2004

Annual Report, 2004

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

2004 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

Department of Biological & Agricultural Engineering

203 Engineering Hall
University of Arkansas
Fayetteville, Arkansas 72701

Phone: (479) 575-2351
Fax: (479) 575-2846
Email: baeg@engr.uark.edu

TABLE OF CONTENTS

TABLE OF CONTENTS

FOREWORD

This annual report describes the outstanding accomplishments of the Department of Biological and Agricultural Engineering faculty, staff, and students in 2004. 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 we have a new Master of Science degree program in Biomedical Engineering and are building a faculty and laboratory base in this area of concentration. Our Biological Engineering programs at the undergraduate and graduate levels are continuing to grow in size and quality. We have research and extension programs in Food and Bioprocess, Ecological, Bioresource, and Pre-Med/Biomedical Engineering concentrations. There are presently 13 faculty members in research and teaching at Fayetteville and four extension engineers in Little Rock. We added a new faculty member in 2004 dedicated full-time to Biomedical Engineering. Currently there are two full-time Biomedical Engineering Professors. Labs for Biomedical Engineering are being completed at the Engineering Research Center.

It was a matter of great pride for the BAE faculty when our student team won second place in the Senior Design Competition at the 2004 International ASAE Meeting in Ottawa, Canada.

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

· Arkansas Department of Higher Education approved the Masters Program in Biomedical Engineering. This is the first of its kind in the state and will have four areas of concentration.

· The John W. White Award of Excellence for Extension at the state level was awarded to Phil Tacker. Mr. Tacker is well known by Arkansas farmers as an expert on crop management practices involving drainage, irrigation, water quality, and the development and management of water resources.

· Dr. Danielle Julie Carrier received the Outstanding Teacher award at the Annual College of Engineering Banquet honoring professors and students. Dr. Jin-Woo Kim received the Outstanding Researcher Award and Dr. Scott Osborn was awarded the Service to Students Award.

· Purdue University choose Dr. Otto Loewer to be honored as an Outstanding Alumnus.

· Dr. Kaiming Ye joined the department in December 2004. Dr. Ye is the second full-time Biomedical Engineering faculty member to join the department.

· Dr. Lalit Verma was named to the Board of Directors of the national Accreditation Board for Engineering and Technology.

· Dr. Dennis Gardisser was awarded the "Aviation Safety Counselor of the Year."

· The Teaching Academy of the University of Arkansas elected Dr. Carl Griffis into the academy.

· Phil Tacker was awarded the M-159 Award for the Advancement of Surface Irrigation.

· Dr. Marty Matlock received a design award from the Arkansas Chapter of the American Institute of Architects for the design of, "Riparian Meadow, Mounds of Rooms Urban greenway in Warren, Arkansas."

· Faculty began researching a computation model for analysis of oxidative stress on the free radical transport in the microcirculation.

The Department Continued:

· The computer model of palatal growth to establish multidisciplinary, multi-institutional research team for image acquisition and processing, numerical modeling, and clinical testing.

· Monitoring and modeling acquired bacterial resistance to medical antibiotics in water ecosystems to create tools to determine the exposure of bacteria to antibiotics in natural water ecosystems.

· Investigating the interface between biological and abiological materials at nanoscale.

· Designing the DNA oligonucleotide building blocks for DNA- based computers and nanotechnology.

· Working on acquisition of a high accuracy and high resolution landscape and structure characterization system.

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

· Working to improve cotton irrigation recommendations in Mid-South.

· Developing online NIR sensor for quantifying beef quality.

· Identifying pesticide pollution in La'Anguille watershed in Arkansas Delta caused by the heavy agricultural pesticide usage and creating a model of the risk of pollution to surface water bodies using GIS and water quality modeling tools.

· Test and validate optical sensing technology for mid-season plant nitrogen estimation and management in rice.

· Developing a watershed nutrient management decision support system (DSS) to improve land use and water resource management decision-making.

· Development of a decision support system and data needs for the Beaver Lake Watershed.

· Development of a statewide nonpoint source pollution plan for Arkansas.

· Developing and testing a field-scale methodology to measure the location of different runoff-contributing areas from pastureland.

· Creating a GIS database with development and watershed modeling in the Arkansas priority watersheds.

SIGNIFICANT ACCOMPLISHMENTS IN 2004

· Growth chambers for bio-regenerative life support in order to develop and improve hardware and software for the control of experiments.

· Working on engineering design and evaluation of animal waste management systems in Arkansas.

· The National Wadeable Stream Assessment by making decision on environmental issues.

· Working to optimize BMPs, water quality, and sustained agriculture in the Lincoln Lake Watershed.

· To work towards sustainable agriculture and water resources in Arkansas by using a bioenvironmental engineering solution.

· Developing SWAT modeling in the Illinois River Watershed.

· Using attainability and water quality assessment of Coffee Creek, Mossy Lake, the Ouachita River, and Southern Arkansas.

· Developing an electrochemical method to destroy *Listeria* in chilling brine for cooked poultry and meat products.

· Modeling pathogen lethality and heat- and mass-transfer of meat thermal processing.

· Designing capillary electrochemical/ optical biosensors for rapid detection of pathogenic bacteria in poultry and meat products.

· Determining the physical, chemical, and genetic mechanism responsible for fissure resistance of rice.

· Developing environmentally relevant biotechnology to degrade recalcitrant pollutants.

· Developing impedance immunosensors for rapid detection of live *Escherichia coli O157:H7*, *Salmonella Typhimurium*, and *Listeria Monocytogene* in food products.

· Working towards developing microfluids based chemiluminescent fiber optical biosensor coupled with immuno microbeads separation for detection of *Escherichia coli O157:H7* and *Salmonella Typhimurium* in food samples.

· Studying milk thistle, watermelon, grape waste, and *Albizia julibrissin* extraction by characterizing the extraction step and by replacing, if possible organic solvents with water.

· Working towards delivering science- based knowledge and educational programs to industry to enable their employees to make practical decision in achieving performance standards.

· Emphasizing agricultural chemical applications.

· Controlling ambient aeration as a pest management strategy stored in rice.

· Educating the public on Farm Safety.

· Providing harvest equipment recommendations that improve profit and meet Arkansas growers' needs.

· Improving efficiency of on farm grain handling and storage.

· Protecting the air, water, and soil from contamination in areas where relatively large quantities of chemical mixes are prepared and loaded for field distribution.

· Investigating practical potential for practical incorporation of precision agriculture practices.

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

· Assisting ginners and other to develop higher-value uses for gin-waste

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, University 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, 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, *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 vitro 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.

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.

DEPARTMENTAL RESOURCES

Faculty

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.

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, *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, *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.

Kaiming Ye, *Assistant Professor*
B.S., M.S., Ph.D., East China University of Science and Technology. Stem cell engineering, high throughput screening platform for screening for breast cancer-specific genes using siRNA library, biosensing and bioimaging.

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) 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.*

Ajay Malshe *(Ph.D., University of Poona) Professor, Mechanical Engineering, University of Arkansas.*

Gal Shafirstein*, (Ph.D., Technion, Israel Institute of Technology.) Assistant Professor, University of Arkansas for Medical Sciences.*

Earl Vories, *(Ph.D., 1987, University of Tennessee) Professor, Biological and Agricultural Engineering, University of Arkansas.*

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

Julian Abram, Lab Coordinator

Ray Avery, Program Technician I

Brandon Beard, Research Specialist I

Eric Cummings, Research Specialist I

Cynthia Corbitt, Administrative Office Supervisor

Paul DeLaune, Post Doctroral Associate

Virginia Glass, Accountant

Betty Martin, Program Tech I

John Murdoch, Program Tech II

Brian Schaffer, Research Specialist I

Lee Schrader, Research Assistant I

Sara Seabolt, Secretary

Xiaoli Su, Post Doctoral Research Associate

Katie Vaughn, Program Tech I

Stephanie Williamson, Research Specialist

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:

· Phil Tacker was awarded the John W. White Award of Excellence for Extension at the state level. Mr. Tacker is well known by Arkansas farmers as an expert on crop management practices involving drainage, irrigation, water quality, and the development and management of water resources.

· Dr. Danielle Julie Carrier received the Outstanding Teacher award at the Annual College of Engineering Banquet honoring professors and students. Dr. Jin-Woo Kim received the Outstanding Researcher Award. Dr. Scott Osborn was awarded the Service to Students Award.

· Dr. Otto Loewer was chosen by Purdue University to be honored as an Outstanding Alumnus.

· Dr. Kaiming Ye joined the department in December 2004. Dr. Ye is the second full-time Biomedical Engineering faculty member to join the department.

Advisory Board

2004-2005 Members

Stan Andrews, Renfroe Engineering
Thomas Badger, UAMS
Virendra Bhumbla, Tyson Foods Inc.
David Beasley, North Carolina State University
Billy Bryan, Professor Emeritus, UA
Dennis Carman, Retired USDA/NRCS
Lawerence Cornett, UAMS
Steven Danforth, Agri Process Innovations
Fred Fowlkes, Retired Entergy, Inc.
Michael Freer, Tyson Foods
John Langston, Retired Arkansas CES
Jeff Madden, Riceland Foods
Ralph Mashburn
Stanley Mathis, USDA
Kyle McCann, Washington Regional Hospital
J.L. Mehta, UAMS
Stanley Reed, Stanley E. Reed Farms
Wesley Ritter, Halliburton
Michael D. Shook, Agri Process Innovations
Gene Sullivan
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 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)
David "Gail" Cowart, B.S. (60)
Steven D. Danforth, B.S. (80)
Joe D. Faddis, B.S. (67)
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)
Dennis R. Gardisser, B.S. (79), M.S. (81), Ph.D. (92)
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)
Eugene H. Snawder, B.S. (69)
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*

DEPARTMENTAL RESOURCES

Facilities

Old Main is located on the University of Arkansas Campus.

The City of Fayetteville

- Northwest Arkansas has seen 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 is 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.

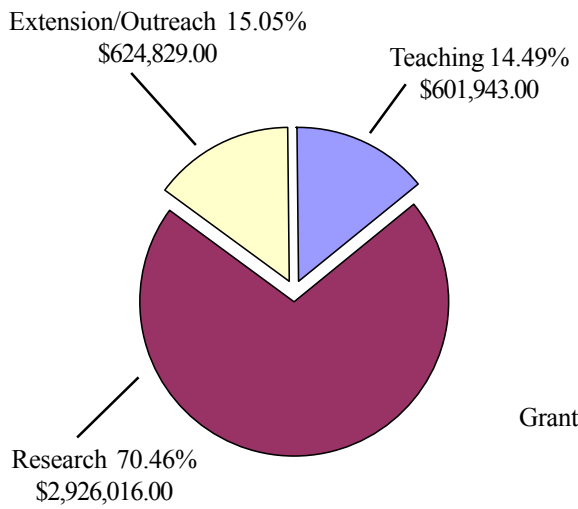
Senior Walk stretches over five miles on campus where the name of every graduate is engraved in the concrete sidewalk.

Department Facilities

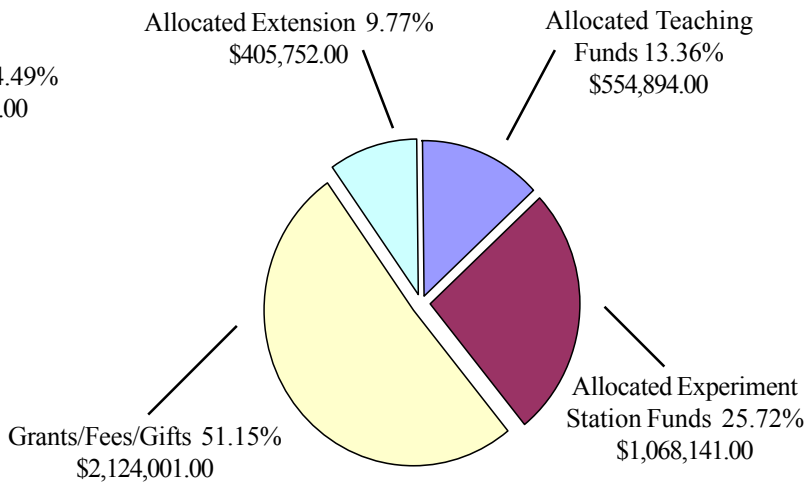
- Department facilities are located in Engineering Hall, adjacent to the Bell Engineering building. We also have research and lab facilities located north of campus at the Agriculture Research and Extension Center and the Engineering Research Center.
- The department has laboratory facilities for thermal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

Total Expenditures, July 1, 2003 to June 30, 2004 - $4,152,788.93

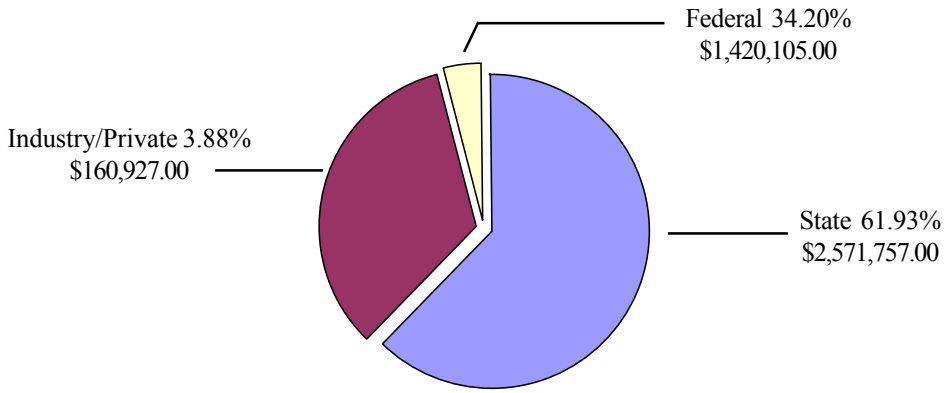
Expenditures by Program Area



Sources: Allocated vs. Grants/Fees/Gifts

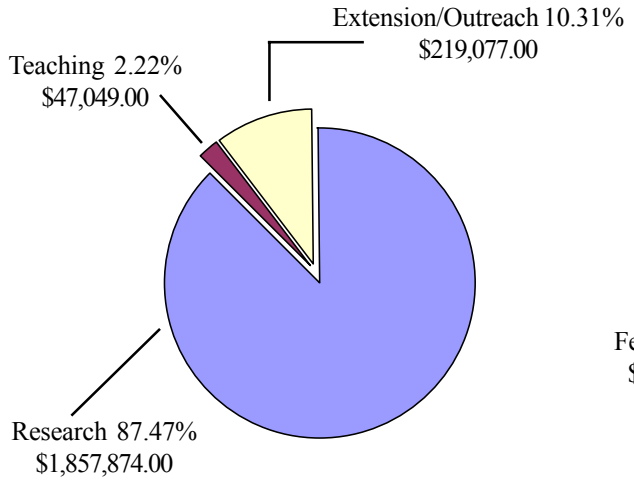


Sources of All Funds

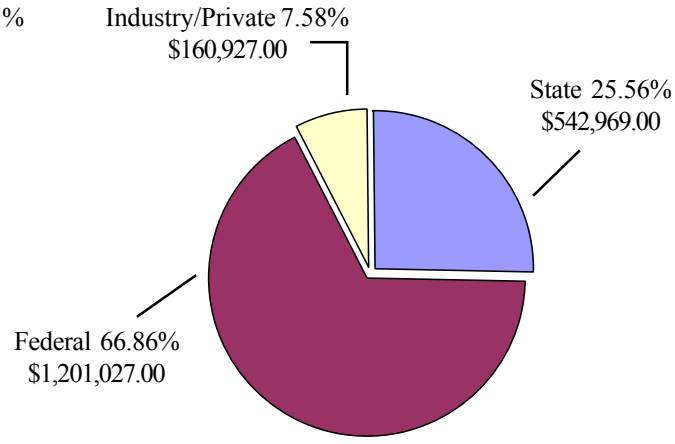


Grants/Fees/Gifts - $2,124,001.00

Expenditures by Program Area



Sources: Allocated vs. Grants/Fees/Gifts



TEACHING PROGRAM

Undergraduate Program

Foreword

Biological Engineers improve people's lives today and help assure a sustainable quality of life for tomorrow. They create solutions to problems by coupling living systems (human, plants, animals, 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 processes (plants, animals, humans, microbes, and ecosystems) 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 Engineering – an overview of instrumentation, physiological modeling, biomechanics, biomaterials 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, geographic information systems and other technology for managing agriculture and bioresources, and designing machines to interface with living systems.

Ecological Engineering – integrates ecological principles into the design of sustainable systems to treat, remediate, and prevent pollution to the environment. Applications include stream restoration, watershed management, water treatment design, ecological services management, urban greenway design and enclosed ecosystem design.

Food and Bioprocess Engineering – biotechnology, food processing, food safety and security, developing new products from biomaterials, and using bacteria to synthesize 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 six 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 adviser. 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 2004

Ray Avery
Eric Cummings
Tyler Gipson
Elizabeth Kaufman
Noel Lawrence
Andrea Ludwig
Brian Schaffer

Biological and Agricultural Engineering Scholarships

J.A. Riggs Tractor Scholarship: Katie Merriman, Kristopher Keller, Cory Scott, and Jonathan Watson.

John W. White Scholarship: Drake McGruder.

Staplcotn Scholarship: Colt McClain.

Xzin McNeal: Napura Bhise, Alexis Brown, Eddy Douglas, Nathan Helms, Sarah Huber, Jacob Irwin, Adam Jokerst, Kendra Kersh, Allison Kroeter, Drake McGruder, Brian Rohlman, Lauren Sherrill, Russel Tate, Jessica Temple and Jeremy Wasson.

Departmental Scholarship: Adam Jokerst, Katie Merriman, Leslie Mooney, Khalil Ibrahim, Patrick Petree, and Ashley Wiedower.

Billy Bryan Scholarship: Leslie Bartsch.

Academy Scholarship: Tom Garrison.

