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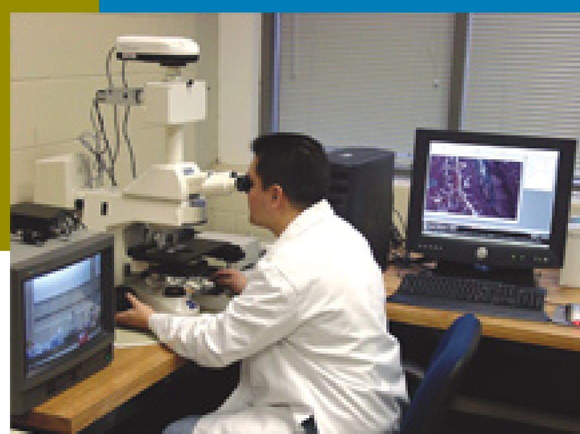
DIVISION OF AGRICULTURE

2006 Annual Report

Department of Biological & Agricultural Engineering

BIOMEDICAL ENGINEERING

ECOLOGICAL ENGINEERING



BIOTECHNOLOGY ENGINEERING

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2006 Annual Report

Department of Biological and Agricultural Engineering

Lalit R. Verma, Head

Arkansas Agricultural Experiment Station

Mark J. Cochran, Associate Vice President for Agriculture-Research

Cooperative Extension Service

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

University of Arkansas Division of Agriculture

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Gregory J. Weidemann, Dean

College of Engineering

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University of Arkansas

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

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FOREWORD

This annual report describes the outstanding accomplishments of the Department of Biological and Agricultural Engineering in 2006.

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 the department experienced growth in teaching, research, and service. With the addition of the Biomedical Engineering master's degree in 2004, our graduate program increased to more than 37 students. The freshmen class also had a record enrollment and our total undergraduates were 116 students. Approximately 51% of our undergraduates were also enrolled in the Honor's College and 33% of our students were females.

Our research and extension programs continued in Biomedical, Biotechnology, and Ecological Engineering. We have 14 faculty members, with three located in the Cooperative Extension Service State office in Little Rock. Our faculty are striving to increase funding from outside sources and have earned grants from the U.S. Department of Agriculture, Environmental Protection Agency, National Science Foundation, National Institute of Health, and the American Heart Association. The expenditures from external grant funding in 2006 was over two million dollars.Our total departmental expenditures totaled over four million dollars.

Our faculty and students have made significant accomplishments in 2006 such as obtaining the John Imhoff Research Award, Planning Design Honor Award from the American Society of Landscape Architects, and Education Honor Award from the American Institute of Architects as well as placing first and second in the 2006 ASABE Gunlogson National Student Design Competition.

We are also proud to announce the induction of three new Academy members, Phil Tacker, Richard Penn, and Robert Chatman.

It is great to have excellent 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

Biological and Agricultural Engineering seniors Adam Jokerst, Britt Hill, Leslie Bartsch and Jennifer Raible were part of a design team that was recognized this year with three national awards: Sustainable Development from the Environmental Design Research Association, Planning and Design Honor Award from the American Society of Landscape Architects (ASLA) for Habitat Trails and Education Honor Award of the American Institute of Architects, with the UA Community Design Center, for Habitat Trails Low Impact Development Design.

First Place, 2006 ASABE Gunlogson National Student Design Competition, "Design of an Enteral Feeding Vest", Senior students: Chase Darr, Andy Reister, Sterling Powers, Faculty Mentor: Thomas A. Costello, presented at the ASABE International Meeting, Portland, Oregon, July 8-13, 2006.

Second Place, 2006 ASABE Gunlogson National Student Design Competition, "Design of a Wireless Heat Stress Monitor for Football Players", Senior students: Matt Graham, John Leach, James McCarty Faculty Mentor: Thomas A. Costello, presented at the ASABE International Meeting, Portland, Oregon, July 8-13, 2006.

Matlock, M. D. 2006. Conducted a Nutrient Criteria National Watershed Management Workshop, Fayetteville, AR, April 2006, in conjunction with the AWRC Annual Meeting. Chair, AWRA Session – Decision Support Systems. AWRA Specialty Conference, Montana, 2006. Keynote Speaker, Low Impact Development Workshop, WRI, Fayetteville, AR August 2006. Invited Keynote Speaker, Arkansas Institute of Architecture Annual Meeting, Hot Springs, AR, November 2006.

Dr. Kaiming Ye made a presentation at ACS annual meeting Stem Cell Engineering Section, 2006.

Varshney, M. and Li, Y. 2006. Impedance biosensing method based on interdigitated array microelectrode coupled with magnetic nanoparticle-antibody conjugates for detection of scherichia coli O157:H7 in ground beef. Presented at IFT 2006 Annual Meeting, June 24-28, 2006, Orlando, FL. Honorary mention (Finalist) of the Student Oral Presentation Competition.

Varshney, M., and Li, Y. 2006. Impedance biosensor based on interdigitated microelectrode coupled with magnetic nanoparticle-antibody conjugates for detection of Escherichia coli O157:H7. Presented at Food Safety Consortium 2006 Annual Meeting, October 1-3, Fayetteville, AR. Abstract in CD of Food Safety Consortium 2006 Symposium. This was awarded the winner for the First Prize of the Graduate Students Poster Contest.

Ye, Z., Li, L., Ying, Y., Su, X., and Sun, Q. 2006. Design, construction and evaluation of a portable biosensor for rapid detection of E. coli O157:H7. Presented at ASABE 2006 Annual Meeting, July 9-12, 2006, Portland, OR. ASABE Paper No. 067121.

Fei Liu, M.S. Student, won the second prize ($75) of the 2006 Student Research Presentation Poster Competition (M.S.) sponsored by the Arkansas Chapter of Gamma Sigma Delta, February 28, 2006, Fayetteville, AR. Her presentation title is "Nanoparticles based QCM immunosensor for detection of E. coli O157:H7."

Madhukar Varshney, Ph.D. Student, won the third prize ($50) of the 2006 Student Research Poster Presentation Competition (Ph.D.) sponsored by the Arkansas Chapter of Gamma Sigma Delta, February 28, 2006, Fayetteville, AR. His presentation title is "Impedance biosensing method based on interdigitated array microelectrode coupled with magnetic nanoparticles-antibody conjugates for detection of E. coli O157:H7 in ground beef."

Fei Liu, M.S. Student, won the second place award ($125) of the 2006 AOC (Association of Overseas Chinese Agricultural, Food and Biological Engineers) Student Paper Competition, July 12, 2006, Portland, OR. Her presentation title is "Detection of E. coli O157:H7 using QCM immunosensor with nanoparticle amplification" (ASABE Paper No. 067119).

Abani Pradhan, Ph.D. student, won the Student Merit Award ($500) of the Society for Risk Analysis 2006 Annual Meeting, December 3-6, 2006, Baltimore, MD. His poster title is "Exposure assessment simulation for microbial behavior of Salmonella during poultry processing."

Madhukar Varshney, Ph.D. Student, won the first place ($250) of the Graduate Student Poster Competition in the Food Safety Consortium 2006 Annual Meeting, October 1-3, 2006, Fayetteville, AR. His presentation title is "Impedance biosensor based on interdigitated microelectrode coupled with nanoparticle-antibody conjugates for rapid detection of E. coli O157:H7."

Fei Liu, M.S. Student, won the third place ($100) of the Graduate Student Poster Competition in the Food Safety Consortium 2006 Annual Meeting, October 1-3, 2006, Fayetteville, AR. Her presentation title is "Detection of E. coli O157:H7 using QCM immunosensor with nanoparticle amplification."

SIGNIFICANT ACCOMPLISHMENTS IN 2006

Yanbin Li was honored with the 2006 John Imhoff Outstanding Research Award, College of Engineering, University of Arkansas.

Xiaoli Su and Yanbin Li won the 2006 ASABE Superior Paper Award, American Society of Agricultural and Biological Engineers.

Yanbin Li visited China Agricultural University, South China Agricultural University, Shengyang Agricultural University, and Zhejiang Agricultural University during his trip to China, September 14 to 29, 2006. He also made short visits to China Academy of Science –Automation Institute in Shengyang, China Academy of Science – Information Technology Institute in Beijing, and Chinese Academy of Inspection and Quarantine in Beijing. The purpose of his trip was to initiate collaboration with Chinese scientists in research on biosensors for rapid detection of avian influenza.

Yanbin Li was a visiting professor position at China Agricultural University, Beijing, China, from September 22, 2006.

Yanbin Li began and continues to serve as the editor for Biological Engineering, a new journal to be published by ASABE.

Kaiming Ye was selected as one of the panel members for NIH/NIEHS U01 proposals. U01 uses a large-size funding mechanism, ranging from $2 million to $5 million.

Dr. Indrajeet Chaubey presented an invited seminar on Modeling approaches to evaluate watershed and water quality processes at the Upper White River Water Quality Conference. Branson, MO. April 6, 2006.

Su, X., Sun, Q., Ye, Z., and Li, Y. 2006. A prototype capillary biosensor for food borne pathogens detection. Presented at PITTCON 2006 Annual Meeting, March 12 – 17, Orlando, FL. Poster # 2140-6P.

Yanbin Li visited IBM Hawthorne Research Laboratory, April 7, 2006, Hawthorne, NY, and gave an invited presentation titled" Biosensors for rapid screening of avian influenza viruses H5:N1."

Vibhava V., Bajwa, S. G. and Chaubey, I. 2006. Spatially distributed hydrological modeling using SWAT and artificial neural networks. ASPRS Central Regions Spring Technical Meeting, April. 20, 2006. Fayetteville, AR.

Dr. Kaiming Ye was selected to be on the Editorial Board of the "Recent Patents on Anticancer Drug Discovery."

Dr. Carl Griffis was nominated for membership and inducted into the Golden Key Honor Society as an Honorary Member.

Departmental Faculty

Sreekala Bajwa, *Associate 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, *Associate 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, *P.E., 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, *P.E., Professor, Associate Head Extension*
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.

Brian E. Haggard, *Associate Professor*
B.S., 1994, University of Missouri–Rolla; M.S., 1997, University of Arkansas; Ph.D., 2000, Oklahoma State University. Ecological engineering including the evaluation of nitrogen, phosphorus, carbon and antibiotics transport and transformation through aquatic systems, the sorption and release of dissolved phosphorus to or from soils and sediments, the determination of factors limiting the growth of periphyton and phytoplankton in streams and reservoirs, and the use of aquatic and terrestrial ecosystems to provide wastewater treatment and nutrient retention.

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, *Associate 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, *P.E., 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

Faculty

products.

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

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

G. Scott Osborn, *P.E., Associate 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, *P.E., 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, *P.E., Professor and Department Head, ASABE 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., 1985, M.S., 1988, Ph.D., 1991, 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.*

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.*

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

Vijay Varadan, *(Ph.D., Northwestern University) Distinguished Professor, HiDEC Director, Graduate Research Chair in Microelectronics and Nigh Density Electronics, Electrical Engineering, University of Arkansas.*

Jim Wimberly *(M.S., 1982, Louisiana State University) Assistant Professor, Organic Resources Management.*

Professional and Academic Staff

Julian Abram, Lab Coordinator

Brandon Beard, Research Specialist I

Eric Cummings, Research Specialist I

Chasity Miller, Extension Administrative Office Supervisor

Paul DeLaune, Post Doctoral Associate

Margaret Gitau, Program Associate

Virginia Glass, Accountant

Betty Martin, Program Tech I

John Murdoch, Program Tech II

Linda Pate, Departmental Administrative Manager

Brian Schaffer, Research Specialist I

Lee Schrader, Research Assistant I

Sara Seabolt, Administrative Secretary

Gurpal Singh-Toor, Program Associate

Wayne Smith, Extension Associate

Katie Vaughn, Program Tech I

Stephanie Williamson, Research Specialist

Jackquelyn Anderson-O'Donnell, Secretary

Ronghui Wang, Post Doctoral Associate

Kentu Lassiter, Program Associate

Faculty and Staff Honors and Awards

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

E. D. Vories, Phil Tacker and R. Hogan were recognized with a 2006 ASABE Superior Paper Award at the Annual International Meeting Awards Luncheon on July 12, 2006 in Portland, OR. This award was made to the top 2.5% of the papers published by ASABE in 2005.

Otto J. Loewer, Director and Professor, University of Arkansas Economic Development Institute (UAEDI) was invited by Zhejiang University (China) to address the 100th Young Scientist Forum on Oct. 31 and students at the School of Biosystems Engineering and Food Science on Nov. 2. His topic was "The Future of Agricultural and Biological Engineering ... and Why." Loewer is currently serving as the immediate past president of the American Society of Agricultural and Biological Engineers, an international engineering society with a membership of nearly 9,000 in over 100 countries. Zhejiang University is located in Hangzhou and is the third ranked university in China.

Kaiming Ye spoke at the ACS annual meeting in the Stem Cell Engineering Section, 2006.

Sreekala Bajwa and Jack Bourne won an undergraduate research award from Teaching Academy for the research paper titled 'Evaluation of rice hull as a lingo-cellulosic substitute in wood plastic composites'.

Marty Matlock was recognized as "Outstanding Mentor" for integrated teaching/research to the 2006 Fall Convocation of Freshmen, representing the College of Engineering, and Bumpers College of Agriculture, Food and Life Sciences.

Yanbin Li was recognized with the John Imhoff "Outstanding Research Award", College of Engineering, University of Arkansas. He also received the ASABE Superior Paper Award of the American Society of Agricultural and Biological Engineers

Carl Griffis and Juhi Srivastava completed the prototype of a non-destructive inspection system for disease and insect damage in rough rice. The prototype will be delivered to the Rice Physiologist in Stuttgart as soon as final testing is complete.

Indrajeet Chaubey received the ASABE Outstanding Engineer Award as well as being recognized with the Faculty Research Award of Merit by Gamma Sigma Delta.

Advisory Board

2006-2007 Members

Stan Andrews, Renfroe Engineering
Thomas Badger, UAMS
Virendra Bhumbla, Tyson Foods Inc.
David Beasley, North Carolina State University
Dennis Carman, Retired USDA/NRCS
Lawrence 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, ANRCC

Academic Advisory Committee

2006-2007 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
Richard Penn, City of Bryant
Chris Pixley, UA Graduate Student
Jennifer Raible, UA 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)
David Beasley, B.S. (71), M.S. (73), Ph.D. (77)
Billy B. Bryan, B.S. (50)
Wesley F. Buchele, M.S. (51)
Dennis K. Carman, B.S. (73)
Robert Chatman, B.S. (71)
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, B.S. (63), M.S. (65), Ph.D. (68)
Floyd R. Gunsaulis, B.S. (88), M.S. (90)
Darrell Holmes, B.S. (81)
John P. Hoskyn, B.S. (60), M.S. (64)
Michael D. Jones, B.S. (67), M.S. (68)
John L. Langston, B.S. (71), M.S. (73)
Otto J. Loewer, B.S. (68), M.S. (70), Ph.D. (73)
Jeffery D. Madden, B.S. (88)
Ralph A. Mashburn, B.S. (58)
Stanley A. Mathis, B.S. (84)
Robert W. Newell, B.S. (54)
Richard Penn, B.S. (82), M.S. (92)
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)
Terry Siebenmorgen, B.S. (79), M.S. (81), Ph.D. (84)
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, B.S. (59)
Phil Tacker, B.S. (79), M.S. (82)
Paul N. Walker, B.S. (70), M.S. (71), Ph.D. (74)
Bruce E. Westerman, B.S. (90)
Robert W. White, B.S. (72), M.S. (76)
J. Randy Young, B.S. (71), M.S. (75)

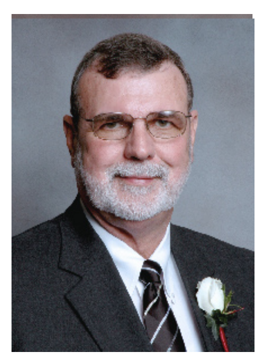
Honorary Members

Albert H. Miller, B.S. (55), M.S. (57) *Posthumously*
Harold S. Stanton, B.S. (50), M.S. (53)
H. Franklin Waters, B.S. (55) *Posthumously*

2006 Inductees


Phil Tacker


Richard Penn


Robert Chatman

DEPARTMENTAL RESOURCES

Facilities

Old Main is located on the University of Arkansas Campus.

