log data in a much more efficient manner. Funding: FSL, ADC funds. Coordination of multi-discipline and multi-state activities will continue. Additional practical applications will be investigated and demonstrated in the future.

EXTENSION PROJECTS

Extension and Outreach Programs

Pesticide Handling, Rinse, and Containment Facilities

Dennis R. Gardisser, Research Professor, Biological and Agricultural Engineering, Extension Engineer, Cooperative Extension Center

Objectives:

1. Protect the air, water, and soil from contamination in areas where relatively large quantities of chemical mixes are prepared and loaded for field distribution.
2. Provide a safe and secure storage location for chemicals that are on hand awaiting the distribution process.

Several commercial and private applicators have been advised on how to best utilize their mixing and loading facilities to meet EPA guidelines and enhance environmental stewardship. Several new aerial applicator loading and handling facilities were designed and have either already been constructed, or are under construction. Several new facilities are in the planning phases. These facilities were designed to meet all current and foreseeable EPA and state guidelines and will serve as an example for other commercial aerial applicators wishing to construct similar facilities. Arkansas engineers just finished an EPA grant to design and build two on-farm pesticide rinse and containment facilities in Arkansas. The plans from these facilities will be used to develop a national training guide for other programs. The materials developed will include slides, scripts, manuals, and detailed plans on AutoCAD 2000. A multi-agency in-service training was conducted with visits to both facilities and an intensive classroom review of the principles.

Accomplishments:

Additional facilities are currently being designed to help other operators with their needs. New concepts and guidelines will be incorporated into these designs and educational programs as they become available.

Pre-and Post-Harvest Factors Affecting Rice Milling Quality

T.J. Siebenmorgen, Professor, Food Science, UAF
J. Meullenet, Associate Professor, Food Science, UAF
P. Counce, Associate Professor, Rice Branch Station
N. Slaton, Assistant Professor, Crop, Soil, and Environmental Sciences, UAF
Dennis R. Gardisser, Research Professor, Biological and Agricultural Engineering, Extension Engineer, Cooperative Extension Service.

Objectives:

1. Evaluate/develop strategies for on-farm rice drying systems, to include in-bin and cross flow systems, utilizing the glass transition concept.

2. Assess the effects of production variables, specifically fertility levels and high ambient temperatures, on milling and processing quality.

Accomplishments:

Field samples were taken during the 2002 growing season as a component of the first year of this project. Laboratory analyses are currently underway.

No publications to date. Preliminary report to RRPB has been given. Poster session with objectives and testing methods was presented at RREC field day in August 2002.

Laboratory analysis will be completed and results submitted for publication as appropriate. This work will continue for at least one additional year.

Proper Cattle Heavy Use Area Design And Management

Karl VanDevender, Research Associate Professor, Biological and Agricultural Engineering, Extension Engineer, Cooperative Extension Service
Jodie Pennington, Extension Dairy Specialist,
Mike Andrews VanBuren County Extension Agent
Danny Griffin, Searcy County Extension Agent
Sid Lowrance, Searcy County District Conservationist
Joe Tapp, Former VanBuren County District Conservationist
Tom Lane Arkansas Soil and Water Conservation Commission Project Officer
Lance and Kim Pruitt VanBuren County Dairy Producers.

Objectives:

This is a EPA 319(h) grant initiated in 2001 with a budget of $96.997 federal dollars and $72,813 state supplied funds for a total budget of $169,810. The project objective is to Implement a properly designed and managed Cattle Heavy Use Area to serve as a model application of available technologies and practices. This model will then be used as the site for field days and a source of pictures and experiences that will be used to develop educational information that will be presented in the local watershed, as well as statewide. The focus of the program will be to encourage the implementation of recommended BMPs on dairy and beef cattle farms where the heavy use areas have the potential for negative impacts on water quality. This project is divided in to the following tasks, 1) Development of Project Guidance Team, 2) Implementation of model BMPs and management practices, and 3) Education and Technology Transfer.

Accomplishments:

Tasks 1 and 2 have been completed. The education and Technology Transfer, Task 3, is in progress and will be completed in May of 2004.

Rice Irrigation Water Management for Water, Labor and Cost Savings

Phil Tacker, Research Associate Professor, Biological and Agricultural Engineering, Cooperative Extension Service
Earl Vories, Professor, Biological and Agricultural Engineering, UAF
Wayne Smith, Technical Support Specialist, Cooperative Extension Service

Objective:

Conduct on-farm demonstrations of multiple inlet rice irrigation system (MIRI) and document its advantages and disadvantages on production size fields.

Accomplishments:

Worked directly with 25 producers in 14 counties on 36 different MIRI field demonstrations. Additional MIRI work was coordinated through county agents in 9 counties and involved several other producers. Three counties had field tours that included Multiple Inlet irrigated fields. Conducted field comparison studies with two cooperators:

Felts Farm	Silt loam fields	13% less water during season with MIRI
Parker Farm	Silt loam fields	25% less water on initial flood – flowmeter problems after first flood

A Prairie County producer participating in a field demonstration successfully ran MIRI down steep slopes. This demonstration provided information on the limits of MIRI use on various field slopes. A White County demonstration cooperator found that MIRI helped him keep a 75 acre field irrigated with one well, rather than two wells as he had used in the past to maintain a field flood. A cooperator in Woodruff County stated, "The MIRI most definitely helped, water savings was a big thing, water management was easier and cold water effects and high salt build up on the top of the field were reduced. The benefits outweigh any negatives and I will put it on more fields next year." A cooperator in Monroe County said, "I will use a lot more next year. It is easier to manage, gets water across the field faster, didn't lose water at the end of the field and the field yielded better with the tubing." The overall response of producers was positive. Many producers are planning to use MIRI after seeing how it works.

State-Wide Nutrient Management Education for Confined Poultry and Livestock Producers

Karl VanDevender, Research Associate Professor, Biological and Agricultural Engineering, Extension Engineer, Cooperative Extension Service
Justin Calhoun, Extension Associate,
Jodie Pennington, Extension Dairy Specialist,
John Jennings, Extension Forage Specialist,
Rex Roberg, Extension Wildlife Specialist,
Beck McPeak, Extension Wildlife Specialist,
Melony Wilson, Technical Assistant, Poultry Science,UAF
Michelle Steele Washington County Extension Agent

Objectives:

This is a EPA 319(h) grant initiated in 1999 with a budget of $259,087 federal dollars and $195,452 state supplied funds for a total budget of $454,539. The project objective is to provide education to poultry and livestock producers on the importance of nutrient (especially phosphorus) management and the BMPs needed to manage the nutrients. This program is taking advantage of increasing animal industry concerns and desire to implement voluntary practices. This project is divided into the following task areas 1) Nutrient Management Planning Workshop for Poultry Producers, 2) Litter Calibration Workshops, 3) Annual Training for Producers With Liquid Manure Systems, 4) Riparian Area Management In-Service Training, 5) Animal Manure Management In-Service Training, and 6) Dairy Nutrient Management Demonstration and Training.

Accomplishments:
This project was completed in June of 2003.