Biological Engineering Student Club

Officers for 2004-2005
President: Kyle McGruder
Vice President: Adam Jokerst
Treasurer: Colt McClain
Secretary: Leslie Bartsch

Alpha Epsilon

Officers for 2004-2005
President: Sunny Wallace
Vice President: Vibhava
Treasurer: Nalini Kotagiri
Secretary: Inoka Wijesekera
Faculty Advisor: Dr. Sreekala Bajwa

TEACHING PROGRAM

Undergraduate Program

Biological and Agricultural Engineering Curriculum - 128 Credits

Fall Semester		*Spring Semester*	
Freshman			
BENG 1012 - Biological Engineering Design Fundamentals	2	BENG 1022 - Biological Engineering Design Studio I	2
ENGL 1013 - Composition I	3	ENGL 1023 - Technical Composition II	3
CHEM 1103 - University Chemistry I	3	CHEM 1123 - University Chemistry II	3
MATH 2554 - Calculus I	4	CHEM 1121L - University Chemistry II Lab	1
Humanities/Social Studies Elective	3	MATH 2564 - Calculus II	4
		BIOL 1543 - Principles of Biology	3
		BIOL 1541L - Principles of Biology Lab	1
Total Semester Hours	**17**	Total Semester Hours	**17**
Sophomore			
BENG 2612 - Biological Engineering Design Studio II	2	BENG 2622 - Biological Engineering Design Studio III	2
PHYS 2054 - University Physics I	4	PHYS 2054 - University Physics I	4
MATH 2574 - Calculus III	4	MEEG 2003 - Statics	3
MBIO 2013 - General Microbiology*	3	MEEG 2403 - Thermodynamics, or	3
MBIO 2011L - General Microbiology Lab	1	CHEG 2313 - Thermodynamics of Single Component Sys.	
Humanities/Social Studies Elective	3	CHEM 2613 - Organic Physiological Chemistry*	3
		CHEM 2611L - Organic Physiological Chemistry Lab	1
Total Semester Hours	**17**	Total Semester Hours	**16**
Junior			
BENG 3712- Engr Properties of Biol Materials	2	BENG 3723 - Unit Operations in Biological Engr	3
ELEG 2103- Electronic Circuits	3	BENG 3803 - Mechanical Design in Biological Engr	3
ELEG 2101L- Electronic Circuits Lab	1	BENG 4103 - Instrumentation in Biological Engr	3
MEEG 3013- Mechanics of Materials	3	MEEG 2013 - Dynamics	3
CVEG 2313 - Hydraulics, or	3	MATH 3404 - Differential Equations	4
MEEG 3503 - Mechanics of Fluids, or	3		
CHEG 2113 - Fluid Mechanics			
CHEM 3813 - Intro. to Biochemistry			
Total Semester Hours	**15**	Total Semester Hours	**16**
Senior			
BENG 4813 - Senior Biological Engr Design I	3	BENG 4822- Senior Biological Engr Design II	2
BENG 3733 - Transport Phenomena in Biological Sys.	3	BENG Design Elective	3
BENG Design Elective	3	Humanities/Social Science Elective	6
Humanities/Social Studies Elective	6	Technical Elective	6
	15		**17**

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

NOTE: Pre-Medical students must take CHEM 3603/3601L, Organic Chemistry I, and CHEM 3613/3611L, Organic Chemistry II, instead of CHEM 2613/2611L, Organic Physiological Chemistry. This requires special scheduling of courses beginning in the first sophomore semester. See your faculty adviser for this schedule plan.

Design Electives:
- BENG 4203 Introduction to Biomedical Engineering†
- BENG 4213 Applications of Biomedical Engineering†

Technical Electives:
- CHEM 3613 Organic Chemistry II
- CHEM 3611L Organic Chemistry II Lab
- BIOL 2404 Comparative Vertebrate Morphology, or BIOL 2443/2441L Human Anatomy†
- BIOL 4234 Comparative Physiology, or BIOL 2213/2211L Human Physiology
- BENG 4113 Risk Analysis for Biological Systems
- BENG 4123 Biosensors and Bioinstrumentation
- BENG 4623 Biological Reactor Systems Design
- BIOL 2533/2531L Cell Biology
- BIOL 4233 Microbial Genetics
- KINS 3353 Mechanics of Human Movement
- ELEG 2903 Digital Systems
- HESC 3204 Nutrition

Bioresource Engineering

Design Electives:
- BENG 4913 Design of Agricultural Waste Management Systems
- BENG 4113 Risk Analysis for Biological Systems
- BENG 4123 Biosensors and Bioinstrumentation

Technical Electives:
- BENG 4803 Precision Agriculture
- GEOL 4413 Principles of Remote Sensing
- GEOG 4563 Vector GIS
- GEOG 4593 Introduction to GPS
- MEEG 3113 Machine Dynamics and Control
- MEEG 4123 Finite Element Methods
- INEG 4533 Application of Machine Vision

Ecological Engineering

Design Electives:
- BENG 4903 Natural Resources Engineering†
- BENG 4113 Risk Analysis for Biological Systems
- BENG 4403 Enclosed Ecosystems Design
- BENG 4623 Biological Reactor Systems Design
- BENG 4913 Design of Agricultural Waste Management Systems
- BENG 4923 Nonpoint Source Pollution Engineering

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 Geographic Information Systems
- ENSC 4034 Analysis of Environmental Contaminants
- BIOL 3863/3861L General Ecology

Food and Bioprocess Engineering

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

Technical Electives:
- FDSC 4304 Food Chemistry
- FDSC 4124 Food Microbiology
- FDSC 3103 Principles of Food Proc.
- CHEM 3453/3451L Elements of Physical Chemistry
- MEEG 4413 Heat Transfer
- CHEG 4423 Auto. Process Control

The following 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.

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 and Biomedical Engineering

Students will be admitted to the Biological Engineering or Biomedical 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 only be admitted to the M.S. program provided 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 not possessing engineering undergraduate degrees often pursue graduate degrees in Biological Engineering or Biomedical Engineering. Students without an ABET accredited engineering degree (or equivalent) can be admited to the program but must earn credit for the following 18 hours of coursework in addition to Masters requirements (note: additional hours may be required for prerequisites):

1. A minimum of 15 credit hours of 2000 level or above of engineering courses (with course prefix BENG, CHEG, CVEG, CENG, ELEG, INEG, or MEEG) currently allowed for credit within the BENG undergraduate program.
2. Minimum of 3 credit hours of 3000 level or above of BENG engineering design course currently allowed for credit within the BENG undergraduate program.
3. Specific deficit courses are to be determined in consultation with the student's advisory committee. Additional deficiency courses may be required for students with insufficient coursework in a critical area (such as life sciences).

Note: Students without ABET accredited undergraduate degrees cannot typically obtain a PE license to practice engineering. The above deficit courses are not sufficient to meet this requirement.

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 con structed 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
Ashish Mishra	M.S.	Dr. Sreekala Bajwa	Page Shurgar	M.S.	Dr. Marty Matlock
Jayarani Kandaswamy	M.S.	Dr. Sreekala Bajwa	Subodh Kulkarni	Ph.D.	Dr. Sreekala Bajwa
Vibhava	M.S.	Dr. Sreekala Bajwa	Sunny Wallace	Ph.D.	Dr. Julie Carrier
Mansour Leh	M.S.	Dr. Indrajeet Chaubey	Vijay Garg	Ph.D.	Dr. Indrajeet Chaubey
Brian Schaffer	M.S.	Dr. Indrajeet Chaubey	Eylem Mutlu	Ph.D.	Dr. Indrajeet Chaubey
Willie Dillahunty	M.S.	Dr. Tom Costello	Kati White	Ph.D.	Dr. Indrajeet Chaubey
Johnny Mason	M.S.	Dr. Tom Costello	Prabhakar Deonikar	Ph.D.	Dr. Mahendra Kavdia
Amber Gosnell	M.S.	Dr. Carl Griffis	Ju-Seok Lee	Ph.D.	Dr. Jin-Woo Kim
Juhi Srivastava	M.S.	Dr. Carl Griffis	Nalini Kanth Kotagiri	Ph.D.	Dr. Jin-Woo Kim
Ray Avery	M.S.	Dr. Brian Haggard	Jeonghwan Kim	Ph.D.	Dr. Jin-Woo Kim
Josh Giovannetti	M.S.	Dr. Brian Haggard/ Dr. Marty Matlock	Dilshika Wijesekera	Ph.D.	Dr. Jin-Woo Kim
			Zhihui Liu	Ph.D.	Dr. Yanbin Li
Prabhakar Bharatan	M.S.	Dr. Mahendra Kavdia	Abani Pradhan	Ph.D.	Dr. Yanbin Li
Sunil Potdar	M.S.	Dr. Mahendra Kavdia	Madhukar Varshney	Ph.D.	Dr. Yanbin Li
Inoka Wijesekera	M.S.	Dr. Jin-Woo Kim	Dawn Farver	Ph.D.	Dr. Marty Matlock
Fei Liu	M.S.	Dr. Yanbin Li	Robert Morgan	Ph.D.	Dr. Marty Matlock
Xiaole Mao	M.S.	Dr. Yanbin Li	Prahlad Jat	Ph.D.	Dr. Scott Osborn
Eric Cummings	M.S.	Dr. Marty Matlock			
Andrea Ludwig	M.S.	Dr. Marty Matlock			

Degrees Earned

Student	Degree	Advisor	Thesis/Dessertation Title
Sujit Ekka	M.S.	Dr. Marty Matlock	Phosphorus Retention and Sediment-Phosphorus Interactions in Point-Source-Impacted Ozark Stream
Dylan Carpenter	M.S.	Dr. Jin-Woo Kim	Estimating the Sequence Complexity of a Random Oligonucleotide Population Using $C_o t$ Anslyses
Xiaole Mao	M.S.	Dr. Yanbin Li	A Nanoparticle Based QCM DNA Sensor for the Detection of *Escherichia coli 0157:H7*
Debabrata Sahoo	M.S.	Dr. Indrajeet Chaubey	Nutrient Retention, Limitation, and Sediment Nutrient Interactions in a Pasture Dominated Stream
Sumit Sen	M.S.	Dr. Indrajeet Chaubey	Quantification of Internal Phosphorus Loading in Beaver Lake, Northwest Arkansas
Senthil Subramaniam	M.S.	Dr. Julie Carrier	An Alternative to Petroleum Ether Defatting: Pretreatment of Milk Thistle Seed to Increase the Silymarin Yield
Omar Trujillo	Ph.D.	Dr. Carl Griffis	Image Processing and Antibody Patterning for Rapid Enumeration of Pathogenic Bacteria
Kati White	Ph.D.	Dr. Indrajeet Chaubey	Linking of Hydrologic and Water-Quality Models to Evaluate Reservoir Water Quality as a Response to Watershed Management

Students in Other Programs Advised by BAE Faculty

Student	Degree	Advisor	Graduate Program
William Little	Ph.D.	Dr. Sreekala Bajwa	Electrical Engineering
Scott Monfort	Ph.D.	Dr. Sreekala Bajwa	Plant Pathology
Tetsuaki Ishibashi	Ph.D.	Dr. Sreekala Bajwa	Crop, Soil, & Environmental Sciences
Chuan Luau	M.S.	Dr. Julie Carrier	Chemical Engineering
Anirban Roy	M.S.	Dr. Julie Carrier	Chemical Engineering
Brian Mattingly	Ph.D.	Dr. Julie Carrier	Chemical Engineering
Nathalia Pandjaitan	Ph.D.	Dr. Julie Carrier	Chemical Engineering
Morella Barreto	Ph.D.	Dr. Julie Carrier	Food Science
Taha Raba	Ph.D.	Dr. Julie Carrier	Food Science
Burmsik Kim	Ph.D.	Dr. Indrajeet Chaubey	Environmental Dynamics
Irene Rhodes	M.S.	Dr. Carl Griffis	Poultry Science
Xiali Liu	M.S.	Dr. Carl Griffis	Poultry Science
Ryan Pooran	Ph.D.	Dr. Jin-Woo Kim	MICRO-EP
Mohamed Al-Fandi	Ph.D.	Dr. Jin-Woo Kim	MICRO-EP
Maryam Nuser	Ph.D.	Dr. Jin-Woo Kim	Computer Science & Computer Engineering
Weixia Yu	Ph.D.	Dr. Jin-Woo Kim	Computer Science & Computer Engineering
Jason Condenon	Ph.D.	Dr. Jin-Woo Kim	MICRO-EP
Jianghong Qian	Ph.D.	Dr. Jin-Woo Kim	Computer Science & Computer Engineering
Lin Cong	M.S.	Dr. Yanbin Li	Poultry Science
Byungchul Kim	M.S.	Dr. Yanbin Li	Food Science
Joyce Berger	Ph.D.	Dr. Yanbin Li	Crop, Soil & Environmental Sciences
Irene Hanning	Ph.D.	Dr. Yanbin Li	Poultry Science
Xiali Liu	M.S.	Dr. Yanbin Li	Poultry Science
Yue Ma	Ph.D.	Dr. Yanbin Li	Poultry Science
Balaji Venkatesh	Ph.D.	Dr. Yanbin Li	Mechanical Engineering
Yun Xi	Ph.D.	Dr. Yanbin Li	Electrical Engineering
Rui Xiong	Ph.D.	Dr. Yanbin Li	Food Science
Dilek Austin	Ph.D.	Dr. Scott Osborn	Food Science

Biological Engineering Courses

BENG1012 Biological Engineering Design Fundamentals (FA) Introduction to the profession of Biological Engineering including a definition, and demonstration through field trips, guest speakers, examples of job opportunities and internships. Basic engineering methodologies, including analysis and design, as applied to biological systems. Introduction to problem solving, data analysis, report writing, presentations, and engineering record keeping. Group activities and team design efforts. Lecture 1 hour, laboratory 3 hours per week. Corequisite: BENG 1010L.

BENG1010L Biological Engineering Design Fundamentals Laboratory (FA) Corequisite: BENG 1012.

BENG1022 Biological Engineering Design Studio I (SP) Continued practice of biological engineering design in the Biological Engineering Design Studio. Design projects explore the unique problems associated with engineering applied to biological systems. Group activities to teach teamwork skills in the context of engineering practice, including reporting, project management, time management, communication and balancing individual and team accountability. Introduction and application to a computer aided graphics package. Lecture 1 hour, laboratory 3 hours per week. Corequisite: BENG 1020L. Prerequisite: BENG 1012.

BENG1020L Biological Engineering Design Studio I Laboratory (SP)

BENG2103 Electronic Applications in Biological Systems (IR) Basic circuit theory and introductory applications of DC circuits, AC circuits and electromechanical 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 Biological Engineering Design Studio II (FA) Applications of biology, chemistry and physics to the design of life support for enclosed biological systems involving people, animals, plants and microbes. Design process will be based upon engineering analyses such as quantifying bioenergetics and growth, energy and mass balances, solar energy and psychrometrics. Student teams will be presented multiple design modules that include literature/experimental discovery, open-ended design and prototype testing. 4 hours of design studio per week. Pre- or Corequisite: PHYS 2054, BIOL 1543/ 1541L and BENG 1012.

BENG2622 Biological Engineering Design Studio III (SP) Continuation of BENG 2612. Design Studio experience includes additional life support system design modules. Design process will include discussion of social issues and ethics, use of engineering economics as a tool to evaluate design alternatives. Use of descriptive statistics and regression to analyze experimental data. Improve written and oral communication skills through presentation of design project results. 4 hours of design studio per week. Pre- or Corequisite: BENG 1022.

BENG3712 Engineering Properties of Biological Materials (FA) Measuring and predicting the physical, chemical, and thermal properties of biological materials necessary for the analysis and design of production and processing systems. Prerequisite: BENG 2622.

BENG3723 Unit Operations in Biological Engineering (SP) (Formerly BENG 3722) Design of basic unit operations typical of biological engineering practice; unit operations include pump-pipe, fan-duct, moist air (psychrometric) processes (cooler/heater/humidifier/dryer), air mixing, aeration, refrigeration and materials conveying; unit operations design will account for unique constraints imposed by biological systems. Lecture 2 hours and lab 3 hours per week. Prerequisite: (MEEG 2403 or CHEG 2313) and (CVEG 3213 or CHEG 2133 or MEEG 3503).

BENG3720L Biological Process Engineering I Laboratory (FA) Corequisite: BENG 3722. BENG3733 Transport Phenomena in Biological Systems (FA) (Formerly BENG 3732) Applications of the principles of kinetics and heat and mass transfer to the analysis and design of biological engineering processes. Biological engineering processes will encompass examples in the realms of bioprocess, bioenvironmental, bioresource, and biomedical engineering. Lecture 3 hours per week. Prerequisite: (CHEG 2313 or MEEG 2403) and (CHEG 2133 or MEEG 3503 or CVEG 3213) and CHEM 3813 and MATH 3404.

BENG3730L Biological Process Engineering II Laboratory (SP) Corequisite: BENG 3732. BENG3803

Mechanical Design in Biological Engineering (FA, SP) Introduction to the mechanical design process applied to biological engineering, with examples of mechanical components interfacing with biological systems. Engineering properties of materials, loading, combined stress analysis, theories of failure. Systems approach in design, including safety, reliability and cost. Lecture 2 hours,

laboratory 3 hours per week. Corequisite: BENG 3800L. Prerequisite: MEEG 3013.

BENG3800L Mechanical Design in Biological Engineering Laboratory (FA, SP) Corequisite: BENG 3803.

BENG4103 Instrumentation in Biological Engineering (SP) 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.

BENG4103H Honors Instrumentation in Biological Engineering (SP) 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) Corequisite: BENG 4103.

BENG4100M Honors Instrumentation in Biological Engineering Laboratory (SP) 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, Odd years) 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.

BENG4203 Introduction to Biomedical Engineering (FA) Engineering principles applied to the design and analysis of systems affecting human health. This is an introductory course focusing on fundamentals of physiological systems and modeling and how this relates to analysis and equipment design. Topics include: brief overview of anatomy and physiology; biomedical sensors, instrumentation and signal processing; physiological modeling, biomechanics, and fluid mechanics. Lecture 3 hours per week. Prerequisite: MEEG 2013, (MEEG 2403 or CHEG 2313), ELEG 2103, (MEEG 3503 or CVEG 3213 or CHEG 2133), MEEG 3013, and BIOL 1543.

BENG4213 Applications of Biomedical Engineering (SP) Continuation of BENG 4203. Biomedical engineering fundamentals applied to biomedical engineering problems. Topics include: biomaterials, tissue engineering, biotechnology, radiation imaging, ultrasound, NMR, MRI, biomedical optics and lasers, rehabilitation engineering, assistive technology, and clinical engineering. Lecture 3 hours per week. Prerequisite: BENG 4203.

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 for 8 hours.

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 bio remediation, bioprocessing and organic (food/animal) waste treatment. Corequisite: BENG 4620L. Prerequisite: BENG 3733.

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

TEACHING PROGRAM

Courses

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 3723 or CHEG 3143 or MEEG 4413.

BENG4700L Food & Bioprocess Engineering Laboratory (SP, Even years) 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 map-based systems, variable-rate machinery, smart controls. Evaluation: Yield mapping, economic analysis. Students are expected to have basic computer skills and statistics knowledge. (Same as CSES 4803) Prerequisite: MATH 1213 and junior standing.

BENG4800L Precision Agriculture Laboratory (FA, Odd years)

BENG4813 Senior Biological Engineering Design I (FA) 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) 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 Natural Resources Engineering (FA, Odd years) 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) 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 byproducts 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) 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 Materials (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 realtime 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 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 Food Safety Engineering (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.