The City of Fayetteville

- Recognized by *Forbes Magazine for* #7 Overall Best Metro Places for Business and Careers
- Fayetteville was recognized by *Sperling's Best Places* for our recent job growth of 6.6%, future job growth 30.46% and overall cost of living 88.2.
- Northwest Arkansas is home to some of the Giants in the nation, such as Wal-Mart, Tyson, J.B. Hunt, Proctor & Gamble and Superior Industries.
- Fayetteville enjoys four (4) distinct seasons, with no extremes of hot or cold weather. The average temperature is 44.9 degrees Fahrenheit in January and 92.6 degrees Fahrenheit in August. The average annual precipitation is 45.8 inches of rain and eight (8) inches of snow.
- *Newsweek* ranked Fayetteville HS in the top 4% of U.S. high schools, based on the number and outcome of advance placement exams.

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 as well as the Engineering Research Center located south of campus.
- The department has laboratory facilities for thermal processing, food safety, bio processing, machine vision, remote sensing and GIS, precision agriculture, ecological engineering, hydrologic modeling, biosensors and bioinstrumentation, biomedical engineering, and water quality. Food Safety and antimicrobial Technologies Labs are located in the Center of Excellence for Poultry Science; Computational Biology Lab; Stem Cell Engineering and singel Molecule Imaging; and nano-bioengineering Laboratories are located at the Engineering Research Center.

University of Arkansas

- The University of Arkansas is ranked as one of America's 100 Best College Buys and *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.

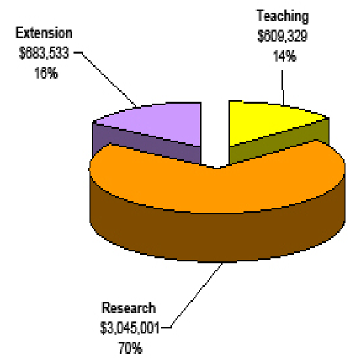
The Fayetteville Square

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

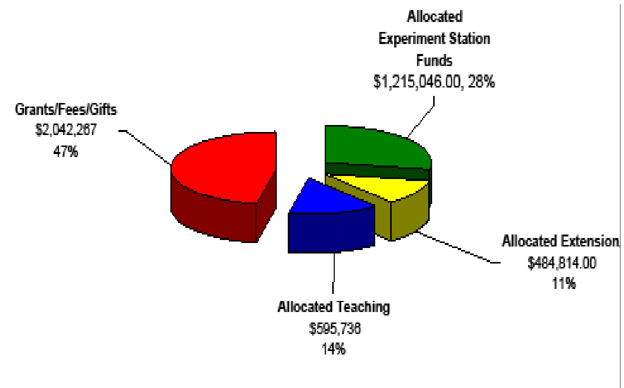
Financial

Total Expenditures, July 1, 2006 to June 30, 2007 - $4,337,863

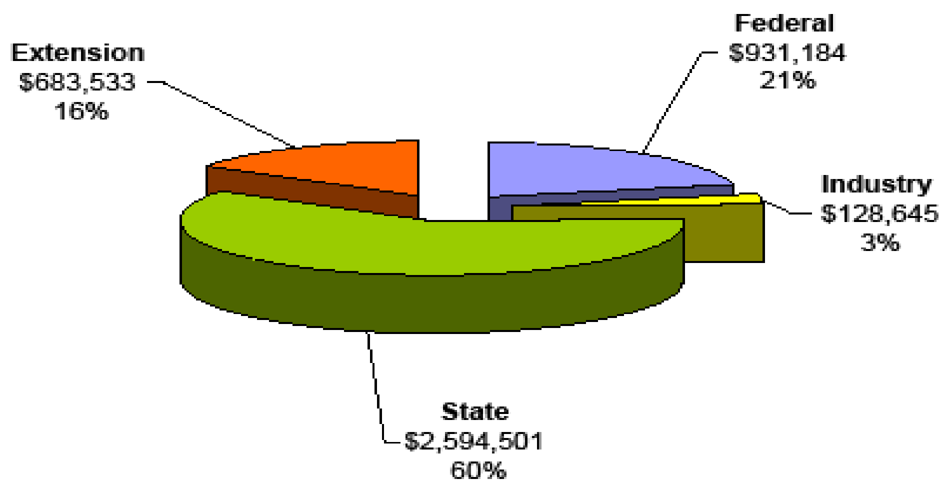
Expenditures by Program Area



Sources: Allocated vs. Grants/Fees/Gifts

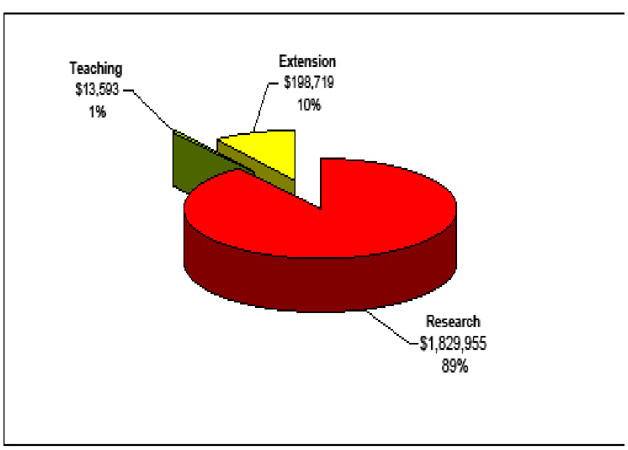


Sources of All Funds

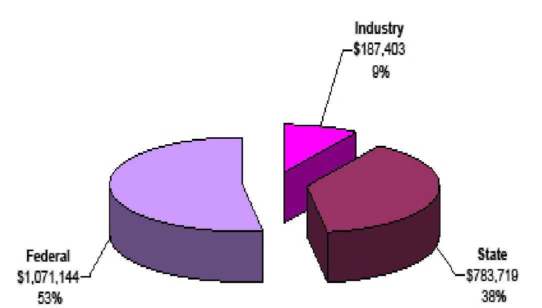


Grants/Fees/Gifts - $2,042,267

Expenditures by Program Area



Sources: Grants/Fees/Gifts



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, plant, animal, 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 biotechnology engineering; secure a healthy and safe environment through ecological engineering. A bachelor of science degree in biological engineering is also excellent preparation for medical school.

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 129 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 (plant, animal, human, microbial, and ecosystem) with demonstrated proficiency in basic professional and personal skills and;

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 Technical Emphasis

The three areas of technical emphasis in biological engineering are as follows:

Biomedical Engineering – nanomedicine, tissue engineering, organ regeneration and its clinical application, bioinstrumentation, biosensing/medical imaging, medical electronics, physiological modeling, biomechanics, and rehabilitation engineering. This area is excellent preparation for medical, veterinary or dental school as well as for graduate programs in biomedical engineering.

Biotechnology Engineering – biotechnology at the micro- and nano-scale, food processing, food safety and security, developing new products from biomaterials, and biotransformation to synthesize industrial and pharmaceutical products.

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 and wastewater treatment design, ecological services management, urban greenway design and enclosed ecosystem design.

Each student is required to complete 15 semester hours of approved electives in his or her area of concentration. Six hours must be from the biological engineering design elective courses (listed below) from a single area of concentration. The remaining nine 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 selected technical electives must include at least three hours of upper-level engineering courses, either within BENG or from other engineering departments. The department maintains a list of approved electives.

The recommended elective courses for each area of technical emphasis are listed beginning on page 19.

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

or contact:

Biological and Agricultural Engineering

Phone: 479-575-2351

Bachelor of Biological Engineering Graduates of 2006

Leslie Bartsch
Charles Darr
James Matt Graham
Joseph B. Hill
Adam Jokerst
Allison Kroeter
John Leach
James McCarty
Colt McClain
Drake McGruder
Katherine Merriman
Jason Millett
Leslie Mooney

Biological and Agricultural Engineering Scholarships

J.A. Riggs Tractor Scholarship
Michael May
Jonathan Watson

Staplcotn Scholarship
Cristina Sattterfield

Xzin McNeal
Nupura Bhise, Eric Ellis, Benjamin Holden, Jennifer Jannings, Nathan McAlister, Heather Sandefur, Linda Tarantino

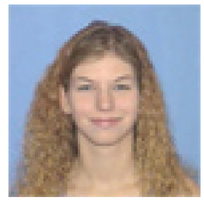
Departmental Scholarship: Charles Jones, Jennifer Jannings, Nelia Sandoval, Russell Tate, Tanushree Thote

Academy Scholarship:
Nupura Bhise
Cristina Satterfield

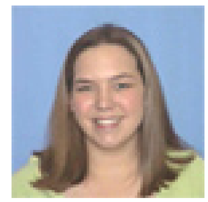
Biological Engineering Student Club

Officers for 2006-2007

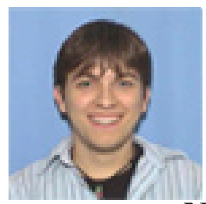
President: Nupura Bhise



Vice President: Toni Peacock



Secretary: Sarah Huber



Treasurer: Nathan Helms

New Alpha Epsilon Inductees and Officers Officers for 2006-2007

Pradbhakar Deonikar, Treasurer
V. Venkatakrishnan, President
Leslie Bartsch, Secretary
Thomas F. Garrison, Vice President
Sunny Wallace, Past President.

Seated: Dr. Sreekala Bajwa and Dr. Thomas Costello.

From (L to R) standing:

Biological Engineering Curriculum - 129 Credits

Freshman

Fall Semester		*Spring Semester*	
GNEG 1103 - Introduction to Engineering	3	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
U. S. History Requirement	3	MATH 2564 - Calculus II	4
		BIOL 1543 - Principles of Biology	3
		BIOL 1541L - Principles of Biology Lab	1
Total Semester Hours	**16**	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 2074 - University Physics II	4
MATH 2574 - Calculus III	4	BLEG 2103 - Electronic Circuits	3
MBIO 2013 - General Microbiology*	3	CHEG 2313 - Thermodynamics of Single Component Sys.	3
MBIO 2011L - General Microbiology Lab	1	CHEM 2613 - Organic Physiological Chemistry*	
MEEG 2003 - Statics	3	CHEM 2611L - Organic Physiological Chemistry Lab	3
			1
Total Semester Hours	**17**		**16**

Junior

BENG 3712 - Engr Properties of Biol Materials	2	BENG 3723 - Unit Operations in Biological Engr	3
MEEG 3013 - Mechanics of Materials	3	BENG 3803 - Mechanical Design in Biological Engr	3
CVEG 3213 - Hydraulic, or		BENG 4103 - Instrumentation in Biological Engr	3
MEEG 3503 - Mechanics of Fluids, or	3	BENG - Design Elective	3
CHEG 2133 - Fluid Mechanics	3	Humanities/Social Studies Elective	3
CHEM 3813 - Intro. to Biochemistry	3		
MATH - 3404 Differential Equations	4		
Technical Elective	**3**		
Total Semester Hours	**18**	Total Semester Hours	**15**

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	3
		Technical (Engineering) Elective	3
Total Semester Hours	**15**	Total Semester Hours	**14**

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

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

Areas of Technical Emphasis

The three areas of technical emphasis in biological engineering are as follows:

- **Biomedical Engineering**
- **Biotechnology Engineering**
- **Ecological Engineering**

The areas of technical emphasis and the recommended elective courses for each follow.

Biomedical Engineering

Design Electives:
BENG 3213 Biomedical Engineering: Emerging Methods and Applications*
BENG 4203 Biomedical Engineering Principles*

Technical Electives:
BIOL 2533/2531L Cell Biology
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
BENG 451VH, Honors Thesis
BIOL 4233 Microbial Genetics
KINS 3353 Mechanics of Human Movement
ELEG 2903 Digital Systems
HESC 3204 Nutrition

Biotechnology Engineering

Design Electives:
BENG 4703 Biotechnology Engineering
BENG 4623 Biological Reactor Systems Design

Technical Electives:
BENG 4113 Risk Analysis for Biological Systems
BENG 4123 Biosensors and Bioinstrumentation
BENG 451VH Honors Thesis
FDSC 4304 Food Chemistry
FDSC 4124 Food Microbiology
FDSC 3103 Principles of Food Proc.
BIOL 4233 Microbial Genetics
BIOL 4313 Physiology of Microorganisms
CHEM 3453/3451L Elements of Physical Chemistry
MEEG 4413 Heat Transfer
CHEG 3153 Non-equilibrium Mass Transfer
CHEG 4423 Auto. Process Control
HESC 3204 Nutrition

Ecological Engineering

Design Electives:
BENG 4903 Ecological Engineering Principles*
BENG 4923 Ecological Engineering Design

Technical Electives:
BENG 4113 Risk Analysis for Biological Systems
BENG 4403 Enclosed Ecosystems Design
BENG 4623 Biological Reactor Systems Design
BENG 4803 Precision Agriculture
BENG 4123 Digital Remote Sensing and GIS
BENG 451VH, Honors Thesis
BIOL 3863/3861L General Ecology
CVEG 3243 Environmental Engineering
CVEG 4243 Environmental Engineering Design
CSES 2203 Soil Science
CSES 4043 Environmental Impact and Fate of Pesticides
GEOG 4543 Geographic Information Systems
ENSC 4034 Analysis of Environmental Contaminants

*Elective strongly recommended by the faculty in a particular area of emphasis.

The list contains 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.

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.

Graduate Programs

Foreword

The Department desires that each graduate student receives a broad and comprehensive educational experience. This experience includes social as well as intellectual development to lead students to an increased level of maturity. Certainly, coursework 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.

An additional part of this development process occurs through service to others. 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 lies in obtaining technical expertise in an area of specialization. Specifically, the objectives of the Master's and PhD engineering graduate program are for 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, graduate students will combine biological or biomedical engineering courses with other engineering fields, the physical sciences, mathematics, statistics and the biological sciences in developing their program of study. The advanced degrees are primarily research degrees awarded for significant creative research or design accomplishment, and not for the completion of a specified number of courses. Therefore, a student's program concentration is on a significant thesis or dissertation problem completed under the supervision of members of the graduate faculty. This complements a program of strong course support to properly address the thesis or dissertation problem.