Swine Waste Demonstration and Training Project

Charles Maxwell, Professor, Animal Science, UAF
Karl VanDevender, Research Associate Professor, Biological and Agricultural Engineering, Extension Engineer, Cooperative Extension Service.
Justin Calhoun, Extension Associate, Cooperative Extension Service
Ken Coffey, Associate Professor, Animal Science, UAF
Ashley Hayes, Research Specialist, Animal Science, UAF
Philip Moore ARS and Adj. Crop Soil and Environmental Science Soil Chemist

Objectives:
This is a EPA 319(h) grant funded in 1998 but initiated in 2000 due to delays in construction of the University Swine Farm. It has a budget of $300,000 federal dollars and $226,316 state supplied funds for a total budget of $526,316. The project objective is to demonstrate BMPs to control solids buildup in holding ponds and reduce phosphorus runoff from swine manure, and to train swine producers and workers in the implementation of those BMPs. This project is divided into the following task areas 1) Demonstration of solids management technology, 2) Demonstration of reduced P runoff by improving bio-availability of dietary P, and 3) Demonstration of alum treatment of swine manure as a means of reducing P runoff. The demonstration of the manure solids management, reduced P runoff, and alum treatment is taking place on the University swine farm. Two commercial swine farms are also being used to demonstrate manure solids management.

Accomplishments:
This project was completed in December of 2003.

Using Cotton Gin Waste

Gary Huitink, Research Associate Professor, Biological and Agricultural Engineering, Extension Engineer, Cooperative Extension Service
Julie Carrier, Associate Professor, Biological and Agricultural Engineering, UAF
Sreekala Bajwa, Assistant Professor, Biological and Agricultural Engineering, UAF
Billy Ussery, Ginner and Manager of Wabash Grain Company, Wabash, AR

Objectives:
Assist ginners and others to develop higher-value uses for gin waste.
Investigate the components in gin waste that may foster fires in tall gin waste piles and attempt to identify if there are marketable components that have not yet been identified.

Accomplishments:
Approaches to managing and marketing gin waste to gain value were explained to ginners who participated in the Annual Cotton Ginners' School in Stoneville, MS, and details provided in individual consultations. A few gin managers are utilizing basic research to investigate creative higher-value alternate uses; in one case, using waste as a raw material to replace a portion of the wood normally used in a wood millwork industry. One Arkansas entrepreneur has begun bagging and selling WalMart composted gin waste for horticultural use.
A number of gins have contracted to supply gin waste to restore productivity to recently-shaped fields. Gin managers are now improving approaches to use waste properly. Dumas Gin Company has terminated an earlier contract with an independent entrepreneur and now sells all of their waste to wholesale clients. They have built their own compost turner and have improved their compost quality on the gin yard. They have more requests for composted gin waste than the amount they produced in the fall of 2003. Gin managers are using contracts, bids and other arrangements to clear waste from gin property before the Arkansas April 15 pink bollworm cleanup deadline. Gin personnel are taking leadership to develop proper uses for waste and are meeting the regulatory standards of the Arkansas Department of Environmental Quality.
Preliminary studies on the properties of gin waste indicate management of the composting procedure is

essential to maintain quality. Professionals throughout the cotton-producing states are working as a team to develop recommendations and training for utilizing gin waste nationwide.

Investigator	Title	Agency	Dates	Amount
Brian Haggard	Research Support	US/USDA/ARS	10/01/02-9/30/03	$42,280
Indrajeet Chaubey	Development of a Decision Support System and Data Needs for the Beaver Lake Watershed	Arkansas Soil and Water Conservation Commission	8/01/02-7/31/05	$269,973
Marty Matlock	City of Rogers Urban Water-shed Management Plan	LG/Rogers Utilities	10/01/02-9/30/06	$151,950
Danielle Julie Carrier	Extraction of High Value Co-Products from Mimosa and Senicea as Energy Crops	US/DOE	9/11/02-7/30/03	$14,977
Indrajeet Chaubey	Quantification of Pathogen Losses from Swine Manure Treated Pasture Fields Under Chemical and Dietary Modifica-tion Conditions	USDA/NCSU	1/01/02-1/31/04	$12,345
Thomas A. Costello	Biomass Furnace for Heating Poultry Houses	NG/ARAEO	7/15/98-6/30/02	$49,422
Indrajeet Chaubey	Quantification of pathogen losses from swine manure treated pasture fields under chemical and dietary modifica-tion conditions	USDA/ CSREES-Prime	1/01/02-1/31/04	$22,838
Marty Matlock	Effects of Urbanization on ecological services in a semi-arid region of the US	NASA	8/01/03-7/31/05	$42,308
Marty Matlock & Indrajeet Chaubey	Nutrient Management Decision Support System for the Eucha Basin	USDA/CSREES	8/1/02-7/31/05	$686,000
Danielle Carrier & ED Clausen	Extraction of high value co-products from mimosa and sericea as energy crops	U.S. Dept. of Energy	9/30/02-7/31/03	$14,977
Indrajeet Chaubey, Tom Costello & Marty Matlock	Development of a decision support system and data needs for the Beaver Lake Watershed	U.S. EPA/ Arkansas Soil and Water Commission	8/1/02-7/31/06	$269,973
Scott Osborn	Determining the physical, chemical, and genetic mecha-nisms responsible for fissure resistance of rice	The Rice Foundation	3/1/02-2/29/04	$66,666

Investigator	Title	Agency	Dates	Amount
Sreekala Bajwa & Gary Huirink	Precision Farming Technology for developing subsoling guidelines in Arkansas	Cotton Foundation	7/1/02-6/30/03	$10,000
Tom Costello & Scott Osborn	Growth Chambers for bio-regenerative life support	Arkansas Space Grant Consortium	3/1/03-2/29/04	$5,500
Indrajeet Chaubey	Use of hyperspectral imaging in lake water quality modeling	Arkansas Space Grant Consortium	3/1/03-2/28/04	$5,500
Indrajeet Chaubey	Quantification of pathogen losses from swine manure treated pasture fields under chemical and dietary modification conditions.	National Center for Manure and Animal Waste Mgmt.	2002-2003	$12,345
Rong Murphy	Value-added poultry processing research	Jones Dairy Farm		$25,000
Rong Murphy	Eliminating *Listeria Monocytogenes* from Packaged and Refrigerated RTE Poultry Products	USDA/ARS	7/01/01-7/01/03	$97,858
Rong Murphy	Thermal Process Validation	Tyson Foods, Inc.		$1,269
Rong Murphy	Value Added Poultry Products	USDA/CSREES	9/15/01-9/30/04	$597,157
Indrajeet Chaubey	Optimizing BMPS, Water Quality and Sustained Agriculture in the Lincoln Lake Watershed	US/EPA Arkansas Soil & Water Conservation Commission	8/01/01-7/31/04	$397,803
Rong Murphy	A Model for Pathogen Lethality and Heat/Mass Transfer of Meat Thermal Processing	USDA/CSREES	11/15/01-6/30/03	$75,000
Lalit R. Verma	Grain Bin Safety Research	William M. Hartz	2/02/02-4/02/03	$5,051
Brian Haggard Marty Matlock Indrajeet Chaubey	Phosphorus Concentrations and Sediment Phoshporus Flux in Streams and Reservoirs: Effect of Chemical Amendments	US/DOI/Geological Survey	3/01/02-12/31/03	$50,418
Danielle Julie Carrier	Assessing the Extraction Possibilities of Five Medicinal Herbs	Tom's of Maine	3/01/02-12/31/03	$2,506
Sreekala Bajwa Johnny Mason	Remote Sensing to Detect Moisture and SDS Stresses in Soybeans - Training Grant	NASA	7/01/02-6/30/03	$24,000