A Fuzzy Controller for the Artificial Beta-Cell

Em Ward, Adjunct Assistant Professor, Biomedical Engineering, UAF

Objectives:

Complete simulations of fuzzy controller-based artificial beta-cell. Submit manuscript for publication.

Accomplishments:

Simulations completed. Manuscript in preparation.

Computational Model for Analysis of Oxidative Stress on the Free Radical Transport in the Microcirculation

Mahendra Kavdia, Assistant Professor, Biomedical Engineering, UAF

Objectives:

Endothelial dysfunction and reduced bioavailability of NO has been implicated in the pathogenesis of many of the diabetes-related vascular complications. Many vascular complications of diabetes mellitus such as increased risk of atherosclerosis, restenosis, and thrombosis are geometrically focal (low, high, or alternating shear stress regions) in nature. In addition, reactive oxygen species (ROS) including superoxide are overproduced by endothelium in diabetics. These ROS can directly interact with nitric oxide or serve as signaling molecules to modulate release of nitric oxide by endothelial cells.

It is necessary to understand interaction of hyperglycemic conditions and shear stress on endothelial cell functions mainly NO and ROS release to understand the mechanism of endothelial dysfunction in diabetic patients and identify potential treatment.

Accomplishments:

We have been quantifying the dynamic changes in NO and ROS generations in cultured vascular endothelial cells. The proposed research involved computational methods to quantify endothelial cell released transport of NO and ROS in the diabetic milieu. We formulated a computational model of NO, superoxide, and peroxynitrite transport in a tissue containing an arteriolar blood vessel. The biochemical interactions of these and other species in the microvascular tissue are quantified. The model predictions indicate that the NO interaction with oxygen, superoxide and peroxynitrite have relatively no effect on the NO level in the vascular smooth muscle. The model predicts that superoxide can diffuse only over few microns from its site of production before it is consumed. This is significant as the cellular sources for superoxide varies in different disease states.

Computer Model of Palatal Growth

Em Ward, Adjunct Assistant Professor, Biomedical Engineering, UAF

Objectives:

Establish multidisciplinary, multi-institutional research team for image acquisition, and processing, numerical modelling and clinical testing. Submit proposal to NIDCR (February 2005).

Accomplishments:

Key Personnel in place, including faculty from CVEG, BENG, Arkansas Children's Hospital, and the Army Corps of Engineers. Preliminary image processing work done, giving three-dimensional spatial co-ordinates of hard palate surface.

Desktop Urinary Pathogen Detection Device

Em Ward, Adjunct Assistant Professor, Biomedical Engineering, UAF

Objectives:

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

Accomplishments:

Resubmission of application awarded priority score, not funded.

Master of Science Biomedical Engineering

Em Ward, Adjunct Assistant Professor, Biomedical Engineering, UAF

Objectives:

Develop courses and collaborative teaching and research efforts supporting a Biomedical Engineering graduate program. Offer courses to graduate students in multiple disciplines. Continue exchanges and seminars with faculty at UAMS, UALR, and WRMC. Develop new industry and community contacts and collaborations.

Accomplishments:

Biomaterials offered for first time Spring 2005. Worked with WRMC to solve an imaging problem for the hospital. Established web site for M.S. program.

Established contacts and explored potential collaborations with Baxter (Mountain Home) and Schmieding Center (Springdale).

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

Scott Osborn, Assistant Professor, Biological & Agricultural Engineering, UAF

Marty Matlock, Associate Professor, Biological & 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 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:

· A company, BlueinGreen, LLC, was formed in partnership with U of A, Marty Matlock, and Virtual Incubation, Inc. to commercialize the intellectual property for a device to oxygenate water.

· The intellectual property owned by the inventors (Osborn and Matlock) was offered to the U of A and a presentation made to the U of A patent committee. The committee recommended that the U of A agree to accept the IP and appropriate agreements were executed.

· Received NSF grant for $100,000 to test oxygenator for ecological oxygenation.

· Testing results on lab-scale unit resulted in 74% cost savings for oxygenation of water over next cheapest technology.

· 3 undergraduate students and 1 graduate student employed by this project.

· Demonstrated Eco-Oxygenator to several companies and established collaborative relationships to further test and commercially develop oxygenator.

Nano-Biotechnology

Jin-Woo Kim, Assistant Professor, Biological & Agricultural Engineering, UAF

Russell Deaton, Professor, Computer Science & Computer 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 novel molecular motor/MEMS hybrid systems.

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 of 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 potentially 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.

Nitric Oxide (NO) Biotransport

Mahendra Kavdia, Assistant Professor, Biomedical Engineering, UAF

Prabhakar Deonikar, Graduate Student, Biomedical Engineering, UAF

Nupura Bhise, Undergraduate Student, Biological Engineering, UAF

Objectives:

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. Its role as a vasodilator has been established over last two decades. However, the fate of NO when it enters the bloodstream is still not established. The overall objective of the proposed research is to use computational modeling and in vitro experiments to improve our understanding of the interactions of NO with the red blood cell (RBC).

Accomplishments:

We investigated interaction of NO with oxygenated and deoxygenated RBCs. For this purpose, NO and nitrogen gaseous mixture at known concentration was reacted with well mixed RBC solution. Samples were collected every five minutes for 30 minutes. NO-RBC interaction products including nitrite and nitrate were measured using chemiluminescence methods. The results showed that the RBC oxygenation has a significant effect on the formation of nitrite and nitrate. The nitrite formation rate was higher in oxygenated RBCs than that of deoxygenated RBCs. Conversely, and the nitrate formation rate was higher in deoxygenated RBCs. The NO –RBC interaction products formation rate was also dependent on the hematocrit. The result suggests that the NO consumption by RBC competes with NO consumption by oxygen. A better understanding of the NO-RBC interaction will provide insight into vascular transport of NO.

Nucleic Acid Technology

Jin-Woo Kim, Assistant Professor, Biological & Agricultural Engineering, UAF

Russell Deaton, Associate Professor, Computer Science & 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, CAST)
Sreekala Bajwa, Assistant Professor, Biological & Agricultural Engineering, UAF
Steve Burian (GeoSci.)

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

Accomplishments:
We have acquired several of the proposed items including a horizontal scanner, total station GPS unit, and an elevated platform. 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.

Application of Precision Agriculture Technology to Define and Manage Site-Specific Production Constraints in Southern Soybean Production Systems

John Rupe (PI)
Rick Cartwright
Terry Krikpatrick (Plant Pathology)
Sreekala Bajwa, Assistant Professor, Biological & Agricultural Engineering, UAF
Subodh Kulkarni, Graduate Student, Biological & 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 2003, we 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. In 2004, we have conducted field experiments in Pine Tree with a single SCN susceptible cultivar, namely Hutcheson. Grid data was collected on soil fertility at the beginning of planting, and on SCN counts at planting and harvesting. In 2004, SCN data were also collected at flowering. 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. The 2004 data is currently being analyzed.

Improving Cotton Irrigation Recommendations in Mid-South

Sreekala Bajwa, Assistant Professor, Biological & Agricultural Engineering, UAF
Earl Vories, Adjunct Professor, Biological & 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.

Accomplishments:
We have conducted a research experiment in 2004 as a randomized complete block, split plot design with four replications. The whole plot factor was irrigation and the split plot factor was cultivar. Irrigation treatments included well watered (use of the Arkansas Irrigation Scheduler and a 1.75-inch allowable deficit), moderately stressed (use of the Arkansas Irrigation Scheduler and a 3.5-inch allowable deficit, and severely stressed (no irrigation). The two cultivars were FM 819 RR and FM 960 RR, which were similar in maturity, but quite different in appearance. Subplots (cultivar) were six 38-inch rows wide by approximately 800 ft, with four rows between each set of irrigation treatments. The soils of the plots were tested prior to planting for underlying variability in soil fertility. The crop was planted in May and harvested in October. Two sets of color-infrared images were acquired by InTime on July 5 and Aug 15. Soil moisture tension and canopy temperature data were collected from Aug. 5 to Sept. 7. Soil electrical conductivity data for the experiment field was measured with a VERIS system. The results showed that the crop did not develop moderate to severe water stress since it was a wet year. However, there was significant difference between treatments on canopy temperature, canopy reflectance and yield. Yield reduced with irrigation, probably due to the wet year.

Online NIR Technology to Quantify Beef Quality

Sreekala Bajwa, Assistant Professor, Biological & Agricultural Engineering, UAF

Jason Apple, Animal Science, UAF

Jean-Francois Meullenet, Food Science, UAF

Jayarani Kandaswami, Graduate Student, Biological & 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 steaks 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 raw and cooked beef patties.

Accomplishments:

An experiment was carried out to test the capability of NIR technology for estimating tenderness of beef steaks. Sample beef steaks of various USDA qualities were purchased and the NIR reflectance of raw stakes were measured within 72 hours of slaughter. The stake samples were then cooked and tested for their shear strength, which is a measure of tenderness, using WB shear test and razor blade shear test. Preliminary data analysis showed considerable differences between the measurements made by the two spectrometers. We also suspected differences between the measurements made various persons due to the differences in the relative orientation of muscle fibers with respect to the fixed lighting and sensor probes. Therefore, a second set of experiment was conducted to test the effect of muscle fiber orientation on reflectance characteristics of beef stakes. We have found considerable differences between reflectance of the same stake measured at different sensing angles with respect to muscle fiber orientation. This issue was never discussed in the research world or NIR technology. So, we hope to come up with a standard protocol for collecting NIR spectra of muscle tissues based on our study, which will be presented at the 2005 ASAE annual meeting. The results of these studies were used to attract funding from AR Beef Council for an elaborated study.

For the second objective, we have conducted an 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 710 degrees F. NIR reflectance of cooked patties was measured by slicing them into half and measuring the reflectance with an ASD spectro-radiometer. The cooked patties were tested at the meat processing lab for cholesterol levels. There were significant difference between the NIR reflectance of patties with different fat levels. The data were further analyzed using chemometrics to model fat and cholesterol contents based on NIR reflectance. Chemometric models were able to accurately predict fat, calories and cholesterol levels of raw and cooked ground beef patties.

Pesticide Pollution Risk Assessment and Mitigation Training in Arkansas Delta

Sreekala Bajwa, Assistant Professor, Biological & Agricultural Engineering, UAF

Dennis Gardisser, Professor, Biological & Agricultural Engineering, UAF

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

Vibhava Vibhava, Graduate Student, Biological & 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.

Accomplishments:

The project started on October 2003. We have acquired two sets of clear Landsat data, one each from crop season in 2003 and 2004. This data is currently being classified to obtain up to date information on land use and land cover. We have also prepared a questionnaire and obtained feedback from selected commercial pesticide applicators in the L'Anguille watershed on the fields they apply chemicals, crop type, type of pesticide, rate of application, and time of application for both 2003 and 2004. The fields were also identified by the applicator on the color-infrared digital orthoquads. These fields are currently used for supervised classification of agriculture land cover types from the Landsat images. In 2004, we have also identified 5 sampling locations along L'Anguille River and collected water samples three times in June, July, and September. The water samples are being analyzed by Arkansas State Plant Board for pesticides such as Glyphosate; 2,4-D; Molinate; Alachlor; Trifluralin; Fluometuron; Metribuzin; Propanil; Thiobencarb; Malathion; Metolachlor; Methyl Parathion; and Command. First set of water samples showed presence of pesticides

such as metolachlor, atrazine and propiconazole. GIS data on soil hydro-geological properties were ordered from NRCS through GIS lab (CSES). SWAT has been selected as the model for water quality analysis. Currently, we are calibrating SWAT model for flow using USDA database for L'Anguille watershed. Pesticide data is available for only one sampling station in L'Anguille watershed for one year, 1997. We expect to finish calibration and validate the model by spring of 2005. Poster presentation: Vibhava, V., S. G. Bajwa, I. Chaubey, and D. Gardisser. 2004. Pesticide pollution risk assessment in L'Anguille Watershed. L'Anguille River Watershed Awareness Day, Environmental Preservation Division of the Arkansas Department of Environmental Quality (ADEQ) and the L'Anguille River Watershed Coalition, July 29, 2004.

Precision Farming Technology for Developing Subsoiling Guidelines in Arkansas

Sreekala Bajwa, Assistant Professor, Biological & Agricultural Engineering, UAF

Gary Huitink, Associate Professor, Biological & 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 Manila in 2004. Fayetteville field experiment included 4 treatments of different levels of compaction, and 4 replications. Manila field did not have any experimental treatments. In this field, soil compaction was mapped with a digital cone penetrometer for identifying the annual compaction levels caused by normal agricultural operations in a cotton field, and to analyze its impact on cotton yield. Data collected from Manila field include COTMAN data, soil compaction with a cone penetrometer, apparent electrical conductivity with a EM machine, and lint yield with a yield monitor. Data collected from Fayetteville field included soil compaction with digital cone penetrometer, canopy reflectance with a spectro-radiometer, soil electrical conductivity with an EM unit and final lint yield. One set of remote sensing data were collected for Fayetteville field and 3 sets of remote sensing data were collected for Manila field.

Analysis of data from 2003-2004 showed that yield was not significantly ($p > 0.05$) correlated to field compaction under normal regression. However geographically weighted regression (GWR) that assumes the spatial non-stationarity in the data showed significant relationship between compaction and yield as well as soil compaction and soil electrical conductivity. These relationships were not very consistent at shallow depth (< 12.5 cm). 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.

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

Sreekala Bajwa, Assistant Professor, Biological & Agricultural Engineering, UAF

Rick Norman (CSES)

Ashish Mishra, Graduate Student, Biological & Agricultural Engineering, UAF

Objectives:

The research objectives of this project were to test and validate optical sensing technology for mid-season plant nitrogen estimation and management in rice.

Accomplishments:

Field experiments were conducted at RREC in Stuttgart, AR in 2002 and 2004, and in Pine Tree Experiment Station in Colt, AR in 2003. Experimental design in 2004 included 6 different nitrogen rates of 0, 30, 60, 90, 120, and 150 lb/acre, and 2 mid-season nitrogen rates of 0 and 45 lb/acre. In 2003 and 2004, experiments were conducted with Wells cultivar. Data were collected on rice canopy reflectance, biomass, and tissue nitrogen content in all three years. In 2004, rice moisture content was also measured.

Data analysis showed that tissue nitrogen, biomass, 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. The study showed that spectral bands 718, 736, 763, 946, 958, 961 nm were most indicative of plant nitrogen in rice. These bands mainly correspond to pigment absorption caused by various pigments such as chlorophyll, carotenoids, and xanthophylls, and biomass. The study also showed that mid-season nitrogen application resulted in significant yield gains in nitrogen stress areas.

A Watershed Nutrient Management Decision Support System for the Eucha Basin

Marty Matlock, Associate Professor, Biological & Agricultural Engineering, UAF

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

Brian Haggard, Adjunct Assistant Professor, Biological & Agricultural Engineering, UAF

Objectives:

A team of scientists in Arkansas and Oklahoma are developing a watershed nutrient management decision support system (DSS) to improve land use and water resource management decision-making. The project efforts will be focused on the Eucha Basin, with results applicable to similar watersheds across the U.S. The Eucha basin was selected because nutrient management issues in this basin are representative of the political, economic, and ecological challenges facing resource managers across the US. The Eucha Basin includes Spavinaw Creek in northwestern Arkansas and drains into Lake Eucha in northeastern Oklahoma, a water supply reservoir for the city of Tulsa, Oklahoma. Water quality in the reservoir has been declining for several years in part due to increased algal growth resulting from increased phosphorus loads from point and nonpoint sources, including the land application of poultry litter. However, there is no clear threshold for managing water quality for algal growth, so there is no clear management endpoint for phosphorus loading to the reservoir.

Accomplishments:

The goal of this project is to develop a nutrient management decision and education support system (NMDESS) for developing comprehensive watershed nutrient management strategies for both agricultural and urban landscapes. The process of Analysis and Deliberation was used to develop this DSS. This process involves intensive discourse, both in public education sessions and private interviews, between the scientific community, watershed managers, and other stakeholders within the basin. NMDESS provides a risk-based approach to identifying substantial nutrient sources within watersheds based on site-specific terrestrial, atmospheric, and hydrologic components of nitrogen and phosphorus nutrient cycles. NMDESS integrates risk-based decision-making theory with geographic information system (GIS)-based watershed modeling (Soil and 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.

Impact:

Outcomes: This project engages community members, educators, policy makers, and scientists from two states to develop NMDESS, a watershed-based ecosystem management framework. The NMDESS framework is unique in its integration of chemical and biological measurements, *in situ* algal growth bioassessments, complex watershed and reservoir models, and stakeholder-developed scenario analyses. Land owners, policy makers, and other stakeholders will be able to analyze the impacts of a wide range of land management scenarios on water quality in the Eucha Basin using this on-line tool. The methods and tools for implementing NMDESS are applicable nation-wide.

Development of a Decision Support System and Data Needs for the Beaver Lake Watershed

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

Marty Matlock, Associate Professor, Biological & Agricultural Engineering, UAF

Tom Costello, Associate Professor, Biological & Agricultural Engineering, UAF

Brian Haggard, Adjunct Assistant Research Professor, Biological & Agricultural Engineering, UAF

Katie White, Graduate Student, Biological & Agricultural Engineering, UAF

Objectives:

1. Organize the water quality data collected by various agencies involved with monitoring the Beaver Lake watershed into a GIS-linked database;

2. 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

3. Outreach to Arkansas Soil and Water Conservation Commission, Arkansas Department of Environmental Quality, and other stakeholders on using the DSS and the GIS-linked water quality database.

Accomplishments:

Objectives 1 and 2 have been completed. We have started outreach and review of the DSS with various stakeholder groups.

Development of an Integrated Water Conservation – Water Quality Program in the Arkansas Delta

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

Marty Matlock, Associate Professor, Biological & Agricultural Engineering, UAF

Earl Vories, Adjunct Professor, Biological & Agricultural Engineering, UAF

J. Popp, Assistant Professor, AEAB, UAF

Tom Costello, Associate Professor, Biological & Agricultural Engineering, UAF

Phil Tacker, Research Associate Professor, Biological & 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 that started in September 2003. Two fields were instrumented and tested in year 1. We are currently analyzing the results for the data collected from the field. In addition, the SWAT modeling of the watershed has already started. We are currently calibrating the model for flow, sediment, and nutrient export from the watershed. A poster will be presented at the 2005 Water Conference at San Diego, CA, in February 2005.