Admission Requirements

Master of Science in Biological Engineering or 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 admitted 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 or Biomedical 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 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:

1. Either passing all deficiency courses (listed above under Master of Science in Biological Engineering)

2. Or upon approval by the Departmental Graduate Committee, after passing a qualifying examination constructed and 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 BS degree in Engineering or the equivalent.

Graduate Students in Biological and Agricultural Engineering (2006)

Student	Degree	Advisor	Student	Degree	Advisor
Prahlad Jat	BENGMS	G Scott Osborn	Zhihui Liu	BENGPH	Yanbin Li
Thomas F. Garrison	BENGMS	Jin-Woo Kim	John Leach	BMENMS	Kaiming Ye
Sathya Ravindranath	BENGMS	Julie Carrier	Jared Garrett	BMENMS	Kaiming Ye
Nirmal Uppugundla	BENGMS	Julie Carrier	Sunil S Potdar	BMENMS	Mahendra Kavdia
Ray Avery	BENGMS	Brian Haggard	Miriam A. Defibaugh	BMENMS	Mahendra Kavdia
Juhi Srivastava	BENGMS	Carl Griffis	Pratyush, Rai	BMENMS	V. J. Vardan
Haritha Gadiraju	BENGMS	Sreekala Bajwa	Siddhant Ramaswamy	BMENMS	Yanbin Li
William Dillahunty	BENGMS	Tom Costello	InokaWijesekera	CEMBMS	Jin-Woo Kim
Nitin Singh	BENGMS	Indrajeet Chaubey	Damira Kanyeva	CEMBMS	Yanbin Li
Yun Wang	BENGMS	Yanbin Li	Vashuda Ramachandran	BMENMS	V. J. Vardan
Jithesh Veetil	BENGPH	Kaiming Ye	Venkata Kolipaka	BMENMS	Mahendra Kavdia
Xinxin Wu	BENGPH	Kaiming Ye	Vicky Zeledon	ENEGMS	G. Scott Osborn
Sunny Wallace	BENGPH	Julie Carrier	Josh Giovannetti	ENEGMS	Brian Haggard
Prabhakar Deonikar	BENGPH	Mahendra Kavdia	Leslie Bartsch	ENEGMS	Brian Haggard
Nisha Lakshman	BENGPH	Mahendra Kavdia	Fei Liu	BENGMS	Yanbin Li
Mansour Leh	BENGPH	Sreekala Bajwa	Kyle Kruger	ENEGMS	Marty Matlock
Subodh Kulkarni	BENGPH	Sreekala Bajwa	Eylem Mutlu	BENGPH	Indrajeet Chaubey
Ju Seok Lee	BENGPH	Jin-Woo Kim	Prabhaker Bharatan	MicroEpMS	Mahendra Kavdia
Nalini K. Kotagirli	BENGPH	Jin-Woo Kim	Robert Morgan	BENGPH	Marty Matlock
Dilshika Wijesekera	BENGPH	Jin-Woo Kim	Chetan Maringanti	BENGMS	Indrajeet Chaubey
Jeonghwan Kim	BENGPH	Jin-Woo Kim	John Judkins	BMENMS	Jin-Woo Kim
John Judkins	BMENMS	Jin-Woo Kim	Venkatsubramaniam Venkatakrishman	BMENMS	Mahandra Kavadia

Degrees Earned

Student	Degree	Advisor	Thesis/Dissertation Title
Abani Pradhan	Ph. D.	Dr. Yanbin Li	Quantitative Risk Assessment of Foodborne Pathogens in Poultry Production and Processing Based on Microbial Challenging Tests and Predictive Models
Madhukur Varshney	Ph. D.	Dr. Yanbin Li	Immunomagentic Particles and Michrofluidics Based Biosensors for Rapid Detection of Food borne Pathogenic Bacteria
Fei Liu	M.S.	Dr. Yanbin Li	QCM Immumosensor with Nanoparticle Amplification for Detection of Escherichia Coli 0157:H7
Vibhava Vibhava	M.S.	Dr. Sreekala Bajwa	Pesticide Pollution Risk Assessment in the L'Anguille River Watershed
Eylem Mutlu	Ph. D.	Dr. Indrajeet Chaubey	Development of Artificial Neural Network Models for Hydrologic Prediction in an Agricultural Watershed
Richa Srivastava	Ph. D.	Dr. Indrajeet Chaubey	Comparison of the Hydrology and Sediment Modeling Components of SWAT and AnnAGNPS Models
Mansour Leh	M.S.	Dr. Indrajeet Chaubey	Quantification of Raninfall-Runoff Mechanisms in a Pasture Dominated Watershed
Andrea Ludwig	M.S.	Dr. Marty Matlock	Periphtic Algae Nutrient Limitation in Streams Draining the Beaver Reservoir Basin, Northwest Arkansas, USA, 2005-2006
Monica Kohler	M.S.	Dr. Marty Matlock	Trophic Conditions and Nutrient Limitations in the Headwaters of Beaver Lake, Arkansas, During a Dry Hydrologic Year, 2005-2006
Katherine Page Shurgar	M.S.	Dr. Marty Matlock	Stessor - Response Relationships Between Land scape Features and Benthic Macroinvetebrate Indices using the USePa Wadeable Stream Assessement Program Data.

Students in Other Programs Advised by BAEG Faculty

Graduate Programs

Leslie Bartsch	ENEGMS	Brian Haggard	Environmental Engineering
Ryan Stoner	CSWSMA	Brian Haggard	Crop, Soil & Environmental Sciences
Joshua Giovannettii	ENEGMS	Brian Haggard	Environmental Engineering
David Lyons	ENDYPH	Brian Haggard	Biology
Brie Menjolet	ESWSPH	Brian Haggard	Crop, Soil & Environmental Sciences
Jason Patton	ENDYPH	Brian Haggard	Geology
Irene Rhodes	POSCMS	Carl Griffis	Poultry Science
Xiali Lui	POSCMS	Carl Griffis	Poultry Science
Zhihui Liu	POSCMS	Carl Griffis	Poultry Science
Justin Loveladay	CHEGPH	D. Julie Carrier	Chemical Engineering
Abby Engleworth	CHEGPH	D. Julie Carrier	Chemical Engineering
Jon Zawislak	ENTOMS	D. Julie Carrier	Entomology
Diek Austin	FDSCPH	G. Scott Osborn	Food Science
Chris Harris	CSCEPH	Jin-Woo Kim	Computer Science & Computer Eng.
Jason Clendenin	MEPHPPH	Jin-Woo Kim	Microelectronics-Photonics
Raj Varakala	CHEGPH	Jin-Woo Kim	Chemical Engineering
Jianghong Qian	CSCEPH	Jin-Woo Kim	Computer Science & Computer Eng.
Ryan Haley	CHEGPH	Jin-Woo Kim	Chemical Engineering
Rachelle B. Flack	CEMBPH	Kaiming Ye	Cell and Molecular Biology
Carmen S. Padilla-Marria	CHEMPH	Kaiming Ye	Chemistry and Biochemistry
Laksimi Kanna	FDSCPH	Kaiming Ye	Food Science
Prabhakar Bharatan	MEPHMS	Mahendra Kavdia	Microelectronics-Photonics
Rajaramesh Varakala	CHEGPH	Mahendra Kavdia	Chemical Engineering
Xin Xin	CEMBPH	Mahendra Kavdia	Cell and Molecular Biology
Sarah Lewis	ENDYPH	Marty Matlock	Environmental Dynamics
Leisha Vance	ENDYPH	Marty Matlock	Environmental Dynamics
Ruth Zeledon-Kelly	ENEGMS	Marty Matlock	Environmental Dynamics
Kyle Kruger	ENEGMS	Marty Matlock	Environmental Dynamics
Stephanie Shepherd	ENDYPH	Marty Matlock	Enviornmental Dynamics
Tesuaki Ishibashi	CSESPH	Sreekala Bajwa	Crop, Soil & Evironmental Sciences
Li Bai	ENDYPH	Sreekala Bajwa	Enviornmental Dynamics
Lisa Cooney	FDSCPH	Yanbin Li	Food Science
Min Li	FDSCPH	Yanbin Li	Food Science
Joyce Berger	CSESPH	Yanbin Li	Crop, Soil & Environmental Sciences
Feng Check	CHEMPH	Yanbin Li	Chemistry and Biochemistry
Rebecca Gill	CEMBPH	Yanbin Li	Cell and Molecular Biology
Irene Hanning	POSCPH	Yanbin Li	Poultry Science
Dave Harbour	ELEGPH	Yanbin Li	Electrical Engineering
Yue Ma	CEMBPH	Yanbin Li	Cell and Molecular Biology
Anh Chu	ELEGPH	Yanbin Li	Electrical Engineering
Michelle McDonald	CHEMPH	Yanbin Li	Chemistry and Biochemistry
Balaji Srinvasan	MEEGPH	Yanbin Li	Mechanical Engineering

BENG1012 Biological Engineering Design Fundamentals (Irregular) 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: Lab component.

BENG1022 Biological Engineering Design Studio I (Irregular) 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. Prerequisite: BENG 1012 or GNEG 1103. Corequisite: Lab component.

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

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 bio-energetics 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 or GNED 1103 or equivalent.

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. Prerequisite: BENG 2612.

BENG3213 Biomedical Engineering: Emerging Methods and Applications (Sp) Introductory course for undergraduate biomedical engineering students. Emerging biomedical engineering topics including: tissue engineering, stem cell engineering, biomedical nanotechnology, medical imaging and biosensing, single molecule imaging, biomarker discovery and proteomics, gene therapy, drug delivery, and protein engineering. Design of components for tissue engineering processes, nano drug delivery and nanotechnology based disease detection. Lecture 3 hours per week. Prerequisite: BIOL 2533. Pre or Corequisite: BENG 3723.

BENG3712 Engineering Properties of Biological Materials (Fa) Measuring and predicting the physical, chemical, and biological properties of biological materials necessary for the analysis and design of production and processing systems. Lecture 2 hours per week. Prerequisite: BENG 2622.

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

BENG3733 Transport Phenomena in Biological Systems (Fa) 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 biotechnology, ecological, 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.

BENG3803 Mechanical Design in Biological Engineering (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: Lab component. Prerequisite: MEEG 3013.

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: Lab component. Prerequisite: BENG 2103 or ELEG 2103. (Same as BENG 4103)

Courses

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: Lab component. Prerequisite: BENG 2103 or ELEG 2103. (Same as BENG 4103H)

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

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

BENG4133 Digital Remote Sensing and GIS (Irregular) Basic digital image processing techniques and geo-spatial analysis applied to monitoring of natural processes and resources. Course topics include introduction to electromagnetic radiation, concept of color, remote sensing systems, and light attenuation by atmosphere, objects and sensors. Advanced topics include data models, spectral transforms, spatial transforms, correction and calibration, geo-rectification, and image classification with hyperspectral and multi-spectral images acquired with aerial and satellite sensors. Raster GIS is integrated into the course throughout the semester. Will use software such as ENVI, ArcGIS and ArcView. Lecture 2 hours, lab 3 hours per week. May be repeated.

BENG4203 Biomedical Engineering Principles (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; bioelectric phenomena, physiological modeling, cardiovascular system, biomechanics, computational biology. Requires a background in circuits, fluid dynamics, mechanics, biology, and chemistry. 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, BIOL 1543 or equivalents.

BENG4403 Design of Enclosed Ecosystems (Irregular) Environmental and functional design of buildings, chambers, rooms and habitats to house/exhibit animals and plants. Advanced analytical techniques which incorporate physiological considerations. Psychometrics, solar and alternate energy principles. Design of ventilation, heating and cooling systems and controls. Design considerations include animal behavior, stress and welfare. Lecture 2 hours, lab 3 hours per week. Corequisite: Lab component. Prerequisite: BENG 2622.

BENG450V Special Problems (Sp, Su, Fa) (1-4) Selected problems in biological engineering are pursued in detail. Prerequisite: senior standing. May be repeated for 4 hours.

BENG451VH Honors Thesis (Sp, Su, Fa) (1-6) Prerequisite: Honors candidacy.

BENG452V Special Topics in Biological Engineering (Irregular) (1-6) Special topics in biological engineering not covered in other courses. May be repeated. May be repeated for 8 hours.

BENG4623 Biological Reactor Systems Design (Fa) 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: Lab component. Prerequisite: MATH 3404. Pre or Corequisite: BENG 3733

BENG4703 Biotechnology Engineering (Sp) Introduction to biotechnology topics ranging from molecular biological engineering, bioprocess engineering, biopharmaceutical manufacturing and biosensors to FDA regulations, as well as engineering principles in the design of the systems in the aforementioned topic areas. Lecture 3 hour per week. Prerequisite: BIOL 2013, (Chem 2613 or CHEM 3603) and (MEEG 2403 or CHEG 2313).

BENG4803 Precision Agriculture (Odd years, Fa) Introduction to precision agriculture, benefits, spatial variability within a field, zone concept, and site-specific management. Spatial data collection: sensors, GPS, yield monitoring, and remote sensing. Knowledge discovery from data: data processing, neural networks, genetic algorithms, and use of GIS. Decision support systems. Variable-rate technology: real-time and map-based systems, variable-rate machinery, and smart controls. Evaluation: Yield mapping and economic analysis. Students are expected to have basic computer skills and statistics knowledge. (same as CSES 4803). Corequisite: Lab component. Prerequisite: MATH 1213 and junior standing.

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. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component. Prerequisite: consent of instructor. Prerequisite: BENG 3723. Pre or Corequisite: BENG 3733.

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 Ecological Engineering Principles (Sp) Engineering principles involved in assessment and management of ecosystems. Includes frequency analysis of rainfall, infiltration, runoff, evapotranspiration. Use of GIS/mathematical models to quantify extent of ecological pollution. Design/implementation of best management practices and discussion of Total Maximum Daily Load (TMDL) principles and processes. Lecture 3 hours per week. Prerequisite: CVEG 3213 or MEEG 3503.

BENG4923 Ecological Engineering Design (Fa) Engineering principles involved in assessment and management of nonpoint source (NPS) pollution, effects of NPS pollution on ecosystem integrity, use of GIS/mathematical models to quantify extent of pollution, design/implementation of best management practices, and discussion of Total Maximum Daily Load (TMDL) principles and processes. Lecture 2 hours, laboratory 3 hours per week. Prerequisite: BENG4903.

BENG500V Advanced Topics in Biological Engineering (Irregular) (1-6) Special problems in fundamental and applied research. Prerequisite: graduate standing. May be repeated for 6 hours.

BENG5103 Advanced Instrumentation in Biological Engineering (Even years, Sp) Applications of advanced instrumentation in biological systems. Emphasis on updated sensing and transducing technologies, data acquisition and analytical instruments. Lecture 2 hours, lab 3 hours per week. Corequisite: Lab component. Prerequisite: BENG 4103.