GRANTS

Investigator	Title	Agency	Dates	Amount
Marty Matlock	Effects of Urbanization on Ecological Services in a Semi-Arid Region of the United States	NASA	5/20/02-8/14/04	$42,308
Indrajeet Chaubey, Earl Vories, & Marty Matlock	Development of an integrated water quality-water management program in the Arkansas delta	USDA/CSREES	2003-2006	$550,000
Tom Costello	Demonstration of on-farm litter combustion	Arkansas Soil and Water Commission	9/1/03-8/31/05	$86,178
Indrajeet Chaubey & Brian Haggard	Differentiating runoff contributing areas for effective water quality management	USDA/CSREES	8/1/03-7/31/05	$75,000
Marty Matlock	Using the internet to teach market-based policies for water quality management	USDA/CSREES	8/1/03-7/31/05	$24,376
Sreekala Bajwa & Gary Huitink	Precision farming technology for developing subsoiling guidelines in Arkansas	Cotton Foundation 7/1/03-6/30/04	7/1/03-6/30/04	$16,500
Indrajeet Chaubey, Marty Matlock, & Earl Vories	Sustainable agriculture and water resources in Arkansas	U.S. EPA	7/1/03-6/30/06	$447,095
R.Y. Murphy	Eliminating *Listeria* monofytogenes from ready-to-eat products	USDA/ARS	7/1/03-6/30/06	$124,000
Yanblin Li	Poultry Safety	BioDetection Instruments, Inc.	11/1/103-10/31/04	$11,000
Yanblin Li	Immunoelectrochemical-Optical Biosensor with a Capillary Bioseparator/Bioreactor for Rapid Detection of Pathogens in Poultry and Meat Products	USDA/NRI	12/01/00-5/31/03	$130,000
Yanblin Li	Systematic Approach to Microbial Risk Assessment from Producers Through Retailers	USDA/CSREES	9/15/00-9/14/03	$228,282
Carl L. Griffis	Enhancement of the Safety of Poultry	Food Safety	7/01/01-6/30/03	$32,000

Investigator	Title	Agency	Dates	Amount
Yanblin Li	Enhancement of the Safety of Poultry Products	Food Safety	7/01/01-6/30/03	$158,800
Rong Y. Murphy	Enhancement of the Safety of Poultry Products	Food Safety	7/01/01-6/30/03	$49,000
Rong Y. Murphy	Institute of Food Science and Engineering	USDA/CSREES	7/01/01-6/30/03	$5,408
Marty Matlock	A Nutrient Management Decision Support System for the Eucha-Basin	US/USDA/CSREES	8/01/02-7/31/05	$686,000

Refereed Publications

S. Lau, **Carrier D.J.**, L. Howard, J. Lay, J. Archambault and **E. Clausen.** "Extraction of Antioxidant Compounds from Energy Crops" Applied Biotechnology and Biochemistry 113-116 (in press)

L. Duan, **Carrier D.J.** and **E Clausen**. "Extraction of Health Beneficial Compounds from Milk ThistleUsing Hot/Liquid Water" Applied Biotechnology and Biochemistry 113-116 (in press)

Chaubey, I., **A.S. Cotter, T.A. Costello**, and T. Soerens. 2003. Effect of DEM data resolution on SWAT output uncertainty. J. Hydrologic Processes. In Press.

Cotter, A.S., **I. Chaubey**, **T.A. Costello**, T.S. Soerens, and M.A. Nelson. 2003. Water quality model output uncertainty as affected by spatial resolution of input data. Journal of Am. Water Resour. Assoc. 39(4): 977-986.

Cotter, A. S., **I. Chaubey**, **T. A. Costello**, T. S. Soerens, M. A. Nelson. 2003. Water quality model output uncertainty as affected by spatial resolution of input data. J. Am. Water Resourc. Assoc. 39(4):977-986.

Garg, V., **I. Chaubey**, and **B.E. Haggard**. 2003. Quantification of model output uncertainty due to calibrating watershed characteristics. Transactions of the ASAE 46(5):1347-1353.

Kavdia M., and R.S. Lewis. Nitric oxide delivery in stagnant systems using nitric oxide donors: A mathematical model. Chemical Research in Toxicology. 16:7-14, 2003.

Kavdia M., and A.S. Popel. Wall Shear Stress Differentially Affects NO level in Arterioles for Volume Expanders & Hb-Based O2 Carriers. Microvascular Research. 66: 49-58, 2003.

Popel A.S., **Kavdia M.**, and N.M. Tsoukias. Effect of hemoglobin -based oxygen carriers on nitric oxide transport: Mathematical models. Keio University International Symposia for Life Sciences Medicine, Artificial Oxygen Carrier: Its Frontline, Vol 12, 2003, submitted.

Tsoukias NM, **Kavdia M.**, and A.S. Popel. A theoretical model of nitric oxide transport in arterioles: frequency vs amplitude dependent control of cGMP formation". American Journal of Physiology-Heart Circ Physiol. 286(3): H1043-56, Accepted.

Kavdia M, and A.S. Popel. Contribution of nNOS and eNOS derived NO to microvascular smooth muscle NO exposure. American Journal of Physiology-Heart Circ Physiol. submitted 2003.

M. Li, **Kim J.W.**, and T.L. Peeples. 2003. Energy-cost reduction in starch processing using aqueous two-phase reactor systems. Sep. Sci. Technol. 38:2709-2724.

R. Deaton, **Kim J.W.** , and J. Chen. 2003. Design and test of non-crosshybridizing oligonucleotide building blocks for DNA computers and nanostructures. Appl. Phy. Lett. 82:1305-1307 (Selected for the March 1, 2003 issue (Vol.5, Issue 5) of the Virtual Journal of Biological Physics Research).

H. Olivo, T.L. Peeples, M.Y. Rios, F. Valazques, **Kim J.W.**, and S. Narang. 2003. Microbial C-hydroxylation and ?-4-O-methylglucosidation of methyl-benzamide 7-azanorbornane ethers with Beauveria bassiana. J. Mol. Catalysis B: Enzymatic. 21:97-105.

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Liu, Y., J. Ye and **Y. Li**. 2003. Rapid detection of *E. coli O157:H7* in ground beef, chicken carcass and lettuce samples with an immunomagnetic chemiluminescence fiber-optic biosensor. Journal of Food Protection 66(3):512-517

Paul, S., P.K. Haan, **Matlock M.,** and S. Mukhtar. 2003. Analysis of the HSPF Parameter Uncertainty in Predicting Peak In-Stream Fecal Coli form Concentrations. Transactions of the ASAE (Accepted, in press).