Development of a Statewide Nonpoint Source Pollution Plan for Arkansas

Marty Matlock, Associate Professor, Biological & Agricultural Engineering, UAF

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

Brian Haggard, Adjunct Assistant Professor, Biological & Agricultural Engineering, UAF

Objectives:

Section 319 of the Clean Water Act requires that each state:

• Assess the waters of the state for impacts from nonpoint source pollution,

• Develop a management program outlining how the state intends to address the categorical sources of pollution and the impaired waters identified in the assessment; and

• Report annually to the Environmental Protection agency progress made in implementation of the program.

Arkansas's management program expires at the end of 2004. New State and Federal regulations along with ever changing environmental conditions in the state make it necessary to develop a major update of the current management program.

Accomplishments:

The Ecological Engineering Group developed an updated State Management Plan for 2005 through 2010. This plan considers the impact of new regulations regarding urban and agricultural runoff, updated water quality information, and improved management measures developed over the last decade. The EEG used the Soil and Water Assessment Tool (SWAT) and ArcView GIS to model impaired watersheds in the state and to target specific nonpoint source problem areas. An extensive consensus building effort was conducted including facilitated meetings with all State and Federal resource management agencies, local watershed action teams, agricultural commodity groups, and other non-government organizations. The results of the modeling and consensus building will be compiled into a single document which will be submitted by the Governor to the EPA on behalf of the State of Arkansas.

Impact:

The Nonpoint Source Management Plan establishes priorities for implementation of the section 319(H) Grant program and gives guidance to all State and Federal agencies in development of their environmental protection actions. In 2004, the section 319(h) program alone expended over 6 million dollars on nonpoint source management. The consensus building program being conducted as an element of this project has brought together over 60 individuals representing 51 different agencies, NGOs, or watershed teams to dis-

cuss workable management actions concerning categorical and watershed based programs. These management measures will be implemented in the State over the next five years.

Funding Sources: U. S. Environmental Protection Agency and Arkansas Soil and Water Conservation Commission

Demonstration of a Greenway Development to Protect Ecological Services in Small Urban Streams

Marty Matlock, Associate Professor, Biological & Agricultural Engineering, UAF

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

Brian Haggard, Adjunct Assistant Professor, Biological & Agricultural Engineering, UAF

Objectives:

The city of Rogers, Arkansas is part of the rapidly growing metropolitan area of Northwest Arkansas. In 2003, this area was determined by the Milken Institute to be the best performing metropolitan area in terms of business development. The urbanization of historically agricultural land has stressed infrastructure to the limit. Alternatives to the current practices are needed to maintain more natural conditions in the streams.

Accomplishments:

A demonstration project on use of riparian corridors as greenway parks is being conducted by the City of Rogers, the Biological and Agricultural Engineering Department (BAEG), the Arkansas Water Resource Center, and Rogers Public Schools. A natural design is being provided to maintain ecological services in 4,900 feet of the Blossom Branch Creek. The BAEG conducted analysis of the ecological services, hydrology, and geomorphology; designed a greenway park; supervised construction of the project; and is evaluating the results. Local and National technology transfer workshops have been held at the site for city planners, city engineers and developers to adopt more sensitive drainage practices in their development plans.

Impact:

The City of Rogers, Arkansas has adopted the Urban Greenway into its comprehensive growth master plan for the city. Plans are currently underway to connect this demonstration with an additional 23 miles of greenway virtually encircling the city, and to connect to the trail system of the City of Bentonville, Arkansas. As a result, ecological services of the headwater streams draining this rapidly expanding town will be retained and the impacts of the development will be significantly lessened.

Funding Sources: U. S. Environmental Protection Agency and Arkansas Soil and Water Conservation Commission

Differentiating Runoff Contributing Areas from Pastures for Phosphorus Management

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

Brian Haggard, Adjunct Assistant Research Professor, Biological & Agricultural Engineering, UAF

Tom Costello, Associate Professor, Biological & Agricultural Engineering, UAF

Katie White, Graduate Student, Biological & Agricultural Engineering, UAF

Objectives:

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

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

Accomplishments:

We have established three fields with a high density of surface runoff sensors, sub-surface saturation sensors, raingauges, shallow groundwater wells, and H-flumes with data loggers to monitor flow and water quality from these plots. In addition, a detailed ground penetrating radar (GPR) survey has been conducted to collect data on geologic characteristics of these fields. Currently we are analyzing results from various runoff events. A presentation will be given at the 2005 Water Conference in San Diego, CA, based on the results obtained from year 1 of the project.

A tour of the research plot was organized for the heads of the Biological and Agricultural Engineering Department from various universities in May 2004. In addition, another fields day was organized in July 2004 and was attended by researchers from various departments in the University of Arkansas.

GIS Database Development and Watershed Modeling in the Arkansas Priority Watersheds

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

Marty Matlock, Associate Professor, Biological & Agricultural Engineering, UAF

Tom Costello, Associate Professor, Biological & Agricultural Engineering, UAF

Objectives:

1. Prepare basic GIS data needed for the 9 priority watersheds in Arkansas to model watershed response.
2. Calibrate SWAT model for hydrology and apply SWAT model to make watershed response predictions
3. Train ASWCC personnel on use of GIS data and model
4. Develop and publish user manual to use GIS data and SWAT model
5. 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.

The first project was completed in August 2004 and the final report was submitted to the Arkansas Soil and Water Conservation Commission. Based on the results obtained from this project, additional projects and funding for further modeling has been secured totaling more than $100,000.

Growth Chambers for Bio-Regenerative Life Support

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

Larry A. Roe, Associate Professor, Mechanical Engineering, UAF

William Dillahunty, Graduate Student, Biological & Agricultural Engineering, UAF

John Sager, Agricultural Engineer, Kennedy Space Center, NASA

Ray Wheeler, Plant Physiologist, Kennedy Space Center, NASA

Objectives:

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:

Recent missions in human space flight involving the space shuttle and the International Space Station include life support systems which depend entirely upon transport of all needed oxygen, food and water from Earth, and subsequent return of wastes (absorbed carbon dioxide, food waste, human waste, packaging) back to Earth aboard the space craft. Long-term space missions, such as the establishment of outposts on Mars or the moon, will require regenerative life support systems because of the high cost of lifting large masses of potable water, oxygen, and food into orbit and beyond. Controlled plant growth chambers provide astronauts with a system which can utilize by-products of life processes 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 at the UA have focused that expertise to develop bio-regenerative life support systems, in collaboration with engineers and scientists at NASA's Kennedy Space Center (KSC). Biological engineering faculty have been working with undergraduate and graduate students 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. Their design placed first nationally in 2003 at the ASAE National Student Design Competition. The UA faculty adviser connected the students with NASA through contacts that were developed while working at KSC during the summers of 2002 and 2003.

The winning design has now formed the basis for further development and modeling of the system through graduate work funded by NASA. Work is underway to describe and predict heat transfer processes inside the growth chamber at sub-atmospheric pressure. Experiments will be conducted to test the heat transfer models. This work will lead to improved growth chamber designs that will provide an updated platform for extensive hypobaric crop research planned at KSC. Continued collaborations between NASA and UA faculty and students are helping to inspire and support 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 & Agricultural Engineering, UAF

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

Larry A. Roe, Associate Professor, Mechanical 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:

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

Accomplishments:

Many poultry farmers, operating in sensitive watersheds, are looking for alternative ways to utilize poultry litter. 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. Use of the litter combustion technology could help offset land applications of manure and decrease the loading of nutrients into streams and lakes. Litter combustion in a biomass-fired furnace not only provides an alternate use of the manure, it can also decrease fossil fuel consumption (and costs) associated with space heating of poultry buildings. Commercial litter combustion technology is not mature; hence, testing and demonstrations are needed to measure their performance and estimate their potential environmental and economic impacts.

Efforts are continuing in the evaluation of commercial prototype litter to energy system, with the goal being to heat poultry buildings using poultry litter as a fuel. A litter-fired furnace built by an Arkansas manufacturer (Lynndale, Inc., Harrison, Ark.) was tested at the UA Engineering Research Center (ERC) in the fall, 2004. Plans are to continue testing in 2005 in a commercial broiler production setting at the UA Applied Broiler Research Facility, near Savoy, Ark. On-farm testing will provide measures of furnace efficiency, emissions, labor requirements, and demonstrate the extent of litter incineration and ash production. Preliminary results from ERC testing indicated a need to improve system efficiency and operational controls. The manufacturer is making modifications prior to the on-farm tests.

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. Phosphorus in ash can be marketed outside sensitive watersheds. Care is needed to insure that air emissions from the furnace protect air quality for farm workers and neighbors.

National Wadeable Stream Assessment – The Arkansas Component

Marty Matlock, Associate Professor, Biological & Agricultural Engineering, UAF

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

Brian Haggard, Adjunct Assistant Professor, Biological & Agricultural Engineering, UAF

Objectives:

To make decisions on environmental issues policy makers need statistically sound, comparable data. Data of this sort is available within individual states in some cases, but little data is available for nation wide use. Deviations in sampling procedure and differences in parameters sampled keep state environmental agencies from comparing data and keeps federal agencies from being able to compile states data for national use.

Accomplishments:

The Wadeable Stream Assessment project was created by the Environmental Protection Agency to provide a statistically sound data set for all states that would be useful for large scale evaluations of stream health. The EPA set out to sample 500 sites in 36 states in the summer of 2004. The Ecological Engineering Group collected samples from 29 randomly selected sites all over the state from June to October 2004 for the EPA. Biological as well as physical parameters of the streams were measured.

Impact:

This study promises to provide a status report on the condition and health of wadeable streams in the United States. It is also meant to help build states capacity for monitoring and assessment and enhance and support integration of monitoring and assessment methods.

Funding Sources: U. S. Environmental Protection Agency Office of Research and Development

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

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

Tom Costello, Associate Professor, Biological & Agricultural Engineering, UAF

Karl VanDevender, Research Associate Professor, Biological & Agricultural Engineering, UAF

M.A. Nelson, Assistant Professor, Arkansas Water Resources

K. Teague, Cooperative Extension Service

M. Steele, 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.

Accomplishments:

All of the objectives of this project have been completed. The project will be completed in January 2005.

Recombining Fluvial Geomorphology and Urban Morphology: Riparian Meadows, Mounds, and Rooms in Urban Greenways

Marty Matlock, Associate Professor, Biological & Agricultural Engineering, UAF

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

Brian Haggard, Adjunct Assistant Professor, Biological & Agricultural Engineering, UAF

Objectives:

Town Branch Creek in Warren, Arkansas, frequently floods streets in the downtown area of the city creating a public health and safety problem. In addition, the eroded condition of the stream has caused it to become an aesthetic liability, and the stream no longer supports normal aquatic flora and fauna. The City of Warren is working to improve its downtown area by upgrading the quality of the urban environment. Walking trails and improved storefronts are integral to their plan. Utilization of the flood prone area adjacent to Town Branch Creek is a promising element of this downtown restoration project.

Accomplishments:

The CityScapes committee of the City of Warren secured grant funding from the Arkansas Forestry Commission to conduct preliminary planning on restoration of Town Branch Creek. The Biological and Agricultural Engineering Department (BAEG) and the U of A Community Design Center (CDC) with the CityScapes committee to evaluate and plan an urban greenway along Town Branch through the heart of downtown Warren. The BAEG conducted ecological, geomorphological and hydrological assessments of the stream. The CDC used the results of the assessment to design a greenway park along the creek.

Impact:

A plan has been presented to the City that recommends enlarging culverts in the downtown area to reduce flooding, widening of the floodplain along the stream to reduce erosion problems, and replacing riparian vegetation. The CDC developed a plan for the greenway park which widened the floodplain and utilized the surplus material to build mounds of earth that function as park facilities. RIPARIAN MEADOWS, MOUNDS AND ROOMS is the winner of the 2005 Honor Award in Urban and Regional Design presented by the American Institute of Architects.

Funding Sources: UA Division of Agriculture

Sustainable Agriculture and Water Resources in Arkansas: A Bioenvironmental Engineering Solution

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

Marty Matlock, Associate Professor, Biological & Agricultural Engineering, UAF

Tom Costello, Associate Professor, Biological & Agricultural Engineering, UAF

Earl Vories, Adjunct Professor, Biological & Agricultural Engineering, UAF

Brian Haggard, Adjunct Assistant Research Professor, Biological & 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 started in May 2004.

SWAT Modeling in the Illinois River Watershed

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

Marty Matlock, Associate Professor, Biological & Agricultural Engineering, UAF

Objectives:

The specific objectives of this project are to:

1. Prepare GIS data needed for SWAT modeling of flow and P transport through the watershed;

2. Update the nonpoint and point source input information for the watershed using currently available animal production and point source concentration data;

3. Calibrate and validate the SWAT model for the Illinois River Drainage Area separately for base flow and storm flow, and P loads (monthly conditions); and

4. Implement the SWAT model to evaluate the effects of alternative watershed management scenarios on P transport and resulting P stream loads.

Accomplishments:

This project started in July 2004. We have developed and submitted a Quality Assurance Project Plan to EPA for approval. Once we get the QAPP approved, we will start working on accomplishing the project objectives.

Use Attainability and Water Quality Assessment of Coffee Creek, Mossy Lake, and the Ouachita River, Southern Arkansas

Marty Matlock, Associate Professor, Biological & Agricultural Engineering, UAF

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

Brian Haggard, Adjunct Assistant Professor, Biological & Agricultural Engineering, UAF

Objectives:

Arkansas and Louisiana Departments of Environmental Quality have designated the Ouachita River to support the propagation of fish and wildlife, primary and secondary contact recreation, perennial Gulf Coast fisheries, public, industrial, and agriculture water supply. Previous assessments in Southeastern Arkansas have shown that water quality standards are not being met and have called for additional study in order to more accurately maintain these uses. Mossy Lake and Coffee Creek are used to treat effluent from Georgia-Pacific and the City of Crossett, Arkansas, before entering the Ouachita River. They flood approximately 60 percent of the year. It is unknown if Mossy lake and Coffee Creek can support additional uses other than its designated industrial water supply.

Accomplishments:

The goal of this project is to perform a water quality assessment of the Ouachita River and to determine if aquatic life uses are attainable in Coffee Creek and Mossy Lake. In order to address previous data gaps, more complete assessment methods will be used. Data to be collected include: water quality field measurements, physical water conditions, analytical water analysis, sediment analysis, habitat assessment, fish and macroinvertebrate community assessment. All sampling protocols will meet ADEQ requirements and ultra clean metal sampling methods will be employed.

Impact:

This project will assess the current water quality status of the Ouachita River, Coffee Creek and Mossy Lake. This information will be used in better management practices in Southeast Arkansas and Northeastern Louisiana.

Funding Sources: U. S. Environmental Protection Agency and Parsons Engineering

Use Attainability and Water Quality Assessment of the Illinois and Kings River in Northwest Arkansas

Marty Matlock, Associate Professor, Biological & Agricultural Engineering, UAF

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

Brian Haggard, Adjunct Assistant Professor, Biological & Agricultural Engineering, UAF

Objectives:

The purpose of this project was to collect water quality and biological data for selected water bodies in the Illinois and Kings River watersheds in northwest Arkansas to assess attainment of the aquatic life use in those watersheds. Of particular interest were the areas above and below wastewater treatment plants of the Cities of Rogers, Springdale, Prairie Grove, and Berryville, Arkansas.

Accomplishments:

The Ecological Engineering Group conducted the water quality assessment of the Illinois and Kings Rivers to determine if aquatic life uses were impacted by wastewater treatment plant outfalls. Data collected included: water quality field measurements, physical water conditions, analytical water analysis, algal species and productivity, habitat assessment, geomorphologic assessment, and fish and macroinvertebrate community assessment.

Impact:

This project provided critical information regarding the complex nature of water quality degradation from human activities in Northwest Arkansas. Specifically, the results of this research demonstrated the importance of sediment as a pollutant in rivers and streams in the region, and provided a landscape context for the processes of nutrient uptake and impact on trophic status of streams.

Funding Sources: U. S. Environmental Protection Agency and Parsons Engineering

An Electrochemical Method to Destroy *Listeria* in Chilling Brine for Cooked Poultry and Meat Products

Yanbin Li, Professor, Biological & Agricultural Engineering, UAF

Michael Slavik, Professor, Poultry Science, UAF

Carl Griffis, Professor, Biological & Agricultural Engineering, UAF

Betty Swem, Research Specialist, Poultry Science, UAF

Zhihui Liu, Graduate Student, Biological & 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 seconds 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 minute in the storage tank was achieved even at 7 mA/cm3 current level with the fresh brine (t = 0 h). For the used brine (t = 20 h), the average D-value was 2.5 minute in the treatment chamber at a current level of 35 mA/cm3, and increased to 9.4 and 61.2 min at current levels of 17.5 and 7 mA/cm3. 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.

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

Carl L. Griffis, Professor, Biological & Agricultural Engineering, UAF

Objectives:

Continuing changes in our culture and economy lead more and more consumers to rely upon ready-to-eat (RTE) meat products for meals. Thermal processing remains the primary means of eliminating pathogens in these products to protect the public from food-borne disease. Unfortunately, standards for adequate thermal processing are not well understood. Since 2001, millions of pounds of ready-to-eat meat products have been recalled due to inadequate cooking. The goal of this project is to help food processors effectively control their cooking processes and eliminate pathogens from RTE meat products. The approach has been to determine fundamental microbiological properties in a laboratory setting, then test our understanding of these properties by cooking products in pilot-scale equipment. Work has also been going on to develop a mathematical model based on the fundamentals of cooking processes, as a tool to predict pathogen lethality based on cooking time, and other parameters of the cooking process.

Accomplishments:

A significant database of fundamental microbiological properties in conjunction with RTE product properties has been developed. Work on the mathematical model continues.

Biocatalysis Technology

Jin-Woo Kim, Assistant Professor, Biological & 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.

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

Yanbin Li, Professor, Biological & Agricultural Engineering, UAF

Xiaoli Su, Research Associate, Biological & Agricultural Engineering, UAF

Byungchul Kim, Graduate Student, Food Science, UAF

Qian Sun, Research Associate, Biological & Agricultural Engineering, 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.

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

Scott Osborn, Assistant Professor, Biological & Agricultural Engineering, UAF

Shannon Pinson, Research Geneticist, USDA-ARS

Objectives:

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:

1. A preproposal entitled, "Development of Selection Tools Associated with Components of Milling Yield in U.S. Long and Medium Grain Cultivars," in cooperation with several scientists from Arkansas, Texas, California, Louisiana, and Missouri, was made to the Rice Foundation. The preproposal was accepted and a full proposal requested. A total of $81,875 was requested ($6,000 for Osborn). The full proposal was funded.

2. Data analysis continued to further develop the rice fissure index model. Ph.D. student Jat formulated a proposal and submitted an abstract for the 2005 ASAE annual meeting.

