2011

Annual Report, 2011

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

Department of Biological and Agricultural Engineering

2011

Annual Report

DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

UNIVERSITY OF
ARKANSAS

2011 Annual Report
Department of Biological and Agricultural Engineering

Lalit R. Verma
Department Head

University of Arkansas
System Division of Agriculture
Mark Cochran
Vice President for Agriculture

Arkansas Agricultural Experiment Station
Clarence Watson Jr.
Associate Vice President for Agriculture Research

Cooperative Extension Service
Tony Windham
Associate Vice President for Agriculture Extension

Dale Bumpers College of Agricultural, Food & Life Sciences
Michael Vayda
Dean

College of Engineering
Ashok Saxena
Dean

University of Arkansas
G. David Gearhart
Chancellor

Sharon Gaber
Vice Chancellor and Provost

Department of Biological & Agricultural Engineering

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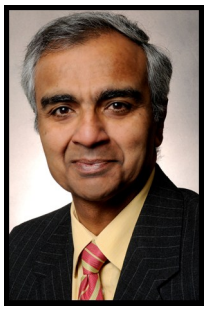
FOREWORD

FROM THE DEPARTMENT HEAD



It is a pleasure to share the accomplishments and activities of our faculty, staff and students in our 2011 Annual Report. It has been a year of engaged review of our academic, research and extension programs with the impending separation of the biomedical engineering portion of our portfolio. The undergraduate curriculum has undergone a comprehensive review and revision to deliver the Biological Engineering degree of *"Healthy Planet, Healthy People"* addressing the challenges in sustainable food, water and energy systems. We had constructive input from some of our graduates through the Academic Advisory Committee. We had a record number of students in some our undergraduate and graduate classes. We have over 135 undergraduates spread among sophomore to senior standings. Our Department of Biological and Agricultural Engineering is truly unique as it resides in the UA System Division of Agriculture and UA Dale Bumpers College of Agricultural, Food and Life Sciences and the College of Engineering. Research and teaching faculty are on campus while our extension colleagues are in the state office of the UA System Division of Agriculture's Cooperative Extension Service. The newest addition of Dr. Chris Henry at the Rice Research and Education Center in Stuttgart has been valuable and seriously needed to address water issues in our Delta region. We have experienced steady growth both in the quality and numbers of our students, and scholarly productivity of our dedicated faculty. Two of our senior student design teams were recognized nationally in June at the ASABE Annual Meeting in Louisville.

Our research and extension programs address problems relevant to our stakeholders, not only dealing with food and agriculture, but also in sustaining ecological prosperity for a healthy planet. The ABET accredited undergraduate degree of Biological Engineering prepares students to design engineering solutions for real-world problems in Biological (living) Systems. Engineers trained to apply their expertise to various biological systems have exciting career paths and job opportunities in areas such as ecological stewardship, sustainability, food and agriculture, biotechnology, healthcare, bio-energy and bio-security.

Spring 2011 started with record enrollments in our classes, challenging us to accommodate students in lectures and multiple lab sections. We have five senior design teams engaged in challenging real-world problems under the guidance of their coordinator Dr. Tom Costello and other faculty mentors. Teams are also preparing for national competitions while completing the projects. Some of our students will participate in study-abroad programs in Belize. Drs. Haggard and VanDevender were recognized in January with the John W. White Outstanding Team Award at the UA System Division of Agriculture and Bumpers College Awards Ceremony.

Three outstanding alumni were inducted in the Arkansas Academy of Biological and Agricultural Engineering, and one of our alums was honored as a Distinguished Alumnus by UA College of Engineering. Please join us this April for the Academy activities. We have reconstituted our Advisory Board and hope to have a meeting in May to seek feedback on our programs. Dr. Carl Griffis retired in the summer after 43 years of dedicated service to the University of Arkansas and this department. Dr. Sreekala Bajwa left to become the Chair at North Dakota State University. We all wish them the very best. Please let us know how you can help us and do not hesitate to call (479-575-2351), e-mail (lverma@uark.edu) or if you are in the area, drop in for a visit. I would be delighted to meet with you.

Lalit R. Verma
Professor and Department Head

Significant Accomplishments in 2011

- Dr. Julie Carrier received the University of Arkansas College of Engineering, Biological and Agricultural Engineering Outstanding Service to Students Award (April 2011)

- Dr. Julie Carrier's Ph.D. graduate student, Ching-Shuan Lau, was selected as Outstanding Ph.D. Graduate Student in Department of Biological and Agricultural Engineering, an annual Honors and Awards event organized by Dale Bumpers College of Agricultural, Food and Life Sciences. He was first place winner in Ph.D. Poster Presentations organized by Gamma Sigma Delta. Title of poster "Mass balance closure of xylose oligomers during total xylose content analysis." (http://gsd.uark.edu/awards.student.program11.html) and won first prize for Engineering 2: organized by the office of the provost, the Graduate School and International Education, the vice provost for research and economic development, the Career Development Center, and the Graduate Dean's Student Advisory Board. Title of poster "Mass balance closure of xylose oligomers during total xylose content analysis. (http://newswire.uark.edu/article.aspx?id=15715)

- Biomedical Engineering student Abby Washipack was accepted to Harvard University's REU program for Bioengineering research.

- Dr. Tom Costello received the John White Teaching Award from the Division of Agriculture at the University of Arkansas.

- Dr. Brian Haggard received the 2011 Biological & Agricultural Engineering Research Award from the College of Engineering.

- Biological Engineering senior design team of Zach Callaway, Danielle Frechette, and Clark Trapp received the Student Presentation Award for the 2011 Biennial Meeting of the National Hydrologic Warning Council in San Diego, CA.

- Dr. Jin-Woo Kim's article, titled "DNA-linked Nanoparticle Building Blocks for Programmable Matter" that was published in the Angewandte Chemie International Edition was selected as the "Hot Paper" by the journal's editors and featured as the back cover of the journal issue.

- Nalini Kotagiri, a Ph.D. graduate, advised by Dr. Jin-Woo Kim, received the "Best Poster Award" at the IEEE-NANOMED 2011 Conference in Jeju, Korea.

- Hua Bai, M.S. student in Biological Engineering, received the Graduate Student Travel Award ($500)of the IBE 2011 annual meeting, held March 3-5, 2011 in Atlanta, GA. Her paper is titled "Aptamer-based SPR biosensor for detection of avian influenza virus"

- Dr. Marty Matlock received the 2011 UA Alumni Award for Outstanding Service. He also received the American Society of Landscape Architects Award of Excellence in Communications: Low Impact Development: a design manual for urban areas was developed by UACDC and UA Ecological Engineering Group under a grant from the U.S. EPA and the Arkansas Natural Resources Commission. This same project also received the 2011 American Institute of Architecture Honors Award in Regional and Urban Design. Dr. Matlock was recognized by the American Academy of Environmental Engineers as a Board Certified Environmental Engineer.

- Dr. Scott Osborn was interviewed by the Arkansas Science and Technology Authority (ASTA) regarding the funding BlueInGreen received from ASTA and how it helped BlueInGreen develop. Mayor Lioneld Jordon of Fayetteville, AR used BlueInGreen's success as an example of how Fayetteville has been successful in developing green technology companies in his annual State of Fayetteville Address. News stations, KHOG and KNWA, featured stories on SDOX technology being utilized at the University of Arkansas Technical Park and interviewed Dr. Osborn for the story. Arkansas Democrat-Gazette newspaper published the story.

- Dr. Dharmendra Saraswat received the 2011 University of Arkansas Cooperative Extension Service Early Career Award. His desktop based tool "ARkansas WAtershed Prioritization (ARWAP)" received the the 2011 University of Arkansas Cooperative Extension Service Innovation Award

Significant Accomplishments in 2011

- Naresh Pai, BENGPH student, won 2nd place for a poster presented at the 2011 annual meeting of the Arkansas section of ASABE in Little Rock on October 7, 2011. Naresh also won the 2011 Love of Learning award from the Phi Kappa Phi National Honor Society (4.4% success rate, 80 students nation-wide, out of 1800 applicants were selected for this award) $500. Naresh was advised by Dr. Dharmendra Saraswat.

- Gurdeep Singh, BENGMS student, received the Ivanhoe Foundation Award, Graduate International Fellowship to recognize water related work, $5,000. Gurdeep is advised by Dr. Dharmendra Saraswat.

- Dr. Brian Haggard and Dr. Karl Vandevender received the University of Arkansas 2011 John W. White Outstanding Team Award as members of the Phosphorus Index Team. Other members included: Mike Daniels, Andrew Sharpley, Chuck West and Tommy Daniel, all in the Department of Crop, Soil and Environmental Sciences; Edward Gbur, director of the Agricultural Statistics Laboratory; Nathan Slaton, director of Soil Testing and Research.

- In 2011, Dr. Karl Vandevender accepted a role as a member of the leadership team for the Livestock and Poultry Environmental Learning Center. He has been a member of the center since its inception in 2006. The center was also awarded "eXtension's Outstanding Community of Practice" award.

- Dr. David Zaharoff advised two SURF/Honors applicants : Jimmy Vo (awarded) and Saumil Shah (pending)

- Biological Engineering student, Chris McDaniel, accepted an internship in the summer of 2011 for the International Children's Heart Foundation (ICHF) in Memphis, TN. Chris is advised by Dr. Yanbin Li.

- Dr. Otto Loewer was awarded the ASABE Outstanding Agricultural Engineer of 2011 by The Arkansas Section of the American Society of Agricultural and Biological Engineers.

- Katherine Rutledge was awarded 2011 Outstanding Senior by the Dale Bumper's College of Agricultural, Food & Life Sciences. Dr. Carl Griffis was her advisor.

Departmental Resources

Faculty

Sreekala G. Bajwa
Associate Professor
B.S. Ag.E. (1991) Kerala Agricultural University, India
M.S. Ag.E. (1993) Indian Institute of Technology, India
Ph.D.(2000) University of Illinois at Urbana-Champaign
Research Areas: Ecological Engineering,
Expertise: Optical remote sensing & GIS, Precision Agriculture, Air Quality

D. Julie Carrier
Professor
B.S.(1984) McGill University, Canada
M.S. (1986) McGill University, Canada
Ph.D. (1992) McGill University, Canada
Research Areas: Processing of biological materials.
Expertise: Biomass saccharification, inhibitory product characterization, compound fractionation and purification and biorefinery co-products development.

Thomas A. Costello, P.E.
Associate Professor
B.S. Ag.E. (1980) University of Missouri
M.S. Ag.E. (1982) University of Missouri
Ph.D. (1986) Louisiana State University
Research Areas: Ecological, Agricultural Engineering. Bio-energy, alternate energy, energy conservation.
Expertise: Development and evaluation of economical BMP's for improved water quality, air quality and sustainability of agricultural production.

Carl L. Griffis, P.E.
Professor
B.S. Ch.E. (1963) University of Arkansas
M.S. Ch.E. (1965) University of Arkansas
Ph.D. Engineering (1968) University of Arkansas
Research Areas: Applications of computers and microcircuitry for monitoring and control of biological processes in food processing, quality, and safety.

Chris Henry
Assistant Professor, Extension
B.S. (1996) Kansas State University
M.S. (1998) Kansas State University
Ph.D. (2009) University of Nebraska
Research Area: Development and implementation of statewide integrated research and Extension programs in irrigation water management and water quality; develop curricula and training materials for educational programs in water management for cropping systems, specifically irrigation scheduling, pumping plant performance and energetics, irrigation systems, and water quality impacts; investigate and develop solutions for reduction of pollutant loads with respect to gulf hypoxia; work with other UA personnel to develop and demonstrate irrigation and farming practices that address environmental, production, and economic considerations; develop and maintain positive working relationships with other government agencies and industries.

Brian E. Haggard
Professor
B.S. Life Sciences (1994) University of Missouri
M.S. Environmental Soil & Water Science (1997) University of Arkansas
Ph.D. Biosystems Eng. (2000) Oklahoma State University
Research Areas: Ecological Engineering, Environmental Soil and Water Sciences.
Expertise: Water Quality Chemistry, Algal Nutrient Limitation, Pollutant Transport in Aquatic Systems, Water Quality Monitoring and Modeling.