Matlock M., K. Kasprzak, and **S. Osborn**. 2003. Potential Sediment Oxygen Demand in the Arroyo Colorado River in South Texas. Journal of the American Water Resources Association. 39(2):267-275.

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Water Resources Association. (Accepted, in revision).

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Murphy, R. Y., K. H. Driscoll, M. E. Arnold, J. A. Marcy, and R. E. Wolfe. 2003. Lethality of *Listeria monocytogenes* in fully cooked and vacuum packaged chicken leg quarters during steam pasteurization. Journal of Food Science. 68:2780-2783

Murphy, R.Y., L.K. Duncan, K.H. Driscoll, J.A. Marcy, and **B.L. Beard**. 2003. Thermal inactivation of *Listeria monocytogenes* on ready-to-eat turkey breast meat products during post-cook in-package pasteurization via hot water. Journal of Food Protection. 66:1618-1622

Murphy, R.Y., L.K. Duncan, **B.L. Beard**, and K.H. Driscoll. 2003. D and z values of *Salmonella*, *Listeria* innocua, and *Listeria monocytogenes* in fully cooked and vacuum packaged poultry products. Journal of Food Science. 68:1443-1447.

Murphy, R.Y., L.K. Duncan, K.H. Driscoll, **B.L. Beard**, M.E. Berrang, and J.A. Marcy. 2003. Determination of thermal lethality for *Listeria monocytogenese* in fully cooked chicken breast meat products during postcook in-package pasteurization. Journal of Food Protection. 66:578-583

Murphy, R.Y., L.K. Duncan, K.H. Driscoll, and J.A. Marcy. 2003. Lethality of *Salmonella* and *Listeria* innocua in fully cooked chicken breast meat products during postcook in-package pasteurization. Journal of Food Protection. 66:242-248.

Varshney, M., **Y. Li.**, R. Nanapanneni, M.G. Johnson, **C.L. Griffis**. 2003. A chemiluminescence sensor coupled with immunomagnetic separation for rapid detection of *Salmonella typhimurium*. Journal of Rapid Methods. 11(2003) 111-131

Varshney, M., **Y. Li**, R. Nannapaneni, M.G. Johnson, **C.L. Griffis**. 2003. A chemiluminescent biosensor coupled with immunomagnetic separation for rapid detection of *Salmonella Typhimurium*. Journal of Rapid Methods and Automation in Microbiology 11(2):111-131.

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Wallace, S., **D.J. Carrier,**, **R. Beitle**, **E. Clausen**. and **C. Griffis.** (2003). HPLC-UV and LC-MS-MS characterization of silymarin in milk thistle seeds and corresponding products. Journal of Nutraceutical, Functional and Medicinal Food 4(2): 37-48.

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Yang, L., **Y. Li**, and G. Erf. 2003. An interdigitated array microelectrode-based impedance immunosensor for rapid detection of *Escherichia coli O157:H7*. Analytical Chemistry (submitted October 24, 2003, revised November 25, 2003, accepted December 8, 2003).

PUBLICATIONS

Non-Refereed Publications

Chaubey, I., **T.A. Costello**, **K.L. White**, and **A.S. Cotter**. 2003. Stochastic validation of SWAT model. Proc. Total Maximum Daily Load: Environmental Regulations II. ASAE, St. Joseph, MI. pp. 168-176.

Ekka, S.A., **B.E. Haggard**, **M.D. Matlock**, and **I. Chaubey**. 2003. Impact of point sources on nutrient interactions in Ozark streams. ASAE Paper No. 03-2282, ASAE, St. Joseph, MI.

Ekka, S.A., **B.E. Haggard**, **M. Matlock**, and **I. Chaubey**. 2003. Impact of wastewater treatment plants in streams of Illinois River Basin. Poster Presented at the AWRA Spring Specialty Conference on Agricultural Hydrology and Water Quality. Kansas City, MO. May 12 – 14.

Garg, V., **S.G. Bajwa**, and **I. Chaube**y. 2003. Effect of suspended sediment distribution on spectral reflectance. Poster Presented at the AWRA Spring Specialty Conference on Agricultural Hydrology and Water Quality. Kansas City, MO. May 12 – 14.

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Sahoo, D., **I. Chaubey**, **B.E. Haggard**, and **M. Matlock**. 2003. Stream nutrient retention and limitation in Moores Creek, Northwest Arkansas. Poster Presented at the AWRA Spring Specialty Conference on Agricultural Hydrology and Water Quality. Kansas City, MO. May 12 – 14.

Sahoo, D., **I. Chaubey**, **M. Matlock**, and **B.E. Haggard**. 2003. Sediment, nutrient interaction in an agricultural watershed in Northwest Arkansas. Poster presented at the 2003 Annual International Meeting of the Institute of Biological Engineering. Athens, GA. January 17 – 19.

Tacker, P., **E. Vories** and **G. Huitink**. 2003. Drainage and irrigation. 13-22 In L. Espinoza and J. Ross (ed.) Corn Production Handbook. Ark. Coop. Ext. Serv., MP437-2M-2-03N.

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White, K.L., **I. Chaubey**, and **T.A. Costello**. 2003. Stake-holder involvement in watershed management: lessons learned. Proc. Total Maximum Daily Load: Environmental Regulations II. ASAE, St. Joseph, MI. pp. 46-50.

White, K.L., **B.E. Haggard**, and **I. Chaubey**. 2003. Changes in water quality at Buffalo National River, Arkansas, 1991 – 2001. Poster Presented at the AWRA Spring Specialty Conference on Agricultural Hydrology and Water Quality. Kansas City, MO. May 12 – 14.

Scherder, E.F., R.E. Talbert, J.D. Branson, M.L. Lovelace, and **Vories E.D.,** 2003. Intermittent irrigation effects on barnyardgrass weed control and rice yield. pp. 156-164. In R.J. Norman and J.-F. Meullenet (ed.). B.R. Wells Rice Research Studies 2002. Ark. Agric. Exp. Sta. Res. Series 504.

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Vories, E.D., **P.L. Tacker** and R.E. Glover. 2003. Improving cotton irrigation scheduling in Arkansas. pp. 141-146 In D.M. Oosterhuis (ed.) Summaries of Cotton Research in Progress in 2002. Ark. Agric. Exp. Sta. Res. Series 507.

Presentations

Bajwa, S. G., **J. M. Mason**, and R. Norman. 2003. High-resolution optical sensing of rice nitrogen. In. Proc. 2003 ASAE annual international meeting, July 27-30, 2003, Las Vegas, NV.

Bajwa, S. G., **J.M. Mason**, and Rupe, J. 2003. Remote sensing for agricultural crop stress monitoring and diagnosis. In. Proc. of 30th International Symposium on Remote Sensing of Environment, November 10-14, 2003, Honolulu, Hawai.

Beitle R. , C. Ying, R. Henry, **J.-W. Kim**, M. Moore. 2003. Nuisance Protein Abatement through Proteome Analysis. 95th AIChE Ann. Meet. (Advances in Bioprocessing Session), San Francisco, CA.