3. A humidity control chamber and associated monitoring and control equipment was purchased and installed.

4. Invited to present a seminar on this work to the bioinformatics faculty at University of Arkansas-Little Rock and did so in February.

5. Submitted final report for 2-year project with Rice Foundation.

Funding Agency: The Rice Foundation and Texas Rice Research Foundation: $100,000 over 3 years.

Environmental Biotechnology

Jin-Woo Kim, Assistant Professor, Biological & 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 needed 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.

Impedance Immonusensors for Rapid Detection of Pathogens in Food Products

Yanbin Li, Professor, Biological & Agricultural Engineering, UAF

Simon Ang, Professor, Electrical Engineering, UAF

Michael Johnson, Professor, Food Science, UAF

Liju Yang, Graduate Student, Biological & Agricultural Engineering, UAF

Yun Xi, Graduate Students, Electrical Engineering, UAF

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. Typhimurium* 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. Typhimurium*. 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.

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

Yanbin Li, Professor, Biological & 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:H7* 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:H7* 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:H7*, 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.

PCR-Based Fluorescent Biosensing Methods and Nanobeads and Quartz Crystal Microbalance-Based DNA Sensor for Rapid Detection of Major Pathogens in Food Samples

Yanbin Li, Professor, Biological & Agricultural Engineering, UAF

Michael Slavik, Professor, Poultry Science, UAF

Hong Wang, Research Associate, Poultry Science, UAF

Xiaoli Su, Research Associate, Biological & Agricultural Engineering, UAF

Xiaole Mao, Graduate Student, Biological & 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 DNA sensor 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 DNA sensor was developed for rapid detection of *Escherichia coli O157:H7*. It was based on the immobilization of DNA probes 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 the amplified DNA fragments of target bacteria onto the immobilized DNA probes decreased the sensor's resonant frequency, and the frequency shift was correlated to the bacterial concentration. The stepwise assembly of the DNA sensor 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 DNA sensor could detect the target bacteria in a range of 10^3-10^8 CFU/ml within several minutes after 2 hrs PCR time.

Phytochemical Extraction and Their Potential to Inhibit Low Density Lipid Oxidization

Danielle Julie Carrier, Associate Professor, Biological & Agricultural Engineering, UAF

Ed Clausen, Professor, Chemical Engineering, UAF

Jackson Lay, Director, Mass Spectrometry Facility, UAF

Shanmugam Nagarajan, Assistant Professor, Children's Nutrition Center, UAMS

Sunny Wallace, Graduate Student, Biological & Agricultural Engineering, UAF

Walter Cooke, Graduate Student, Chemical Engineering, UAF

Justin Loveladay, Graduate Student, Chemical Engineering, UAF

Lijun Duan, Postdoctoral Associate, Chemical Engineering, UAF

Katie Vaughn, Research Technician, Biological & Agricultural Engineering, UAF

Objectives:

1. To study milk thistle, watermelon, grape waste and *Albizia julibrissin* extraction by characterizing the extraction step and by replacing, if possible, organic solvents with water.

2. To couple the phytochemical extraction with energy conversion

3. To determine if the addition of milk thistle, watermelon, grape waste or *Albizia julibrissin* extracts can minimize electrophoretic mobility ,and chemically and cell mediated low density lipid (LDL) oxidization.

Accomplishments:

We have characterized milk thistle, watermelon, grape waste and Albizia julibrissin extracts in terms of their phytochemicals. We can routinely analyze by High Pressure Liquid Chromatography (HPLC) silymarins from milk thistle, flavonols and anthocyanins from grape waste, lycopene from watermelon and flavonols from *A. julibrissin*. We can extract silymarins and *A. julibrissin* flavonols with pressurized hot water and lycopene with supercritical fluids. We have just begun the grape waste extraction project.

In the southeastern US *A. julibrissin* is receiving attention as a potential energy crop, with forage yields of 6-7.5 dry tons/acre/yr. *A. julibrissin* foliage contain 2 % (w/w) of the flavonols hyperoside and quercitrin. Literature shows that hyperoside can inhibit in vitro low density lipid (LDL) oxidation. Flavonol extraction from *A. julibrissin* could possibly occur prior to its use as an energy crop, rendering added value to the producer. However, the key to effectively and economically extract high value compounds, such as flavonols, from energy crops is the ability to couple extraction with biomass conversion to energy. The use of water as an extraction solvent can facilitate the coupling of extraction to biomass conversion.

To assess the biological activity of our phytochemical extracts, including *A. julibrissin*, we have focused on endothelial dysfunction diseases, such as stroke and atherosclerosis. An important component in the progression of endothelial dysfunction diseases is the formation of oxidized LDL. The atherogenic effects of oxidized LDL, namely damage to the vascular endothelium, have been demonstrated both *in vivo* and *in vitro*. Drs. Carrier and Clausen are currently generating results with the chemically medicated LDL oxidization assay using silymarin and lycopene. In the next six months, flavonols from *A. julibrissin* will be tested. Dr. Nagarajan is pursuing the electrophoretic mobility studies. Non oxidized LDL migrates slower than oxidized LDL. The co-incubation of LDL with phytochemicals should result in LDL that migrates more slowly than oxidized LDL. Drs. Carrier and Nagarajan have a NIH R-15 proposal pending "Milk thistle on endothelial and inflammatory cells" $150,000 – submitted September, 2004. Drs. Carrier and Clausen have a USDA-NRI proposal pending "Conversion of *Albizia julibrissin* to high value products and ethanol" $409,784 – submitted January, 2005.

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

Yanbin Li, Professor, Biological & Agricultural Engineering, UAF

Phil Crandall, Professor, Food Science, UAF

Betty Swem, Research Specialist, Biological & Agricultural Engineering, UAF

Abani Pradhan, Graduate Student, Biological & Agricultural Engineering, UAF

Lin Cong, Graduate Student, Poultry Science, 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 eggs, chicks, chicken carcasses and cooked poultry meat 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. The risk model can present the probability of microbial hazards in terms of percentage of contaminated poultry products or pathogen level of each product 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 products 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 be benefited from safer poultry products and the society will be benefited from reduced foodborne diseases and related medical costs.

Quality and Safety for Thermally Processed Foods

Carl L. Griffis, Professor, Biological & 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, have been studied. 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. Models are being 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 have been 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.

Thermal Process Validation

Carl L. Griffis, Professor, Biological & 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 have been inoculated with *Salmonella Senftenberg*, *Listeria monocytogenes*, and *Listeria Innocua*, and studied in the Biosafety Level 2 laboratory. Then, samples of the food products have been inoculated with the non-pathogenic Listeria Innocua and processed in prototype commercial cooking equipment at the University of Arkansas. Factors that affected pathogen lethality under commercial operating conditions have been evaluated. Both pathogen process lethality and real time pathogen survival/kill models are being established.

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.

Agricultural Chemical Applications

Dennis Gardisser, Professor & Extension Engineer, Biological & Agricultural Engineering, Cooperative Extension Service, UAF

Objectives:

1. Improve chemical application efficiency - to increase efficacy.

2. Reduce the potential for drift and demonstrate ways to be better environmental stewards.

3. Provide guidance for newpests (i.e. west nile virus and soybean rust)

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 co-chair 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, Professor & Extension Engineer, Biological & Agricultural Engineering, Cooperative Extension Service, UAF

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.

Accomplishments:

All 14 meetings were held in the spring of 2004 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, Professor & Extension Engineer, Biological & Agricultural Engineering, Cooperative Extension Service, UAF

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 regional 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. CSREES annual report has been submitted and a poster was developed and exhibited at the RREC field day in August 2003. Three state conferences were held to relay the findings from this project to clientele. See http://beaumont.tamu.rice/ricessweb/ for programs and other rice information. 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, Associate Professor & Extension Engineer, Biological & Agricultural Engineering, Cooperative Extension Service, UAF

Objectives:

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

Provide recommendations that 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 provided 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 subsoiled annually now 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, Tennessee and other states.

The Cooperative Extension Service has developed guidelines, based on research and demonstration. Power Point presentations have been provided. The University of Arkansas Cooperative Extension Service guidelines are also available in print and on the Cooperative Extension Service web site.

Farm Safety Programs

Gary Huitink, Associate Professor & Extension Engineer, Biological & Agricultural Engineering, Cooperative Extension Service, UAF

Jeremy Wesson, Arkansas Farm Bureau, 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 UACES data base). A variety of educational activities have emphasized reducing farm injuries and fatalities in Arkansas. As the invited speaker, the thrust of Arkansas Farm Safety approaches were presented at the Southern Regional CSREES meeting at Nashville, TN, and at the March 23-24, 2004, Health and Safety Summit at Jacksonville, MS. Over 600 farm owners,

managers, workers, gin owners, gin managers, consultants, and safety personnel participated in meetings addressing farm safety issues only. Many other production meetings included hazards and safety as one of the topics. Over 200 gin personnel attended one of 3 programs addressing entanglement hazards, electrocution, falls, and other cotton gin press hazards conducted jointly by the University of Arkansas Cooperative Extension Service and the Southern Cotton Ginners' Association. A number of important dairy safety issues were addressed at the ARK-TENN Field Day at Center Ridge, AR. 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. The U.S. Forest Service now uses portions of our "Chain Saw Safety" fact sheet for reference and training. We now have 9 "fact sheets" and 4 videos available for loan posted on our web site.

Arkansas Farm Bureau and the University of Arkansas Cooperative Extension Service conduct joint workshops in counties to train EMTs and volunteer fire department personnel efficient farm accident rescue. Joint training of local personnel have provided "hands-on" farm rescue training for many rural communities. Many local emergency rescue units have acquired air bags, 4-wheel drive vehicles for rescue in remote areas or other rescue equipment upgrades after participating in our training. The experience and equipment obtained will also prove valuable for logging, backhoe, construction, traffic, and other accidents. Several states have patterned rescue training programs 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, Associate Professor & Extension Engineer, Biological & Agricultural Engineering, Cooperative Extension Service, UAF

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, measure, and reduce field loss of corn, grain sorghum, rice, soybeans, and wheat. Growers have requested assistance from the Extension engineer or crop specialists in agronomy to obtain the proper harvest attachments. Others attended meetings like the Valley Implement Harvest Clinic at McGehee to receive maintenance and fine-tune harvesting tips.

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

On-Farm Grain Handling and Storage

Dennis Gardisser, Professor & Extension Engineer, Biological & Agricultural Engineering, Cooperative Extension Service, UAF

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 population.

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.

Organic Burial Composting of Cattle Mortality

Karl VanDevender, Professor & Extension Engineer, Biological & Agricultural Engineering, Cooperative Extension Service, UAF

Jodie Pennington, Extension Dairy Specialist,

Merle Gross Washington County Extension Agent

Johnny Gunsaulis, Washington County Extension Agent

Dewayne Davis, Washington County Dairy Producers

Objectives:

Demonstrate that Organic Burial Composting of Cattle Mortality is an acceptable method of cattle mortality disposal that addresses animal disease and water quality concerns. Traditional animal mortality composting techniques utilize roofed wooden structures on concrete pads. This approach is appropriate for poultry and swine operations where mass of mortality generated warrants the significant facility and management costs. However for small dairies and beef cattle operations this type of composting is not justified and the absence of available rendering facilities leaves burial as the only legal practical option. However, burial is typically inconvenient and locating environmentally appropriate sites to protect water quality is often difficult. With Organic Burial Composting the concept is to simply bury the mortality above ground in a sufficient quantity of carbon material to allow decomposition at temperatures to kill most pathogens, filter any potential objectionable odors, and absorb any leachate from the mortality before is contacts the soil.

Accomplishments:

A dairy farm in Washington County was located were 15 dairy mortality were composted over the course of the year. Collected temperature information and observational information were then presented to the Arkansas Livestock and Poultry Commission, who then modified the existing regulations to include Organic Burial Composting as an acceptable large animal mortality disposal option. Since then this approach has been presented several times to producers and favorably received.

Pesticide Handling, Rinse, and Containment Facilities

Dennis Gardisser, Professor & Extension Engineer, Biological & Agricultural Engineering, Cooperative Extension Service, UAF

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.

Precision Agriculture

Dennis Gardisser, Professor & Extension Engineer, Biological & Agricultural Engineering, Cooperative Extension Service, UAF

Sreekala Bajwa, Assistant Professor, Biological & Agricultural Engineering, UAF

Ahish Mishra, Graduate Student, Biological & Agricultural Engineering, UAF

Suzanne Wiley, GIS Specialist, UA 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 half 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 coordi-

nators for this effort.

One major activity has been to develop training opportunities for Arkansas youth on remote sensing and GIS databases. 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.

Proper Cattle Heavy Use Area Design and Management

Karl VanDevender, Professor & Extension Engineer, Biological & Agricultural Engineering, Cooperative Extension Service, UAF

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 an EPA 319(h) grant completed in the spring of 2004 with a budget of $96.997 federal dollars and $72,813 state supplied funds for a total budget of $169,810. The project objective was to implement a properly designed and managed Cattle Heavy Use Area to serve as a model application of available technologies and practices. This model was then used as the site for field days and a source of pictures and experiences that will continue to be presented in the local watershed, as well as statewide meetings. The focus of the program was 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 was divided in to the following tasks:

1. Development of Project Guidance Team
2. Implementation of model BMPs and management practices
3. Education and Technology Transfer

Accomplishments:

All three tasks were completed and the developed factsheets, posters, and slide sets are available for continued use.

Rice Irrigation Water Management for Water, Labor and Cost Savings

Phil Tacker, Associate Professor & Extension Engineer, Biological & Agricultural Engineering, Cooperative Extension Service, UAF

Wayne Smith, Technical Support Specialist, Cooperative Extension Service, UAF

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 16 producers in 12 counties on 18 different MIRI field demonstrations. Additional MIRI work was coordinated through county agents in 10 counties and involved several other producers. Two counties had field tours that included Multiple Inlet irrigated fields. Conducted field comparison studies with seven cooperators:

1. Crittenden County:
Daurghette Farm, Clay fields, 23% less water
2. Poinsett County:
Jones Farm, Silt Loam Fields, 22% less water
Walls Farm, Silt Loam Fields, 28% less water
3. White County:
Moore Farm, Silt Loam Fields, 2% less water
4. Arkansas County:
Hall Farm, Silt Loam fields, *8.2% more water
5. Cross County:
Wood Farms, Silt Loam fields, *15% more water
6. Mississippi County:
Clay Fields, results not available

*Not sure at this point why the results from these 2 field demonstrations show more water being used in the Multiple Inlet fields because the 2 farmers felt they were pumping less on the Multiple Inlet fields

1. Terry & Eddie Ciganek, in Prairie County, questioned whether MIRI could help them at first, but after seeing the results they plan to use it on more fields.

2. On the Jones farm in Poinsett County we were able to run poly pipe as a supply line rather than a flume ditch to reach the MIRI field. The overall run of the tubing supply line and MIRI field was about one mile. This tested the length water can be pumped with poly pipe. It was a success in saving water and labor.

3. C.J. Parker in Lonoke County found that having MIRI helped him pump up his field much faster. The well had been pressed to keep up, due to the size of the field and a low flow rate.

4. Danny Hall in Arkansas County didn't see savings in water usage, but he was still pleased with the reduction in labor and his ability to water up the field much faster.

Using Cotton Gin Waste

Gary Huitink, Associate Professor & Extension Engineer, Biological & Agricultural Engineering, Cooperative Extension Service, UAF

Julie Carrier, Associate Professor, Biological & Agricultural Engineering, UAF

Sreekala Bajwa, Assistant Professor, Biological & 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 deep gin waste piles and mitigate the potential of fire.

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 specific recommendations were provided in individual consultations. More gin managers are utilizing basic research and guidelines 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. A developing use is for stabilizing construction sites to restrict the amount of sediment reaching streams. At least two Arkansas entrepreneurs have begun bagging and selling composted gin waste for horticultural use, one to regional WalMart outlets.

A number of gins have contracted to supply gin waste to restore productivity to recently-shaped or graded fields. Gin managers continue to improve their approaches to use waste properly. Dumas Gin Company 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 had more requests for composted gin waste than their gin produced during the 2003 and 2004 cotton harvest. 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 chemical 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 nationwide training on utilizing gin waste.