Sha Jin
Assistant Professor
B.S. (1985) East China University of Science and Technology
M.S. (1988) East China University of Science and Technology
Ph.D. (1996) Kyushu Institute of Technology, Japan
Research Area: Pluripotent stem cells/iPS cell and tissue engineering, Mechanobiology, Molecular genetics and cell biology in disease prevention and control, Drug discovery, Vaccine development.

JIN-WOO KIM
Professor
B.S. Ch.E. (1986) Seoul National University, Korea
B.S. Microbiology (1991) University of Iowa
M.S. Biology (1994) University of Wisconsin
Ph.D. Ag.E. (1998) Texas A&M University
Research Areas: Biotechnological Engineering-Biomedical Engineering
Expertise: Biocatalysis technology, environmental biotechnology, nucleic acid technology, and nano-biotechnology.

YANBIN LI, P.E.
Professor
B.S. Ag.E. (1978) Shenyang Agricultural University, China
M.S. Ag.E. (1985) University of Nebraska
Ph.D. Ag.E. (1989) Pennsylvania State University
Research Areas: Biotechnology Engineering and Bio-medical Engineering, Biosensor technologies, microbial predictive modeling, quantitative risk assessment, and antimicrobial technologies.

YI LIANG
Assistant Professor, Extension
B.S. Ag. E. (1990) China Agricultural University, China
M.S. Ag. E. (1995) China Agricultural University, China
Ph.D. (2000). University of Alberta, Canada
Research Areas: Research Areas: Air quality and energy efficiency with confined animal feeding operations, quantification of emission and transportation of air pollutants, development and evaluation of emission prevention and control technologies.

OTTO J. LOEWER, P.E.
Professor
Director, University of Arkansas Economic Development Institute
ASABE Fellow
B.S. Ag.E. (1968) Louisiana State University
M.S. Ag.E. (1970) Louisiana State University
M.S. Ag. Econ (1980) Michigan State University
Ph.D. Ag.E. (1973) Purdue University
Research Areas: Computer simulation of biological systems; grain drying, handling, and storage systems.

MARTY D. MATLOCK, P.E.
Professor
B.S. Soil Chemistry (1984) Oklahoma State University
M.S. Plant Physiology (1989) Oklahoma State University
Ph.D. Biosystems Engineering (1996) Oklahoma State University
Research Areas: Ecological Engineering
Expertise: Ecological Watershed modeling, Biological assessment & monitoring, Ecosystem Design and Management.

G. SCOTT OSBORN, P.E.
Associate Professor
B.S. Ag.E. (1984) University of Kentucky
M.S. Ag.E. (1987) University of Kentucky
Ph.D. Bio & Ag.E. (1994) North Carolina State University
Research Areas: Biotechnology Engineering, Ecological Engineering
Expertise: Dissolved oxygen and ozone technologies, Biological Modeling, drying and energy processes.

SAMY SADAKA, P.E.
Assistant Professor, Extension
B.S. (1982) Alexandria University, Egypt
M.S. (1988) Alexandria University, Egypt
Ph.D. (1995) Dalhousie University, Nova Scotia, Canada and Alexandria University, Egypt
Research Areas: Bioenergy and energy conservation.
Expertise: Gasification, pyrolysis, biodrying, energy conservation

DHARMENDRA SARASWAT
Assistant Professor, Extension
B.S. Ag.E. (1988) Allahabad University, India
M.S. Ag.E. (1990) Indian Agricultural Research Institute, India
Ph.D.(2007) Ohio State University
Research Areas: Ecological Engineering
Expertise: Watershed modeling, Geospatial Analysis, Mobile; Web; and Cloud based system design and development, Precision Agriculture for nursery plants and row crops, and Bio-Energy.

Departmental Resources

Faculty

Karl VanDevender, P.E.
Professor, Extension
B.S. Ag.E. (1985) Mississippi State University
M.S. Ag.E. (1987) Mississippi State University
Ph.D. Engineering (1992) University of Arkansas
Research Areas: 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., Department Head
Professor
Department Heat
B.Tech Ag.E. (1972) Agricultural University, India
M.S. Ag.E. (1973) Montana State University
Ph.D. Engineering (1976) University of Nebraska
Research Areas: Dr. Verma conducts the administration of the Department of Biological and Agricultural Engineering department, overseeing all components of the department including curriculum design, teaching, research, and extension.

Jeff Wolchok
Assistant Professor
B.S. (1992) University of California at Davis
M.S. (1995) University of California at Davis
Ph.D. (2009) Unversity of Utah, Salt Lake City
Research Areas: Biomedical Engineering
Expertise: Biomaterials, cell-derived biomaterials, tissue engineering and regenerative medicine, bioreactors and the influence of mechanical force on cell behavior, design of medical devices.

Kaiming Ye
Associate Professor
B.S. (1985) East China University of Science & Technology
M.S. (1988) East China University of Science & Technology
Ph.D. (1991) East China University of Science & Technology
Research Areas: Biomedical Engineering
Expertise: Biomedical Engineering and Molecular Cell Biology Expertise and Instrumentation: Stem cell engineering, tissue engineering, nanosensors, nanomedicine, single-molecule imaging, siRNA, and gene delivery

David Zaharoff
Assistant Professor
B.S. (1997) University of Illinois at Urbana-Champaign
Ph.D.(2002) Duke University
Research Areas: Biomedical Engineering
Expertise: Delivery systems for cancer vaccines and immunotherapies; biomaterials; prostate, breast, colorectal and bladder cancers; immunobioengineering; cytokine depots; non-invasive imaging; pathogen-mimicking vaccines.

JULIAN ABRAM
Program Tech Lab Coordinator

PAUL ALGEE
Technology Support Specialist

HOLLY BEASON
Secretary II, Extension

MEGAN COLBERT
Administrative Specialist III

ERIC CUMMINGS
PROGRAM ASSOCIATE

STEVE GREEN
Program Associate

JERRY JACKSON
Research Lab Technician

Jeonshwan Kim
Post Doctoral Associate

LINDA PATE
Administrative Manager

JU SEOK LEE
Post Doctoral Associate

BETTY MARTIN
Technical Assistant

LESLIE MASSEY
Program Associate

JAMES MCCARTY
Program Technician

JOHN MURDOCH
Program Technician

WILL NASH
Administrative Specialist III

LEE SCHRADER
Program Technician

JEFFIE THOMAS
Department Fiscal Manager

AMY WALKER
Fiscal Support Specialist

KAREN WITHERS
Administrative Office Supervisor, Extension

RONGHUI WANG
Post Doctoral Associate

Teaching Faculty for the Biological Engineering Program

Dr. Danielle Julie Carrier, Professor

Dr. Carl Griffis, Professor

Dr. Brian Haggard, Professor

Dr. Jin-Woo Kim, Professor

Dr. Yanbin Li, Professor

Dr. Marty Matlock, Professor

Dr. Karl VanDevender, Professor

Dr. Lalit Verma, Professor and Department Head

Dr. Sreekala Bajwa, Associate Professor

Dr. Tom Costello, Associate Professor

Dr. Scott Osborn, Associate Professor

Dr. Kaiming Ye, Associate Professor

Dr. Sha Jin, Assistant Professor

Dr. Yi Liang, Assistant Professor

Dr. Samy Sadaka, Assistant Professor

Dr. Dharmendra Saraswat, Assistant Professor

Dr. Jeff Wolchok, Assistant Professor

Dr. David Zaharoff, Assistant Professor

Teaching and Supporting Faculty for the M.S. Biomedical Engineering Program

Distinguished Professors:

Dr. Vasu Varadan, Electrical Engineering, Billingsly Chair

Dr. Vijay Varadan, Electrical Engineering

Professors:

Dr. Simon Ang, Electrical Engineering

Dr. Robert Beitle, Chemical Engineering

Dr. Edgar Clausen, Chemical Engineering

Dr. Russell Deaton, Computer Science Computer Engineering

Dr. Jeannine Durdik, College of Arts and Sciences

Dr. Magda El-Shenawee, Electrical Engineering

Dr. Ingrid Fritsch, Chemistry and Biochemistry

Dr. Panneer Selvam, Civil Engineering

Associate Professors:

Dr. Rick Couvillion, Mechanical Engineering

Dr. Ernie Heymsfield, Civil Engineering

Dr. Keith Roper, Chemical Engineering

Dr. Gal Shafirstein, UAMS

Dr. Steve Tung, Mechanical Engienering

Dr. Kaiming Ye, Biological Engineering

Dr. Vladimir Zharov, UAMS

Assistant Professors:

Dr. Christa Hestekin, Chemical Engineering

Dr. Sha Jin, Biological & Agricultural Engineering

Dr. Shannon Servoss, Chemical Engineering

Dr. Jeff Wolchok, Biological Engineering

Dr. David Zaharoff, Biological Engineering

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UAMS

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TONI PEACOCK
Stormwater Project Manager, Walmart

CHRISTOPHER PIXLEY
BAEG Alumnus

GRACE RICHARDSON
Blue in Green

Rusty Tate
Garver Engineers

Departmental Resources

Academy Members and Inductees

Active Academy Members

David Anderson
B.S. ('70)

Stanley B. Andrews
B.S. ('90), M.S. ('93)
COE Young Alumni 2007

Howard B. Austin
B.S. ('56)

Pat Bass
B.S. ('76)

David Beasley
B.S. ('71), M.S. ('73), Ph.D. ('77)

John L. Bocksnick
B.S. ('76), M.S. ('78)

Dennis K. Carman
B.S. ('73)

Robert Chatman
B.S. ('71)

Randy Childress
B. S. ('85)

John J. Classen
B.S. ('87), M.S. ('90), Ph.D. ('95)

William L. Cooksey
B.S. ('79)

David "Gail" Cowart
B.S. ('60)

Steven D. Danforth
B.S. ('80)

Joe D. Faddis
B.S. ('67)

Alan D. Fortenberry
B.S. ('72), M.S. ('77)
COE Distinguished Alumni 2007

Fred G. Fowlkes
B.S. ('68), M.S. ('77)

Michael W. Freer
B.S. ('85), M.S. ('88)

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)
COE Young Alumni 2006

Kevin Henry
B.S. ('99)

Darrell Holmes
B.S. ('81)

John P. Hoskyn
B.S. ('60), M.S. ('64)

Michael D. Jones
B.S. ('67), M.S. ('68)

Dayna King-Cook
B.S. ('85), M.S. ('88)

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)

Bruce Netherton
B.S. ('60)

Robert W. Newell
B.S. ('54)

Richard Penn
B.S. ('82), M.S. ('92)

Carl Peters
B.S. ('68), M.S. ('61)

Jonathan W. Pote
B.S. ('75), M.S. ('75), PhD ('79)

David Wesley Ritter
B.S. ('79), M.S. ('81)

Bill R. Ridgway
B.S. ('88)

Richard M. Rorex
B.S. ('78), M.S. ('81)

Michael D. Shook
B.S. ('82)

Eugene H. Snawder
B.S. ('69)

Freddie C. Stringer
B.S. ('70)

Albert E. "Gene" Sullivan
B.S. ('59)
COE Distinguished Alumni 200'7

Phil Tacker
B.S. ('79), M.S. ('82)

Karl VanDevender
B.S. ('87), M.S. ('87), PhD ('92)

Paul N. Walker
B.S. ('70), M.S. ('71), Ph.D. ('74)

William K. Warnock
B.S. ('72), M.S. ('75), Ph.D. ('77)

Bruce E. Westerman
B.S. ('90)
COE Young Alumni 2005

Robert W. White
B.S. ('72), M.S. ('76)

J. Randy Young
B.S. ('71), M.S. ('75)
COE Distinguished Alumni 2006

Honorary Academy Members

Albert H. Miller
Posthumously

Stanley E. Reed
B.S. ('73) Posthumously

Harold S. Stanton
B.S. ('50), M.S. (53)

H. Franklin Waters
B.S. ('55) Posthumously

2011 Academy Inductees

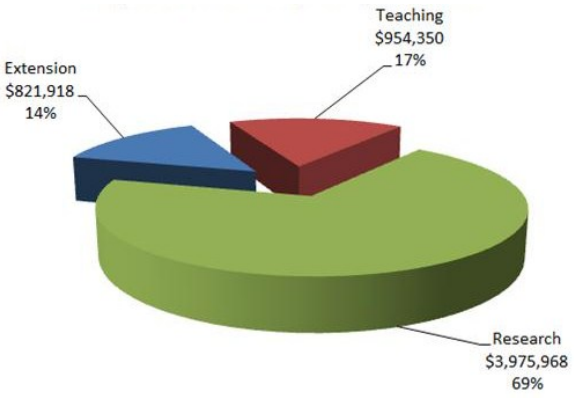
Earl Vories
B.S. ('81), M.S. ('83), PhD ('87)