Appel T, Staufer T, **Carrier, D.J.** and **E. Clausen**. (2003). "Extraction of silymarin from commercially available dietary supplements". Presentation to the Midwest American Institute of Chemical Engineering student competition, Lawrence Kansas April 5, 2003.

Lau S, **Carrier, D.J.**, Howard L, Lay J, Archambault J and **E Clausen**. "Extraction of Antioxidant Compounds from Energy Crops" presented at the 25th Symposium on Biotechnology for Fuels and Chemicals, Breckenridge, CO. (poster)

Duan, L, **Carrier D.J.** and **E Clausen**. "Extraction of Health Beneficial Compounds from Milk ThistleUsing Hot/Liquid Water" presented at the 25th Symposium on Biotechnology for Fuels and Chemicals, Breckenridge, CO. (poster)

Carrier D.J. and **E. Clausen**. "Extraction Activities at the University of Arkansas" presented at the S-1007 committee meeting USDA, Washington D.C. May 2003

Carrier D.J., **S. Wallace** and **E. Clausen**. Milk thistle an interesting herb. The annual IFT meeting, Chicago, July 2003

Carrier D.J.. "An overview of dietary supplements". Annual Fall Nutrition Update, Springdale AR, September 2003 (invited presentation)

Chaubey, I., **M. Matlock**, and **B.E. Haggard**. (Invited). Integrating physical, chemical, and biological response monitoring for watershed management: stream reach to watershed scale processes and lessons. Annual Conference of the ASA, SSSA, and CSA. Denver, CO. November 2-6, 2003.

Chaubey, I., **D. Sahoo**, **B.E. Haggard**, **K.L. White**, and **M. Matlock**. (Invited) Assessment of nutrient dynamics in an agriculturally dominated stream. 2003 Arkansas Water Resources Conference Center Conference on Quality Water Resources to Meet Our Competing Needs. Fayetteville, AR. April 22 – 23.

Chaubey, I., **T.A. Costello**, **K.L. White**, and **A.S. Cotter**. 2003. Stochastic validation of SWAT model. Proc. Total Maximum Daily Load: Environmental Regulations II. ASAE, St. Joseph, MI. pp. 168-176.

Chaubey, I., **A.S. Cotter**, **T.A. Costello**, M.A. Nelson, and T.S. Soerens. 2003. Quantification of runoff and nutrient load prediction uncertainty due to GIS data resolution. (peer-reviewed) Proc. AWRC Conference on "Adequate Quality Water Supplies to Meet Our Growing Needs: Scientific, Regulatory, and Public Perspectives", Fayetteville, AR, April 22-23.

Costello, T.A.. 2003. Plant growth chambers for bio-regenerative life support. Invited presentation to Arkansas-Oklahoma Center for Space and Planetary Sciences, Spring 2003 Seminar Series, February 13, 2003, University of Arkansas, Fayetteville.

Costello, T.A., **I. Chaubey**, **K. White**, M. Nelson, C. Dunigan, and M. Gross. 2003. Optimizing best management practices, water quality and sustained agriculture in Lincoln Lake. Washington County Conservation District Field Day, Lincoln, AR, October 30, 2003 (presented by Costello).

Ekka, S., **B. Haggard**, **M. Matlock**, and **I. Chaubey**. 2003. Nutrient cycling in urban streams. ASAE International Meeting, Las Vegas, NV, July 2003.

Garg, V., **S. G. Bajwa**, **I. Chaubey**, and **B. E. Haggard**. 2003. Effect of Suspended Sediment Depth Distribution in Water on Spectral Reflectance. 2003 AWRA Spring Specialty Conference Agricultural Hydrology and Water quality. May 12-14, Kansas City, MO.

Griffis. C. and **D.J. Carrier** ASEE meeting Nashville June 2003 American Society for Engineering Education (Nashville, TN, June 03) "Being a freshman in Biological Engineering at the University of Arkansas"

Griffis, C. and **M. Matlock**. 2003. Design Studio Approach to Engineering Education – Phase 1. ASEE Annual Meeting, Nashville Tennessee, June 2003.

Haggard, B.E., **S.A. Ekka**, **M. Matlock**, P.A. Moore, Jr., and **I. Chaubey**. (Invited). Release of phosphorus from streams and reservoir sediment: effect of chemical amendments. 2003 Arkansas Water Resources Conference Center Conference on Quality Water Resources to Meet Our Competing Needs. Fayetteville, AR. April 22 – 23.

Kavdia M, and A.S. Popel. Contribution of non-endothelial sources of nitric oxide to smooth muscle nitric oxide availability. Biomedical Engineering Society (BMES) Annual Fall Meeting, Nashville, Tennessee, October, 2003.

Kavdia M, and A.S. Popel. Model for endothelium-derived nitric oxide transport between paired arterioles and venules Biomedical Engineering Society (BMES) Annual Fall Meeting, Nashville, Tennessee, October, 2003.

S. Tung, **J.-W. Kim**, A. Malshe, C.C. Lee, and R. Pooran. 2003. A Cellular Motor Driven Microfluidic System. Tranducers'03 – 12th International Conference on Solid-State Sensors, Actuators and Microsystems, Boston, MA.

M. Al-Fandi, A. Malshe, **J.-W. Kim**, S. Tung, J. Jenkins, and S. Sundaram. 2003. Design and Analysis of Viscous Micropump Actuated Using Biological Cell Motors. ASME International Mechanical Engineering Congress and R&D Expo (IMECE), Washington DC.

R. Pooran, **J.-W. Kim**, S. Tung, A. Malshe, C.C. Lee, and R. Pooran. 2003. Integration of cellular motors with micro channels. ASME International Mechanical Engineering Congress and R&D Expo (IMECE), Washington DC.

Kim J.W., C.C. Lee, R. Pooran, S. Tung, and A. Malshe. 2003. Bio-Micro-Electro-Mechanical System (Bio-MEMS) Controlled by Microbial Cell Motors 2003 American Society of Agricultural Engineers (ASAE) Annual International Meeting, Las Vegas, NV.

Kim J.W., A. Malshe, and S. Tung. 2003. Bio-Inspired MEMS: A Novel Microfluidics System Actuated by Biological Cell Motors. 2003 Institute of Biological Engineering (IBE) Annual Meeting, Athen, GA.

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Kim J.W., A. Malshe, and S. Tung. 2003. Bio-Inspired MEMS: A Novel Microfluidics System Actuated by Biological Cell Motors. 2003 Institute of Biological Engineering (IBE) Annual Meeting, Athen, GA.

Kim J.W.. 2003. Interfacing Biological and Abiological Components at the Nanoscale. 2003 ASAE Annual Meeting (Special Session of Opportunities in Nanoscale Engineering), July 27-30, Las Vegas, NV.

Kim, B., X.L. Sun and **Y. Li**. 2003. Detection of *Salmonella Typhimurium* Based on Oxygen Consumption Monitoring Using a Fiber Optic Oxygen Sensor. Presented at IBE 2003 Annual Meeting, January 17-19, Athens, GA.