Investigator	Title	Agency	Dates	Amount
Bajwa, Sreekala & Huitink, Gary	Precision Farming Technology for Developing Subsoiling Gidelines in Arkansas	Cotton Foundation	7/01/03 - 6/30/04	$16,500
Bajwa, Sreekala & Vories, Earl	Improving Cotton Irrigation Recommendations in the Mid-South	Cotton Incorporated		$10,000
Bajwa, Sreekala; Chaubey, Indrajeet; & Gardisser, Dennis	Pesticide Pollution Risk Assessment and Mitigation Training in Arkansas	US EPA		$41,995
Carrier, Julie & Clausen, Ed	Quercitrin and Effect on Oxidative Stress	Arkansas Bioscience Institute	1/01/04- 01/01/2005	$42,745
Carrier, Julie & Erf, Gisela	Lycopene and Effect on Oxidative Stress	Arkansas Bioscience Institute	9/01/04- 8/01/2006	$76,954
Chaubey, Indrajeet	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
Chaubey, Indrajeet	Quantification of Pathogen Losses from Swine Manure Treated Pasture Fields Under Chemical and Dietary Modification Conditions	USDA/NCSU	1/01/02- 1/31/04	$12,345
Chaubey, Indrajeet	Use of Hyperspectral Imaging in Lake Water Quality Modeling	Arkansas Space Grant Consortium	3/01/03- 2/28/04	$5,500
Chaubey, Indrajeet	Optimizing BMPS, Water Quality and Sustained Agriculture in the Lincoln Lake Watershed	US.EPA/ Arkansas Soil and Water Commission	8/01/01- 7/31/04	$397,803
Chaubey, Indrajeet	Quantification of Pathogen Losses from Swine Manure Treated Pasture Fields Under Chemical and Dietary Modification Conditions	USDA CSREES- Prime		$22,838
Chaubey, Indrajeet	L'Anguille River Watershed Best Management Practices	EPA	3/01/04- 7/31/05	$31,900
Chaubey, Indrajeet & Haggard, Brian	Differentiating runoff contributing areas for effective water quality management	USDA/CSREES	8/01/03- 7/31/05	$75,000
Chaubey, Indrajeet & Matlock, Marty	GIS Database Development and Watershed Modeling in Arkansas Priority Watersheds	Arkansas Soil and Water Conservation Commission		$60,871
Chaubey, Indrajeet; & Vories, Earl; & Matlock, Marty	Development of an integrated water quality-water management program in the Arkansas delta	USDA/CSREES	2003-2006	$555,000
Chaubey, Indrajeet; Haggard, Brian; & Costello, Tom	Development of Techniques for Identifying and Linking Physical Characteristics to Surface Runoff Source Areas	Water Resources Research Institute	3/01/03- 2/29/04	$14,838

GRANTS

Investigator	Title	Agency	Dates	Amount
Chaubey, Indrajeet; Matlock, Marty; & Costello, Tom	GIS Database Development and Watershed Modeling in Arkansas Priority Watersheds	Arkansas Soil and Water Conservation Commission		$85,184
Chaubey, Indrajeet; Matlock, Marty; & Vories, Earl	Sustainable Agriculture and Water Resources in Arkansas	US EPA	7/01/03- 6/30/06	$447,095
Costello, Tom	Heat Transfer Within a Hypobaric Plant Growth Chamber	NASA	8/01/04- 7/31/05	$24,000
Costello, Tom & Osborn, Scott	Growth Chambers for Bio-regenerative Life Support	Arkansas Space Grant Consortium	3/01/03- 2/29/04	$5,500
Costello, Tom, & Roe, Larry	Demonstration of On-Farm Litter Combustion	Arkansas Soil & Water Conservation Commission & Arkansas Dept. of Environmental Quality	9/01/03- 8/31/05	$250,000
Griffis, Carl	Value Added Poultry Products	USDA/CSRESS	9/15/01- 9/30/04	$597,157
Griffis, Carl	Rice Processing	Industry	6/1/98- 5/20/04	$19,104
Griffis, Carl	Food Safety	USDA	7/01/01- 6/30/04	$32,000
Griffis, Carl	Food Safety	USDA	7/01/04- 6/30/04	$49,000
Griffis, Carl	Food Safety	USDA	7/01/03- 6/30/04	$64,500
Griffis, Carl & Bernhardt, John	Automated Non-Destructive Machine-Vision Systems for Inspection of Rough Rice	Rice Research and Promotion Board		$24,610
Haggard, Brian	Research Support	USDA ARS		$42,280
Haggard, Brian	Haggard Research Support	USDA	10/01/04- 9/30/05	$47,425
Kavdia, Mahendra	Endothelial Dysfunction in Diabetes Mellitus: Qualifying of Nitric Oxide		1/01/2004- 5/30/2005	$83,000
Kavdia, Mahendra	Nicotine Induced Reactive Oxygen Species & Nitric Oxide Generation by VA		7/01/2004- 6/15/2005	$25,000
Kim, Jin-Woo	Design & Fabrication of a Micro-Flagellar Motor Based Dynamo	NSF	5/01/2004- 4/30/2007	$209,834

Investigator	Title	Agency	Dates	Amount
Kim, Jin-Woo	NUE: Integrating Nanoscale Science & Technology into Introductor Computer	NSF	6/01/2004- 5/31/2006	$99,062
Kim, Jin-Woo	Genome Enabled Medical Diagnosis Using a Biological Memory with *In Vitro* Learning	ABI	7/01/2003- 6/30/2004	$49,921
Kim, Jin-Woo	Genome Enabled Medical Diagnosis Using a Biological Memory with In Vitro Learning	ABI	7/01/2004- 6/30/2005	$45,892
Kim, Jin-Woo	Theoretical and Experimental Validation of a DNA-Based Pattern Classifier	ABI	7/01/2004-6/30/2005	$90,000
Li, Yanbin	Poultry Safety	BioDetection Instrumentation, Inc.	11/01/04- 10/31/05	$11,000
Li,Yanbin	Poultry Saftey	BioDetection Instrumentation, Inc.	11/01/04- 10/31/05	$20,000
Li, Yanbin	Systematic Approach to Microbial Risk Assessment; Producers thru Retailers	USDA/CSREES	9/15/00- 9/14/05	$228,280
Li, Yanbin	Biosensor for Rapid Detection of Pathogens in Poultry	USDA/CREES	8/01/04- 7/31/05	$40,000
Li, Yanbin	Rapid Detection of Foodbone Pathogens Using Biosensor Technology	USDA/FAS	8/02/04- 7/31/06	$45,000
Li, Yanbin	Eliminating *Listeria Monocytogenes* from ready-to-eat products	USDA/ARS	10/01/03- 09/30/05	$124,000
Li, Yanbin	Enhancing Food Saftey of Poultry	USDA/CSREES	7/01/01- 6/30/04	$158,800
Li, Yanbin	Food Safety	USDA	7/01/03- 6/30/05	$95,805
Matlock, Marty	City of Rogers Urban Watershed Management Plan	LG/Rogers Utilities	10/01/02- 7/31/05	$151,950
Matlock, Marty	Using the Internet to Teach Market-Based Policies for Water Quality Management	USDA/CSREES	8/31/03- 7/31/05	$24,376
Matlock, Marty	Effective Stormwater and Sediment Control During Pipeline Construction Using a New Filter Fence Concept	US EPA/IPEC		$11,000
Matlock, Marty	Stream Sampling for Nutrient Impairment	EPA		$56,532
Matlock, Marty	4 Yr Physical & Biological Stream Assessment & Monitoring Program.	LC/City of Fayetteville	12/01/04- 11-30-08	$10,512

GRANTS

Investigator	Title	Agency	Dates	Amount
Matlock, Marty	Development of Lotic Ecosystem Trophic Status Index Using Periphytometer NG Non Government	NG/US/Pawnee Nation of OK	9/01/04- 8/30/05	$4,000
Matlock, Marty	Wadable Stream Assesment for Arkansas	USEPA	6/1/04- 8/30/05	$220,000
Matlock, Marty & Chaubey, Indrajeet	Nutrient Management Decision Support System for the Eucha Basin	USDA/CSREES	8/01/03- 7/31/05	$686,000
Matlock, Marty & Chaubey, Indrajeet	Update of Arkansas Nonpoint Source Pollution Management Program	Arkansas Soil and Water Conservation Commission		$99,329
McClung, Lincombe,; Jodari, Ruter; Siebenmorgen, Terry;l & Osborn, Scott	Development of Selection Tools Associated with Componets of Milling Yield in U.S. Long and Medium Grain Cultivars	Rice Foundation	9/01/04- 8/31/06	$81,875
Osborn, Scott	Determining the Physical, Chemical, and Genetic Mechanisms Responsible for Fissure Resistance of Rice	The Rice Foundation	3/01/02- 2/29/04	$66,666
Osborn, Scott; Matlock, Marty; & Thompson, Clay	Portable Water Ecosystem Oxygenator	National Science Foundation	7/01/04- 12/31/04	$100,000
Tacker, Phil	Rice Irrigation Water Management for Water, Labor and Cost Savings	Rice Research and Promotion Board		$31,960
Tacker, Phil; Lorence; & Tingle, Chris	Improving Technology Transfer for Profitable and Sustainable Soybean Production	Soybean Promotion Board		$70,025
Vories, Earl	Improved Irrigation Efficiency and Reduced Potential for Surface Water Contamination Using intermittent plus Multiple-Inlet Irrigation in Rice Production	USDA CSREES- Prime		$93,603
Vories, Earl	Improving Corn Irrigation Practices and Recommendations in Arkansas	Arkansas Corn & Grain Sorghum Board		$20,861
Vories, Earl & Purcell, Larry	Soybean Drought Tolerance Research	Soybean Promotion Board		$70,658
Vories, Earl & Tacker, Phil	Improving Yield and Yield Stability for Irrigated Soybean	Soybean Promotion Board		$55,447
Vories, Earl, Purcell, Larry, & Dombek, Don	Ultra- Short Season Corn Hybrid Evaluation	Arkansas Corm & Grain Sorghum Board		$17,500

PUBLICATIONS

Books:

Matlock M. 2004. Journal of the Ecological Engineering and Ecotechnology – Book Review. Ecological Engineering Principles and Practice, Author: P. Kangas. Ecological Engineering (2004)

Matlock M. 2004. Kluwer Press – Invited Book Review. Storm Water Management for Smart Growth, Authors Davis and McCuen (2004).

Book chapters in the book entitled "Frontiers of Combinatorial Bioengineering" edited by M. Ueda. (2004) CMC Publishers. Tokyo, Japan

Ye, K. Charpter 2: *E. coli* protein display and its application for directed-evolution of proteins

Ye, K. Charpter 5: Construction of a combinatorial library

Ye, K. Charpter 7: Retroviral peptide display libraries

Ye, K. Charpter 11: RNA interference and siRNA libraries

Non-Refereed:

Chaubey, I. and **K.L. White**. 2004. Stochastic validation of SWAT model. Presented at the AWRA Annual International Conference, Orlando, FL.

Chaubey, I., **D. Sahoo**, **M.D. Matlock**, **B.E. Haggard**, and **T.A. Costello**. 2004. Quantifying stream nutrient retention in an agriculturally dominated stream. Annual Conference of the Institute of Biological Engineering. Fayetteville, AR. January 9 – 11.

DeLaune, P.B., **I. Chaubey**, **B.E. Haggard**, M.J. Cochran, T.C. Daniel, and **V. Garg**. 2004. Development of the Eucha-Spavinaw phosphorus Index within a court settlement agreement. Poster Presented at the Annual International Conference of the ASA/SSSA/CSA. Seattle, WA.

Garg, V., and **I. Chaubey**. 2004. Remote sensing of chlorophyll and suspended sediment concentrations. ASAE Paper No. 042016. 2004 Annual International Conference, Ottawa, Canada. 12 pp.

Garg, V., and **I. Chaubey**. 2004. A model for predicting spectral signature of suspended sediments. Annual Conference of the American Ecological Engineering Society. Fayetteville, AR. June 7- 10.

Garg, V., and **I. Chaubey**. 2004. Hyperspectral remote sensing of chlorophyll-a for Beaver Reservoir, Arkansas. ASPRS Annual Conference. Denver, CO. May 23 – 28.

Mutlu, E., **I. Chaubey**, **M. Matlock**, **R. Morgan**, **B. Haggard**, and D.E. Storm. 2004. NMDESS: A GIS based decision support system for nutrient management. Presented at the AWRA Annual International Conference, Orlando, FL.

Mutlu, E., **I. Chaubey**, **M.D. Matlock**, **B.E. Haggard**, D.E. Storm, and M. White. 2004. NMDESS: A decision support system for nutrient management. Annual Conference of the American Ecological Engineering Society. Fayetteville, AR. June 7- 10.

Panda, S.S., **I. Chaubey**, and **V. Garg**. 2004. Artificial neural networks application in lake water quality estimation using satellite imagery. ASAE Paper No. 042073. 2004 Annual International Conference, Ottawa, Canada. 13 pp.

Panda, S.S., **I. Chaubey**, and **M.D. Matlock**. 2004. Using interactive GIS mapping in a watershed management DSS design. Annual Conference of the American Ecological Engineering Society. Fayetteville, AR. June 7- 10.

Panda, S., **I. Chaubey**, **M.D. Matlock**, **B.E. Haggard,** and **K.L. White**. 2004. Development of GIS-based decision support system for Beaver Lake watershed management. 2004 Spring Specialty Conference on GIS and Water Resources III. Nashville, TN. May 17 – 19.

Sen, S., **B.E. Haggard**, **I. Chaubey**, K.R. Brye, **M.D. Matlock**, and **T.A. Costello**. 2004. Preliminary estimation of sediment phosphorus flux in Beaver Lake, Northwest Arkansas. ASAE Paper No. 042269. 2004 Annual International Conference, Ottawa, Canada. 17 pp.

Sen, S., **B.E. Haggard**, **I. Chaubey**, **T.A. Costello**, **M. Matlock**, and K. Brye. 2004. Quantification of internal phosphorus load in Beaver Lake, northwest Arkansas under aerobic and anaerobic conditions. Annual Conference of the American Ecological Engineering Society. Fayetteville, AR. June 7- 10.

White, K.L., **I. Chaubey**, **B.E. Haggard**, and **M. Matlock**. 2004. Evaluation of reservoir water quality response to watershed management using computer modeling. Presented at the AWRA Annual International Conference, Orlando, FL.

White, K.L., **I. Chaubey**, **B.E. Haggard**, and **M.D. Matlock**. 2004. Comparison of two methods for modeling monthly TP yield from a watershed. ASAE Paper No. 042075. 2004

PUBLICATIONS

Annual International Conference, Ottawa, Canada. 11 pp.

White, K.L., **I. Chaubey**, and **B.E. Haggard**. 2004. Linking watershed and reservoir models. ASAE Paper No. 042075. 2004 Annual International Conference, Ottawa, Canada. 12 pp.

White, K.L., **I. Chaubey**, **B.E. Haggard**, and **M. Matlock**. 2004. Comparison of two methods for modeling monthly TP yield from a watershed. Annual Conference of the American Ecological Engineering Society. Fayetteville, AR. June 7- 10.

Papers & Reports

Carpenter, D.P., J.-W. Kim, and R. Deaton. 2004. Evaluating Complexity for Large Mixtures of Many Different DNA Oligonucleotides Using Cot Analyses. Institute of Biological Engineering (IBE) Annual Meeting, Fayetteville, AR.

Chaubey, I., **M. Matlock**, **T. Costello**, **C. Cooper**, and **K. White**. 2004. GIS database development and watershed modeling in Arkansas priority watersheds. Final Report Submitted to Arkansas Soil and Water Conservation Commission. Project No. 04-120.

Chaubey, I., S. Panda, K.L. White, M. Matlock, B. Haggard, and **T.A. Costello**. 2004. Beaver Lake watershed decision support system. Proceedings of the 2004 Annual Conference of the Arkansas Water Resources Center.

Chaubey, I., M. D. Matlock, T. A. Costello, C. Cooper, and **K. White**. 2004. GIS database development and watershed modeling in Arkansas priority watersheds. Final report submitted to Arkansas Soil and Water Conservation Commission, Project No. 04-120.

Costello, T. A,. and L. A. Roe. 2004. On-farm demonstration of litter combustion. Quarterly and annual reports submitted to Soil and Water Conservation Commission, Project No. 03-800.

Griffis, Carl L., Betty Martin, Tareq Osaili, and Brandon Beard. 2004. Cooking Process Test for Vegetable Links. A report to Jones Dairy Farm, Wisconsin.

Kavdia, M, and Popel AS. Microvascular smooth muscle NO bioavailabilty: Role of neuronal and endothelial NO sources. FASEB Journal. 18 (5): A1321-A1321 Supl. MAR 24 2004. (Peer Reviewed)

Kavdia, M., Model for prediction of nitric oxide, superoxide, and peroxynitrite profiles from activated immune cells in an encapsulated cell matrix. FASEB Journal 18 (4): A759-A759 Suppl. S MAR 23 2004 . (Peer Reviewed)

Kavdia, M., Model for Nitric Oxide and Superoxide Interactions in the Microcirculation. Biomedical Engineering Society (BMES) Annual Fall Meeting, Philadelphia, PA October, 2004. (Peer Reviewed)

Kim, J.-W., S. Tung, J.S. Lee, N.K. Kotagiri, R. Pooran, and M. Al-Fandi. A Hybrid Flagellar Motor/MEMS Micro-Pump. 96th AIChE Ann. Meet. (Nanoscale Science and Engineering Session), Austin, TX.

Kim, J.-W., C.E. Long, and T.L. Peeples. 2004. Revealing Extreme Thermostability of Glycosyl Hydrolases from a Hyperthermophilic Archaeon Methanococcus jannaschii. 96th AIChE Ann. Meet. (Extremophile Bioprocessing Session), Austin, TX.

Kim, J.-W., I.D. Wijesekera, and R. Beitle. 2004. Expression and Characterization of Thermostable, Acid-Tolerant Citrate Synthase from a Hyperthermoacidophilic Archaeon Sulfolobus tokodaii Strain 7. 96th AIChE Ann. Meet. (FPBE Division), Austin, TX.

Kim, J.-W., N.K. Kotagiri, S. Tung, and R. Deaton. 2004. Development of an Electrically Addressable Nanotube-Wire Nanosenor Through Controlled DNA-Nanotube Interfacing. 96th AIChE Ann. Meet. (Nanoscale Science and Engineering Session), Austin, TX.

Pooran, R., M. Al-Fandi, S. Tung, **J.-W. Kim**, and **J.S. Lee**. 2004. Bacterial Flagellar Motors as Microfluidic Actuators. ASME International Mechanical Engineering Congress and R&D Expo (IMECE), Anaheim, CA.

Chen, J., R. Deaton, M. Gazon, **J.-W. Kim**, D. Wood, H. Bi, **D. Carpenter**, and Y.-Z. Wang. 2004. Characterization of Non-Crosshybridizing DNA Oligonucleotides Manufactured In Vitro. DNA 10: 10th International Meeting on DNA Computing, Milan, Italy.

Kim, J.W.,, S. Tung, R. Deaton, **J.S. Lee**, and **I. Kodikara**. 2004. DNA-Directed Self-Assembly of Single-Walled Carbon Nanotubes through Controlled DNA-Nanotube Interfacing. Institute of Biological Engineering (IBE) Annual Meeting, Fayetteville, AR.

R. Pooran, S. Tung, **J.-W. Kim**, A. Malshe, and **J.S. Lee**. 2004. Performance of a Flagellar Motor Based Pump. Institute of Biological Engineering (IBE) Annual Meeting, Fayetteville, AR (won 1st place in the IBE student poster competition).

M. Al-Fandi, R. Pooran, S. Tung, **J.-W. Kim**, and A. Malshe. 2004. *E. coli* Cell Motors for MEMS Devices: Fabrication and Modeling. First International Workshop on Nano Bio-Packaging, Atalanta, GA.

Kulkarni, S. and **Bajwa, S. G**. 2004. Soil compaction modeling in cotton. In. Summaries of Arkansas Cotton Research 2003. D. M. Oosteruis (Ed.), pp. 68-70, Research Series 521, Arkansas Agricultural Experiment Station, Fayetteville, AR.

Li, Y., R. Al-Haddad, **L. Yang**, and S. Ang. 2004. A microelectrode based impedance immunosensor for detection of *E. coli O157:H7* in foods. Presented at the 2004 ASAE Annual International Meeting, August 1-4, 2004, Ottawa, Canada. ASAE Paper No. 047044. American Society of Agricultural Engineers, St. Joseph, MI.

Li, Y., S. Ang, X.L. Su, **L. Yang**, and X Yu. 2004. Immunoimpedance biosensor for detection of foodborne pathogens. A progress report in: CD of Food Safety Consortium 2004 Annual Meeting—Agenda, Presentations, and Progress Reports, October 3-5, Ames, IA.

Li, Y., **X.L. Su**, and **B. Swem**. 2004. QCM immunosensor for detection of foodborne pathogens in poultry products. A progress report in: CD of Food Safety Consortium 2004 Annual Meeting—Agenda, Presentations, and Progress Reports, October 3-5, Ames, IA.