BENG5113 DIGITAL Remote Sensing and GIS (Irregular) Basic digital image processing techniques and geo-spatial analysis applied to monitoring of natural processes and resources. Course topics include introduction to electromagnetic radiation, concept of color, remote sensing systems, and light attenuation by atmosphere, objects and sensors. Advanced topics include data models, spectral transforms, spatial transforms, correction and calibration, geo-rectification, and image classification with hyperspectral and multi-spectral images acquired with aerial and satellite sensors. Raster GIS is integrated into course throughout the semester. Will use software such as ENVI, ArcGIS and ArcView. Requires a class project in the student's area of interest. Lecture 2 hours, lab 3 hours per week. Students may not earn credit for both BENG 5113 and BENG 4133. Corequisite: Lab component. Prerequisite: MATH 3404.

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

BENG5203 Mathematical Modeling of Physiological Systems (Sp) Application of mathematical techniques to physiological systems. The emphasis will be on cellular physiology and cardiovascular system. Cellular physiology topics include models of cellular metabolism, membrane dynamics, membrane potential, excitability, wave propagation and cellular function regulation. Cardiovascular system topics include models of blood cells, oxygen transport, cardiac output, cardiac regulation, and circulation. Background in biology and physiology highly recommended. Lecture 3 hours per week. Prerequisite: MATH 3404.

BENG5213 Introduction to Bioinformatics (Odd years, Sp) Application of algorithmic techniques to the analysis and solution of biological problems. Topics include an introduction to molecular biology and recombinant DNA technology, biological sequence comparison, and phylogenetics, as well as topics of current interest. (Same as CSCE 5213).

BENG5223 Biomedical Engineering Research Internship (Sp, Su, Fa) Minimum six-week program (possibly up to several months) in a medical research environment working on an original engineering research project. Possible specialty areas include Anesthesiology, Cardiology, Informatics, Ophthalmology, Orthopedic Surgery, and Radiology. Prerequisite: graduate standing and approval of coordinator.

BENG5233 Tissue and Cell Engineering (Fa) This course introduces students to biological, engineering and clinical aspects of tissue and cell engineering. The introduction to stem cells and histology are reinforced with a concomitant lab that introduces cell culture techniques and illustrates functional and structural aspects of various biological tissues. Topics include Cell Signaling, Transport and Kinetics, Scaffolds, Surface Interactions, Drug Delivery, and Clinical, Ethical and Regulatory Considerations. Two to three lecture hours per week plus three lab hours per week. Corequisite: lab component. Prerequisite: MATH 3404 and CHEM 3813.

BENG5243 Biomaterials (Sp) a graduate course on molecular structure-property relationships in biomaterials. Special focus is given to polymers, metals, ceramics, composites, and biodegradable materials. The design of artificial biomaterial for biosensors, drug delivery and medical implants is considered. Host response and biocompatibility factors are introduced. Previous course in materials desirable.

BENG5253 Bio-Mems (IR) Topics include the fundamental principles of microfluidics, Navier-Stokes Equation, bio/abio interfacing technology, bio/abio hybrid integration of microfabrication technology, and various biomedical and biological problems that can be addressed with microfabrication technology and the engineering challenges associated with it. Lecture 3 hour per week. Prerequisites: MEEG 3503 or CVEG 3213 or CHEG 2133. (Same as MEEG 5253)

BENG5263 Biomedical Engineering Principles (Fa) Engineering principles applied to the design and analysis of systems affecting human health. This is a course focusing on fundamentals of physiological systems and modeling. Topics include: brief overview of anatomy and physiology, bioelectric phenomena and neuronal model, compartmental modeling, cardiovascular system and blood flow, biomechanics, computational biology and signal transduction. Requires a background in circuits, fluid dynamics, mechanics, biology, and/or biochemistry. Lecture 3 hours per week. Students may not earn credit for both BENG 5263 and BENG 4203. Prerequisites: MATH 3404 or equivalent and graduate standing. May be repeated.

BENG5613 Simulation Modeling of Biological Systems (Irregular) Application of computer modeling and simulation of 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 3333.

BENG5703 Design and Analysis of Experiments for Engineering Research (Irregular) 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. Students must have an introductory background in statistics. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component.

BENG5713 Food Product and Process Development (Odd years, Fa) 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: Lab component. Prerequisite: BENG 4703.

BENG5723 Food Safety Engineering (Even years, Fa) Principles of engineering methods applied to food and safety and sanitation. Principles of engineering methods applied to food safety and security. Discussion of thermal, chemical and 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 Biotechnology Engineering (Odd Years, Fa) 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 and nanobiotechnology in addition to classical applied enzyme and cell-growth kinetics and advanced bioreactor design. Prerequisite: BENG 3733 or CHEG 5531.

BENG5743 Biotechnology Engineering (Sp) Introduction to biotechnology topics ranging from molecular biological engineering, bioprocess engineering, biopharmaceutical manufacturing and biosensors to FDA regulations, as well as engineering principles in the design of the systems in the aforementioned topic areas. Requires background in microbiology, organic chemistry and thermodynamics. Lecture 3 hour per week. Students may not earn credit for both BENG 5743 and BENG 4703

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

BENG5903 Water Quality Modeling and Management (Irregular) 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 (Irregular) 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 (Fa) 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) 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.

BENG5943 Ecological Engineering Principles (Sp) Engineering principles involved in assessment and management of ecosystems. Includes frequency analysis of rainfall, infiltration, runoff, and evapotranspiration. Use of GIS/mathematical models to quantify extent of ecological pollution. Design/implementation of best management practices and discussion of Total Maximum Daily Load (TMDL) principles and processes. Lecture 3 hours per week. Students may not earn credit for both BENG 5943 and BENG 4903. Prerequisites: CVEG or equivalent.

BENG5953 Ecological Engineering Design (Fa) Design of low impact development techniques to enhance ecological services, reduce peak runoff, and capture sediments, nutrients and other pollutants resulting from urban development. Techniques may include: bio-swales, retention basins, filter strips. Design of sustainable ecological processes for the treatment and utilization of wastes/residues. Techniques may include: direct land application to soils/crops, composting systems, lagoons and constructed wetlands. Design goals include optimization of ecological services to maintain designated uses of land, water and air; including enhancement of habitat for wildlife and recreation, and the discovery of economically viable methods for co-existence of urban and agricultural land uses. Lecture 3 hours per week. Students may not earn credit for both BENG 5953 and BENG 4923. Prerequisite:

BENG600V Master's Thesis (Sp, Su, Fa) (1-6) Prerequisite: graduate standing.

BENG700V Doctoral Dissertation (Sp, Su, Fa) (1-18) Prerequisite; Candidacy.

Biomedical Engineering

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

Mahendra Kavdia, Assistant Professor, Biomedical Engineering Program, UAF

Objective:

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:

The dynamic changes in NO and ROS generations in cultured vascular endothelial cells are being quantified. The proposed research involved computational methods to quantify endothelial cell released transport of NO and ROS in the diabetic milieu. A computational model of NO, superoxide and peroxynitrite transport in a tissue containing an arteriolar blood vessel was formulated. 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.

Engineered Bacterial and Yeast Live Avian Flu Vaccine for Peripheral and Mucosal Immunization

Kaiming Ye, Assistant Professor, Biomedical Engineering Program, UAF;

Sha Jin, Research Scientist, The DNA Core Facility, UAF;

Billy Hargis, Professor, Poultry Science Department, UAF;

Kimberly Cole, Research Scientist, Poultry Science Department, UAF;

Xinxin Wu, Graduate Student, Biomedical Engineering Program, UAF

Objective:

Most vaccines today include live or killed viruses, attenuated bacterial, recombinant viruses, etc. In this project, we intend to develop a novel way to manufacture vaccine by displaying viral proteins that trigger body or mucosal immune response onto the surface of bacterial and yeast. Mucosal delivery or injection of these engineered bacterial and yeast will induce a systemic immunity including peripheral and mucosal immune response to protect the body from infection of viruses such as influenza virus or HIV virus. The display of the viral proteins on the surface of bacteria and yeast allows a direct exposure of the proteins to body immune systems, triggering the secretion of antibodies, especially IgA (in mucosal immune response) and IgG (in blood immune response). These antibodies protect our body from virus infection after immunization.

The engineered bacterial and yeast vaccine can be readily delivered through nasal spray, oral ingestion, or injection for the immunization. The mucosal membranes are one of the largest organs of the body. Collectively, they cover a surface area of more than 400 m^2 (equivalent to one and a half tennis courts) and comprise the lining of the gastrointestinal, urogenital and respiratory tracts. Nasal or oral delivery of yeast vaccine will provide mucosal immunization, the first lines of defense to virus infection.

Accomplishments:

Both bacterial and yeast cell surface protein expression systems were established. These systems are now being tested for their capability of displaying the avian flu proteins on the cell surface, followed by animal experiment to verify the capability of live vaccine for peripheral and mucosal immunization in chicken and eventually in human.

Based on these results, an invention disclosure has been filed and a patent filing is under preparation.

Fluorescence Nanosensor for Visualizing Intracellular Glucose within Living Cells

Kaiming Ye, Assistant Professor, Biomedical Engineering Program, UAF;

Xinxin Wu, Graduate Student, Biomedical Engineering Program, UAF;

Jeffrey D. Prichard, Graduate Student, Biomedical Engineering Program, UAF

Objective:

The goal of this project is establish a novel technique to visualize glucose within living cells using a fluorescence nanosensor and demonstrate the utility of this technique in measuring glucose uptake in skeletal muscle cells. Skeletal muscles are major tissues for glucose consumption and account for up to 85% of the whole-body glucose utilization in healthy human. Insulin resistance in the skeletal muscle precedes and contributes to the development of type 2 diabetes and obesity. Impaired insulin-stimulated glucose disposal in the skeletal muscle might result from both genetic factors and acquired components related to diet, exercise, and other lifestyle factors. Thus, the determination of the glucose uptake in skeletal muscle cells is not only critical for quantifying the two initial steps of muscular glucose metabolism: glucose transport and phosphorylation, but it is also an essential factor in our understanding of the development of type 2 diabetes and obesity in insulin-resistant subjects.

To develop a glucose nanosensor, we isolated a glucose binding protein (GBP) from *E. coli* and demonstrated that a FRET (Förster resonance energy transfer) signal transduction function can be directly introduced into GBP for sensing glucose. Recently, from these observations we developed the hypothesis that a class of GIPs can be designed based on mutated GBPs that possess different affinities for glucose, the binding of which can be reported through a change in their fluorescent properties. Furthermore, we hypothesize that the genes of these GIPs can be introduced into cells so that the "fluorescent nanosensors" can be biosynthesized and retained internally for visualizing glucose within living cells through the lifetime FRET microscopy.

Accomplishments:

We engineered a glucose indicator protein (GIP) that is capable of visualizing intracellular glucose. By fusing different fluorescent proteins to each end of a glucose binding protein, we developed a variety of GIPs. For example, to eliminate the effect of pH on the measurement of intracellular glucose with the GIP, we constructed a GIP which consists of a pH insensitive cyan fluorescent protein and a pH insensitive yellow fluorescent protein. Out experiment demonstrated the intracellular glucose concentration can be reliably measured by the engineered GIPs using ratio FRET microscopy. We are now developing a more accurate microscopy technique, which is fluorescence lifetime imaging microscopy to determine the intracellular glucose concentration in mice skeletal muscle cells. These results will be reported in the annual meeting of ACS, March, 2006.

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

Objective:

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

Research in the 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/nanominiature analytical devices capable biomolecular detection. The potential applications include bio/nano-sensing of medical diseases, pathogens, and environmental toxins.

Another area of focus is in the field of BioInspired Micro-Electro-Mechanical System (MEMS). In recent years, micro- and nano-fluidics have aroused considerable interest due to its potential ground breaking impact on a wide range of science and engineering disciplines. In particular, the integration of bio- and abio-systems 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. 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, which 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. Therefore, instead of reinventing the wheel, this 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 Program, UAF;
Prabhakar Deonikar, Graduate Student, Biomedical Engineering Program, UAF;
Nupura Bhise, Undergraduate Student, Biological & Agricultural Engineering, UAF

Objective:
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 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:
Interaction of NO with oxygenated and deoxygenated RBCs was investigated. For this purpose, NO and nitrogen gaseous mixture at known concentration was reacted with well mixed RBC solution. Samples were collected every 5 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, nitrate formation rate was higher in deoxygenated RBCs. The NO –RBC interaction products formation rate were 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

Objective:
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 the laboratory is DNA word design for computation. Conducting research on designing the DNA oligonucleotide building blocks for DNA-based computers and nanotechnology continues.

Using DNA computing, a new methodology for genome-enabled diagnostic systems is also being investigated. 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 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.

Differentiation of Embryonic Stem Cells into Insulin-Producing Cells for Islet Transplantation

Kaiming Ye, Assistant Professor, BAEG, UAF;
Xiuli Wang, Postdoctoral Associate, BAEG, UAF;
John Leach, Graduate Student, BAEG, UAF;
Julie Abbott, Undergraduate Student, BAEG, UAF

Objective:

Islet transplantation is a cure for diabetes, which can significantly improve patients' life quality. However, this promising therapy has been hampered due to the lack of donors. We intend to develop a new technique that can offer a renewable cell source for islet transplantation. Our invention capitalized a 3D culture system developed in our laboratory. This project is also aimed to understand the mechanism lying in the pancreatogenesis in 3D microenvironment during the embryo development.

Accomplishments:

Production of sufficient numbers of pancreatic endocrine cells that function similarly to primary islets is the premise of cell therapies for diabetes. To characterize the differentiation of embryonic stem (ES) cells into insulin-producing cell clusters (ILCCs) in three-dimensional (3D) environments, we cultured mouse ES Cells within collagen scaffolds and four-step differentiation protocol was developed and used to direct a pancreatic lineage-specific differentiation. The cell differentiation was determined by gene or protein-profiling the expression of a variety of islet-specific markers. Our data indicate that ES cells differentiated within 3D scaffolds and embryoid bodies (EBs) formed were similar to those in traditional two-dimensional (2D) cultures; however, unlike 2D differentiation, these EBs appeared embedded in a network of extracellular matrix and their sizes are more uniform. Most significantly, the differentiation of ES cells into IPCC on 3D collagen scaffolds gives rise to cells displaying morphological features, gene expression patterns and functional activities characteristic of islets, which may provide a potential source of differentiated cells for the diabetes treatment.

Yeast-Conjugated Flu Vaccines for Peripheral and Mucosal Immunization

Kaiming Ye, Assistant Professor, BAEG, UAF;
Xinxin Wu, Graduate Student, BAEG, UAF

Objective:

Most vaccines today include live or killed viruses, attenuated bacterial, recombinant viruses, etc. In this project, we intend to develop a novel way to manufacture vaccine by displaying viral proteins that trigger body or mucosal immune response onto the surface of bacterial and yeast. Mucosal delivery or injection of these engineered bacterial and yeast will induce a systemic immunity including peripheral and mucosal immune response to protect the body from infection of viruses such as influenza virus or HIV virus. The display of the viral proteins on the surface of bacteria and yeast allows a direct exposure of the proteins to body immune systems, triggering the secretion of antibodies, especially IgA (in mucosal immune response) and IgG (in blood immune response). These antibodies protect our body from virus infection after immunization.