Li, Y., **X. Su**, B. Kim and **L. Yang**. 2003. Electrochemical, optical and impedance sensing methods for detection of live *Salmonella Typhimurium*. Presented at the 2003 ASAE Annual International Meeting, July 27-30, 2003, Las Vegas, NV. ASAE Paper No. 037006.

Li, Y. 2003. Food safety and security engineering. Invited presentation at Forum on Advanced Agricultural and Biological Engineering in China, Hangzhou, China, October 10, 2003.

Li, Y., S. Ang, **X.L. Su**, **L. Yang**, and X Yu. 2003. Immuno-impedance biosensor for detection of foodborne pathogens. Presented at the Food Safety Consortium 2003 Annual Meeting, October 12-14, Fayetteville, AR. A progress Report in: CD of Food Safety Consortium 2003 Annual Meeting—Agenda, Presentations, and Progress Reports.

Li, Y., S. Ang, **X.L. Su**, **L. Yang**, R. Al-Haddad and B. Swem. 2003. An immuno-impedance biosensor for rapid detection of pathogens in poultry samples. A progress Report in: CD of Food Safety Consortium 2003 Annual Meeting—Agenda, Presentations, and Progress Reports, October 12-14, Fayetteville, AR.

Li, Y., and **X.L. Su**. 2003. A QCM based immunosensor for rapid detection of *Escherichia coli O157:H7*. A progress Report in: CD of Food Safety Consortium 2003 Annual Meeting—Agenda, Presentations, and Progress Reports, October 12-14, Fayetteville, AR.

Liu, Z., B. Swem, and **Y. Li**. 2003. Pasteurization of bacon chilling brine using a flow-through electrolyzing treatment chamber: a pilot plant test. Presented at the Food Safety Consortium 2003 Annual Meeting, October 12-14, Fayetteville, AR. Abstract of the poster in: CD of Food Safety Consortium 2003 Annual Meeting—Agenda, Presentations, and Progress Reports.

Mao, X., **L. Yang**, and **Y. Li**. 2003. A quartz crystal microbalance based DNA sensor for detection of *Escherichia coli O157:H7*. Presented at the Food Safety Consortium 2003 Annual Meeting, October 12-14, Fayetteville, AR. Abstract of the poster in: CD of Food Safety Consortium 2003 Annual Meeting—Agenda, Presentations, and Progress Reports.

Mason, J. M., **S. G. Bajwa**, and J. Rupe. 2003. Discrimination between soybean stresses using hyperspectral reflectance data. In. Proc. 2003 ASAE annual international meeting, July 27-30, 2003, Las Vegas, NV.

Matlock, M. I. **Chaubey**, **B.E. Haggard**, and **T.A. Costello**. (Invited). Engaging stakeholders in watershed management process using a decision support system. Annual Conference of the ASA, SSSA, and CSA. Denver, CO. November 2-6, 2003.

Matlock M. , 2003. The TMDL Program - Challenges and Opportunities. Texas A&M University Seminar Series - Soil, Crop, and Environmental Sciences Department. College Station, TX, April 2, 2003.

Matlock M., 2003. Rules of Engagement for Stakeholders. Arkansas Water Resource Center Annual Conference, Fayetteville, AR. April 22, 2003.

Matlock M., 2003. Developing an Urban Watershed Rehabilitation Method Using Stakeholder Feedback. National EPA Research Conference, EPA Region VI, Dallas, Texas. May 28, 2003.

Matlock M., 2003. Keynote Speaker: Developing Ecologically-Based Thresholds for Significant P Thresholds in Waters. The International Phosphorus Linking Workshop - "Linking sources of phosphorus and sediment in the landscape to ecological impacts in waters - seeking an integrated approach". Sponsored by the Department for Environment, Food, and Rural Affairs, United Kingdom. London, England, May 8-9, 2003.

Matlock M., 2003. Collaborative Learning as a tool for Analysis and Deliberation in Watershed Policy Development. Geological Society of America Annual Meeting, Seattle, WA. Nov. 3, 2003.

Matlock M., R. Kiesling, D. Storm, **B. Haggard**, 2003. Developing a Phosphorus Threshold for Ozark Streams. Invited Presentation, USEPA Region VI Technical Advisory Group Meeting, Dallas, TX. December 2, 2003.

Matlock M., **I. Chaubey**, **B. Haggard**, and **T. Costello**, 2003. Engaging Stakeholders in Watershed Management Processes Using a Decision Support System. "Changing Sciences for a Changing World: Building a Broader Vision" 2003 ASA-CSSA-SSSA Annual Meetings, Denver, Colorado. November 2-6, 2003.

Mishra, A. **S. G. Bajwa**, and R. Norman. 2003. Remote sensing for rice nitrogen estimation and management. ASAE state meeting, Oct 4, 2003.

Mishra, A. **S. G. Bajwa**, and R. Norman. 2003. Remote sensing for rice nitrogen estimation and management. GIS day open house and symposium, Nov 19, 2003.

Morgan, R., **A. Ludwig**, **B. Schafer**, **E. Cummings**, and **M. Matlock**. 2003. Restoring ecological services to an urban stream. ASAE International Meeting, Las Vegas, NV, July 2003.

Murphy, R.Y. 2003. ThermoPro — an integrated approach in thermal processing and food safety. March 21, 2003. USDA-FSIS. Washington DC

Murphy, R.Y. Eliminating *Listeria monocytogenes* from packaged and refrigerated ready-to-eat poultry products. National Alliance for Food Safety Annual Meeting. August 9, 2003. New Orleans, LA.

Murphy, R. Y. 2003. Process Validation. October 9, 2003. Thermal Processing, Safety, and Validation Workshop. Fayetteville, AR.

Murphy, R. Y. 2003. Improving process control to ensure food safety. October 7, 2003. Thermal Processing, Safety, and Validation Workshop. Fayetteville, AR

Murphy, R.Y. 2003. Ensure food safety. September 28, 2003. Poultry Science. (invited)

Murphy, R.Y., K.H. Driscoll, and **B.L. Beard**. 2003. Heat transfer coefficient in different thermal processing systems for meat and poultry products. 29D-12. IFT Annual Meeting. July 12-16, Chicago, IL.

Murphy, R.Y. 2003. A model for heat/mss transfer and pathogen kinetics. March 17, 3003, American Meat

Institute. Washington DC

Murphy, R.Y. 2003. A model for heat/mass transfer and pathogen kinetics. March 18, 2003. Food and Drug Administration. Washington DC

Osaili, T.M. and **R.Y. Murphy**. 2003. Thermal inactivation of *Salmonella* and *Listeria* in chicken leg quarters during steam and air impingement cooking. 85-3. IFT Annual Meeting. July 12-16, Chicago, IL. (oral)

Murphy, R. Y. 2003. Improving process control to ensure food safety. September 10, 2003. USDA-ARS. Eastern Regional Research Center, Wyndmoor, PA. (invited)

Osaili, T.M. and **Murphy R.Y.**, 2003. Thermal inactivation D and z values of *Salmonella* Senftenberg in chicken dark muscle meat. 60C-22. IFT Annual Metting, July 12-16, Chicago, IL.