Dawn Wheeler-Redfearn
B.S. ('99), M.B.A. ('00)

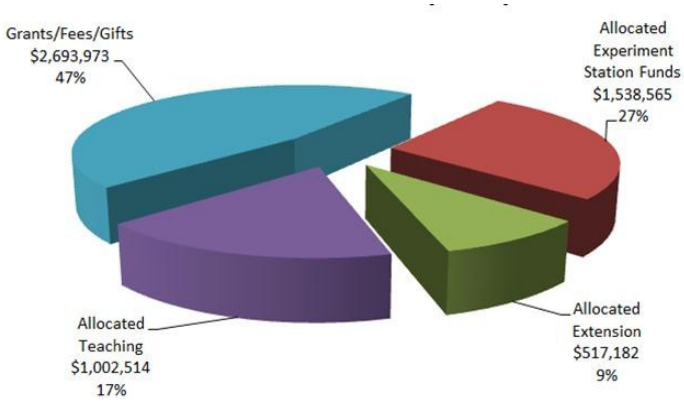
Greg Baltz
B.S. ('80)

Total Expenditures, July 1, 2010 to June 30, 2011
$5,752,236

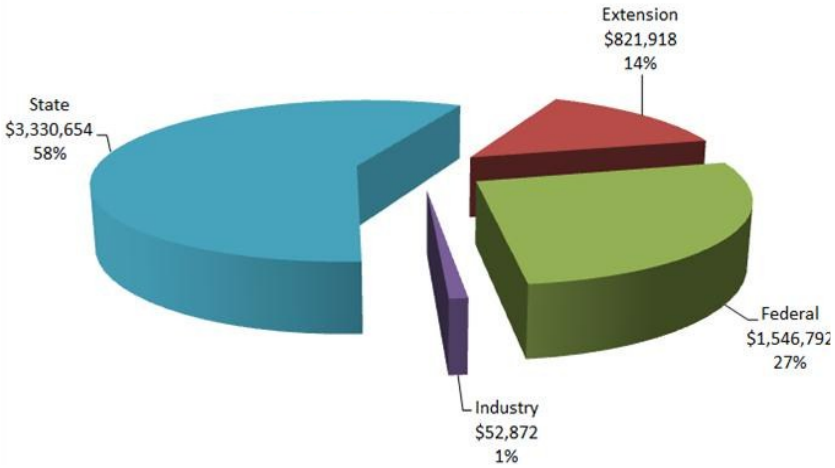
Expenditures by Program Area



Sources: Allocated vs. Grants/Fees/Gifts

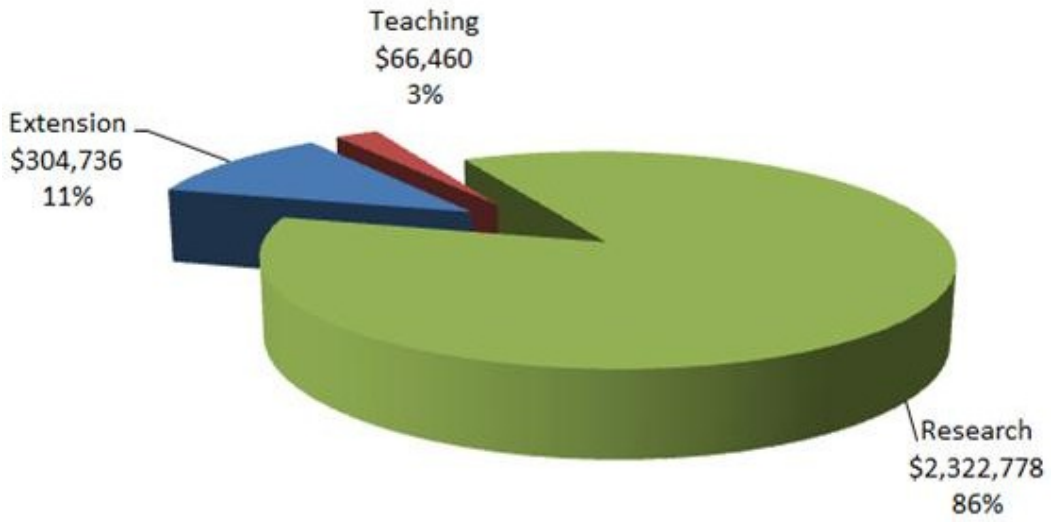


Sources of All Funds



Grants/Fees/Gifts - $2,693,974

Expenditures by Program Area



Sources: Grants/Fees/Gifts

UNIVERSITY OF ARKANSAS

The University of Arkansas was founded in 1871 under the Morrill Land-Grant Colleges Act of 1862. Originally named Arkansas Industrial University, classes began in February of 1872.

Old Main was completed in 1875, and was the primary instructional and administrative building. The first class to graduate etched their names in the sidewalk in front of Old Main, starting Senior Walk and a tradition that is still going today.

The University of Arkansas became the first major Southern public university to admit African-American student without litigation when Silas Hunt of Texarkana, an African-American veteran of World War II, was admitted to the university's School of Law in 1948. Vitamin E was co-discovered by UA Agricultural Chemistry Professor Barnett Sure (1920-51). Sure, along with fellow professor Marinus C. Kik (1927-67), made major advances in nutrition science during their tenures at the university. Along with this discovery, Sure extended knowledge of how vitamin E, amino acids, and B-vitamins function on reproduction and lactation. Kik developed the process for parboiling rice to increase retention of vitamins and shorten cooking time. Kik also documented benefits of adding fish and chicken to rice and grain diets to provide adequate protein for a growing world population.

The university has many great traditions like Senior Walk. The *UA Alma Mater* was written in 1909 by Brodie Payne and was recognized in 1931 as one of the twenty-five best college songs by the University College Song Association in New York, and at the end of the song, students and alumni always point toward Old Main. The *Arkansas Fight Song* was written in the late 1920's and is still sung at every football game. The university received the Razorback mascot in 1909 during a speech by the current football coach, Hugo Bezdek, when he referred to the team as "a wild bang of Razorback hogs," and in 1910, the student body voted to change the mascot from the Cardinals to the Razorbacks. The "calling of the Hogs" began in the 1920's, when several local farmers attending a football game decided to try to help a lagging team and yelled "Woo, Pig Sooie!" The school colors are cardinal red and white.

DEPARTMENT OF BIOLOGICAL & AGRICULTURAL ENGINEERING

In 1921, the University of Arkansas activated the Department of Agricultural Engineering to teach service courses and conduct applied research. The department was housed in Gray Hall, located where Mullins Library now stands. The department moved to the old campus infirmary, nicknamed "the old agriculture building" and now called the Agriculture Annex, in 1966, and finally to its current location in Engineering Hall in 1990 after a renovation of the building originally built in the early 1900's.

The first Bachelor of Science on Agricultural Engineering was conferred in 1950, with the first Master of Science in Agricultural Engineering following in 1952. The first Ph.D. degree was conferred in 1984.

To reflect the change in the Engineering field of study, the department's name was changed to Biological and Agricultural Engineering in 1988. In 1990, the B.S. and M.S. degrees were renamed to reflect the change in the curriculum and the new name of the department, and in 2002, were renamed again to Biological Engineering.

In 2003, the department received approval from the Arkansas Department of Higher Education to begin the M.S. in Biomedical Engineering program. This showed the department's continued goal of keeping up with the changes in the biological engineering research fields. The first M.S. in Biomedical Engineering was conferred in 2006.

The Biological and Agricultural Engineering Department is housed on the second floor of Engineering Hall. The main department office and all the faculty offices are located on the second floor. The department has use of two classrooms, two conference rooms, one computer lab, one student lab, and a study lounge. The department also has offices and labs at the Biological and Agricultural Lab, located on North Garland Avenue, and at the Engineering Research Center, located off South School Street.

City of Fayetteville and Northwest Arkansas

The City of Fayetteville recently ranked eighth in the Best Metro on Forbes Magazines "Best Places for Business and Careers," boasting a ranking of 12 and 16 for cost of doing business and job growth for 2007. Kiplinger's 2008 "Best Cities to Work, Live and Play" list featured Fayetteville as its number seven choice.

According to the 2010 census, Fayetteville has a population of 73,580 and is the third most populous city in Arkansas. It boasts a proud history, with several notable residents including authors Ellen Gilchrist (*In the Land of Dreamy Dreams*, 1981) and Donald Harrington (*The Cherry Pit*, 1965), Arkansas U.S. Senators J. William Fulbright and David Pryor, poet Miller Williams and his Grammy Award-winning songwriter daughter Lucinda, and noted architect E. Fay Jones.

The city of Fayetteville has many highlights, including the town square, where a farmer's market is held from April through November. Dickson Street is a main thoroughfare leading to the University of Arkansas and is

lined with shops and restaurants. The Walton Arts Center is a professional performing arts center and hosts many national and international fine art events throughout the year.

Many industry giants consider Northwest Arkansas home. Bentonville based Wal-Mart, is the world's largest public corporation by revenue, according to the 2008 Fortune Global 500. Founded by Sam M. Walton in 1962, it is the largest private employer in the world and the fourth largest utility or commercial employer. Lowell is the home for J.B. Hunt Transport Services, Inc., one of the largest truckload transportation companies in the United States, with annual revenues of over $2 billion. Tyson Foods, Inc. is based out of Springdale and is the world's largest processor and marketer of chicken, beef, and pork. With 2005 sales of $26 billion, Tyson Foods is the second-largest food production company in the Fortune 500, the largest meat producer in the world, and according to Forbes one of the 100 largest companies in the United States.

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 medications through biotechnology engineering; secure a health, safe environment through ecological engineering. A bachelor or science in biological engineering is excellent preparation for medical school.

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

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

- *Effectively apply engineering to biological systems and phenomena (plant, animal, human, microbial, and ecosystem) with demonstrated proficiency in basic professional and personal skills.*

- *Are well prepared for diverse careers in biological engineering, life-long learning, and professional and ethical contributions to society through sustained accomplishments in biomedical engineering, ecological and biotechnology.*

AREAS OF TECHNICAL EMPHASIS

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

BIOMEDICAL ENGINEERING

This emphasis focuses on nanomedicine, tissue engineering, organ regeneration and its clinical application, bioinstrumentation, biosensing/medical imaging, medical electronics, physiological modeling, biomechanics, and rehabilitation engineering. This area provides exceptional preparation for medical, veterinary, or dental school as well as for graduate programs in biomedical engineering.

BIOTECHNOLOGY ENGINEERING

This emphasis entails biotechnology at the micro and nano scale, food processing, food safety and security, development of new products from biomaterials, and biotransformation to synthesize industrial and pharmaceutical products.

ECOLOGICAL ENGINEERING

The integration of ecological principles into the design of sustainable systems for treatment, remediation, and prevention of pollution to the environment are key components of this area of emphasis. Stream restoration, watershed management, water and wastewater treatment design, ecological services management, urban greenway design, and enclosed ecosystem design are several applications used in this emphasis.

Each student is required to complete eighteen 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 twelve hours are classified as technical electives and consist mainly of upper-level courses in engineering, mathematics, and the sciences as approved by the student's advisor. The selected technical electives must include at least six hours of upper-level engineering courses, either within BENG or from other engineering departments. The department maintains a list of approved electives.

The areas of technical concentration and the recommended elective courses for each are listed beginning on page sixteen.

For more information, visit the website at http://www.baeg.uark.edu or contact the Department of Biological and Agricultural Engineering office at (479) 575-2351.

Teaching Program

Undergraduate Program

Areas of technical emphasis

The Biological Engineering curriculum has a choice of three areas of technical emphasis for students. The areas of technical emphasis and the recommended elective courses for each emphasis are listed below. This list contains courses required for the Bachelor of Science in Biological Engineering degree and a suggested course sequence. Some courses are not offered every semester, so students who deviate from the suggested sequence must pay close attention to course offerings each semester and the required pre-requisites for courses. Students are strongly encouraged to meet with their advisors on a regular basis.