The engineered bacterial and yeast vaccine can be readily delivered through nasal spray, oral ingestion, or injection for the immunization. The mucosal membranes are one of the largest organs of the body. Collectively, they cover a surface area of more than 400 m2 (equivalent to one and a half tennis courts) and comprise the lining of the gastrointestinal, urogenital and respiratory tracts. Nasal or oral delivery of yeast vaccine will provide mucosal immunization, the first lines of defense to virus infection.

Accomplishments:

Both bacterial and yeast cell surface protein expression systems were established. These systems are now being tested for their capability of displaying the avian flu proteins on the cell surface, followed by animal experiment to verify the capability of live vaccine for peripheral and mucosal immunization in chicken and eventually in human.

Biotechnology 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

Objective:
To develop an electrochemical method to inactivate *Listeria monocytogenes* and aerobic bacteria in chilling brine.

To design and construct the electrochemical treatment chamber and optimize the parameters.

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.

Biocatalysis and Molecular Biological Engineering

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

Objective:
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

Objective:

- To develop immuno-electrochemical and optical biosensing methods based on capillary bioseparator/bioreactors for separation of target bacteria from food samples and enzymatic amplification.
- 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.
- 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, MgCl2 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 ´101 to 5.0 ´106 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´102 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 MgCl2 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

Objective:

The objective of this project is to create a reliable, effective technique for developing fissure-resistant rice varieties. This project will identify and quantify the relationship between important physical and chemical properties of the rice kernel and resistance to field fissuring. The relative importance of the contribution of each physicochemical property to fissure resistance will also be determined. This knowledge of 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:

- Prahlad Jat collected and analyzed data for determining critical fissure resistance parameters in rice. This work will allow him to complete MS degree in early 2007.

- Jat, P. and G.S. Osborn. 2006. Chemical Reaction Kinetics Approach to Model Moisture Adsorption of Rough Rice. 31st Rice Technical Working Group. Annual Meeting, The Woodlands, TX.

Elimination of *Listeria monocytogenes* During Thermal Processing of Ready-To-Eat Poultry Products

Yanbin Li, Professor, Biological & Agricultural Engineering, UAF;
Abani Pradhan, Graduate Student, Biological & Agricultural Engineering, UAF;
John Marcy, Professor and Extension Specialist, Poultry Science, UAF;
Mark Tamplin, Lead Scientist, USDA/ARS ERRC

Objective:
The overall goal of this project is to evaluate the thermal processing conditions in an air-steam impingement oven to eliminate L. monocytogenes from different shapes and sizes of ready-to-eat (RTE) poultry products and provide the poultry processing industry and regulatory agencies with microbial kinetics and risk assessment models for pathogen lethality validation of commercial thermal process.

Accomplishments:
Treatment schedules were designed to achieve the targeted pathogen reduction on various shapes and sizes of RTE poultry products including chicken breasts, wings, nuggets, strips, and the process lethality was evaluated at different time-temperature combinations in an air-steam impingement oven without compromising product quality and yield. A heat/mass transfer model coupled with pathogen kinetics has been developed to predict L. monocytogenes inactivation in RTE poultry products in an air-steam impingement oven as a function of time, temperature, pH and moisture content. A computer simulation software is ready for use on Internet. The predictive model will be further validated for thermal processing of RTE poultry products by conducting tests in commercial poultry processing plants.

This research will help the poultry processing industry in eliminating L. monocytogenes while minimizing the detrimental effect to the product quality. With the optimized temperature-time combination for thermal processing of RTE products, the temperature to destroy L. monocytogenes could be guaranteed while the flavor and weight could be maintained, therefore, the poultry processor would obtain the pathogens-free products with the maximum yield for more profits. The predictive models will be able to assist the poultry processors of RTE poultry products design the cost-effective treatment schedule for complete elimination of L. monocytogenes to ensure food safety and security.

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

Objective:
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:

- To develop impedance immunosensing methods based on interdigitated microelectrodes for microsystem and specific growth medium for differentiation between live and dead cells.
- 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 105-106 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 105 CFU/ml were tD =- 1.38 Log N + 10.01 and tD=-1.57 Log N +11.39

in the pure medium and milk samples, respectively, both with R2= 0.99. The detection times for 4.8 CFU/ml and 5.4 x 105 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 & Agricultural Engineering, UAF;
Ballaji Venkatesh, Graduate Assistant, Mechanical Engineering, UAF

Objective:

- To develop chemiluminescent fiber optic biosensor coupled with immuno-microbeads separation for detection of Escherichia coli O157:H7 and Salmonella Typhimurium in food samples.

- To design and fabricate a prototype biosensor by assembling the components of sample pretreatment, biosensing devices and optical transducer into an automated instrument.

- 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 minutes 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

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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

Objective:

- To develop a PCR-based fluorescent biosensing method for rapid detection of S. Typhymuirum, C. jejuni, E. coli O157:H7 and L. monocytogenes in poultry samples.
- 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;
Katie Vaughn, Research Technician, Biological & Agricultural Engineering, UAF

Objective:

- To study milk thistle and Albizia julibrissin extraction by characterizing the extraction step and by replacing, if possible, organic solvents with water.
- To couple the phytochemical extraction with energy conversion
- To determine if the addition of milk thistle or Albizia julibrissin extracts can minimize electrophoretic mobility ,and chemically and cell mediated low density lipid (LDL) oxidization.

Accomplishments:

In the southeastern U.S., Albizia 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. The hyperoside and quercitrin content in bark, foliage, flowers and whole plant was determined. A. julibrissin biomass. Literature shows that hyperoside can inhibit in vitro low density lipid (LDL) oxidation. Thus, polyphenol 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. We have shown that the polyphenols hyperoside and quercitrin can be extracted with water (Vaughn, et al. 2006).

To assess the biological activity of A. julibrissin and Silybum marianum, we 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, Clausen and Nagarajan are currently generating results with the chemically medicated LDL oxidization assay using silymarin and polyphenolics. Electrophoretic mobility and monocyte adhesion studies have been performed in Dr. Nagarajan's laboratory. A thesis on the effect of S. marianum and their effect on LDL oxidization was submitted by Sunny Wallace.

Precision Farming Technology for Developing Subsoiling Guidelines in Arkansas

Sreekala Bajwa, Assistant Professor, Biological & Agricultural Engineering, UAF;
Subodh Kulkarni, Graduate Student, Biological & Agricultural Engineering, UAF

Objective:

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. The Fayetteville field experiment included four treatments of different levels of compaction, and four replications. The 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 the 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 the Fayetteville field include 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 was collected for Fayetteville field and three 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. This research resulted in three publications.

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

Objective:
- 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.
- To develop quantitative risk assessment model for S. Typhimurium and C. jejuni in a poultry systems.
- 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. Conversely, it also 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 benefit from safer poultry products and society will benefit from reduced food borne diseases and related medical costs.

Rapid Integration of Advanced Technology for Sensing, Characterization, and Control in Production and Processing of Biological Materials

Carl Griffis, Professor, Biological & Agricultural Engi-

neering, UAF
Objective:
1. To develop innovative methods for sensing quality and safety of biological materials such as meats, fruits, vegetables, grains, and other commodities, using advanced electronics, biosensors, and computer models, and to integrate these methods into production and processing operations.
2. To characterize, control, and improve agricultural production and processing through advanced technology.
3. To enhance the safety and quality of agricultural products.

Accomplishments:
• Machine Vision System for Examination of Rough Rice
• Development of the machine vision system for non-destructive examination of rough rice for insect and disease damage is nearly complete. Construction of the prototype device for delivery to the rice physiologist in Stuttgart is well under way.

Rapid Detection of Food born Pathogens and Pesticide Residues Using Biosensor Technologies

Yanbin Li, Professor, Biological & Agricultural Engineering, UAF; **Madhukar Varshney**, Biological & Agricultural Engineering, UAF; **Yibin Ying**, Professor, Biosystems Engineering, ZJU, **China Weihuan Fang**, Professor, Animal Science, ZJU, **China Ping Wang**, Professor, Biomedical Engineering, ZJU, **China Jianping Wang**, Professor of Food Engineering, ZJU, China

Objective:
The overall goal of this research is to establish collaboration with scientists in Zhejiang University, China, in research for rapid detection of food borne pathogens using biosensor technologies. The supporting objectives are:

1. To exchange visiting researchers for establishment of long-term collaboration in biosensor research; and
2. To develop magnetic beads and microfluidics based optical biosensor for rapid detection of *E. coli* O157:H7 in various foods.

Accomplishments:
In the past year, four professors from Zhejiang University came to UA for a visit to the Biosensors and Bioinstrumentation Laboratory. In addition, Dr. Li visited Zhejiang University three times. Through this collaboration, a new bioanalysis instrumentation laboratory has been setup at Zhejiang University.

A chemiluminescent biosensor has been developed based on magnetic immunobeads and microfluidics for detection of *E. coli* O157:H7 in food samples. An impedance biosensor based on interdigitated microelectrode array was studied for detection of pesticide residues in ready-to-eat foods. These biosensors could be able to detect target pathogens down to 100 cfu/ml (or cfu/g) or target pesticide residues down to 10 ppb in less than one hour.

The biosensors being developed in this project would provide the food industry, regulatory agencies, and consumers with more rapid, sensitive and cost-effective method for detection of pathogenic bacteria and pesticide residues in food products for ensuring food safety and food security. These biosensors will be rapid, specific, inexpensive, and portable for use in filed or on site. The biosensors developed in this project will be further evaluated with different pathogenic bacteria in varieties of food samples in China.

A Low Impact Development Demonstration Habitat for Humanity Community in Rogers, Arkansas

Marty Matlock, Associate Professor, Biological & Agricultural Engineering, UAF;
Steve Luoni, Director, The Community Design Center, UAF;
Aaron Gabriel, Project Architect, The Community Design Center, UAF;
Mark Boyer, Landscape Architect, Department of Architecture, UAF

Objective:

The project team is working with the Benton County, Arkansas, Habitat for Humanity to design, construct, and manage a low impact development model community on five acres in Rogers, Arkansas. A concept for ecologically-friendly community design, which was adopted by the City of Rogers as a model for development, was developed

Accomplishments:

We are working with the CDC to educate local engineering consulting firms and developers on the advantages of low-impact development. We received authorization from the City of Rogers to proceed with construction in February 2006, and anticipate initiating construction on the first home by July 2006. Twelve homes will be constructed in the neighborhood, with a common park and meadow integrated with the stormwater runoff treatment system.

Funding Sources:

U. S. Environmental Protection Agency and Arkansas Natural Resources Conservation Commission.

A Watershed Nutrient Management Decision Support System for the Eucha Basin

Marty Matlock, Associate Professor, Biological & Agricultural Engineering, UAF;
Indrajeet Chaubey, Associate Professor, Biological & Agricultural Engineering, UAF;
Brian Haggard, Associate Professor, Biological & Agricultural Engineering, UAF

Objective:

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 U.S. 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.

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.

Accomplishments:

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 nationwide.

Funding Sources:

U. S. Department of Agriculture.

Air Quality Monitoring in Commercial Broiler Houses

Sreekala Bajwa, Associate Professor, Biological & Agricultural Engineering, UAF;

Ecological Engineering

Tom Costello, Associate Professor, Biological & Agricultural Engineering, UAF;
Frank Jones, Extension Section Leader, Poultry Science; **Susan Watkins,** Extension Specialist, Poultry Science

Objective:
The project goal is to monitor emission of air pollutants, particularly ammonia and particulate matter from a commercial broiler production facility in Arkansas.

Accomplishments:
The project started in 2005. Base instrumentation for monitoring ammonia and particulate matter from confined animal feeding operations were acquired. Currently, these devices are being assembled and configured for installation at the commercial broiler house in Savoy. The data collection is expected to start in 2006.

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, Associate Professor, Biological & Agricultural Engineering, UAF

Objective:
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' management program expired 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.

The ecological engineering group in BAEG 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.

Accomplishments:
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 six million dollars on nonpoint source management. The consensus building program being conducted as an element of this project brought together more than 60 individuals representing 51 different agencies, NGOs, or watershed teams to discuss workable management actions concerning categorical and watershed based programs. These management measures will be implemented in Arkansas 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, Associate Professor, Biological & Agricultural Engineering, UAF;
Brian Haggard, Associate Professor, Biological & Agricultural Engineering, UAF

Objective:
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.

A demonstration project on use of riparian corridors as greenway parks is being conducted by the City of Rogers, 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 were held at the site for city planners, city engineers and developers to adopt more sensitive drainage practices in their development plans.

Accomplishments:

The City of Rogers, Arkansas, 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.

Effect of Reduced Effluent Phosphorus Concentrations on Stream Water Phosphorus Concentrations at the Illinois River Drainage Area, Northwest Arkansas

Brian E. Haggard, Associate Professor, Biological & Agricultural Engineering, UAF

Objective:

In 2003, phosphorus concentrations were significantly reduced in the effluent discharge from Springdale's wastewater treatment plant (WWTP); previous research has shown that elevated phosphorus concentrations during base flow at the Illinois River could be traced 47 river km upstream to this effluent discharge. The objective of this study was to evaluate the effect of the reduced effluent phosphorus concentration on the spatial distribution of stream water phosphorus concentrations at the Illinois River Drainage Areas (IRDA) in Northwest Arkansas.

Accomplishments:

Water samples have been collected on an approximately monthly basis from 30 stream water quality monitoring sites at the IRDA, and these sites vary spatially from the Illinois River, South of Siloam Springs at Highway 59 to sites upstream from the each of the three major WWTP effluent discharges (i.e., Fayetteville, Springdale and Rogers). These water samples have shown that stream water phosphorus concentrations in the IRDA have been decreasing since 2003, and concentrations were least during spring when base flow was greatest.

Funding Sources:

UA Division of Agriculture and USDA ARS Poultry Production and Product Safety Research Unit.

Engineering Design and Evaluation of Animal Waste Management Systems in Arkansas

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

Indrajeet Chaubey, Associate Professor, Biological & Agricultural Engineering, UAF;

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

Frank Jones, Research Professor and Extension Section Leader, Cooperative Extension Service, UAF; 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) 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, Arkansas. 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.

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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.

Fecal Bacteria Transport in Ozark Streams

Brian E. Haggard, Associate Professor, Biological & Agricultural Engineering, UAF

Objective:

In 2006, the USDA NRI Water and Watershed Program identify pathogen transport as its research priority. This funded project is design to evaluate fecal bacteria transport in regional streams using an existing database; the database is the USGS National Water Information Systems (NWIS). The USGS monitored fecal bacteria at select water quality monitoring stations in the Illinois River Basin, and the purpose of this study was to statistically evaluate the relations between fecal bacteria and water chemistry, stream discharge, and landscape characteristics.

Accomplishments:

A graduate research assistant was recently identified to work on this project, and the first task was downloading fecal bacteria numbers and other physico-chemical data from the USGS NWIS database. The next task will be completing the geographical information systems and statistical analyses, and this project will serve as the basis of this student's thesis research.

Funding Sources:

USDA CSREES NRI Water and Watersheds Program.