Murphy, R.Y., J.A. Marcy, **B.L. Beard**, and N. Feze. 2003. Thermal inactivation of *Listeria monocytogenes* in vacuum-packaged ready-to-eat poultry products during post-cook in-package pasteurization. 85-6. IFT Annual Meeting, July 12-16, Chicago, IL. (oral)

Murphy, R.Y. 2003. Thermal process modeling. July 9, 2003. USDA-FSIS. Technical Service Center, Omaha, NE

Davidson, M., **R.Y. Murphy**, and J.A. Marcy. 2003. Thermal inactivation kinetic values for E. coli O157:H7 in commercially formulated beef franks. The Second Governor's Conference on Ensuring Meat Safety: E. coli Progress and challenges. April 7-8, 2003, Lincoln, Nebraska

Osborn, G.S. and **M.D. Matlock**. 2003. A Portable Oxygenator for Enhancing Biological Treatment Processes in Water Ecosystems. ASAE Technical Meeting Presentation no. 037035. ASAE. St. Joseph, MI.

Pradhan, A.K., B. Swem, and **Y. Li**. 2003. A mathematical predictive model for the survival/growth/death of *Salmonella Typhimurium* in broiler hatchery. Presented at the Food Safety Consortium 2003 Annual Meeting, October 12-14, Fayetteville, AR. Abstract of the poster in: CD of Food Safety Consortium 2003 Annual Meeting—Agenda, Presentations, and Progress Reports.

Swem, B., **A.K. Pradhan**, and **Y. Li**. 2003. Penetration of *Salmonella Typhimurium* through the shell of fertile hatching eggs. Presented at the Food Safety Consortium 2003 Annual Meeting, October 12-14, Fayetteville, AR. Abstract of the poster in: CD of Food Safety Consortium 2003 Annual Meeting—Agenda, Presentations, and Progress Reports.

Sahoo, D., **I. Chaubey**, **B.E. Haggard**, **M.D. Matlock**, and **T.A. Costello**. 2003. Stream nutrient dynamics and sediment nutrient interactions in an agricultural watershed. ASAE Paper No. 03-2281, ASAE, St. Joseph, MI.

Sahoo, D., **I. Chaubey**, **B. Haggard**, and **M. Matlock**. 2003. Nutrient cycling in agricultural streams. ASAE International Meeting, Las Vegas, NV, July 2003.

Su, X., and **Y. Li**. 2003. A quartz crystal microbalance (QCM) immunosensor for rapid detection of *Escherichia coli O157:H7*. Presented at IBE 2003 Annual Meeting, January 17-19, Athens, GA.

Su, X., **L. Yang** and **Y. Li**. 2003. A novel piezoelectric microgravimetric immunosensor for detection of *Escherichia coli O157:H7* based on self-assembled monolayers. Presented at PITTCON 2003 Annual Meeting, March 9-14, Orlando, FL. Paper # 330-13P.

Su, X., **L**. Zhang, B. Kim and **Y. Li**. 2003. Capillary immunosensing system for detection of *Salmonella Typhimurium*. Presented at the 2003 ASAE Annual International Meeting, July 27-30, 2003, Las Vegas, NV. ASAE Paper No. 037061.

Kim, B., **X.L. Su**, and **Y. Li**. 2003. Evaluation of three immobilization methods for a capillary immunosensor for rapid detection of *Salmonella Typhimurium*. Presented at the Food Safety Consortium 2003 Annual Meeting, October 12-14, Fayetteville, AR. Abstract of the poster in: CD of Food Safety Consortium 2003 Annual Meeting—Agenda, Presentations, and Progress Reports.

Su, X.L., **L. Yang**, and **Y. Li**. 2003. Comparison of QCM and SPR immunosensors for detection of *Escherichia coli O157:H7*. Presented at the Food Safety Consortium 2003 Annual Meeting, October 12-14, Fayetteville, AR. Abstract of the poster in: CD of Food Safety Consortium 2003 Annual Meeting—Agenda, Presentations, and Progress Reports.

Subramanian, S, **D.J. Carrier** and **E. Clausen**. The Effect of Pretreatment on the Extraction of Flavanolignans From Milk Thistle (Silybum marianum) Seeds" presented at the 25th Symposium on Biotechnology for Fuels and Chemicals, Breckenridge, CO. (poster)

Vaughn K, **D.J. Carrier**, Howard L and **E. Clausen**. Extraction of lycopene from watermelon. The annual IFT meeting, Chicago, July 2003 (poster)

Varshney, M., and **Y. Li**. 2003. Effects of immuno-separation/reaction procedures on the detection of *Salmonella Typhimurium* using a chemiluminescence fiber optic biosensor. Presented at IBE 2003 Annual Meeting, January 17-19, Athens, GA.

Varshney, M., **Y. Li**, **X.L. Su**, B. Venkatesh, and S. Tung. 2003. An optical biosensor based on immuno-magnetic beads for detection of E. coli O157:H7. Presented at the Food Safety Consortium 2003 Annual Meeting, October 12-14, Fayetteville, AR. Abstract of the poster in: CD of Food Safety Consortium 2003 Annual Meeting—Agenda, Presentations, and Progress Reports.

Vories, E.D. and **P.L. Tacker**. 2003. Investigating a multiple inlet approach to reduce water requirements for rice production. ASAE Annual Meeting, Las Vegas, NV, July 29.

Vories, E.D., R.E. Glover, K.J. Bryant and **P.L. Tacker**. Estimation the cost of delaying irrigation for mid-South cotton on clay soil (poster). Beltwide Cotton Prod. Res. Conf., NCC, Nashville, TN, Jan 7-10.

Vories, **E**., J. Greene, W. Robertson, **P. Tacker**, T. Teague, B. Phipps, L. Pringle and S. Hague. Determining the optimum timing for the final irrigation on mid-South cotton. Beltwide Cotton Prod. Res. Conf., NCC, Nashville, TN, Jan 9.

Wallace, S., **D.J. Carrier** and **E.C. Clausen**, "Extraction of Nutraceuticals from Milk Thistle" presented at Pharm Forum 2003, the Southern Regional Discussion Group of the American Association of Pharmaceutical Scientists, Little Rock, AR, May, 2003.

Wallace S, **D.J. Carrier** and **E. Clausen**. Yield and stability of flavonolignans from milk thistle seeds. The annual IFT meeting, Chicago, July 2003

White, K.L., and **I. Chaubey**. (Invited). Demonstration of SWAT model using Beaver Lake watershed. 2003 Arkansas Water Resources Conference Center Conference on Quality Water Resources to Meet Our Competing Needs. Fayetteville, AR. April 22 – 23.

White, K.L, **B.E. Haggard**, and **I. Chaubey**. Water quality during base flow and surface runoff conditions at the Buffalo National River near St. Joe, Arkansas from 1991 – 2001. Poster presented at the 2003 Arkansas Water Resources Conference Center Conference on Quality Water Resources to Meet Our Competing Needs. Fayetteville, AR. April 22 – 23.

White, K.L., **I. Chaubey**, and **T.A. Costello**. 2003. Stakeholder involvement in watershed management: lessons learned. Proc. Total Maximum Daily Load: Environmental Regulations II. ASAE, St. Joseph, MI. pp. 46-50.