Biomedical Engineering/Pre-Medical

Design Electives

BENG	3213	Biomedical Engineering: Emerging Methods & Applications*
BENG	4203	Biomedical Engineering Principles*

Technical Electives

BENG	4113	Risk Analysis for Biological Systems
BENG	4123	Biosensors and Bioinstrumentation
BENG	4233	Tissue Engineering
BENG	4243	Biomaterials
BENG	451VH	Honors Thesis
BIOL	4233	Genomics and Bioinformatics
ELEG	2904	Digital Design
HESC	3204	Nutrition for Health Professionals and Educators
KINS	3353	Mechanics of Human Movement

Choose one:

BIOL	2404	Comparative Vertebrate Morphology*
BIOL	2443/2441L	Human Anatomy*

Choose one:

BIOL	4234	Comparative Physiology
BIOL	2443/2441L	Human Physiology

*Students in the Pre-Medical Concentration **must** see a faculty advisor for alternate scheduling and elective course requirements. Pre-Medical students must take CHEM 3613/3611L (Organic Chemistry I) and CHEM 3603/3601L (Organic Chemistry II). This requires special scheduling of courses beginning in the first semester of the Sophomore year. Consultation with faculty advisors are greatly encouraged.*

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

Biotechnology Engineering

Design Electives

BENG	4123	Biosensors and Bioinstrumentation
BENG	4703	Biotechnology Engineering

Technical Electives

BENG	4113	Risk Analysis for Biological Systems
BENG	4233	Tissue Engineering
BENG	4243	Biomaterials
BENG	451VH	Honors Thesis
BIOL	4233	Microbial Genetics
BIOL	4313	Molecular Cell Biology
CHEG	3153	Non-equilibrium Mass Transfer
CHEG	4423	Automatic Process Control
CHEM	3453/3451L	Elements of Physical Chemistry
FDSC	3103	Principles of Food Processing
FDSC	4124	Food Microbiology
FDSC	4304	Food Chemistry
HESC	3204	Nutrition for Health Professionals and Educators
MEEG	4413	Heat Transfer

Ecological Engineering

Design Electives

BENG	4903	Watershed Eco-Hydrology
BENG	4923	Ecological Engineering Design

Technical Electives

BENG	4113	Risk Analysis for Biological Systems
BENG	451VH	Honors Thesis
BENG	4133	Digital Remote Sensing and GIS
BENG	4803	Precision Agriculture
BIOL	3863/3861L	General Ecology
CVEG	3223	Hydrology
CVEG	3243	Environmental Engineering
CVEG	4243	Environmental Engineering Design
CSES	2203	Soil Science
CSES	4043	Environmental Impact and Fate of Pesticides
ENSC	4043	Analysis of Environmental Contaminants

BIOLOGICAL ENGINEERING CURRICULUM

2011-2012 COURSE CATALOG

The following is a list of courses required for the Bachelor of Science in Biological Engineering degree and a suggested course sequence. Some courses are not offered every semester, so students who deviate from the suggested sequence must pay close attention to course offerings each semester and the required pre-requisites for courses. Students are strongly encouraged to meet with their advisors on a regular basis. Students with a Pre-medical focus area must see a faculty advisor for alternate scheduling and elective course requirements.

FRESHMAN YEAR

FIRST SEMESTER

GNEG 1111 Introduction to Engineering I
ENGL 1013 Composition I
CHEM 1103 University Chemistry I
MATH 2554 Calculus I
PHYS 2054 University Physics I

*Total of **15 Semester hours***

SECOND SEMESTER

GNEG 1121 Introduction to Engineering II
ENGL 1023 Technical Composition II
Freshman Engineering Science Elective*
MATH 2564 Calculus II
Humanities/Social Science Elective

Total of 15 Semester Hours

SOPHOMORE YEAR

FIRST SEMESTER

BENG 2612 Biological Engr Design Studio II
Sophomore Science Elective**
MATH 2574 Calculus III
CHEM 3603 Organic Chemistry I
CHEM 3601L Organic Chemistry I Lab
GNEG 1122 Introduction to CAD

Total of 16 Semester Hours

SECOND SEMESTER

BENG 2622 Biological Engineering Design Studio III
MATH 3404 Differential Equations
CHEM 3613 Organic Chemistry II
CHEM 3611L Organic Chemistry II Lab
MEEG 2003 Statics
BIOL 2013 General Microbiology
BIOL 2011L General Microbiology Lab

Total of 17 Semester Hours

JUNIOR YEAR

FIRST SEMESTER

BENG 3712 Engineering Properties of Biological Materials
CHEM 3813 Introduction to Biochemistry
MEEG 2403 Thermodynamics, or CHEG 2313 Thermodynamics of Single Component Systems
MEEG 3013 Mechanics of Materials
CVEG 3213 Hydraulics, or MEEG 3503 Mechanics of Fluids, or CHEG 2133 Fluid Mechanics
Technical Elective

Total of 17 Semester Hours

Second Semester

BENG 3723 Unit Operations in Biological Engr
BENG 3803 Mechanical Design in Biological Engr
BENG 4104 Instrumentation in Biological Engr
BENG Design elective
U.S. History Requirement
ENGL 2003 Advanced Composition or Exemption

Total of16 Semester hours

SENIOR YEAR

FIRST SEMESTER

BENG 4813 Senior Biological Engr Design I
BENG 3733 Transport Phenomena in Biological Systems
BENG Design Elective
Technical Elective
Humanities/Social Science Elective

*Total of **18 Semester hours***

SECOND SEMESTER

BENG 4822 Senior Biological Engr Design II
Humanities/Social Science Elective
Technical elective

*Total of **14 Semester hours***

128 TOTAL HOURS REQUIRED

Teaching Program

Undergraduate Program

Graduates for 2011

Bachelor of Science in Biological Engineering

Spring 2011

Nicholas Blazic
Joseph Chidiac
Evan Childress
Danielle Frechette
Oscar Guevara Ortiz
Yamama Hafeez
Nathan Holeman
James Kelly
Haley Malle
Caroline Powell
Katherine Rutledge
Jacob Taylor
Kaitlyn Terrell
Clark Trapp
Casey Vickerson
Jeff Welch

Summer 2011

Zachary Callaway
Tai Wen Chou
William Scott

Fall 2011

Alvaro Perez

Biological Engineering Student Club

2011-2012 Officers

William Putman—*President*

Iain Bailey—*Vice President*

Ismael Mojica—*Treasurer*

Mary Bonaduce—*Secretary*

Advisors: Dr. Lalit Verma and Dr. Scott Osborn

Biomedical Engineering Student Club

2011-2012 Officers

Abby Washispack—*President*

Jimmy Vo—*Vice President*

Saumil Shah—*Treasurer*

Katelin Cherry—*Secretary*

Advisor: Dr. David Zaharoff

Ecological Engineering Student Club

2011-2012 Officers

Chris Randall—*President*

Morgan Welch—*Vice President*

Jana Hindman—*Treasurer*

Paige Heller—*Secretary*

Advisors: Dr. Marty Matlock

Scholarship Recipients for 2011

Arkansas Academy of Biological & Agricultural Engineering Scholarship

Danielle Frechette *(Sp 2010)*
Shiloh Hurd *(Sp 2010)*
Anh Vu *(Fall 2011)*
Jackson Daniel *(Fall 2011)*

Biological & Agricultural Engineering Departmental Scholarship

Iain Bailey *(Fall 2011)*
Ashley Kiene *(Fall 2011)*
Colby McWhorter *(Fall 2011)*
Kristin Perrin *(Fall 2011)*
Nathan Redding *(Fall 2011)*
Heather Sandefur *(Fall 2011)*
Saumil Shah *(Fall 2011)*

Billy Bryan Scholarship

Tai-Wen Chou *(Sp 2010)*
Colby McWhorter *(Fall 2011)*
Hannah Perkins *(Fall 2011)*
Kristin Perrin *(Fall 2011)*
Chris Randall *(Fall 2011)*
William Ryan *(Sp 2010)*
Lauren Tessaro *(Fall 2011)*

Xzin McNeal Scholarship

Joseph Chidiac *(Sp 2010)*
Alvaro Claure *(Fall 2011)*
Yamama Hafeez *(Sp 2010)*
Paige Heller *(Sp 2010)*
Kelly Holmes-Smith *(Sp 2010)*
James Kelly *(Sp 2010)*
Chris McDaniel *(Sp 2010)*
Amy Powless *(Sp 2010)*
Heather Sandefur *(Fall 2011)*
Lauren Wilson *(Fall 2011)*

J.A. Riggs Tractor Company Scholarship

Kayle Arkangel *(Sp 2010)*
Nick Blazic *(Sp 2010)*
Shiloh Hurd *(Fall 2011)*
Christopher McDaniel *(Fall 2011)*
Charles Walker *(Fall 2011)*
Lauren Wilson *(Fall 2011)*

MASTER OF SCIENCE IN BIOLOGICAL ENGINEERING

FOREWORD

The Department of Biological and Agricultural Engineering 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:

- Develop the ability to comprehend and apply engineering principles in order to solve problems in research, development and design.
- Obtain sufficient understanding of the mathematical, physical and biological sciences for comprehension of literature in these and related fields.
- Acquire the skills required to use appropriate equipment, including instruments and computers, in solving problems in their areas of interest.
- 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

Admission to the M.S.B.E. program is a three-step process. First, the prospective student must be granted admission to the University of Arkansas Graduate School. Second, the prospective student must be accepted into the department's program which depends on transcripts, recommendations, a statement of purpose, and the following additional requirements:

- A cumulative GPA in the last sixty hours of course work of 3.0.
- A cumulative GRE score of 1100 or higher (verbal and quantitative combined).
- A TOEFL score of at least 550 (paper-based), 213 (computer -based), or 80 (internet-based). This requirement is waived for applicants whose native language is English or earned a bachelor's or master's degree from a U.S. institution.
- An eligible member of the faculty (graduate status of group II or higher) must agree to serve as the major advisor to the prospective student.

Third, the prospective student will only be admitted to the M.S. program provided engineering competence can be demonstrated by satisfying one of the following criteria:

- Receipt of a B.S. degree in engineering from a program accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET) or equivalent.
- Completion of 18 hours of additional undergraduate course work (deficiency courses) in addition to the Master's program requirements (additional hours may be required for course pre-requisites).

More detail on admission requirements may be found at http://catalogofstudies.uark.edu/.

Teaching Program

Graduate Program

Master of Science in Biomedical Engineering

Foreward

The Master of Science in Biomedical Engineering is a multidisciplinary degree program designed for students from a multitude of academic areas. The objectives of the M.S.B.M.E. program are to prepare graduates for careers in biomedical engineering practice with government agencies, engineering firms, or industries and to provide a foundation for continued study at the past-masters level. This program focuses on Bioimaging and Biosensing; Bioinformatics and Computational Biology; Tissue Engineering and Biomaterials; and Bio-MEMS/ Nanotechnology.

Admission Requirements

In general, admission to the Biomedical Engineering Graduate Program is a multiple-step process. First, the prospective student must be admitted to graduate standing by the University of Arkansas Graduate School. Second, the student must be accepted into the Biomedical Engineering Program, which depends on transcripts, recommendations, a statement of purpose, and the following GPA and test scores.

Basic Requirements

Engineering Academic Background: The admission requirements for students with an ABET-accredited BS degree in engineering are: a minimum GRE of 1100 and a GPA of 3.0 or greater.

Non-Engineering Academic Background: Students with a BS or MS degree in a non-engineering background can also pursue the MS in Biomedical Engineering. The admission requirements are: a minimum GRE of 1100 and a GPA of 3.0 or greater. In addition, these students will be required to complete these courses prior to enrollment in the program or before the end of year one at UA:

Calculus I
Calculus II
Ordinary Differential Equations
General Chemistry
University Physics I

The Student's Graduate Committee will make a recommendation on the Plan of Study.
Finally, a member of the faculty who is eligible (graduate status of group II or higher) must agree to serve as a major advisor to the prospective students concerning admission for both international and domestic students are provided in the UA Graduate School Handbook.

Doctor of Philosophy In Biological Engineering

Admission Requirements

In addition to the requirements of the University of Arkansas Graduate School, admission to the departmental aspect of the PhD program depends strongly on the judgment of the individual professor who will serve as the graduate advisor. The minimal admission criteria are as follows:

- A GRE score of 1100 or above (verbal and quantitative).
- A TOEFL score of at least 550 (paper-based), 213 (computer-based), or 80 (internet-based). This requirement is waived for applicants whose native language is English or who earn a bachelor's or master's degree from a U.S. institution.
- A member of the faculty who is eligible (graduate status of group II or higher) must agree to serve as major advisor to the prospective student.
- A Master of Science degree in Engineering with a thesis.