GIS Database Development and Watershed Modeling in the Arkansas Priority Watersheds

Indrajeet Chaubey, Associate Professor, Biological & Agricultural Engineering, UAF;
Marty Matlock, Associate Professor, Biological & Agricultural Engineering, UAF;
Tom Costello, Associate Professor, Biological & Agricultural Engineering, UAF

Objective:

1. Prepare basic GIS data needed for the nine 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; and
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 developed, calibrated, and validated Soil and Water Assessment Tool (SWAT) model in 11 priority watersheds in Arkansas. In addition, we are currently developing a SWAT model for all 11-digit HUC watersheds within each priority watershed. These models will be used to rank watersheds based on their relative contribution of flow, sediment, nutrient, and pesticide losses. These results can be used by various State and Federal agencies to develop watershed management plans and to target areas for BMP implementation to minimize nonpoint source pollution in these watersheds. The modeling results have also been directly used to develop a nonpoint source management plan by the Arkansas Natural Resources Commission.

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

Objective:

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 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.

Improving Cotton Irrigation Recommendations in Mid-South

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

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

Accomplishments:
Field experiments were conducted in 2003 and 2004 with three rates of irrigation on different cotton cultivars. Field data were collected on soil water tension, canopy reflectance, canopy temperature and weather on days when the field was relatively dry. In both years, the plots did not develop significant soil moisture tension at 40 cm depth. Consequently, there was no difference in the lint yield between the treatments. However, both canopy temperature based stress indices and canopy reflectance-based stress indices were able to identify the difference in moisture levels at shallow depths (20 cm) through plant response. This research indicated that plant-response based stress indicators are very sensitive to even mild levels of water stress in the plant, and therefore, they would make valuable contribution to irrigation scheduling programs, if incorporated. A final report has been submitted to Cotton Inc.

Improving Nutrient Management for Cotton Production in Arkansas

Sreekala Bajwa, Associate Professor, Biological & Agricultural Engineering, UAF;
Morteza Mozzafari, Assistant Professor, Crop, Soil & Environmental Sciences, UAF

Objective:
The research objective for this project is to test if remote sensing could be a valuable indicator of nitrogen stress in cotton.

Accomplishments:
Field experiments were conducted in 2003-2005 period with five different rates of nitrogen. The crops were monitored for petiole nutrients. Field data were collected on canopy reflectance. Also, aerial remote sensing was performed. Data analysis did not show consistently significant correlation between canopy reflectance and petiole NO3-N. However, canopy reflectance was highly correlated to N application rates and petiole S content. Similarly, vegetative indices derived from aerial remote sensing showed moderate correlation with petiole NO3N. Currently, the aerial remote sensing data are being further analyzed to develop predictive relationship between cotton petiole NO3-N or N application

rate and vegetative indices.

Land Use Effects on Ozark Stream Organic Carbon and Nutrient Concentrations

Brian E. Haggard, Associate Professor, Biological & Agricultural Engineering, UAF;
Marty D. Matlock, Associate Professor, Biological & Agricultural Engineering, UAF

Objective:
The purpose of this study was to determine factors related to spatial and temporal variation in organic carbon and nutrient concentrations in Ozark streams, particularly in the Beaver Lake Basin, in order to understand catchment interactions between organic carbon and nutrients from the landscape through streams. A variety of sites within the Beaver Lake Basin were selected and monitored for organic carbon and nutrient concentrations to compare across: (1) different hydrologic conditions, (2) different catchment land use distributions, and (3) other physico-chemical characteristics at the selected sites. Sediments were also sampled at these sites to investigate the relation between catchment land use and nutrient composition in depositional environments within the fluvial channel.

Accomplishments:
Water and sediment samples were collected from 20 selected stream water quality monitoring stations across the Beaver Lake Basin, and analyzed for nitrogen, phosphorus and organic carbon. This study showed that constituent concentrations were greater during storm events compared to base flow conditions, and that stream water nitrogen and phosphorus concentrations increased significantly with an increase in pasture land use within the catchment; sediment nutrient contents showed similar results. Organic carbon concentrations were greatest in streams draining urban areas, and sestonic algal production in streams were the factor most strongly correlated to organic carbon in the stream water during summer base flow. This research was the basis of a graduate research assistant in the Environmental Engineering Program which graduated in May 2007.

Funding Sources:
Beaver Water District.

National Wadeable Stream Assessment – The Arkansas Component

Marty Matlock, Associate Professor, Biological & Agricultural Engineering, UAF;
Indrajeet Chaubey, Associate Professor, Biological & Agricultural Engineering, UAF;
Brian Haggard, Associate Professor, Biological & Agricultural Engineering, UAF

Objective:
In order to make decisions on environmental issues, policy makers need statistically sound, comparable data. Data of this sort are available within individual states in some cases, but little data is available for nationwide use. Deviations in sampling procedures and differences in parameters sampled keep state environmental agencies from comparing data and keep federal agencies from being able to compile states data for national use.

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.

Accomplishments:
This study promises to provide a status report on the condition and health of wadeable streams in the U.S. It is also meant to help build state capacity for monitoring and assessment, and to enhance and support integration of monitoring and assessment methods.

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

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;
Jin-Woo Kim, Assistant Professor, Biological & Agricultural Engineering, UAF;
Brian Haggard, Associate Professor, Biological & Agricultural Engineering, UAF;
Robert Beitle, Associate Professor, Chemical Engineering, UAF;
Indrajeet Chaubey, Associate Professor, Biological & Agricultural Engineering, UAF;
Julie Carrier, Associate Professor, Biological & Agricultural Engineering, UAF

Objective:
This project is a collection of several subprojects 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. The project was further focused in 2003 to investigate the effects of oxygen on antibiotic residual/organism interaction in the aquatic ecosystem. Before reaction kinetics can be determined representing these interactions, tools for determining and monitoring the oxygen profile in sediment must be created. Also, an experimental method for controlling oxygen concentration in the ecosystem must be available.

The specific sub-objectives are:

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

Net Changes in Stream Antibiotic Concentrations Downstream from Effluent Discharges

Brian E. Haggard, Associate Professor, Biological & Agricultural Engineering, UAF

Objective:

In 2004, a study was conducted to evaluate the occurrence of many pharmaceutical and personal care products in selected stream in Northern and Northwest Arkansas; this study identified many different organic chemicals. In particular, the occurrence of these chemicals [especially antibiotics] was most frequent or only downstream from effluent discharges. Therefore, a new study was initiated to evaluate the net retention of antibiotics and other pharmaceutical and personal care products in select study reaches downstream from three municipal wastewater treatment plants (i.e., Decatur, Fayetteville and Springdale).

Accomplishments:

Water samples have been collected in 2006 from three different study reaches (i.e., Decatur Branch, Mud Creek and Spring Creek), and the samples were analyzed for 45 different antibiotics at the USGS Organic Chemistry Research Lab at Lawrence, Kansas and over 60 other pharmaceuticals and personal care products at the USGS National Water Quality Lab near Denver, Colorado. Net changes in stream antibiotic concentration demonstrated that net retention and release occur at the selected study reaches, and net retention and release varies temporally and spatially at these streams.

Funding Sources:

UA Division of Agriculture and USGS Arkansas Water Sciences Center.

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

Objective:

The research objectives were to identify pesticide pollution in the 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 October 2003. Two sets of clear Landsat data, one each from crop season in 2003 and 2004 were acquired. These data are currently being classified to obtain up to date information on land use and land cover. We 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, five sampling locations along the L'Anguille River were identified, and water samples were collected 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,

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Fluometuron, Metribuzin, Propanil, Thiobencarb, Malathion, Metolachlor, Methyl Parathion, and Command. The 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). Modeling of rainfall-runoff dynamics with SWAT model using USDA database for L'Anguille watershed resulted in relatively low accuracy. An artificial neural network model for rainfall-runoff has resulted in R^2-values of 0.99. The project will train and validate both SWAT and ANN models for sediment and pesticide transport. 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 2006.

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

Indrajeet Chaubey, Associate Professor, Biological & Agricultural Engineering, UAF;
Tom Costello, Associate Professor, Biological & Agricultural Engineering, UAF;
Karl VanDevender, Professor & Extension Engineer, Biological & Agricultural Engineering, Cooperative Extension Service, UAF;
M.A. Nelson, Assistant Professor, Arkansas Water Resources; **K. Teagu**e, Cooperative Extension Service, UA
M. Steele, Cooperative Extension Service, UA

Objective:
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. A final report was submitted to the Arkansas Natural Resources Commission. Based on the results obtained from this project, we secured a Conservation Effectiveness Assessment Project (CEAP) entitled, "Effectiveness and optimization of BMPs in improving water quality from an agricultural watershed." Dr. Chaubey is the project principal investigator and the project is funded by the USDA-CSREES. The total amount of funding is $650,000 for three years.

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

Marty Matlock, Associate Professor, Biological & Agricultural Engineering, UAF;
Indrajeet Chaubey, Associate Professor, Biological & Agricultural Engineering, UAF;
Brian Haggard, Associate Professor, Biological & Agricultural Engineering, UAF

Objective:
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.

The Warren 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 UA Community Design Center (CDC) worked with the CityScapes committee to evaluate and plan an urban greenway along Town Branch through the heart of downtown Warren. 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.

Accomplishments:
A plan has been presented to Warren 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," was 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.

Stream Phosphorus Dynamics below a Rural Effluent Discharge in Northwest Arkansas

Brian E. Haggard, Associate Professor, Biological & Agricultural Engineering, UAF

Objective:
In 2003, a lawsuit over phosphorus between Tulsa Metropolitan Utility Authority and the City of Tulsa [Oklahoma] and several poultry companies in Northwest Arkansas and the City of Decatur [Arkansas] was settled out of court. Within the settlement agreement, the Decatur wastewater treatment plant (WWTP) was directed to reduce effluent phosphorus concentrations to less than 1 mg P L-1; historic water quality monitoring has shown phosphorus concentrations as great as 10 mg P L-1 downstream from the effluent discharge. The objective of this study is to monitor stream phosphorus retention and sediment-phosphorus interactions downstream from the effluent discharge in the receiving stream.

Accomplishments:
Water samples have been collected on an approximately monthly basis from several water quality monitoring sites along the study reach downstream from the Decatur effluent discharge at Decatur Branch (locally referred to as Columbia Hollow). Recently, a graduate research assistant in Crop, Soil and Environmental Sciences was recruited, and this project will be the core of this student's thesis research. This student will crunch the historical data, as well as collect additional data through Water Year 2007.

Funding Sources:
UA Division of Agriculture and USDA ARS Poultry Production and Product Safety Research Unit.

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

Indrajeet Chaubey, Associate 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**, Associate Professor, Biological & Agricultural Engineering, UAF.

Objective:
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; and
3. Quantification of pharmaceutical and antibiotic residuals in streams in Northwest Arkansas.

The following objectives will be accomplished in this project:

- Quantify linkages among water use, water conservation, water quality, and ecosystem response at various geographic scales (farm to watershed scale).
- Develop seasonal external P load thresholds for Beaver Lake using in situ bioassays.
- Measure and assess concentrations of pharmaceutical and antibiotic residuals in water samples from northwest and north-central Arkansas streams.
- Disseminate information to state/federal agencies, stakeholders, and other interested groups.

This project supplements another ongoing project entitled, "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:
In 2005, we instrumented four paired fields to quantify water balance, water conservation, and water quality as result of BMP implementation in rice production. The BMP tested were conventional irrigation and multiple inlet rice irrigation (MIRI). Results indicate that the MIRI result in significant water savings as compared to the conventional irrigation. In addition, quarterly water quality data were collected from various locations in the L'Anguille River to link water quality at field and watershed scales. We have developed, calibrated and validated a SWAT model to evaluate response of various management scenarios on crop production, water conservation and water quality.

SWAT Modeling in the Illinois River Watershed

Indrajeet Chaubey, Associate Professor, Biological & Agricultural Engineering, UAF;
Marty Matlock, Associate Professor, Biological & Agricultural Engineering, UAF

Objective:

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:

All the project tasks have been completed and a final report was submitted to the Arkansas Natural Resources Commission.

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, Associate Professor, Biological & Agricultural Engineering, UAF;

Brian Haggard, Associate Professor, Biological & Agricultural Engineering, UAF

Objective:

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.

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.

Accomplishments:

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.

Agricultural Chemical Applications

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

Objective:
1. Improve chemical application efficiency–to increase efficacy;
2. Reduce the potential for drift and demonstrate ways to be better environmental stewards; and
3. Provide guidance for new pests, 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 150 Arkansas aircraft for both spray and granular type applications at eleven agricultural aviation workshops conducted by Extension. Several field trials are being conducted to assist applicators with variable rate – prescription applications. 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, rights-of-way sprayers, 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. This year's workshop included a strong emphasis on application safety to reduce drift complaints and reduce aircraft accidents.

Extension has also provided many additional government agencies with guidance and assistance concerning chemical application problems. Extension is assisting the EPA by serving on the new Drift Reduction Technology (DRT) advisory committee.

Application guidelines were developed and presented as an ongoing part of pesticide license recertification for all types of commercial and private applicators.

I continue to provide leadership with the "National Drift Minimization Coalition," and serve as the technology cochair for that group. I served on the new PAASS (Professional Aerial Applicator Support System) content committee and have assisted with that program on numerous phone conferences and the development of the 2006 program "Spray System Maintenance."

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

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

Objective:
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 U.S. (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 four 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.

This project finished in September, but the benefits and information is still being utilized by growers to incorporate temperature control practices into their normal strategy for controlling insects.

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

Objective:

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 and meetings provided growers practical techniques to improve seeding corn, cotton, rice, soybeans and wheat. 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. In excess of two-thirds of the wheat crop and more than one-third of the soybean crop were direct-seeded (no-tillage). More than one million acres were subsoiled during the fall of 2005 in Arkansas, using recommendations based on UA research and education. Subsoiling developments pioneered in Arkansas are being imitated in educational efforts in Alabama, Illinois, Iowa, 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

Objective:

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

Special emphasis was placed on traffic safety where farm equipment and other agricultural operations are using rural roads.

Accomplishments:

Agriculture is a dangerous work environment; however, farm fatalities in Arkansas have declined from 19 in 1999 down to 10 in 2003 and only 4 in the latest complete UACES data base for 2004. A variety of educational activities have emphasized reducing farm injuries and fatalities in Arkansas. More than 500 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. More than 150 gin personnel attended one of three programs addressing entanglement hazards and rechecking the effectiveness of the proximity switches and other safety devices in their cotton gins, conducted jointly by the University of Arkansas Cooperative Extension Service and the Southern Cotton Ginners' Association. Alabama, Nebraska and Kansas 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. Pennsylvania State University has used elements of "Lawn Mower Safety" and "Tractor Safety" fact sheets. The U.S. Forest Service now uses portions of our "Chain Saw Safety" fact sheet for reference and training. We now have ten fact sheets and four videos available for loan posted on our web site.

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

Objective:

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 and meetings provided growers practical techniques to improve combine adjustments, measure, and reduce field loss of corn, 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 to receive maintenance and fine-tune harvesting tips. The Rice Production Manual was updated this year.

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.