Matlock, M., R. Morgan, and K. Thornton. 2004. Breakfast from Arkansas: Ecological and Economic Sustainability. The Oklahoma Academy 2004 Proceedings of the Town Hall Workshop 1.21 – 1.26.

Matlock, M., **R. Morgan**, C. Burdorf, M. Vargas, *E. Cummings, A. Ludwig, B. Schafer*, A. Brown, A. Radwell, and R. Reese. 2004. An Ecological Assessment of Streams of Northwest Arkansas. USEPA Region VI Technical Report. Dallas, TX.

Sen, S., **B. E. Haggard**, **I. Chaubey**, K. R. Brye, **M. D. Matlock**, and **T. A. Costello**. 2004. Preliminary estimation of sediment phosphorus flux in Beaver Lake, Northwest Arkansas. ASAE Paper No. 04-2269. 2004 Annual International Conference, Ottawa, Canada. 17 pp.

Su, X.L. and **Y. Li**. 2004. An automatic quartz crystal microbalance immunosensor system for Salmonella detection. Presented at the 2004 ASAE Annual International Meeting, August 1-4, 2004, Ottawa, Canada. ASAE Paper No. 047043. American Society of Agricultural Engineers, St. Joseph, MI.

Wijesekera I.D., J.-W. Kim, and **R. Beitle**. Thermostable, Acid-Tolerant Citrate Synthase from Hyperthermoacidophilic Archaeon Sulfolobus tokodaii Strain 7. Institute of Biological Engineering (IBE) Annual Meeting, Athens, GA (accepted).

Ye, K., Jin, S., Mohammad, M.A., and Schultz, J. S. (2004) Tagging retroviruses with a metal binding peptide and one-step purification with immobilized metal affinity chromatography. J. Virol. 78:9820-9827

Ye, K., Bratic, K., Jin, S., and Schultz, J. S. (2004). Cell surface display of a glucose binding protein. J. Molecular Catalysis B: Enzymatic. 28:201-206.

Ye, K. Jin, S., and Schultz, J.S. (2004) Genetic engineering of a fluorescent cell marker for labeling CD34+ hematopoietic stem cells. Biotechnol. Prog. 20:561-565.

Patents:

Li, Y., and **X. Su**. 2004. Quantum Dot Biolabeling Coupled with Immunomagnetic Separation for Detection of Foodborne Pathogens. US Patent in filing process, December 18, 2004.

Li, Y., and **M. Varshney**. 2004. Magnetic Nanoparticle-Antibody Conjugates for Highly Efficient Separation of Bacterial Pathogens from Food Samples. US Patent in filing process, December 18, 2004.

Li, Y., and **X. Su**. 2004. An Immuno-magnetic Beads Based Viscoelastic Biosensor for Detection of Bacterial Pathogens. US Patent in filing process, December 18, 2004.

Osborn, G. S., M. D. Matlock, S. S. Teltschik. Portable System to Enhance Biological Treatment Processes for Improving Water Quality: A portable water ecosystem oxygenator. Pending. Accepted by U of A Patent committee. Provisional patent filed. Patent Attorney hired.

Schultz S. J. and **Ye, K**. System and method for detecting bioanalytes and method for producing a bioanalyte sensor. US patent, pending. (Filed in 2004).

PUBLICATIONS

Presentations:

Bajwa, S. G., M. Mozaffari, and **A. Mishra**. 2004. Remote Sensing and Petiole Nutrient Analysis for Cotton Nitrogen Management. In. Proc. International Precision Agriculture Conference, Minneapolis, MN.

Bajwa, S. G. 2004. Pesticide pollution risk assessment and mitigation training in Arkansas Delta. EPA Region 6 meeting, March 30, 2003, Little Rock, AR. (Invited)

Bhise N, Deonikar P, Potdar SS, and **Kavdia M.** Model for Nitric Oxide and Superoxide Interactions in the Microcirculation. Arkansas Biosciences Institute Research Symposium, Little Rock, Arkansas, Oct 28, 2004.

Carpenter, D.P., J.-W. Kim, and R. Deaton. 2004. Evaluating Complexity for Large Mixtures of Many Different DNA Oligonucleotides Using Cot Analyses. Institute of Biological Engineering (IBE) Annual Meeting, Fayetteville, AR.

Lau, S, **Carrier DJ**, Howard, L, Lay J, Beitle B and Clausen E . "Identification and quantification of flavonoids in mimosa". Institute of Biological Engineering, Fayetteville, AR January 2004.

Carrier, DJ, and Clausen E. "Milk Thistle an interesting dietary supplement". Institute of Biological Engineering, Fayetteville, AR January 2004.

Lau S, **Carrier DJ**, Howard, L, Lay J, Beitle B and Clausen. "Identification and quantification of flavonoids in mimosa". Institute of Biological Engineering, Fayetteville, AR January 2004. (poster)

Duan, L, **Carrier, DJ,** and E Clausen C. "Thermal degradation of silymarin compounds in pressurized hot water." Institute of Biological Engineering, Fayetteville, AR January 2004. (poster)

Carrier, DJ, and Clausen EC. "Milk thistle an interesting herb" Natural Health Product Conference, Montreal February 2004. (poster)

Lau, C.S., **Carrier, DJ**, J.O. Lay, Jr., L.R. Howard and E.C. Clausen, "Extraction of Antioxidants from Energy Crops," Southern Bio-Products Conference, Biloxi, MS, March, 2004. Invited.

Lau S, **Carrier, DJ**, Beitle B, Lay J, Howard L, Liyanage R and Clausen E. "Identification and Quantification of Flavonoids in Kudzu (Pueraria lobata)" presented at the 26th Symposium on Biotechnology for Fuels and Chemicals, Chattanooga May 2004 (poster)

Lau, S, **Carrier, DJ**, and Clausen E. "Parameters Affecting Flavonoids Extraction from Mimosa (Albizia julibrissin)" presented at the 26th Symposium on Biotechnology for Fuels and Chemicals, Chattanooga May 2004 (poster)

Carrier, DJ, and E.C. Clausen, "Energy Crops as a Potential Source of Antioxidants," presented at the South Central Region Sun Grant Initiative Conference & Workshop, Oklahoma City, June, 2004.

Duan, L, **Carrier, DJ,** and Clausen E. "Extraction of Silymarin Compounds from ground milk thistle seeds using Hot Water". Presentation at the 11th International meeting of supercritical fluid chromatography, extraction and processing. Pittsburgh, PA, August 2004. (poster).

Duan L, **Carrier, DJ,** and Clausen E. "Thermal Degradation of Silymarin Compounds." Presentation at the 11th International meeting of supercritical fluid chromatography, extraction and processing. Pittsburgh, PA, August 2004. (poster).

Jerry W. King, Clausen, EC, **Carrier, DJ**. "Optimization and Experimental Pitfalls in the Use of Subcritical Fluids". Presentation at the 11th International meeting of supercritical fluid chromatography, extraction and processing. Pittsburgh, PA, August 2004. Invited.

Carrier, DJ, and Clausen E. "Medicinal Plants". American Society of Agricultural Engineering, Ottawa, Canada August 2004

Carrier, DJ, and Clausen E. "Research Updates at the University of Arkansas". The Science and Engineering for a Biobased Industry and Economy Multistate Research Project, Golden, CO September 2004

Carrier, DJ, Vaughn K, Erf G, Duan L, Wallace S and E.C. Clausen "Protective effect of lycopene and silymarins ". ABI meeting, Little Rock, AR October 2004 (poster)

Carrier, DJ, and Clausen EC, "Bioprocess Engineering" Bioresource Engineering Department, McGill University, Montreal, Canada, November 2004. Invited.

Cochran, M., T. Daniel, and **I. Chaubey**. Update on Eucha-Spavinaw Phosphorus Index Development. Seminar presented at the Quad State Poultry Dialogue Symposium. Fayetteville, AR. May 6, 2004.

Chaubey, I., and **V. Garg**. Water quality modeling using hyperspectral remote sensing. Twelfth Annual Arkansas Space Grant Symposium. Lyon College, Batesville, AR. April 30, 2004

Daniel, T.C. and **I. Chaubey**. "Eucha/Spavinaw Phosphorus Index". 2004. SERA-17 Annual International Conference. New Bern, NC. June 20-22. (Invited Presentation).

Chaubey, I. "Water resources, sustainable agriculture, and economic development in Arkansas: an Ecological Engineering solution". Rural Friendship Development Day conference. Fayetteville, AR. August 12, 2004. (Invited Presentation).

Chaubey, I., S. Panda, K.L. White, M. Matlock, B. Haggard, and **T.A. Costello**. "Beaver Lake watershed decision support system (BLWDSS)". 2004 Arkansas Water Resources Center Conference. Fayetteville, April 20-21, 2004 (Invited Presentation)..

Chaubey, I. "Uncertainty analyses in hydrologic/water quality models". Environmental Dynamics Colloquium, University of Arkansas, Fayetteville. January 26, 2004. (Invited Presentation).

Chaubey, I., K.L. White, and **C. Cooper**. Using SWAT models in watershed response assessment. Workshop conducted at the Arkansas Soil and Water Conservation Commission. July 15, and August 26, 2004.

Chaubey, I. 2004. Decision Support System research activities within the Ecological Engineering program. Presented at the Public Policy Colloquium, University of Arkansas, Fayetteville. January 21.

Chaubey, I., D. Sahoo, M.D. Matlock, B.E. Haggard, and **T.A. Costello.** 2004. Quantifying stream nutrient retention in an agriculturally dominated stream. Annual Conference of the Institute of Biological Engineering. Fayetteville, AR, January 9–11.

Costello, T. A. and L. A. Roe. 2004. Utilization of poultry litter as source of heat for poultry production. Poultry Litter and Renewable Resource Seminar <http://www.epa.gov/earth1r6/6pd/pd-u-sw/wte_chickenseminar.htm>, EPA Region 6, Fayetteville, AR, May 5 (invited).

Costello, T.A., I. Chaubey and **K. White**. 2004. Potential use of poultry litter as a fuel for space heating. Washington County Conservation District Field Day, Lincoln AR, March 30.

Costello, T. A. and **A. Ludwig.** 2004. Stream habitat assessment techniques. In-Service Training, University of Arkansas Cooperative Extension Service, Fayetteville, AR, November 3.

Dillahunty, W. D., and **T. A. Costello**. 2204. Plant growth chamber for advanced life support system research. Arkansas Space Grant Consortium Annual Meeting, Newport, AR, April 30.

Kandaswamy, J., S. G. Bajwa, and J. Apple. 2004. Prediction of fat, calories and cholesterol in fresh and cooked ground beef with near-infrared spectroscopy. State ASAE meeting, October 4, Little Rock, AR.

Kavdia, M, and Popel AS. Microvascular smooth muscle NO bioavailabilty: Role of neuronal and endothelial NO sources. Experimental Biology, Washington D.C. April 17-21, 2004.

Kavdia, M. Model for prediction of nitric oxide, superoxide, and peroxynitrite profiles from activated immune cells in an encapsulated cell matrix. Experimental Biology, Washington D.C. April 17-21, 2004.

Kavdia, M. Model for Nitric Oxide and Superoxide Interactions in the Microcirculation. Biomedical Engineering Society (BMES) Annual Fall Meeting, Philadelphia, PA October, 2004.

Kim, J.-W., S. Tung, **J.S. Lee**, **N.K. Kotagiri**, R. Pooran, and M. Al-Fandi. A Hybrid Flagellar Motor/MEMS Micro-Pump. 96th AIChE Ann. Meet. (Nanoscale Science and Engineering Session), Austin, TX.

Kim, J.-W., C.E. Long, and T.L. Peeples. 2004. Revealing Extreme Thermostability of Glycosyl Hydrolases from a Hyperthermophilic Archaeon Methanococcus jannaschii. 96th AIChE Ann. Meet. (Extremophile Bioprocessing Session), Austin, TX.

Kim, J.-W., **I.D. Wijesekera**, and R. Beitle. 2004. Expression and Characterization of Thermostable, Acid-Tolerant Citrate Synthase from a Hyperthermoacidophilic Archaeon Sulfolobus tokodaii Strain 7. 96th AIChE Ann. Meet. (FPBE Division), Austin, TX.

Kim, J.-W., **N.K. Kotagiri**, S. Tung, and R. Deaton. 2004. Development of an Electrically Addressable Nanotube-Wire Nanosenor Through Controlled DNA-Nanotube Interfacing. 96th AIChE Ann. Meet. (Nanoscale Science and Engineering Session), Austin, TX.

Pooran, R., M. Al-Fandi, S. Tung, **Kim, J.-W**., and **J.S. Lee**. 2004. Bacterial Flagellar Motors as Microfluidic Actuators. ASME International Mechanical Engineering Congress and R&D Expo (IMECE), Anaheim, CA.

PUBLICATIONS

Chen, J., R. Deaton, M. Gazon, **Kim, J.-W.,** D. Wood, H. Bi, **D. Carpenter**, and Y.-Z. Wang. 2004. Characterization of Non-Crosshybridizing DNA Oligonucleotides Manufactured *In Vitro*. DNA 10: 10th International Meeting on DNA Computing, Milan, Italy.

Kim, J.-W., S. Tung, R. Deaton, **J.S. Lee**, and **I. Kodikara**. 2004. DNA-Directed Self-Assembly of Single-Walled Carbon Nanotubes through Controlled DNA-Nanotube Interfacing. Institute of Biological Engineering (IBE) Annual Meeting, Fayetteville, AR.

Pooran, R.,, S. Tung, **Kim J.-W**., A. Malshe, and **J.S. Lee**. 2004. Performance of a Flagellar Motor Based Pump. Institute of Biological Engineering (IBE) Annual Meeting, Fayetteville, AR (won 1st place in the IBE student poster competition).

Al-Fandi, M., R. Pooran, S. Tung, **Kim J.-W**., and A. Malshe. 2004. E. coli Cell Motors for MEMS Devices: Fabrication and Modeling. First International Workshop on Nano Bio-Packaging, Atalanta, GA.

Kim, J.-W. and R. Deaton. 2004. Genome-Enabled Medical Diagnosis Using a Biological Memory. 2004 Arkansas Biosciences Institute Fall Research Symposium, October 28, Little Rock, AR. Invited

Kim, J.-W., Steve Tung, and R. Deaton. 2004. Interfacing Micro-/Nano-Scale Biological and Abiological Materials for Bio/Abio Hybrid Systems. 206th Meeting of the Electrochemical Society (Biological Nanostructures, Materials, and Applications Session), Honolulu, Hawaii. Invited

Tung, S., and **Kim J.-W**.. 2004. Flagellar Motor Based Micro Hybrid Devices. 26th Annual International Conference IEEE Engineering in Medicine and Biology Society (EMBS), San Francisco, CA. Invited

Steve Tung and **Kim, J.-W**.. 2004. Molecular Motors. IEEE International Conference on Robotics and Biominetics (ROBIO), Shenyang, China. Invited

Kulkarni, S. S., S. G. Bajwa, G. Huitink, M. Crow, and W. baker. 2004. Modeling soil compaction with soil electrical conductivity and yield in cotton. In. Proc. 2004 Beltwide Cotton Producers National Research Conferences, January 5-9, San Antonio, TX.

Al-Haddad, R., **Y. Li**, S. Ang and **L. Yang**. 2004. Microelectrode array based immunosensor for detection of *E. coli O157:H7*. Presented at IBE 2004 Annual Meeting, January 9-11, Fayetteville, AR.

Li, Y., and **X. Su**. 2004. Microfluidics based optical immunosensor for detection of Escherichia coli O157:H7. Presented at IBE 2004 Annual Meeting, January 9-11, Fayetteville, AR.

Li, Y., **L. Yang**, R. Al-Haddad and S. Ang. 2004. Interdigitated microelectrode immunosensor for detection of foodborne pathogens. Presented at the 2004 World Biosensors Congress Annual Meeting, May 24-26, 2004, Granada, Spain. Abstract No. BS-526.

Li, Y., R. Al-Haddad, **L. Yang**, and S. Ang. 2004. A microelectrode based impedance immunosensor for detection of *E. coli O157:H7* in foods. Presented at the 2004 ASAE Annual International Meeting, August 1-4, 2004, Ottawa, Canada. ASAE Paper No. 047044.

Li, Y., and **X. Su**. 2004. Microfluidics-based optical immunosensor for detection of foodborne pathogens. Presented at the 2004 IAFP Annual Meeting, August 8-11, 2004, Phoenix, AZ. Abstract # T63.

Li, Y., S. Ang, **X. Su**, and Y. Xi. 2004. Microfluidics based optical biosensor for rapid detection of Escherichia coli O157:H7. An invited presentation given at the 2004 CIGR (International Commission of Agricultural Engineering) International Meeting, October 11-14, 2004, Beijing, China.

Li, Y., and **Z. Liu**. 2004. Inactivation of Listeria in recirculated chilling brine using flow-through electrolyzing treatment. Presented at the 2004 CIGR International Meeting, October 11-14, 2004, Beijing, China.

Li, Y. 2004. Brief introduction of biological engineering program at the University of Arkansas. An invited presentation given at the International Forum on Biosystems Engineering, October 16-18, 2004, Zhejiang University, Hangzhou, China.

Li, Y., X.L. Su, L. Yang, B. Swem, S. Ang, and X Yu. 2004. Immunosensors for rapid detection of foodborne pathogens: An update. Presented at the Food Safety Consortium 2004 Annual Meeting, October 3-5, Ames, IA. In: CD of Food Safety Consortium 2004 Annual Meeting—Agenda, Presentations, and Progress Reports.

Liu, Z. and **Y. Li**. 2004. The effect of brine age, NaCl concentration, pH and storage temperature on the survival of Listeria innocua in bacon brine. Presented at IBE 2004 Annual Meeting, January 9-11, Fayetteville, AR.

Liu, Z., **B.L. Swem** and **Y. Li**. 2004. In situ HClO generation using a flow-through electrolyzing chamber for the pasteurization of chilling brine: a pilot plant test. Presented

at IFT 2004 Annual Meeting, July 12-16, 2004, Las Vegas, NV. Poster No. 17H-5.

Liu, Z. and **Y. Li.** 2004. Flow-through electrochemical treatment chambers for in-line inactivation of Listeria in recirculated chilling brine. Presented at the 2004 ASAE Annual International Meeting, August 1-4, 2004, Ottawa, Canada. Poster No. 046023.

Liu, Z., B. Swem, and **Y. Li**. 2004. The mechanism, scale up, and pilot plant scale test of a flow-through electrolyzing chamber for in-line inactivation of Listeria in recirculated chilling brine. Presented at the Arkansas Section of ASAE 2004 Annual Meeting, October 1, Little Rock, AR. The winner of the First Prize of the Graduate Students Poster Competition.