Prospective PhD students may decide to go directly from a bachelor's degree to the PhD program if the following criteria are met:

- A cumulative GPA in the last sixty hours of 3.5.
- A minimum GRE score of 1200.
- A Bachelor of Science in Engineering from an ABET accredited program.

Students with a non-engineering B.S. degree may be considered for conditional admissions into the Ph.D. program provided they meet the criteria outlined below. Otherwise, they need to start an M.S. program first. The Departmental Graduate Committee will make a specific recommendation to the Department Head.

Conditional admission criteria: The following are the minimum criteria for the conditional admission to PhD program for students with non-engineering B.S. degree:

- GPA: 3.50 or higher for the baccalaureate degree
- GRE Scores: 1300 (Quantitative + Verbal) with 700 or higher in Quantitative; 5 or higher in
- Writing.
- TOEFL: 580 (or equivalent) or higher (for international applicants only)
- Students must earn credit for the following 18 hours of coursework including credit for all prerequisites listed in the undergraduate catalog:

DOCTOR OF PHILOSOPHY IN BIOLOGICAL ENGINEERING

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.

Minimum of 3 credit hours of 3000 level or above of BENG engineering ***design*** courses currently allowed for credit within the BENG undergraduate program.

Specific deficit courses are to be determined in consultation with the student's major advisor and advisory committee. Additional deficiency courses may be required for students with insufficient coursework in a critical area (such as life sciences).

Upon completion of the required conditions, the conditional status will be removed and the students will be fully admitted to the BAEG PhD program.

More detail on admission requirements may be found at http://catalogofstudies.uark.edu/.

Teaching Program

Graduate Programs

Graduate Students

The following students were part of the Graduate program during 2011. Several students cannot be listed due to limitations of the Family Educational Rights and Privacy Act (FERPA). Faculty advisors provided support and planning to the students throughout their career in the Department of Biological and Agricultural Engineering.

Master of Science in Biological Engineering

Hua Bai	Dr. Yanbin Li
Prathamesh Bandekar	Dr. Sreekala Bajwa
Bryan Bailey	Dr. Brian Haggard
Amber Brown	Dr. Marty Matlock
Eric Boles	Dr. Marty Matlock
Zachary Callaway	Dr. Yanbin Li
Angele Mezindjou Dijoleu	Dr. Julie Carrier
Nathan Holeman	Dr. Tom Costello
Min Lei	Dr. Yi Liang
Ryan Johnston	Dr. Marty Matlock
Caroline Powell	Dr. Marty Matlock
George Sakhel	Dr. Jin-Woo Kim
Gurdeep Singh	Dr. Dharmendra Saraswat

Master of Science in Biomedical Engineering

Student	Advisor
Luke Brockman	Dr. Yanbin Li
Jonathan Earls	Dr. Kaiming Ye
Pantrika Krisanarungson	Dr. Sha Jin
Michael May	Dr. Christa Hestekin
Sruthi Ravindranathan	Dr. David Zaharoff
Alexander Ziegler	Dr. Sreekala Bajwa

Master of Science in Cell and Molecular Biology

Student	Advisor
Hanan Alismail	Dr. Sha Jin
Iaryna Maskiuk	Dr. Kaiming Ye
Jingjing Zhao	Dr. Yanbin Li

Master of Science in Environmental Engineering

Student	Advisor
Ben Holden	Dr. Sreekala Bajwa
John Metrailer	Dr. Brian Haggard

Doctor of Philosophy in Biological Engineering

Student	Advisor
Kris Bunnell	Dr. Julie Carrier
Mary Kate Herzog	Dr. Marty Matlock
John Judkins	Dr. Jin-Woo Kim
Bhanuprasanth Koppolu	Dr. David Zaharoff
Mansoor Leh	Dr. Sreekala Bajwa
Naresh Pai	Dr. Dharmendra Saraswat
Pratyush Rai	Dr. Vajay Vardan
Mahmoud Sharara	Dr. Samy Sadaka
Sean Smith	Dr. David Zaharoff

Doctor of Philosophy in Cell and Molecular Biology

Student	Advisor
Nalinikanth Kotagiri	Dr. Jin-Woo Kim
Ngoc Thien Lam	Dr. Kaiming Ye
Jacob Lum	Dr. Yanbin Li
Huantong Yao	Dr. Sha Jin
Weiwei Wang	Dr. Sha Jin
Lu Zhang	Dr. Kaiming Ye

GRADUATE STUDENT ADVISEES IN OTHER AREAS

The following students are participating in other programs across the university with a member of the department's faculty serving in an advising role. Several students cannot be listed due to limitations of the Family Educational Rights and Privacy Act (FERPA).

STUDENT	PROGRAM	ADVISOR
Jacob Anderson	MS Horticulture	Dr. Brian Haggard
Jamar Blackmon	Ph.D. Electrical Engineering	Dr. Sreekala Bajwa
Siva Chalamalasetty	MS Microelectronics-Photonics	Dr. Yanbin Li and Dr. Kaiming Ye
Jason Davis	MS Agri, Food & Life Science	Dr. Samy Sadaka
Zhuxin Dong	PhD Mechanical Engineering	Dr. Kaiming Ye
Micah Doubledee	MS Plant Pathology	Dr. Sreekala Bajwa
John Fohner	MS Crop, Soil & Environmental Science	Dr. Brian Haggard
Shrijeeta Ganguly	PhD Biology	Dr. Brian Haggard
Erin Grantz	MS Crop, Soil & Environmental Science	Dr. Brian Haggard
Orain Hibbert	MS Micoelectronics– Photonics	Dr. Jin-Woo Kim
Jacob Hohnbaum	MS Mechanical Engineering	Dr. Jin-Woo Kim
Liang Huang	PhD Electrical Engineering	Dr. Kaiming Ye
Eric Krueger	PhD Physics	Dr. Kaiming Ye
Anirudh Ladha	MS Computer Science	Dr. Dharmendra Saraswat
Lucas Leshe	MS Horticulture	Dr. Samy Sadaka
Katherine McCoy	MS Civil Engineering	Dr. Brian Haggard
John Metrailer	MS Environmental Engineering	Dr. Brian Haggard
Irene Pagana	MS Food Science	Dr. Julie Carrier
Leigh Parette	PhD Poultry Science	Dr. Yanbin Li
Soloman Parker	MS Civil Engineering	Dr. Brian Haggard
Colin Reinhardt	MS Geology	Dr. Brian Haggard
Husein Rokadia	PhD Mechanical Engineering	Dr. Jin-Woo Kim
Erin Scott	MS Crop, Soil & Environmental Science	Dr. Brian Haggard
Balaji Srinivasan	PhD Mechanical Engineering	Dr. Jin-Woo Kim and Dr. Yanbin Li

Teaching Program

Graduate Programs

Graduate Degrees Earned

The following students completed all requirements for their degree program and were awarded a degree from the University of Arkansas.

Mansoor Leh
Ph.D., Biological Engineering
Dr. Sreekala Bajwa
Dissertation: "Quantification of Sediment Sources in a Mixed Land Use Watershed: A Remote Sensing and Modeling Approach"

Bryan Bailey
M.S., Biological Engineering
Dr. Brian Haggard
Dissertation: "Water Quality Trends for Section 319 Priority Watersheds in Northwest Arkansas, 1997-2010"

Naresh Pai
Ph.D., Biological Engineering
Dr. Dharmendra Saraswat
Dissertation: "Geospatial Tools and Techniques for Watershed Management Using SWAT 2009"

The following courses are taught as part of the Biological and Agricultural Engineering curriculum for the Undergraduate, Master's, and Ph.D. programs.

BENG2612 Biological Engineering Design Studio II
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 use of watershed modeling tools. 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. Prerequisite: GNEG 1121. Pre- or Co-requisite: PHYS 2054, BIOL 1543/1541L.

BENG2622 Biological Engineering Design Studio III
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.

BENG3104 Electronic Instrumentation for Biological Systems
Theory and advanced applications of analog circuits, digital circuits, and commercial instruments involving biological materials and systems. Lecture 3 hours, laboratory 3 hours per week. Prerequisite: PHYS 2074.

BENG3104H Honors Electronic Instrumentation for Biological Systems
Theory and advanced applications of analog circuits, digital circuits, and commercial instruments involving biological materials and systems. Lecture 3 hours, laboratory 3 hours per week. Prerequisite: PHYS 2074.

BENG3712 Engineering Properties of Biological Materials
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.

BENG3213 Biomedical Engineering: Emerging Methods and Applications
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, nanodrug delivery and nanotechnology based disease detection. Lecture 3 hours per week. Prerequisite: BIOL 2533. Pre- or Co-requisite: BENG 3723.

BENG3723 Unit Operations in Biological Engineering
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. Co-requisite: Lab component. Prerequisite: (MEEG 2403 or CHEG 2313) and (CVEG 3213 or CHEG 2133 or MEEG 3503).

BENG3803 Mechanical Design in Biological Engineering
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. Co-requisite: Lab component. Prerequisite: MEEG 3013.

BENG4113 Risk Analysis for Biological Systems
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
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. Co-requisite: Lab component. Prerequisite: BIOL 2013 and BENG 4103.

BENG4133 Digital Remote Sensing and GIS
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.

BENG4203 Biomedical Engineering Principles
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.

BENG4233 Tissue Engineering
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. Co-requisite: lab component. Prerequisite: MATH 3404 and CHEM 3813.

BENG4223 Numerical Methods in Biomedical Engineering
Application of mathematical techniques and numerical methods for analyzing biological data and solving biological problems. The emphasis will be computer simulation and mathematical modeling applications in biomedical engineering. Prerequisite: MATH 3404.

BENG4243 Biomaterials
Study of different classes of biomaterials and their interactions with human tissues. From absorbable sutures to Ziconium alloy hip implants, biomaterials science influences nearly every aspect of medicine. Topics include: biocompatibility factors: natural and synthetic biopolymers, ceramics and metals, orthopedic, dental and cardiovascular implants; ophthalmological and dermatological materials; degradable polymers for drug delivery; nanobiomaterials; smart biomaterials and the regulation of devices and materials by the FDA. Three lectures per week. Prerequisite: (BENG 3712 or MEEG 2103) and MEEG 3013

BENG4283 Electronic Response of Biological Tissues
Understand the electric and magnetic response of biological tissues with particular reference to neural and cardiovascular systems. Passive and active forms of electric signals in cell communication.. We will develop the central electrical mechanisms from the membrane channel to the organ, building on those excitation, dielectric models for tissue behavior, Debye, Cole-Cole models. Role of bound and free water on tissue properties. Magnetic response of tissues. Experimental methods to measure tissue response. Applications to Electrocardiography & Electroencephalography, Microwave Medical Imaging, RF Ablation will be discussed that are common to many electrically active cells in the body. Analysis of Nernst equation, Goldman equation, linear cable theory, and Hodgkin-Huxley Model of action potential generation and propagation. High frequency response of tissues to microwave.
Prerequisites: ELEG 3703 or equivalent; MATH 3404 or equivalent;
basic biology. (Same as ELEG 4773)

BENG450V Special Problems (I-V)
Selected problems in biological engineering are pursued in detail. Prerequisite: senior standing. May be repeated for 4 hours.

BENG451VH Honors Thesis (1-6)
Prerequisite: Honors candidacy.

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

BENG4703 Biotechnology Engineering
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).

BENG4813 Senior Biological Engineering Design I
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. Co-requisite: Lab component. Prerequisite: consent of instructor. Prerequisite: BENG 3723. Pre- or Co-requisite: BENG 3733.

BENG4822 Senior Biological Engineering Design II
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 Watershed Eco-Hydrology
Engineering principles involved in assessment and management of surface water flow and hydrologic processes within ecosystems. Includes frequency analysis of rainfall, infiltration, runoff, evapotranspiration. Use of GIS/mathematical models to quantify hydrologic processes at the watershed landscape scale. Design/implementation of best management practices and ecological engineering principles and processes for advanced ecological services. Lecture 3 hours per week. Prerequisite: CVEG 3213.

BENG4923 Ecological Engineering Design
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, and 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 coexistence of urban and agricultural land uses. Lecture 3 hours per week. Prerequisite: BENG4903.