Nutrient Management Education to Protect Water Quality

Mike Daniels, Associated Professor & Extension Environmental Management Specialist, Environmental and Natural Resources Section, Cooperative Extension Service, UA;

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

Melony Wilson, Nutrient Management Training Coordinator, Environmental and Natural Resources Section, Cooperative Extension Service, UA;

Patrick Fisk, Land Resource; Specialist Poultry, Arkansas Natural Resources Commission;

Keith Brown, Manager State Permits Branch Water Division, Arkansas Department of Environmental Quality; **Wavey Austin**, Environmental Engineer, UDSA Natural Resources Conservation Commission;

Helen Denniston, State Agronomist, UDSA Natural Resources Conservation Commission

Objective:

Increasing concerns regarding the potential adverse effects of animal manure and commercial fertilizers has increased the desired knowledge and skill level of land and nutrient managers. Previously only the Arkansas Department of Environmental Quality's (ADEQ) Regulation No. 5 required producers utilizing water to manage animal manure be permitted and receive annual training. Recently, the Arkansas Natural Resources Commission (ANRC) has enacted regulations that designate those watersheds to flow into Okalahoma and Missouri as Nutrient Surplus Areas. They also require certified Nutrient Applicators, and plans written by Certified Nutrient Planners within the Nutrient Surplus Areas. Both certification processes are based on the concept of providing training to increase the knowledge and skill levels of nutrient planners and applicators. To help assure technical adequacy, all developed Nutrient Management Plans must meet USDA Natural Resources Conservation Commission (NRCS) Standards. To provide the required training the University Of Arkansas Division Of Agriculture, Cooperative Extension Service (CES) received a $1,353,399 EPA 319 technology transfer grant administered by the Arkansas Natural Resources Commission.

Accomplishments:

Utilizing these funds, CES with the input and support of ANRC, ADEQ, and NRCS developed presentation and printed materials for nutrient applicator meetings and nutrient planner workshops. With the support of the regulatory agencies, the 2.5 hour applicator meetings were designed to meet the legal requirements of both ADEQ's Regulation No. 5 and ANRC's Nutrient Surplus Regulations. This allowed livestock producers in the nutrient surplus areas to attend a single meeting and satisfy the requirements of two separate regulations. Collaborations between CES, NRCS, ANRC, and ADEQ resulted in 3.5 day Nutrient Planner Workshops where participants became certified to write plans that met the legal and technical requirements of ANRC, ADEQ and NRCS. By December 2005, more than 1500 individuals attended a nutrient applicator meeting and more than 70 individuals have become certified nutrient management planners.

On-Farm Grain Handling and Storage

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

Objective:

1. Improve efficiency of on-farm grain handling systems;
2. Maintain the best grain quality possible during on-farm storage; and
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.

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

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

Precision Agriculture

Dennis 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, Cooperative Extension Service, CES-Monticello, UA

Objective:
1. Investigate practical potential for practical incorporation of precision agriculture practices; and
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. Dr. Bajwa and I serve as cochairs of ARPAWG and will serve as editors and coordinators for this effort.

One major activity has been to develop training opportunities for Arkansas youth on remote sensing and GIS databases. 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. Many pesticide applicators are utilizing GIS data to find and log application information. Several classes were conducted within the last year to provide guidance in this area. Coordination of multi-discipline and multi-state activities will continue. Additional practical applications will be investigated and demonstrated in the future.

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:

Demonstrations on MIRI were conducted with 15 producers, in 10 counties, on 21 different fields. Additional MIRI work was coordinated through county agents and involved several other producers. Four counties had field tours that included Multiple Inlet irrigated fields. Conducted field comparison studies with four cooperators that showed an average water savings of 23% with MIRI:

- Craighead County: Parrish Farm, 18% less water with MIRI
- White County: Taylor Farm, 27% less water with MIRI
- St. Francis County: Hall Farm, 19% less water with MIRI
- Cross County: Imboden Farms, 29% less water with MIRI

Other Experiences/Observations:

1. Billy Linderman, in Lonoke County, questioned whether MIRI could help them at first, but after seeing the results from this year he plans to use it on more fields.
2. Dennis Fortenberry, in Greene County, found that the MIRI helped him get the field pumped back up quicker after his well went down during the summer.
3. Randy Marsh, in Woodruff County, commented that he was better able to water a soybean field from the same well he used on rice because he was using multiple inlet in the rice field.

4. The MIRI not only reduced the water pumped but it was especially helpful in reducing the pumping cost since diesel was double the cost this year as compared to the 2004 season.

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

Objective:

- 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; and
- Publish results in a Beltwide reference for cotton ginners.

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, Mississippi, 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. More cotton gins have contracted with firms providing cover for construction sites. Higher value options are desired, thus the growth of sales for entrepreneurs who have begun bagging and selling composted gin waste for horticultural use, one to regional Wal-Mart outlets is an advance.

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. Several gins including the Dumas Gin Company sell 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, 2004 and 2005 cotton harvests. 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. This information is too preliminary at this stage to implement in higher technology applications. Professionals throughout the cotton-producing states are working as a team to develop recommendations and nationwide training on utilizing gin waste.

GRANTS

Investigator	Title	Agency	Dates	Amount
Bajwa, Sreekala	Use of Near-Infrared Spectroscopy to predict beef tenderness of several muscles	Arkansas Beef Council	2004-2006	$86,299
Bajwa, Sreekala	Precision Farming Technology for Developing Subsoiling Arkansas	Cotton Incorporation	07/01/02-9/30/06	3,000
Bajwa, Sreekala	Improving Cotton Irrigation Recommendations in the Mid-South	Cotton Incorporation		$10,000
Chaubey, Indrajeet, Matlock, Marty & Bajwa, Sreekala	Environmental Resource Management to Develop Watershed Technologies and Management Tools	US EPA	6/07/05-3/31/2008	$148,800
Carrier, D. J., Clausen, Ed Cross, R. A., & Beitle, R. R.	Process Improvements in the Gallo Wineries	E & J Gallo Wineries	2004-2007	$400,000
Carrier, D. J.	NRI 71.2 Acquisition of a Preparative LC to enhance Research on Subcritical Water Extration of Phytochemicals	NRI	2006-2007	$20,429
Carrier, Julie & Erf, Gisela	Lycopene and Effect on Oxidative Stress	Arkansas Bioscience Institute	9/01/04-8/1/2006	$76,954
Carrier, Julie, Clausen, Ed & King, Jerry	Alternative energy workshop	DOE SER-BEP	1/1/06-12/31/2006	$48,000
Chaubey, Indrajeet, & Matlock Marty	Watershed Response Modeling in II Digit Priority Watersheds in Arkansas	Arkansas Soil and Water Conservation Commission	10/01/05-3/31/07	$76,104
Chaubey, Indrajeet, & Popp, Jennie	Effectiveness and Optimization of BMP's in Improving Water Quality from an Agriculturally Domination Watershed.	USDA CREES - Prime	9/15/05-9/14/08	$650,000

Investigator	Title	Agency	Dates	Amount
Chaubey, Indrajeet, Vories, Earl & Matlock, Marty	Development of an integrated water in quality-water Management Program the Arkansas Delta	USDA/CS-REES	2003-2006	$555,000
Chaubey, Indrajeet, Vories, Earl & Matlock, Marty	Sustainable Agriculture and Water Resources in Arkansas	US EPA	7/01/03-6/30/2006	$447,095
Haggard, Brian	Research Support	USDA ARS	10/06 - 09/07	$41,856
Haggard, Brian	Fecal Bateria Transport in Ozark Streams	USDA NRI Water and Watersheds Program	08/06 -07/08	$91,915
Haggard, Brian & Boss	Sediment Characterization in 3 Coves Beaver Lake, Arkansas	USGS State Water Resources Research Initive Pro.	03/06 - 02/07	$16,900
Haggard, Brian & Savin, Mary	Occurrence and Antibiotic Resistance in Fecal Indicator Bacteria Upstreatm and Downstream of Wasterwater Treatment Plants in Northwest Arkansas	USGS State Water Resources Research Initiative Pro.	03/2006-02/2007	$17,817
Kavdia, Mahendra	Nitric Oxide Trans. in the Microcirculation	American Heart Association	1/1/05-12/31/08	$260,000
Kavdia, Mahendra	ABI: Endothelial Cell Dysfunction	ABI	08/2006-06/2007	$83,000
Kim, Jin-Woo	Engineering Ultrasensitive, Electrically Addressable Nanotube-Wire Nan-sensors Through Controlled DNA - Nanotube Interfacing	USDA/CS-REES - NRI	4/01/05-3/31/2007	$157,000

GRANTS

Investigator	Title	Agency	Dates	Amount
Kim, Jin-Woo	Development of a Bacterial Source Tracking and Apprtionment Methdology Using DNA Microarrays and Luminex Microbeads and Its Application in the Ozark Plateau	ABI	7/01/05-6/30/2006	$48,000
Kim, Jin-Woo	NER: Exploration of a Nano-Engineered Flagellar Motor Based TNT Detection System	NSF	7/15/05-7/14/2006	$135,000
Kim, Jin-Woo	Large-Scale DNA Associative Memories	NSF	7/15/05-7/14/2006	$135,000
Kim, Jin-Woo	Design & Fabrication of a Micro- Flagellar Motor Based Dynamo	NSF	5/5/04 - 4/30/07	$209,834
Kim, Jin-Woo	Gold-Coated Carbon Nanotube Mediated Nanphotothermolysis as Noninvasive Anticancer Therapeutic	ABI	2006-2007	$74,217
Kim, Jin-Woo	NUE: Integrating Nanoscale Science & Technology into Introduction Computer	NSF	6/01/2004-5/31/06	$99,062
Kim, Jin-Woo	Genome Enabled Medical Diagnosis Using a Biological Memory with In Vitro Learning	ABI	7/01/03-6/30/2006	$139,713
Kim, Jin-Woo	SURF: Cloning and Overexpression of Hyperthermostable Glucoamylase from and Extremophilic Archeon, Methanococcus Jannashii	ADHE	12/20/05 - 8/31/06	$3, 070.00
Li, Yanbin	Rapid Detection of Foodburne Pathogens Using Bisensor Technology	USDA/FAS	8/02/04-7/31/06	$45,000
Li, Yanbin	Biosensor for Rapid Screening of Avian Influeenza Viruses	ABI		$75,000

Investigator	Title	Agency	Dates	Amount
Li, Yanbin	Nanpoarticle-based Fluorescent Biosensor for Rapid Detection of Listernia Monocytogenes in Foods	USDA/CS-REES		$214,216
Li, Yanbin	Nanofiber based Biosensor for Detection of Foodborne Pathogens	IFSE-BDI		$200,000
Li, Yanbin	Enhancing the Safety of Poultry Products	USDA/CS-REES		$40,000
Osborn, Scott	Development of Selection Tools Associated with Components of Milling Yield in U.S. Long and Medium Grain Cultivars	Rice Foundation	9/01/04-8/31/2006	$81,875
Bajwa, Sreekala	Improving nutrient management for cotton production in Arkansas	Arkansas Soil Testing &Research Lab	2003-2006	$178,658
Osborn, Scott, Huang, M., Matlock, Marty, Thompson, Craig & McCain, A.	Point Source Ozonation to Minimize Antibiotic Resistance - SBIR Phase 1	NIH	8/01/05-7/31/2006	$100,000
Osborn, Scott,	A Portable Dissolved Oxygen Del. System for Rapid Treatment Org. Spills.	NSF SBIR		$100,000
Matlock, Marty	Adaptive Management Approach for Review of Arkansas NPS Management Plan	Arkansas Soil & Water Conservation Commission		$76,104
Matlock, Marty	Adaptive Management Approach for Review of Arkansas NPS Management Plan	Arkansas Soil & Water Conservation Commission		$222,880
Matlock, Marty	Analysis of Land Use Impact on Stream Ecological Services in Fayetteville, Arkansas	City of Fayetteville		$119,477

GRANTS

Investigator	Title	Agency	Dates	Amount
Matlock, Marty	Use Attainability and Water Quality Assessment of Coffee Creek, Mossy Lake, and the Ouachita River, Southern Arkansas	Parsons Engineering		$12,126
Matlock, Marty	Demonstration of Low Impact Development Best Management Practices	Arkansas Soil & Water		$69,999

Extention

Investigator	Title	Amount
Huitink, Gary	Farm Safety	$12,066.03
Gardisser, Dennis	406 - Stored Rice	$3,875.22
Tacker, Phil	Chaubey/L'Anguille River Watershed	$55,458.61
Tacker, Phil	ASWCC/BMP Implementation	$70,043.49
Tacker, Phil	Soybean/Irrigation/Tacker (EV)	$24,555.00
Tacker, Phil	SPB/Sust Soybean/Tacker (DS)	$2,638.00
Tacker, Phil	Rice Water Management	$30,000.00

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Ye, Kaiming and Jin, S. (2006) Engineered bacterial and yeast live vaccine for peripheral and mucosal immunization against virus infection. US patent, Filed.

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Ekka, S. A., Haggard, B. E. , Matlock M. D., and Chaubey, I. 2006. Dissolved phosphorus concentrations and sediment interactions in effluent dominated Ozark streams. Ecological Engineering 26:375-391.

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Other Lectures, Papers, and Oral Presentations

Bajwa, S. G., and Mozaffari, M. 2006. Response of cotton canopy reflectance to nitrogen fertilization. In. N. A. Slaton (Ed.) Wayne E. Sabbe Arkansas Soil Fertility Studies 2005, p.18-21, Research Series 525, Arkansas Agricultural Experiment Station, Division of Agriculture, Fayetteville, AR.

Bajwa, S. G., and Mozaffari, M. 2006. Correlating vegetative indices with nitrogen treatments in Cotton. In. D. Oosterhuis (Ed.) Summaries of Arkansas Cotton Research 2005, p.164-170, Arkansas Agricultural Experiment Station, Division of Agriculture, Fayetteville, AR..

Singh, N., and Bajwa, S. G. 2006. Analysis of evolving surface urban heat island in NW Arkansas. IEEE Region 5 Technical Meeting, April 20-22, 2007, Fayetteville, AR.

Leh, M., and Bajwa, S. G. 2006. Long term land use patterns in NW Arkansas. IEEE Region 5 Technical Meeting, April 20-22, 2007, Fayetteville, AR.

Bajwa, S. G., and Rupe, J. 2006. Soybean disease discrimination with canopy reflectance. ASABE annual international meeting and conference, July 17-21, Minnesota, MN.

Bajwa, S. G., and Gardisser, D. 2006. GIS/GPS spatial technology utilization in agricultural aviation. A professional development course presented at the National Agricultural Aviation Association Annual Meeting, Dec. 3-6, 2006, Orlando, FL.

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Vibhava, V., and Bajwa, S. G. 2006. Spatially distributed hydrological modeling with GIS and artificial neural networks. ASPRS Central Region's Spring Technical Meeting. April. 20, 2006. Fayetteville, AR.

Bajwa, D. S., and S. G. Bajwa. 2006. Effect of accelerated aging on Wood-Plastic Composites. In. Proc. Woodfiber-Plastic Composite 2006 International Conference, May 1-2, Toronto, ON, Canada. (Co-author)

Bajwa, S. G., and Kulkarni, K. 2006. Soil Compaction Monitoring and Modeling with VERIS and Crop Response. Report Submitted to Cotton Foundation.

Bajwa, S. G. 2006. Pesticide pollution risk assessment and mitigation training in Arkansas Delta. Report submitted to EPA Region 6.