Ludwig, A., Marty Matlock, B. Haggard, R. Morgan, I. Chaubey, and Monty Matlock. 2004. The influence of riparian forest canopy on stream primary productivity. AWRA Summer Specialty Conference on "Riparian Ecosystems and Buffers: Multi-scale Structure, Function, and Management". Olympic Valley, CA. June 28-30.

Matlock, Marty. Keynote Speaker: The Role of the Academic Community in Balancing Economic and Environmental Sustainability. Oklahoma Academy on State Planning, Oklahoma City, Oklahoma, January 2005. Invited.

Matlock, Marty. Organizer and host, two Statewide NPS Stakeholder Meetings, Littlerock, AR, August and November 2004. Invited.

Matlock, Marty. Monitoring and Managing Ecological Services in Arkansas. Arkansas Water Policy Meeting, Littlerock, AR, November 2004. Invited.

Matlock, Marty. Chair, Interstate Water Resource Conflict session, Arkansas Watershed Advisory Group, Littlerock, AR September 2004. Invited.

Matlock, Marty. Urban Landscape Impacts on Sediment Loads to Streams. Session honoring Dr. Bill Barfield, ASAE , Toronto, Canada. July 2004. Invited.

Matlock, Marty. Host and Chair of the American Ecological Engineering Society Fourth Annual Meeting, Fayetteville, AR, June 2004. Invited.

Matlock, Marty, R. Morgan, T. Daniels 2004. The state of water in Arkansas. ANR Extension Annual Meeting, March 2004. Invited.

Matlock, Marty, I. Chaubey, B. Haggard, D. Storm, M. Smolen, and W. Focht. 2004. Developing a Nutrient Management Decision and Educations Support System (NMDSS). USDA-CSREES Annual Meeting, Tampa, Florida, January 2004. Invited.

Matlock, Marty, 2004. Chair, Ecological Engineering Symposia, Institute of Biological Engineering Annual Meeting, January 2004. Invited.

Matlock, Marty, R. Morgan, I. Chaubey. 2004. Organized and presented symposia on Ecological Engineering. University of Arkansas Public Policy Forum Series, January 2004.

Matlock, Marty, R. Morgan, D. Farver. 2004. Taught one week workshop on Ecological Engineering. University of Arkansas Landscape Architecture Design Studio, February 2004.

Mao, X., L. Yang, and **Y. Li.** 2004. Two procedures for rapid detection of *Escherichia coli O157:H7* using QCM DNA sensor. Presented at IBE 2004 Annual Meeting, January 9-11, Fayetteville, AR.

Mao, X., L. Yang, and **Y. Li.** 2004. QCM and nanomagnetic beads based DNA sensor for rapid detection of Escherichia coli O157:H7. To be presented at BMES 2004 Annual Meeting, October 13-16, Philadelphia, PA. Poster No. 1130.

Mao, X., L. Yang and **Y. Li**. 2004. A QCM and nanoparticle based DNA sensor for the detection of Escherichia coli O157:H7. Presented at the Arkansas Section of ASAE 2004 Annual Meeting, October 1, Little Rock, AR.

Mishra, A. S, G. Bajwa, and R. Norman. 2004. Nitrogen monitoring and management in rice. In. Proc. of 2004 ASAE International Meeting, Ottawa, Canada.

Mishra, A. S, G. Bajwa, and R. Norman. 2004. Nitrogen monitoring and management in rice. ASPRS Annual Meeting. Denver, CO.

Morgan, R. A., E. Cummins, S. Ekka, G. Goh, **A. Ludwig, M. Matlock, A. McAllister**, C. Thompson. 2004. Ecological Services Provided By Blossomway Creek, Rogers, Ark. AWRA Summer Specialty Conference, June 28-30, 2004, – Riparian Ecosystems and Buffers: Multi-Scale Structure, Function and Management. Resort at Squaw Creek, Olympic Valley, California.

Osborn, G.S. "Research and Development: Applying YOUR Skills for Truly Making the World a Better Place" made to Undergraduate Research Students within NSF-REU program U of A, Fayetteville. Invited.

PUBLICATIONS

Osborn, G.S. "How Biological Engineering Can Contribute to Bioinformatics" Made to Biosciences and Bioinformatics Seminar Series at U of A, Little Rock. Invited.

Osborn, G.S. "Biomedical Engineering at U of A" made to Biomedical Engineering Symposium, U of A, Fayetteville.

Osborn, G.S. Moderator of poster session, American Ecological Engineering Society, 2004 Annual Meeting, Fayetteville, AR.

Osborn, G.S. Moderator technical session, "Applications of Ecological Engineering in Both Rural and Urban Settings", ASAE annual meeting 2004, Ottawa, Canada.

Pradhan, A.K., H. Yang, **B.L. Swem**, and **Y. Li.** 2004. Survival/death of *Salmonella Typhimurium* on chicken skin during poultry scalding: data analysis using statistical software. Presented at IBE 2004 Annual Meeting, January 9-11, Fayetteville, AR.

Pradhan, A.K. and **Y. Li**. 2004. A quantitative microbial risk assessment model for *Salmonella Typhimurium* in poultry processing. Presented at IFT 2004 Annual Meeting, July 12-16, 2004, Las Vegas, NV. Poster No. 99B-21.

Pradhan, A.K., and **Y. Li.** 2004. Quantitative microbial risk assessment simulation for *Salmonella Typhimurium* in poultry processing. Presented at the SRA 2004 Annual Meeting, December 5-8, 2004, Palm Springs, CA.

Pradhan, A.K., and **Y. Li**. 2004. A quantitative microbial risk assessment model for *Salmonella Typhimurium* in poultry processing. Presented at the Arkansas Section of ASAE 2004 Annual Meeting, October 1, Little Rock, AR. The winner of the Second Prize of the Graduate Students Poster Competition.

Schaffer, B., I. Chaubey, M. Matlock, J. Popp, **P. Tacker**, and **E. Vories**. Integrated water quality – water conservation program in the Arkansas Delta. Poster presented at the L'Anguille River Watershed Awareness Day. Forest City, AR. July 29, 2004.

Sen, S., B. E. Haggard, I. Chaubey, T. A. Costello, M. D. Matlock, and K. R. Brye. 2004. Quantification of internal phosphorus load in Beaver Lake, northwest Arkansas under aerobic and anaerobic conditions. Annual Conference of the American Ecological Engineering Society. Fayetteville, AR, June 7-10.

Sen, S., B. E. Haggard, I. Chaubey, T. A. Costello, M. D. Matlock, and K. R. Brye. 2004. Quantification of internal phosphorus load in Beaver Lake, northwest Arkansas under aerobic and anaerobic conditions. Annual Conference of the American Ecological Engineering Society. Fayetteville, AR, June 7- 10.

Kim, B., **X.L. Su**, and **Y. Li**. 2004. Rapid detection of *Salmonella Typhimurium* by capillary immunosensor coupled with an electrochemical measurement. Presented at IBE 2004 Annual Meeting, January 9-11, Fayetteville, AR.

Kim, B., **X.L. Su**, and **Y. Li**. 2004. A capillary immunosensor for rapid detection of *Salmonella Typhimurium* in poultry products. Presented at IFT 2004 Annual Meeting, July 12-16, 2004, Las Vegas, NV. Poster No. 99A-28.

Su, X.L. and **Y. Li.** 2004. Quantum dots as fluorescent probes for detection of Escherichia coli O157:H7. Presented at IBE 2004 Annual Meeting, January 9-11, Fayetteville, AR.

Su, X.L. and **Y. Li.** 2004. An automatic quartz crystal microbalance immunosensor system for Salmonella detection. Presented at the 2004 ASAE Annual International Meeting, August 1-4, 2004, Ottawa, Canada. ASAE Paper No. 047043.

Su, X.L., and **Y. Li**. 2004. QCM immunosensors coupled with immuno-magnetic beads for detection of *Salmonella Typhimurium* in poultry products. Presented at the Food Safety Consortium 2004 Annual Meeting, October 3-5, Ames, IA. Abstract of the poster in: CD of Food Safety Consortium 2004 Annual Meeting—Agenda, Presentations, and Progress Reports.

Subramanian, S, Carrier DJ and Clausen E. "The Effect of Pretreatment on the Extraction of Flavanolignans From Milk Thistle (Silybum marianum) Seeds". Institute of Biological Engineering, Fayetteville, AR January 2004.

Swem, B.L. and **Y. Li.** 2004. Transmission of Salmonella Typhimurium from shell to fetal chick prior to hatch. Presented at IFT 2004 Annual Meeting, July 12-16, 2004, Las Vegas, NV. Poster No. 67E-33.

Varshney, M., X. Su and **Y. Li.** 2004. An optical immunosensor based on magnetic beads for detection of *E. coli O157:H7*. Presented at IBE 2004 Annual Meeting, January 9-11, Fayetteville, AR.

Varshney, M., X. Su and **Y. Li**. 2004. Magnetic bead-based chemiluminescent and fluorescent immunosensors for detection of *E. coli O157:H7*. Presented at the 2004 ASAE Annual International Meeting, August 1-4, 2004, Ottawa, Canada. Poster No. 047007.

Varshney, M., and **Y. Li**. 2004. Magnetic immuno-nanoparticles for hightly efficient separation of *Escherichia coli O157:H7* from food samples. Presented at the Food Safety Consortium 2004 Annual Meeting, October 3-5, Ames, IA. Abstract of the poster in: CD of Food Safety Consortium 2004 Annual Meeting—Agenda, Presentations, and Progress Reports.

Varshney, M., and **Y. Li**. 2004. Immuno-nanoparticles for highly effective separation of *E. coli O157:H7* from food samples. Presented at the Arkansas Section of ASAE 2004 Annual Meeting, October 1, Little Rock, AR.

Vaughn K, Carrier DJ, Howard L, King J and Clausen E. "Extraction of lycopene from watermelon". Institute of Biological Engineering, Fayetteville, AR January 2004. Institute of Biological Engineering, Fayetteville, AR January 2004.

Vibhava, V., S. G. Bajwa, I. Chaubey, and **D. Gardisser**. 2004. Pesticide pollution risk assessment in L'Anguille Watershed. L'Anguille River Watershed Awareness Day, Environmental Preservation Division of the Arkansas Department of Environmental Quality (ADEQ) and the L'Anguille River Watershed Coalition, July 29, 2004.

Vories, E. and **S. G. Bajwa**. 2005. Using Precision Agriculture Techniques to Improve Irrigation Recommendations. In: Proc. of 2005 Beltwide Cotton Producers National Research Conferences, January 5-7, New Orleans, LA.

Wallace S, Carrier DJ and Clausen E."Extraction of silymarins from Milk Thistle". Institute of Biological Engineering, Fayetteville, AR January 2004.

Wallace S, Carrier DJ, **Vaughn K, Subramanian** S, Duan L, and Clausen E. "Extraction of silymarins from Milk Thistle". First international meeting on antioxidants, Orlando Florida, June 2004. (poster)

Wallace S., Carrier DJ, Vaughn K, Subramanian S, Duan L, and E.C. Clausen, "Extraction of silymarins from Milk Thistle". American Society of Pharamcagnosy Society, Phoenix, AZ, 2004. (poster)

Yang, L. and **Y. Li**. 2004. Faradiac and non-Faradiac impedance measurements using interdigitated array microelectrodes for rapid detection of pathogenic bacteria. Presented at IBE 2004 Annual Meeting, January 9-11, Fayetteville, AR.

Refereed Publications:

Bajwa, S. G., P. Bajcsy, P. Groves, and L. F. Tian. 2004. Hyperspectral image data mining for band selection in precision agriculture applications. Transactions of the ASAE 47(3): 895-907.

Bajwa, S. G., M. Mozaffari, and **A. Mishra**. 2004. Remote Sensing and Petiole Nutrient Analysis for Cotton Nitrogen Management. In. Proc. International Precision Agriculture Conference, July 25-28, Minneapolis, MN.

Bajwa, S. G., and R. J. Norman. 2004. Partial least square regression modeling of rice plant nitrogen on spectral data. Submitted in March 2004, Transactions of the ASAE (in review).

J. Chen, R. Deaton, M. Gazon, J.-W. Kim, D. Wood, H. Bi, **D. Carpenter**, and Y.-Z. Wang. 2004. Characterization of Non-Crosshybridizing DNA Oligonucleotides Manufactured In Vitro. Proceedings of DNA 10: 10th International Meeting on DNA Computing, Milan, Italy.

Lau S, **Carrier DJ**, **Beitle B**, Lay J, Howard L, Liyanage R and E Clausen C. "Identification and Quantification of Flavonoids in Kudzu (Pueraria lobata)". Applied Biotechnology and Biochemistry (in press).

Gurley B, Gardner S, Hubbard M, Williams K, Gentry B, **Carrier DJ,** Edwards D and Khan I. (2004). "Assessment of botanical supplementation on human cytochrome P450 phenotype: citrus aurantium, echinacea, milk thistle, saw palmetto." Clinical Pharmacology and Therapeutics 76(5): 428-440.

Costello T and **Carrier DJ**. (2004). "Emergence of Biological Engineering at the University of Arkansas". International Journal of Engineering Education.

Tao, Y., Z. Chen, and **C. L. Griffis**. 2004. Chick feather pattern recognition. IEEE Proc.-Vis. Image Signal Process., Vol. 151, No. 5, October, 2004.

Haggard, B.E., S.A. Ekka, M.D. Matlock, and **I. Chaubey**. 2004. Phosphate equilibrium between stream sediments and water: potential effects of chemical amendments. Transactions of the ASAE 47(4):1113-1118.

Haggard, B., S. Ekka, M. Matlock, I. Chaubey. 2004. Phosphate equilibrium between stream sediments and water: Potential effect of chemical amendments. Transactions of ASAE, 47(4):1113-1118.

PUBLICATIONS

Kandaswamy, J., S. G. Bajwa, and J.K. Apple. 2005. Chemometric modeling of fat, cholestrol and caloric content in fresh and cooked ground beef with NIR reflectance spectroscopy. In. Proc. of SiCON-Sensor for Industry Conference, Houston, TX, Feb 8-10, 2005. Piscataway, NJ: IEEE. (Accepted)

Popel AS, **Kavdia M**, and Tsoukias NM. Effect of hemoglobin –based blood substitutes on nitric oxide transport: Mathematical models. In: Artificial Oxygen Carrier: Its Frontline. K. Kobayashi, Ed. Springer Verlag, Tokyo, 2004.

Tsoukias NM., **Kavdia M**, and Popel AS. 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-H1156, 2004.

Kavdia M, and Popel AS. Contribution of nNOS and eNOS derived NO to microvascular smooth muscle NO exposure. Journal of Applied Physiology. 97(1): 293-301, 2004.

J.-W. Kim, S. Tung, and R. Deaton. 2004. "Interfacing micro-/nano-scale biological and abiological materials for bio/abio hybrid systems," in Proceedings of International Symposium on Nanoscale Devices, Materials, and Biological Systems: Fundamentals and Applications, M. Cahay, M. Urquidi-Macdonald, S. Bandyopadhyay, P. Guo, H.

Steve Tung and **J.-W. Kim**. 2004. Flagellar Motor Based Micro Hybrid Devices. Proceedings of 26th Annual International Conference IEEE Engineering in Medicine and Biology Society (EMBS), San Francisco, CA.

Steve Tung and **J.-W. Kim**. 2004. Molecular Motors. Proceedings IEEE International Conference on Robotics and Biominetics (ROBIO), Shenyang, China.

R. Pooran, M. Al-Fandi, S. Tung, **J.-W. Kim**, and **J.S. Lee**. 2004. Bacterial Flagellar Motors as Microfluidic Actuators. Proceedings of ASME International Mechanical Engineering Congress and R&D Expo (IMECE), Anaheim, CA.

Kulkarni, S. S., and **S. G. Bajwa.** 2004. Spatial modeling of soil compaction with geographically weighted regression. In: Proc. of ASPRS Annual Fall conference, Sept 12-16, Kansas City, MO.

Liu, Y.D., Y.B. Ying, J.P. Wang, X.P. Fu, and **Y. Li**. 2005. Fourier transform near-infrared determination of total soluble solids and available acid in intact peaches. Transactions of the ASAE 48(1) (accepted November 15, 2004).

Yang, L., and **Y. Li**. 2004. AFM and impedance spectroscopy characterization of the immobilization of antibodies on indium-tin oxide electrodes and their capture of *E. coli O157:H7*. Biosensors & Bioelectronics 20(7):1407-1416.

Matlock M., K. Kasprzak, and **S. Osborn**. 2004. Discussion of Potential sediment oxygen demand in the Arroyo Colorado River in South Texas. Journal of the American Water Resources Association. 40(1):266.

Neil,l W. H., E. L. Oborny Jr., S. R. Craig, **M. D. Matlock** and D. M. Gatlin III. 2003. Estimating Metabolism of Fish in Aquacultural Production Systems. International Journal of Recirculating Aquaculture. 4:25-32. (notified of printing in 2004).

Matlock, M.D., Kasprzak, K.R., and **G.S. Osborn**. 2004. Reply to Discussion – "Sediment Oxygen Demand in the Arroyo Colorado River". J. Am. Water Resources Assoc., 40(1):266.

Aboukinane, C, R.E. Lacey, **G.S. Osborn**. 2004. Evaluation of the sensitivity of an electronic nose to headspace humidity. CIGR Journal of Scientific Research.

Su, X.L., and **Y. Li**. 2004. A self-assembled monolayer-based piezoelectric immunosensor for rapid detection of Escherichia coli O157:H7. Biosensors & Bioelectronics 19(6):563-574.

Su, X.L. and **Y. Li**. 2004. Quantum dot and magnetic bead based immunosensor for rapid detection of Escherichia coli O157:H7. Analytical Chemistry 76(16):4086-4810.

Su, X.L. and **Y. Li**. 2004. Surface plasmon resonance and quartz crystal microbalance immunosensors for detection of Escherichia coli O157:H7. Transactions of the ASAE (submitted March 1, 2004, revised July 30, 2004, accepted October 27, 2004).

K.L. White, B.E. Haggard, M.D. Matlock, and **J.-W. Kim**. 2004. Periphytic chlorophyll-A response to triclosan exposure: application of a passive diffusion periphytometer. Appl. Eng. Ag.

Yang, L., Y. Li, C.L. Griffis and M.G. Johnson. 2004. Interdigitated microelectrode (IME) impedance sensor for the detection of viable *Salmonella Typhimurium*. Biosensors & Bioelectronics 19(10):1139-1147.

Yang, L., Y. Li, and G. Erf. 2004. Interdigitated array microelectrode-based electrochemical impedance immunosensor for detection of Escherichia coli O157:H7. Analytical Chemistry 76(4):1107-1113.