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

BENG5103 ADVANCED INSTRUMENTATION IN BIOLOGICAL ENGINEERING
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. Co-requisite: Lab component. Prerequisite: BENG 4103.

BENG5113 DIGITAL REMOTE SENSING AND GIS
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. Co-requisite: Lab component. Prerequisite: MATH 3404.

BENG5203 MATHEMATICAL MODELING OF PHYSIOLOGICAL SYSTEMS
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
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
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, Opthalmology, Orthopedic Surgery, and Radiology. Prerequisite: graduate standing and approval of coordinator.

BENG5233 TISSUE ENGINEERING
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. Co-requisite: lab component. Prerequisite: MATH 3404 and CHEM 3813.

BENG5243 BIOMATERIALS
Study of different classes of biomaterials and their interactions with human tissues. From absorbable sutures to Ziconium alloy hip implants, biomaterials science influences nearly every aspect of medicine. Topics include: biocompatibility factors: natural and synthetic biopolymers, ceramics and metals, orthopedic, dental and cardiovascular implants; ophthalmological and dermatological materials; degradable polymers for drug delivery; nanobiomaterials; smart biomaterials and the regulation of devices and materials by the FDA. Three lectures per week. Students may not earn credit for both BENG 5243 and 4243 Prerequisite: (BENG 3712 or MEEG 2103) and MEEG 3013

BENG5253 BIO-MEMS
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
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.

BENG5273 NUMERICAL METHODS IN BIOMEDICAL ENGINEERING
Application of mathematical techniques and numerical methods for analyzing biological data and solving biological problems. The emphasis will be computer simulation and mathematical modeling applications in biomedical engineering. Lecture 3 hours per week. Students may not earn credit for both BENG 5273 and BENG 4223. Prerequisite: MATH 3404.

BENG5283 ELECTRONIC RESPONSE OF BIOLOGICAL TISSUES
Understand the electric and magnetic response of biological tissues with particular reference to neural and cardiovascular systems. Passive and active forms of electric signals in cell communication. We will develop the central electrical mechanisms from the membrane channel to the organ, building on those that are common to many electrically active cells in the body. Analysis of Nernst equation, Goldman equation, linear cable theory, and Hodgkin-Huxley Model of action potential generation and propagation. High frequency response of tissues to microwave excitation, dielectric models for tissue behavior, Debye, Cole-Cole models. Role of bound and free water on tissue properties. Magnetic response of tissues. Experimental methods to measure tissue response. Applications to Electrocardiography & Electroencephalography, Microwave

Medical Imaging, RF Ablation will be discussed. Students may not receive credit for both BENG 4183 BENG 5283. Prerequisites: MATH 3404, ELEG 3703 PHYS 3414, BIOL 2533 or equivalent (Same as ELEG 5773)

BENG5303 FUNDAMENTALS OF BIOMASS CONVERSION (FA)
Web-based overview of the technology involved in the conversion of biomass to energy, including associated sustainability issues. Overview of biomass structure and chemical composition; biochemical and thermochemical conversion platforms; issues, such as energy crop production related to water consumption and soil conservation. Further topics include: biomass chemistry, logistics and resources; biological processes; and thermochemical processes. Two web-based lectures/meetings per week. Prerequisite: Graduate standing or instructor consent.

BENG5303 FUNDAMENTALS OF BIOMASS CONVERSION (FA)
Web-based overview of the technology involved in the conversion of biomass to energy, including associated sustainability issues. Overview of biomass structure and chemical composition; biochemical and thermochemical conversion platforms; issues, such as energy crop production related to water consumption and soil conservation. Further topics include: biomass chemistry, logistics and resources; biological processes; and thermochemical processes. Two web-based lectures/meetings per week. Prerequisite: Graduate standing or instructor consent.

BENG5313 FUNDAMENTALS OF BIOPROCESSING (SP)
This course covers the fundamentals of mass and energy balances, fluid dynamics, heat and mass transfer, as applied to Bioprocessing. The microbial growth, kinetics and fermenter operation as applicable to Bioprocessing will be covered in this course. Industrial Bioprocessing case studies that involve the integration of the course contents will be discussed. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non-UA faculty member at a participating university. Prerequisite: MATH 2554, CHEM 3813, and PHYS 2054.

BENG5323 BIOSEPARATIONS (EVEN YEARS, SP)
Study of separations important in food and biochemical engineering such as leaching, extraction, expression, absorption, ion exchange, filtration, centrifugation, membrane separation, and chromatographic separations. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non-UA faculty member at a participating university. Prerequisite: Instructor Consent.

BENG5333 BIOCHEMICAL ENGINEERING (ODD YEARS, SP)
The analysis and design of biochemical processing systems with emphasis on fermentation kinetics, continuous fermentations, aeration, agitation, scale up, sterilization, and control. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non-UA faculty member at a participating university. Prerequisite: Instructor Consent Required.

BENG5343 ADVANCED BIOMASS THERMOCHEMICAL CONVERSION (ODD YEARS, FA) Advanced study, evaluation, and application of thermochemical conversion pathways in biofuel production. Specific topics include biomass gasification, pyrolysis, liquefaction, and heterogeneous catalysts. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non-UA faculty member at a participating university. Prerequisite: Instructor Consent.

BENG5351 SUSTAINABILITY SEMINAR (SU) Topics in environmental sustainability, green engineering, life cycle analysis, sustainable development and sustainability science. This course is offered on -line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non-UA faculty member at a participating university. Prerequisite: CHEM 1123.

BENG5613 SIMULATION MODELING OF BIOLOGICAL SYSTEMS
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
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. Co-requisite: Lab component.

BENG5723 FOOD SAFETY ENGINEERING
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
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
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
Reports presented by graduate students on topics dealing with current research in agricultural engineering. Prerequisite: graduate standing.

BENG5923 NONPOINT SOURCE POLLUTION CONTROL AND MODELING
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
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 WATERSHED ECO-HYDROLOGY
Engineering principles involved in assessment and management of surface water flow and hydrologic processes within ecosystems. Includes frequency analysis of rainfall, infiltration, runoff, evapotranspiration. Use of GIS/mathematical models to quantify hydrologic processes at the watershed landscape scale. Design/implementation of best management practices and ecological engineering principles and processes for advanced ecological services. Lecture 3 hours per week. Students may not earn credit for both BENG 5943 and BENG 4903. Prerequisites: CVEG 3213 or equivalent.

BENG5953 ECOLOGICAL ENGINEERING DESIGN
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: BENG 4903 or equivalent.

BENG600V MASTER'S THESIS (1-6)
Prerequisite: graduate standing.

BENG700V DOCTORAL DISSERTATION (1- 18)
Prerequisite: candidacy.

Research Projects

Biomedical Engineering

Regenerative Biomaterials Lab

Jeff Wolchok, Assistant Professor

Our group is developing cell-derived biomaterials that, unlike synthetics, can be remodeled by the body's own wound healing machinery. To create this type of material, we are developing innovative approaches to concentrate and collect the extracellular matrix secreted by populations of cells (primary of stem cells) during growth in culture. By combining various cell types (cardiac, musculoskeletal, neural) with any number of culture conditions (growth factors, mechanical stimulation, topographical cues) we can create a range of materials, each with a potentially different clinical target. We are currently evaluating the use of these materials for the repair of damaged vocal and muscle tissues.

Contact: Jeff Wolchok, Assistant Professor, Department of Biological & Agricultural Engineering
jwolchok@uark.edu / 479-575-2850

Vaccine and Immunotherapy Delivery

David Zaharoff, Assistant Professor

Our laboratory designs and develops novel, translatable delivery systems for vaccines and immunotherapies. Our delivery systems often exploit both natural and engineered biomaterials to control the context in which antigens and cytokines are introduced to the immune system. Controlling delivery allows us to manipulate immunity and limit systemic side effects. We exploit multi-disciplinary concepts in transport phenomena, biomaterials engineering, immunology, chemistry, physics, biology and nanotechnology. Our primary focus is in the treatment of cancer with minor efforts in combating illicit drug addiction and infectious diseases.

Contact:
David Zaharoff, Assistant Professor,
Department of Biological & Agricultural Engineering
zaharoff@uark.edu / 479-575-2005

Tissue Engineering and Stem Cell Lab

Kaiming Ye, Associate Professor

The Tissue Engineering and Stem Cell Lab focuses on tissue engineering and regenerative medicine. The research projects involve the building of 3D scaffolds for directing stem cell lineage-specific differentiation. The lab also focuses on vaccine development and nanomedicine, especially targeted and controlled drug delivery for cancer treatment.

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Disease Control and Treatment Lab (DCTL)

Sha Jin, Assistant Professor

The emergence of induced pluripotent stem cells (iPSC) technology raises hope of generating patient-specific cells for cell replacement therapy. The clinical application of these cells necessitates the development of new technologies that enable the human pluripotent stem cells (HPSCs)-human embryonic stem cells (hESCs)/iPSCs-maintenance and differentiation under chemically defined or xeno-free conditions due to safety concern of the use of animal-derived products in current HPSC maintenance and differentiation systems. To address these challenges, the DCTL is testing a number of technologies for long-term maintenance of HPSCs in chemically defined medium for clinical applications. The capability of maintaining and further differentiating HPSCs into clinically relevant cell lineages under xeno-free conditions will offer renewable cell sources for cell replacement therapy to treat many diseases that are otherwise incurable with traditional medicines.

In parallel, DCTL explores a new technology stemming from membrane-based cell culture systems. The study performed in the lab demonstrated that not only proliferation but also lineage-specific differentiation of HPSC can be considerably enhanced when tissue engineered membrane substrates are used to support HPSC growth and differentiation. These results suggested that a membrane substrate can offer better physicochemical cues for enhancing in vitro hESC attachment, proliferation, and differentiation.

DCTL also works on generating transplantable β cells for insulin deficient diabetes treatment. Extracellular matrix is a key component of the stem cell niche in vivo and can influence stem cell fate, such as attachment, migration, and differentiation. The studies performed in DCTL demonstrated that the pancreatic differentiation of ECS can benefit from three dimensional (3D) cultures. The lab is currently testing various biomaterials for constructing optimized tissue niches for hESC pancreatic lineage specification.

Influenza virus continues threaten human health and lives. To address this challenge, the DCTL is collaborating with other lab in the college to a new fashion of influenza vaccine using a protein surface display technology.

Contacts:
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Nanoparticles and Self-Assembled Nanocomposites for Multiplex, Multimodal Nanotheranostics

Jin-Woo Kim, Professor

ISSUE:
Many therapeutic and diagnostic – termed "theranostic" – modalities have been developed to detect and treat tumors and infections. However, it is still far from ideal to realize their early diagnosis and treatment despite recent progresses. There is a great need for new technologies, which will enable us to overcome these huddles and serve as innovative, integrated theranostic tools with increased sensitivity and specificity for the early diagnosis and treatment of tumors and infections. Recent advances in nanotechnologies have shown promises to address this significant clinical need. However, there are still many challenges that persist and most of the existing nanotechnology-based approaches are not clinically relevant as of yet. Significant challenges of the current nanotechnology-based approaches include low targeting sensitivity and specificity, treatment efficiency, toxicity concerns, and insufficient theranostic devices among many others.

ACTION:
To meet the challenge, our group is in the process of developing noninvasive theranostic platforms by uniquely combining novel nanoparticles (NPs) and their composites, and real-time integration of various theranostic modalities for effective medical diagnosis and treatment. multifunctionalities.

This includes developing a versatile and environmentally friendly means to synthesize and assemble various NPs and their composites with control over their structural configuration, and realizing accurate, scalable and high-rate self-assembly of biocompatible hybrid nanotheranostic agents with desirable

IMPACT:
This technology, if successfully developed, would provide an effective and efficient route to a "second-generation" multifunctional nano-architecture with properties that are "programmable/customizable" on the basis of the target biomedical applications. The research has generated over 8 publications and presentations, 1 pending patent, and 1 provisional patent during the year 2011.

FUNDING: Arkansas Bioscience Institute (ABI)

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Micro/Nanoscale Bio/Abio Interfacing Technology

Jin-Woo Kim, Professor

ISSUE:
The biomaterials, including DNA, proteins, and cells, are well optimized through evolution, exhibiting unique recognition, transport, catalytic, and replication properties. Instead of reinventing the wheels, the integration of such pre-engineered biomaterials into nano systems would lead to the realization of the next generation bio/abio hybrid engineered systems for applications raging from MEMS/NEMS to biosensing and nanomedicine. However, the major challenges for making this merger feasible are integration and interfacing of the micro- and nanoscale biological and abiological materials at similar scales. The successful development of interfacing techniques for their integration is imperative to overcome the challenges.