Invited Lectures

Bajwa, S. G., and Gardisser, D. 2006. GIS/GPS spatial technology utilization in agricultural aviation. A professional development course presented at the National Agricultural Aviation Association Annual Meeting, Dec. 3-6, 2006, Orlando, FL.

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Bajwa, D. S., and Bajwa, S. G. 2006. Effect of accelerated aging on Wood-Plastic Composites. In. Proc. Woodfiber-Plastic Composite 2006 International Conference, May 1-2, Toronto, ON, Canada. (Co-author)

Bajwa, S. G. 2006. Remote sensing to detect nitrogen stress in rice. Precision Agriculture Symposium. Arkansas Crop Management Conference. Jan. 31, 2006. Little Rock, AR. (Invited)

Costello, T. A. 2006. Update on On-Farm Litter Combustion, presented to Arkansas Farm Bureau commodity meetings, June 21, 2006, Conway, Arkansas.

Costello, T. A. 2006. Alternate Energy for Heating Poultry Building using Broiler Litter as a Fuel", presented to Poultry Energy Workshop, UA Cooperative Extension Service, December 12, 2006, Broiler Energy Farm, Savoy Arkansas.

Costello, T. A. 2006. Demonstration of Broiler Litter Fired Furnace to Heat a Poultry House presented to Field Day (Open House) participants, December 14, 2006, Broiler Energy Farm, Savoy, Arkansas.

White, M., Storm, D. E. , and Haggard, B. E. 2006. Modeling phosphorus transport from catchments using SWAT and an in-stream component. Modeling Phosphorus Transport in Agroecosystems: Joining Users, Developers, and Scientists, SERA17-IEG, Ithaca, New York.

Several students (i.e., M. Köller, A. Ludwig, and J. Giovanetti) gave poster presentations at the Beaver Water District Press Day.

Kim J.-W., Deaton R., and Tung, S. 2006. Development of Electrically Addressable DNA-Based Carbon Nanotube Wire Bio/Nano Sensors. International Food Nanotechnology Conference, Orlando, FL.

Kim J.-W., and Tung, S. 2006. Hybrid Flagellar Motor/MEMS Based TNT Detection System. The International Society for Optical Engineering (SPIE) (Session – Micro (MEMS) and Nanotechnologies for Space Applications), Orlando, FL.

Kim J.-W., Deaton R., Chen, J., and Lee, J. S. PhD. 2006. Genomic Pattern Classifier Based on a Biological Memory with In Vitro Learning and Associative Recall. DNA 12: 12th International Meeting on DNA Computing, Seoul, Korea.

Zharov, V. P., Kim, J.-W., Curiel, D. T., and Everts, M. 2006. Amplified Laser-Nanocluster Interaction in DNA, Viruses, Bacteria, and Cancer Cells: Potential for Nanodiagnostics and Nanotherapy. 26th Annual Meeting of the American Society for Laser medicine and Surgery, Boston, MA.

Kim, J.-W., Deaton, R., Lee PhD., J. S., and Wijesekera, H. D., PhD. 2006. In Vitro Selection for Large Libraries of Non-Crosshybridizing DNA Oligonucleotides for DNA Computing and DNA-Based Nanotechnology. Institute of Biological Engineering (IBE) Annual Meeting, Tucson, AZ.

Kotagiri, N., PhD., and Kim J.-W., 2006. Modeling of Hybridization kinetics of DNA-CNT Adducts in Solution. Institute of Biological Engineering (IBE) Annual Meeting, Tucson, AZ.

Kim, J.-H., PhD., and Kim J.-W., 2006. DNA Hybridization Kinetics Based on Reaction and Diffusion in DNA-Carbon Nanotube Nanoarrray System. Institute of Biological Engineering (IBE) Annual Meeting, Tucson, AZ.

Garrison, T. F., Kim, J.-W., and Deaton, R. 2006. Self-Assembly of Microscopic DNA Wire Through One-Dimensional DNA Percolation. Institute of Biological Engineering (IBE) Annual Meeting, Tucson, AZ.

Lee, J. S. PhD., Kim, J.-W., and Deaton, R. 2006. A Biological Memory with In Vitro Learning and Associative Recall as a Genomic Pattern Classifier. Institute of Biological Engineering (IBE) Annual Meeting, Tucson, AZ.

Clendenin, J. PhD., Tung, S., and Kim, J.-W. 2007. An Aligned Carbon Nanotube Biosensor for DNA Detection. IEEE International Conference on Nano/Micro Engineered and Molecular Systems (IEEE-NEMS), Bangkok, Thailand.

Kim, J.-W.. 2006. Bio/Nano Technology: Extremophile Biocatalysis and Bio/Abio Interfacing Technology. University of Georgia, Athens, GA (Invited)

Jiang, X., Ying, Y., Wang, J., Ye, Z., Li., Y., and Zhu, G. 2006. Applications of antibody-based biosensor to pesticide residues monitoring. Presented at ASABE 2006 Annual Meeting, July 9-12, 2006, Portland, OR. ASABE Paper No. 067116.

Li, Q., Wang, J., Ying, Y., and Li, Y. 2005. Rapid detection of E. coli O157:H7 using piezoelectric immunosensor. Presented at ASABE 2006 Annual Meeting, July 9-12, 2006, Portland, OR. ASABE Paper No. 067117.

Liu, F., Su, X. and Li, Y. 2006. Detection of Escherichia coli O157:H7 using a QCM immunosensor with nanoparticle amplification. Presented at ASABE 2006 Annual Meeting, July 9-12, 2006, Portland, OR. ASABE Paper No. 067119.

Pradhan, A., Cooney, L., and Li, Y. 2006. Predictive modeling of microbial inactivation kinetics for Listeria and heat and mass transfer during thermal processing of ready-to-eat poultry products. Presented at IFT 2006 Annual Meeting, June 24-28, 2006, Orlando, FL.

Pradhan, A., and Li, Y. 2006. Exposure assessment simulation for microbial behavior of Salmonella in poultry processing. Presented at SRA 2006 Annual Meeting, December 3-6, 2006, Baltimore, MD. The Winner of the Student Merit Awards of SRA 2006.

Srinivasan, B., Tung, S., Li, Y., and Varshney, M. 2006. Simulation of an electrical impedance based microfluidic biosensor for detection of E. coli O157:H7. Presented at 2006 COMOS meeting, November 5-11, Houston, TX.

Su, X., Sun, Q., Ye, Z., and Li, Y. 2006. A prototype capillary biosensor for foodborne pathogens detection. Presented at PITTCON 2006 Annual Meeting, March 12 - 17, Orlando, FL. Poster# 2140-6P.

Sun, Q., Su, X., Millett, J., and Li, Y. 2006. A capillary-based immunosensor for rapid detection of atrazine residue. Presented at IFT 2006 Annual Meeting, June 24-28, 2006, Orlando, FL.

Ye, Z., Li, Y., Ying, Su, X., and Sun, Q. 2006. Design, Construction and evaluation of a portable biosensor for rapid detection of E. coli O157:H7.

Li, Y. presented at ASABE 2006 Annual Meeting, July 9-12, 2006, Portland, OR. ASABE Paper No. 067121.

Cooney, L., Li, Y., Tian, R., Dong, W., Wang, H., and Slavik, M. F. 2006. TiO2 nanofiber coating with UV catalysis for inactivation of Escherichia coli O157: H7. Presented at Food Safety Consortium 2006 Annual Meeting, October 1-3, Fayetteville, AR. Abstract in CD of Food Safety Consortium 2006 Symposium.

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Pradhan, A., and Li, Y. 2006. Quantitative microbial risk assessment model for exposure assessment of Salmonella during poultry processing. Presented at Food Safety Consortium 2006 Annual Meeting, October 1-3, Fayetteville, AR. Abstract in CD of Food Safety Consortium 2006 Symposium.

Su, X., Sun, Q. Ye, Z., Bielke, L., and Li, Y. 2006. A versatile multichannel immunoassay instrument for food safety and quality. Presented at Food Safety Consortium 2006 Annual Meeting, October 1-3, Fayetteville, AR. Abstract in CD of Food Safety Consortium 2006 Symposium.

Sun, Q., Su, X., Millett, J., and Li, Y. 2006. A capillary column-based immunosensor for rapid detec tion of atrazine residue in drinking water. Presented at Food Safety Consortium 2006 Annual Meeting, October 1-3, Fayetteville, AR. Abstract in CD of Food Safety Consortium 2006 Symposium.

Wang, R., Li, Y., Hargis, B., Tung, S., and Bottje, W. 2006. Microfluidics-based impedance biosensor for rapid screening of avian influenza viruses H5N1. Presented at Food Safety Consortium 2006 Annual Meeting, October 1-3, Fayetteville, AR. Abstract in CD of Food Safety Consortium 2006 Symposium.

Ye, Kaiming, Li., L., Su, X., and Sun, Q. 2006. Design, construction and evaluation of a portable biosensor for rapid detection of E. coli O157:H7. Presented at Food Safety Consortium 2006 Annual Meeting, October 1-3, Fayetteville, AR. Abstract in CD of Food Safety Consortium 2006 Symposium. Board Member, Northwest Arkansas Museum of Science and Nature science advisory board, 2006-present
Jat, P. and G.S. Osborn. 2006. Chemical Reaction Kinetics Approach to Model Moisture Adsorption of Rough Rice. 31st Rice Technical Working Group. Annual Meeting, The Woodlands, TX.

Osborn, G. S. 2006. Teaching Food/Bio Engineering: Spiraling Ahead. ASABE Annual Meeting, Invited Session, Portland, OR. Invited.

Osborn, G. S. 2006. Applications of the SDOXTM for Emergency Spill Response. Presentation made to Arkansas Department of Environmental Quality, Little Rock, AR. Invited.

Osborn, G. S., Matlock, M. D., Magness, G. M. 2006. Potential Applications of Dissolved Ozone Injection for Drinking Water Treatment. Presentation to City of Tulsa Utilities Water Division. Invited.

Osborn, G. S. 2006. Point Source Ozonation to Minimize Antibiotic Resistance. EPA Region VI Pretreatment Conference. N. Little Rock, AR. Invited.

Osborn, G. S. 2006. Incorporating Design as Spiraling Connection in Biological Engineering Education. Presentation to College of Engineering Seminar Series. Virginia Polytechnic University. Blacksburg, VA. Invited.
Li, Y. 2006. Nanotechnologies and biosensors for detection of foodborne pathogens. In: CD of Food Safety Consortium 2006 Symposium, October 1-3, Fayetteville, AR.

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Jiang, X., Ying, Y., Wang, J., Ye, Z., Li., Y., and Zhu, G. 2006. Applications of antibody-based biosensor to pesticide residues monitoring. Presented at ASABE 2006 Annual Meeting, July 9-12, 2006, Portland, OR. ASABE Paper No. 067116.

Li, Y. 2006. Biosensors for detection of foodborne pathogenic bacteria: A review. Presented at ASABE 2006 Annual Meeting, July 9-12, 2006, Portland, OR. ASABE Paper No. 067026.

Liu, F., Su, X., and Li, Y. 2006. Detection of Escherichia coli O157:H7 using a QCM immunosensor with nanoparticle amplification. Presented at ASABE 2006 Annual Meeting, July 9-12, 2006, Portland, OR. ASABE Paper No. 067119.

Liu, F., Su, X., and Li, Y. 2006. Detection of Escherichia coli O157:H7 using a QCM immunosensor with nanoparticle amplification. Presented at Food Safety Consortium 2006 Annual Meeting, October 1-3, Fayetteville, AR. Abstract in CD of Food Safety Consortium 2006 Symposium. The winner of the Third Prize of the Graduate Students Poster

Pradhan, A., Cooney, L., and Li, Y. 2006. Predictive modeling of microbial inactivation kinetics for Listeria and heat and mass transfer during thermal processing of ready-to-eat poultry products. Presented at IFT 2006 Annual Meeting, June 24-28, 2006, Orlando, FL.

Ye, Z., Li, Y., Ying, Y., Su, X., and Sun, Q. 2006. Design, construction and evaluation of a portable biosensor for rapid detection of E. coli O157:H7. Presented at ASABE 2006 Annual Meeting, July 9-12, 2006, Portland, OR. ASABE Paper No. 067121.

Merriman, K., Gitau, M., and Chaubey, I. 2006. A tool for estimating best management practices effectiveness in Arkansas. Discovery 7:57-65.

Sen, S., Haggard, B. E., Chaubey, I., Brye, K. R., Costello, T. A., and Matlock, M. D. 2007. Sediment phosphorus release at Beaver Reservoir, northwest Arkansas, 2002-3. Air, Soil, and Water Pollution 179:67-77.

Migliaccio, K. W., Chaubey, I., and B. E. Haggard. 2007. Evaluation of landscape and instream modeling to predict watershed nutrient yields. Environmental Modeling and Software 22(7): 987-999.

Sudheer, K. P., Chaubey, I., and Garg, V. 2006. Lake water quality assessment from Landsat TM data using neural network: An approach to optimal band combination selection. Journal of the American Water Resources Association 42(6):1683-1695.

DeLaune, P. B., Haggard, B. E., Daniel, T. C., Chaubey, I., and Cochran, M . J. 2006. The Eucha/Spavinaw Phosphorus Index: A court mandated index for litter management. Journal of Soil and Water Conservation 61(2):96-105.

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Gitau, M. and Chaubey, I. 2006. Regionalization of SWAT model parameters in Arkansas Priority Watersheds. Abstract published in the proceedings of the Workshop "Managing Agricultural Landscapes for Environmental Quality: Strengthening the Science Base". Kansas City, MO. October 11-13, 2006. 29 p.

Merriman, K, Gitau, M., and Chaubey, I. 2006. A tool for estimating best management practice effects in Arkansas. Poster presented at the Annual Conference of the Arkansas Water Resources Association. Fayetteville, AR. April 18, 2006.

Leh, M., Chaubey, I., Brahana, J.B., Murdock, J., and Haggard, B. E. 2006. Field investigations of rainfall-runoff processes in a Karst watershed. Poster presented at Mutlu, E., Chaubey, I., Hexmoore, H., and S. Bajwa. 2006. Comparison of artificial neural network models for hydrologic prediction in agricultural watersheds. Poster presented at the Annual Conference of the Arkansas Water Resources Association. Fayetteville, AR. April 18, 2006.

Cooney, L., Li, Y., Tian, R., Wang, H., Dong, W., and. Slavik, M. F. 2006. TiO2 nanofiber coating with UV catalysis for inactivation of Escherichia coli O157:H7. Presented at Food Safety Consortium 2006 Annual Meeting, October 1-3, Fayetteville, AR. Abstract in CD of Food Safety Consortium 2006 Symposium.

Jiang, X., Ying, Y., Wang, J., Ye, Z., Li, Y., and Zhu, G. 2006. Applications of antibody-based biosensor to pesticide residues monitoring. Presented at ASABE 2006 Annual Meeting, July 9-12, 2006, Portland, OR. ASABE Paper No. 067116.

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Su, X., Sun, Q., Ye, Z., Bielke, L. , and Li, Y. 2006. A versatile multichannel immunoassay instrument for food safety and quality. Presented at Food Safety Consortium 2006 Annual Meeting, October 1-3, Fayetteville, AR. Abstract in CD of Food Safety Consortium 2006 Symposium.

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