Yang, L., and **Y. Li**. 2003. Detection of *Salmonella Typhimurium* using impedance measurement with interdigitated microelectrodes. Presented at PITTCON 2003 Annual Meeting, March 9-14, Orlando, FL. Paper # 2130-10P.

Yang, L., and **Y. Li.** 2003. An interdigitated array microelectrode based impedance immunosensor for rapid detection of *Escherichia coli O157:H7*. Presented at the Food Safety Consortium 2003 Annual Meeting, October 12-14, Fayetteville, AR. Abstract of the poster in: CD of Food Safety Consortium 2003 Annual Meeting—Agenda, Presentations, and Progress Reports.

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Reports

Bajwa, S. G., **J. M. Mason**, and J. Rupe. 2003. Remote sensing for agricultural crop stress monitoring and diagnosis. In. Proc. 30th International Symposium on Remote Sensing of Environment, November 10-14, 2003, Honolulu, Hawaii.

Bajwa, S. G., **J. M. Mason**, and R. Norman. 2003. High-resolution optical sensing of rice nitrogen stress. In. Proc. 2003 ASAE annual international meeting, July 27-30, 2003, Las Vegas, NV.

Beitle R., C. Ying, R. Henry, **J.-W. Kim**, M. Moore. 2003. Nuisance Protein Abatement through Proteome Analysis. 95th AIChE Ann. Meet. (Advances in Bioprocessing Session), San Francisco, CA.

Costello, T. A., J. C. Sager, and R. M. Wheeler. 2003. Development of algorithms for control of humidity in plant growth chambers: Final report. 2003 NASA/ASEE Summer Faculty Fellowship Program, John F. Kennedy Space Center, Cape Canaveral, FL.

Costello, T. A. 2003. Quarterly report to ASWCC, project: Demonstration of on-farm litter combustion, October 5, 2003.

Costello, T. A., **I. Chaubey**, **M. D. Matlock**. 2003. Environmental engineering activities within Biological Engineering. Report to Environmental Engineering Program, University of Arkansas, September 15, 2003.

Garg, V., S. **G**. B**ajwa**, **I. Chaubey**, and **B. E. Haggard**. 2003. Effect of Suspended Sediment Depth Distribution in Water on Spectral Reflectance. Accepted for 2003 AWRA Spring Specialty Conference Agricultural Hydrology and Water quality. May 12-14, Kansas City, MO.

Gosnell, Amber, and **C.Griffis**. 2003. Non-Destructive Evaluation of Damage in Rough Rice Using Machine Vision. Oral Presentation at the International Meeting of ASAE, Las Vegas July 2003

S. Tung, **Kim, J.W.**, A. Malshe, C.C. Lee, and R. Pooran. 2003. A Cellular Motor Driven Microfluidic System. Tranducers'03 – 12th International Conference on Solid-State Sensors, Actuators and Microsystems, Boston, MA.

M. Al-Fandi, A. Malshe, **Kim, J.W.** , S. Tung, J. Jenkins, and S. Sundaram. 2003. Design and Analysis of Viscous Micropump Actuated Using Biological Cell Motors. ASME International Mechanical Engineering Congress and R&D Expo (IMECE), Washington DC.

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Mason, J. M., **S. G. Bajwa**, and J. Rupe. 2003. Discrimination between soybean stresses using hyperspectral reflectance data. In. Proc. 2003 ASAE annual international meeting, July 27-30, 2003, Las Vegas, NV.

Charbonnet, D., **Osborn, G.S.**, **M.D. Matloc**k, and P.K. Haan. 2003. Using a Spreadsheet-Based Model to Determine In-Stream Sediment Oxygen Demand from Simple Field and Lab Measurements. ASAE Meeting Technical Paper No. 032284. ASAE. St. Joseph, MI.

Waggoner, A.T., **Osborn, G.S.** , S.R. Pinson. 2003. Using a Moisture Transport Model for Identifying the Genes Expressing Field Fissure Resistance in Rice Seed. ASAE Meeting Technical Paper No. 036193. ASAE. St. Joseph, MI.

Osborn, G.S. and S.R. Pinson. 2003. Annual progress report to Rice Foundation for funded grant, "Determining the Physical, Chemical and Genetic Mechanisms Responsible for Fissure Resistance of Rice".

Pinson, S.R, and **Osborn, G.S.**. 2003. Annual progress report to Texas Rice Research Foundation for funded grant, "Determining the Physical, Chemical and Genetic Mechanisms of Fissure Resistance".

Su, X., Z. Zhang, B. Kim and **Y. Li.** 2003. Capillary immunosensing system for detection of *Salmonella Typhimurium*. ASAE Paper No. 037061.

Trujillo, O., **Griffis, C**., Slavik, M., and **Li, Y**. 2003. Recognition and Enumeration of *Salmonella typhimurium* Using Image Analysis, Pattern Recognition, and Surface Modification on Glass Slides. Abstract and Oral presentation for the 2003 ASAE Annual International Meeting in Las Vegas, NV.

Purcell, L.C. and **Vories, E.D.**. 2003. Soybean drought tolerance research summary. Annual Report to AR Soybean Promotion Board.

Vories, E.D. 2003. Improving yield and yield stability for irrigated soybean (year 2). Annual Report to AR Soybean Promotion Board.

Vories, E.D. and R.E. Glover. 2003. Comparing the timing of the last effective boll populations in UNR and conventional cotton. Final Report to Cotton Incorporated for Agreement No. 01-128.

Vories, E.D., R.E. Glover, K.J. Bryant and **P.L. Tacker**. 2003. Estimation the cost of delaying irrigation for mid-South cotton on clay soil. Proc. Beltwide Cotton Prod. Res. Conf. Nat. Cotton Council, Memphis, TN:656-661 (CD ROM).

Vories, E., J. Greene, W. Robertson, **P. L. Tacker**, T. Teague, B. Phipps, L. Pringle and S. Hague. 2003. Determining the optimum timing for the final irrigation on mid-South cotton. Proc. Beltwide Cotton Prod. Res. Conf. Nat. Cotton Council, Memphis, TN:548-553 (CD ROM).

Vories, E., J. Greene, W. Robertson, **P. L. Tacker**, T. Teague, B. Phipps, L. Pringle and S. Hague. 2003. Determining the optimum timing for the final irrigation on mid-south cotton. Final Report to Cotton Incorporated for Agreement No. 01-130.

Vories, E.D. and **P.L. Tacker**. 2003. Investigating a multiple inlet approach to reduce water requirements for rice production. ASAE Paper No. 032014. ASAE, St. Joseph, MI.

Vories, E., **P. L. Tacker**, J. Kelley and J. Ross. 2003. Improving corn irrigation practices and recommendations in Arkansas (Year 2). Annual Report to AR Corn and Grain Sorghum Promotion Board.

Vories, E.D., **P.L. Tacker**, T.G. Teague, D.M. Oosterhuis, and K.J. Bryant. 2003. Improving Cotton Irrigation Practices and Recommendations in Arkansas. Final Report to Cotton Incorporated for Agreement No. 01-927AR.