ACTION:
Currently, we are in the process of developing technical platforms for 'controllable' interfaces between biological materials, such as nucleotides, proteins, cells, and abiological materials, such as nanoparticles, at the nanoscale.

Also a series of nano hybrid devices are being developed through the stable and controllable interfacing technology: (a) a nano flagellar motor based AC dynamo (nFMD), (b) a nano flagellar motor based TNT detection system (nFMTNT), (c) a DNA-based CNT wire (DNA/NTW) nanosensor, and (d) a photoacoustic and photothermal theranostic system using near-infrared responsive nanoparticles.

IMPACT:
These projects are important steps towards realization of the bio/nano nanotechnology that bridges the sciences of biology, medicine, nano-materials, and MEMS/NEMS by pairing their advantages. The research has generated over 4 publications and presentations, and 1 provisional patent during the year 2011.

FUNDING: National Science Foundation (NSF; award #: ECCS-1137948) and Arkansas Bioscience Institute (ABI)

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Nanoparticles based Optical Biosensor for Simultaneous Detection of Multiple Pathogens in Foods

Jin-Woo Kim, Professor

Issue

Contaminated food, mainly by pathogenic microorganisms, is estimated to cause 76 million illnesses, 325,000 serious illnesses resulting in hospitalization, and 5,000 deaths in the US each year. USDA/ERS estimates the medical costs and productivity losses associated with *E. coli* O157, *Salmonella*, *Listeria monocytogenes* and *Campylobacter* alone amount to at least $6.9 billion annually. Current methods for detection of bacteria rely upon culture plating, ELISA and PCR. However, these methods are time consuming, expensive, or not specific, and require trained operators with laboratory facilities. There is an urgent need for rapid method in detection of major foodborne pathogens.

Action

The objective of this project is to develop a nanoparticle-based fluorescent biosensor for rapid and simultaneous detection of three bacterial pathogens in foods. The biosensor system consists of a novel nanobeads bioseparator, novel quantum dots biolabels, and a fluorescent detector. The nanotechnology based biosensor is evaluated for the food industry to screen *E. coli* O157, *Salmonella*, and *L. monocytogenes* in poultry, meat and vegetables, specifically ready-to-eat food products. The result showed that magnetic immuno-nanobeads could capture target pathogenic bacteria in foods with more than 90% capture efficiency in 15 min, which is advantageous over magnetic immuno-microbeads as well as centrifuge and filtration. Quantum dots nanoparticals were coated with anti-pathogen antibody and used as fluorescence labels in the immunosensor, which gave more than 100 times fluorescence emission compared to common fluorescent materials used in immunoassays.

The fluorescent intensity measured is proportional to the concentration of target bacterial cells in a range of 1 to 10^6 cfu/ml. A totally automated instrument, which consists of a nano-bioseparator, a flow-through detection chamber and an optical detector, has been designed and fabricated for this biosensing technology. The biosensing device is able to provide the required specificity (strain level), sensitivity (10-100 cfu/ml) and time (less than 2 hrs).

Impact

The food industry and federal regulatory agencies can apply this novel biosensing method to food safety inspection and quality control to ensure food safety and security. Our society could be benefited from this technology in terms of reducing foodborne diseases and consequently related medical costs. Application of the new nanotechnology-based biosensor would enable the food industry to be benefited economically in terms of prevention of product recalls and international embargo associated with the microbial contamination of food products.

Contact

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Cooperators

Michael Slavik (Poultry Science Dept.), and Andrew Wang (Ocean NanoTech LLC)

Funding

NSF, Ocean NanoTech

Aptamers for Rapid Detection of Avian Influenza

Issue

Avian influenza (AI) virus H5N1 has been reported by WHO in more than 46 countries for animal cases and in 15 countries for human cases with 576 people infected and 339 died since 2003. Outbreak of low pathogenic AI in 2001 and 2002 in US resulted in the depopulation of over 4.5 million chickens and turkeys and cost the poultry industry more than $125 million. World Bank estimated that more than 140 million birds had died or been destroyed due to AI H5N1 and losses to the poultry industry are in excess of $10 billion worldwide. Immunoassays are commonly applied for rapid screening of avian influenza virus, but are limited by the temperature sensitive and high cost antibodies that are used in the tests.

Action

Aptamers showed great potential to provide higher affinity for target virus and better thermal stability than antibodies. Aptamers to specifically bind avian influenza H5N1 virus were selected using SELEX method, and their affinity and specificity were evaluated using Dot ELISA and Dot Blot and compared with polyclonal and monoclonal antibodies against AI H5N1. Three DNA-apatmer sequences were obtained and those aptamers have better specificity and stronger binding affinity to AI subtype H5N1 than monoclonal antibodies.

The selected aptamers are also being tested for the detection of AI subtype H5N1 at low concentrations in poultry swab samples using a biosensor method such as SPR, impedance or magnetoelastic biosensors.

Impact

Since the applications of immunoassays for in-field screening of avian influenza virus are limited by the use of temperature sensitive antibodies, the aptamer sensing material would provide a better option to the biosensor technology as well as diagnostic kits for in-field rapid, sensitive and specific screening of avian influenza H5N1 in poultry swab samples. This will help the poultry industry more effectively monitoring avian influenza H5N1, different subtypes and other poultry diseases with lower testing cost.

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Funding

ABI

Portable Impedance Biosensor for In-field Detection of Avian Influenza

Yanbin Li, Professor

Issue

Avian influenza (AI) virus H5N1 was discovered in the late 1990s, and it has been reported by WHO in more than 46 countries for animal cases and in 15 countries for human cases with 576 people infected and 339 died since 2003. In the US, a recent outbreak of low pathogenic AI in 2001 and 2002 resulted in the depopulation of over 4.5 million chickens and turkeys and had cost the poultry industry approximately $125 million. World Bank estimated that more than 140 million birds had died or been destroyed due to AI H5N1 and losses to the poultry industry are in excess of $10 billion worldwide. A key in controlling the spread of AI is to rapidly detect the disease, and then eradicate infected animals, quarantine and vaccinate animals. The technology for detection of AI H5N1 is mature, but many tests are complex, some are liable to error, and some can be performed safely only in BSL3 facilities. A simple, rapid, robust and reliable AI test, suitable for use in the field, is urgently needed.

Action

A portable biosensor has been developed for in-field sensitive and specific detection of AI virus H5N1 in poultry swab samples. Magnetic nanobeads are coated with specific antibodies to target virus and used in the sampler to separate and concentrate target virus from a poultry swab sample. Red blood cells, as biolabels, are mixed with the captured target virus to form the bio-nanobead-virus-red blood cell complex. A microfluidic biochip is designed and fabricated as a flow-through device to deliver the complex to an embedded interdigitated array microelectrode for impedance measurement. The change in impedance of the bionanobead-virus-red blood cell complex is correlated to the concentration of AI virus H5N1 in the original swab sample.

Our results showed that a positive signal was clearly obtained when the concentration of AI virus H5N1 in cloacal swabs was equal to or more than 100 EID_{50}/mL. The test on live H5N2 virus in infected chickens indicated the biosensor presented the same results as that by RT-PCR. A US patent has been filed. A research prototype of this biosensor has been designed and fabricated and is being evaluated with viable AI H5N1 in a BSL-3 lab and field tests.

Impact

Since currently there is no any in-field AI test instrument available, this biosensor would provide the poultry industry with a very needed technology for rapid, sensitive and specific screening of AI H5N1 in poultry. This will help the poultry industry be better prepared for AI H5N1, ensure poultry product safety and security, and minimize the testing cost. Further, this will help our society in surveillance and control of avian influenza infections with animal and human. The biosensor technology developed in this research can also be applied to the detection of other poultry and animal diseases.

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Conversion of biomass into liquid fuels: Understanding the depolymerization of hemicellulose

Danielle Julie Carrier, Professor

Issue:

Becoming, as much as possible, energy self-reliant is a national priority. Renewable energy is carbon neutral and is one way of assuring this energy self-reliance. Within the renewable energy technology portfolio, biomass conversion to electricity and liquid fuels is certainly enticing. To convert biomass into liquid fuels, the biomass must first be broken down, through pretreatment and enzymatic hydrolysis, into its individual sugar component. Unfortunately during pretreatment, inhibitory compounds are formed from the degradation of hemicellulose into furfural, acetic acid and formic acid; or lignin-derived phenolic compounds and oligomers. The listed inhibitory compounds inhibit the sugar release step, which, in turn, impedes the conversion of biomass into biofuels or other biobased products. Understanding how to release the sugars from biomass, without producing the slew of inhibitory compounds, is critical for maximizing biofuel and biobased production yields.

Action:

Our group is studying herbaceous and wood hemicellulose. We pretreat and enzymatically hydrolyze the biomass and then calculate the sugar release. We also track the release of inhibitory compounds. We are determining the rates of sugar release and of inhibitory compound production. Our goal is to determine which processing conditions will minimize the release of inhibitory compounds, while maximize the sugar concentration.

Impact:

The payoff is quite important in the sense, that an increase of sugar release and a decrease of inhibitory compound concentration will set the stage for better use of our biomass resources. In other words, more gallons of ethanol will be produced from a said amount of feedstock. This, in turn, will help the US march towards the goal of 21 billion gallons of advanced biofuels to be produced by 2022.

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Cooperating Scientists or Institutions:

Drs. Chuck West and Matt Pelkki.

Funding Source:

NSF, NSF EPSCoR – P3, DOE and DOT.

DDGS Fiber Filled Thermoplastic Composites

Sreekala Bajwa, Associate Professor

Issue:
DDGS is the waste stream from ethanol production. DDGS fiber is a one component of the DDGS waste stream. DDGS fibers are also produced during elucitration of poultry feed to remove the fibers. These fibers do not have a significant nutrient value although some of it is used in animal feeds. Although it can be used for biodiesel production, the technology currently is not commercially feasible. This project explores the use of DDGS fibers in thermoplastic composites as filler for thermal and dimensional stability.

Action:
To evaluate DDGS fiber as a filler in thermoplastic composites, an experiment was conducted with different proportions of wood and DDGS in the composite matrix. The different fiber proportions included (a) 100% oak, (b) 25% DDGS + 75% oak, (c) 50% DDGS+50% oak, and (e) 75% DDGS+25% oak. All samples were replicated 3 times and the samples were run as a completely randomized block design. The samples were tested for physical and mechanical properties. The tested properties indicate that DDGS has great potential for use in composites. The major concern was the odor during extrusion process due to the denaturing of the small amount of protein in the fiber.

Impact:
DDGS is a major waste stream from ethanol production, with half of the DDGS being exported. A new application of DDGS will add value and enhance economics of corn ethanol production. Approximately 6-11% of DDGS is fiber. Also, removing fiber from ground corn used as feed for non-ruminants will add to the nutritional value of these feed as non-ruminants do not digest fiber.

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Funding Source: None

Application of Cotton Gin Waste and Recycled Cotton Bale Wrap in Ligno-Cellulosic Composites (LCC)

Sreekala Bajwa, Associate Professor

Issue:
Two of the major waste streams of cotton cultivation include the gin waste that comes from cotton gins, and the plastic film used for wrapping the cotton bales in the new John Deere cotton module builder. Both of these waste streams do not have any significant application at present. On the other hand, they pose serious environmental issues such as the fire hazard of gin waste piles, if merely discarded. Therefore, it is necessary to find alternate uses or disposal strategies for these waste materials without adding additional cost to the producers.

Action:
The focus of this research project is to generate value added products from the two waste streams coming from cotton agriculture, the gin waste and bale wraps. Cotton gin waste is rich in natural ligno-cellulosic fibers, which may be used to replace the more expensive wood fiber in composite boards. Similarly, cotton bale wraps may be able to replace part of the high-density polyethylene in composite boards, without compromising the mechanical and physical properties of the end products. We have demonstrated the potential of cotton gin waste and agricultural film in thermoplastic composite products such as deck board, garden boxes and paving stones. We have also demonstrate the potential of cotton burr and stems as the fiber source in manufactured fire logs.

Impact:
It is important to protect our environment for future generations, and to help rural communities by making agriculture more profitable. The new composites made with cotton gin waste and recycled bale wrap will add value to two of the waste streams from cotton agriculture, and reduce their environmental impact by removing them from the environment. The new composite material made from these materials will have lower costs as the raw materials are inexpensive. The cotton farmers will benefit from this product by selling the cotton gin waste for a price instead of paying for its disposal. The many wood-plastic composite industries situated in the cotton belt will benefit from this product by substituting the scarce and expensive raw materials with inexpensive and abundant raw materials that are locally available.

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Funding Source: Cotton Inc.

Research Projects

Ecological Engineering

REU SITE: Assessment and Sustainable Management of Ecosystem Services

Marty Matlock, Professor

Issue:
Underrepresented minorities are falling further behind in representation across disciplines in science and engineering. Experience with mentors in hands-on activities early in their undergraduate experience can be very helpful in increasing participation in these fields.

Action:
The University of Arkansas is providing an integrated research experience for three cohort groups of 15 undergraduate students each working with federally recognized Native American Tribal programs in Oklahoma, Kansas, and Nebraska, and South Dakota. This experience integrates classroom and field research within each cohort with Tribal management of ecological services. Cohorts are recruited through Tribal educational programs from Native-serving two-year colleges, four-year universities, Tribal Universities, and research universities.

Impact:
During the first year of this project nine undergraduate students worked with five faculty to develop and implement research projects.

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Demonstration of an Algal Turf Scrubber for Biofuels Feedstock Development

Marty Matlock, Professor

Issue:
Alternative biofuel feedstocks are in high demand, especially as competition for alternative uses of traditional food and feed crops increases.

Action:
The project objective is to operate the test bed ATS for one year. Algae will be harvested from the scrubber once per week over an annual cycle. Details of harvesting methods will be established by the CER and will be consistent with methods used at other project sites (Potomac River, Susquehanna River) so that direct comparisons of data can be made. Samples of algae from the ATS test bed will be dried and weighed to establish productivity rates. Some samples will be analyzed for nitrogen and phosphorus content, either once or twice per month. Other samples will be sent off for further analysis at the Smithsonian Institution and at Western Michigan University.

Impact:
A demonstration scale algal turf scrubber was constructed in Springdale, AR and has operated for 10 months. Algal production efficiency and effectiveness is being evaluated.

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Emerging Contaminants from Wastewater Treatment

Scott Osborn, Associate Professor

Issue:
The overwhelmingly most common method for disinfection of wastewater before it is released into the environment is chlorine followed by Ultraviolet radiation (UV). Neither of these methods removes industrial chemicals, drug residuals, endocrine disruptors or other emerging contaminants from the wastewater. Therefore, these chemicals of concern are prevalent in receiving waters and can also be found in drinking water. The obvious solution to this problem is to use ozonation as a replacement method for chlorine and UV. The problem with ozonation is that it is very expensive especially when used in wastewater. Currently, there are less than 10 operating ozonation systems for disinfecting wastewater in the US. However, ozonation has been repeatedly shown to breakdown many emerging contaminants of concern.

An invention created by U of A Division scientists Osborn and Matlock, called the HyDOZ, has the potential to dramatically reduce capital and operating costs for using ozone to disinfect wastewater. Pilot studies conducted as part of an NIH funded research project over the past 3 years clearly showed that many emerging contaminants were destroyed. In 2011, a scaled version of the HyDOZ was tested at the Paul R. Noland Wastewater Treatment Facility in Fayetteville to determine if their regulatory requirements for disinfection could be met. Also, the capital and operating costs of a unit to replace their existing UV system was estimated. Initial results were discouraging as the costs to meet the requirements to remove fecal coliforms to required levels proved to be too expensive.

But, based on a simulation model he created, Osborn determined that if several changes in the operation of the unit were made, the model indicated a dramatic increase in efficiency could be realized. Proper intellectual property protection was acquired, and then the new method was tested as part of the pilot. The results were dramatic. The fecal coliform levels post treatment dropped to none detected while the energy and cost inputs to the HyDOZ fell substantially. The improved operation method was retested for several different conditions and the same good results were realized. The new method also removed *e. coli* and many of the emerging contaminants of concern. When the overall costs were calculated, the HyDOZ system to treat the entire facility appeared to be substantially less than traditional ozonation systems and was cost competitive with the UV system.

The impact of this innovation could be that the HyDOZ makes ozonation a cost competitive option for disinfection of wastewater so that many more treatment facilities adopt ozonation as their method of disinfection. This will improve the health of our nations aquatic ecosystems and human drinking water. More testing is planned for 2012.

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Linkages among Technology, Economics and Societal Values

Otto Loewer, Professor

Issue:

There is considerable evidence that the world in general and the United States in particular are on a path to the foreseeable future that will not lead to sustainable prosperity and wellbeing. It is extremely important that those of different backgrounds, experiences, expertise and perspectives be able to communicate effectively in a shared quest to develop and implement feasible solutions to the formidable challenges facing the world. To do so, enlightened leadership will be required, leadership that understands the nature of change from a conceptual, historical and factual base.

Action:

Towards addressing the above issue, I have developed a unique interdisciplinary graduate course along with a 1300 page text entitled *"The Linkages Among Technology, Economics and Societal Values"* with the subtitle *"Understanding Change and the Emerging Chaos."*

Such a course requires innovative and creative thinking and the willingness and wherewithal to develop the materials required to teach a formal course and associated seminars and workshops to a wide range of audiences. Towards that end, the year 2011 was devoted to successfully completing three major endeavors that have the potential to impact positively all those in any type of leadership position. These were:

Getting approval for a formal UA course on this topic.

Creating and offering a distance education course so that this topic can now be offered literally worldwide .

Creating approximately 20-hours of video lectures which are part of the distance education offering.

Fully upgrading and updating my 1300-page class text on this topic to reflect the 2010 census and other sources (via an off-campus duty assignment for the Fall-2011). *(Note: The final product provides a wealth of historical and statistical data in a unique and especially intuitive manner via a conceptual model.)*

Publishing a refereed journal article and conducting an international workshop on the material in this course via *Science in Society* organization (an international interdisciplinary group).

Impact:

The impact is that this course is rapidly growing in graduate student enrollment that embraces the overall course goal of helping develop, prepare and equip Society's future leaders in the quest to obtain sustainable prosperity and wellbeing by providing them with the following:

- A macro-level understanding of how the linkages among technology, economics and societal values have shaped history and will likely impact changes in society in the foreseeable future.
- Knowledge of past societal demographics and the associated influence on current events, long-term trends and future societal directions.
- The opportunity to enhance effective communication skills in a supportive but challenging environment designed to foster critical thinking and enlightened leadership in the face of societal change.
- The ability to convey the nature of change to those having differing expertise, experiences, backgrounds and perspectives.
- The underlying but necessary skills and insights required to provide the enlightened leadership needed for society to obtain sustainable prosperity and wellbeing.

The immediate measure is that three UA graduate degree programs are now using this course as part of their graduate program offering:

Biological Engineering (BENG): Open to any on-campus graduate student or senior.

Operations Management Program (OMGT): OMGT is the largest graduate program on the UA campus and its programs are offered worldwide via distance education.

Master of Science in Engineering – MSE – program: Offered to off-campus MS students through distance education.

As evidence of the growth in this course, a total of 20 graduate students enrolled in Terms 3 (first 8-weeks of the Spring 2012 semester) as compared to 5 students when the course was offered for the first time in the Spring of 2010. The potential is for substantially more growth. Furthermore, the material content has been and continues to be offered to via seminars and workshops to a wide range of local, national and international audiences.

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Funding Sources: None

An Ammonia Emission Mitigation System for Commercial Broiler Houses

Sreekala Bajwa, Associate Professor

Issue:
Air quality impacts from confined animal feeding operations (CAFO) is an emerging issue. Potential regulations could affect the economic viability of animal agriculture all over the US. As a top poultry state, and home to several poultry integrators, there is an opportunity for Arkansas to become a benchmark state for conducting research on air quality issues from poultry operations. Ammonia and particulate matter are the two pollutants of concern emitted from poultry houses. Mitigation of ammonia emission from broiler houses would be important for future viability of broiler operations and for protecting the environment and community health.

Action:
This project aims at developing a simple and effective at-source mitigation system for reducing ammonia emission from commercial broiler houses. Preliminary analysis of a two-component mitigation system that combined a water scrubber with a biofilter to treat the exhaust air from a broiler house showed poor effectiveness. Currently, we are modeling a biofilter and also testing it with various filter media at laboratory scale. This proposed mitigation system is expected to be non-hazardous, easily disposable and will have minimal impact on water and air quality at disposal.

Impact:
As a top poultry state in the US, Arkansas could be seriously impacted by evolving air quality issues, if they are not addressed immediately. As most biofilters have shown to remove 90-95% of the ammonia from the treated air, we expect that the bag biofilter system will have high effectiveness while being more compact in size and easy/inexpensive to construct and implement. As the treated air is circulated back to the house, this system is expected to provide significant bird and human health benefits while reducing the ventilation requirements. The immobilization of ammonia in the filter bed would provide major environmental quality benefits. The spent filter media rich in immobilized N could be land applied as a bio-fertilizer for uptake to crops, thereby avoiding re-release of ammonia to the airshed.

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Dharmendra Saraswat, BAEG, UAF

Funding Source: USDA-NRI

Water Quality Trends Show Effects of Watershed Management

Brian Haggard, Professor

Issue: The state of Arkansas through various state and federal programs has been investing millions of dollars into activities to improve water quality, and our studies have used long-term water quality databases to see what changes might have occurred. The efforts to improve water quality transcend through all stakeholders, from farmers through urban municipalities. This problem is extremely important, because water quality concerns exist locally, across state boundaries, and downstream all the way to the Gulf of Mexico.

Action: We compiled various water quality databases, organizing the data over time, and then matched collected water samples to the river discharge on the sampling date. Concentrations of nitrogen, phosphorus and sediment are strongly related to discharge, so you have to flow-adjust concentrations to look at water quality trends. We used a simple flow-adjustment procedure, and then look at changes in flow-adjusted concentrations over time to see if nitrogen, phosphorus and sediment were increasing, staying about the same, or decreasing.

Impact: We clearly showed that flow-adjusted concentrations of nitrogen, phosphorus and sediment are decreasing in rivers across northwest Arkansas and into northeast Oklahoma, including the Eucha-Spavinaw Watershed, Illinois River Watershed, and the Upper White River Basin. Our studies have particularly focused on phosphorus, because the poultry industries and municipal effluent discharges have been suggested as primary phosphorus sources.

Our results have shown that improvements in wastewater treatment have resulted in dramatic decreases in phosphorus, and that evidence suggests that implementation of best management practices on the landscape has improved water quality. The bottom line is that phosphorus, as well as nitrogen and sediment, are decreasing in many of our regional streams because of the efforts of the watershed stakeholders.

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Andrew N. Sharpley, Professor, Crop, Soil, and Environmental Sciences Department, University of Arkansas, Fayetteville, Arkansas
U.S. Geological Survey Arkansas Water Sciences Center, Little Rock, Arkansas

Funding Sources: The funding for these trend analyses came from multiple state and federal agencies, including the Section 319 Program of the Arkansas Natural Resources Commission, the U.S. Geological Survey 104B Program, and the University of Arkansas System's Division of Agriculture; some of the data used in these studies came from the U.S. Geological Survey National Water Information Systems (NWIS), and these efforts were funded by various federal, state and local partners through the state cooperative program.

Development of Sustainable Agriculture Metrics

Marty Matlock, Professor

Issue:

Earth's population will exceed 9 billion by 2050. The demand for food, feed, fiber and fuel from agricultural production is estimated to double in that time. Over 40 percent of Earth's surface is already in agricultural production (grains, fruits, vegetables, pasture and grazing lands). The remaining arable land is in the tropical regions where biodiversity is most at risk. Expanding the footprint of agriculture will have a devastating impact on global ecosystem services. The challenge we are addressing is how to meet the expanding needs of production from the land without destroying critical ecosystems.

Action:

The CARS team, led by Dr. Matlock, has been working with The Sustainability Consortium and The Keystone Alliance for Sustainable Agriculture to develop metrics for sustainable agriculture. The Field to Market (FtM) initiative was started by leading commodity crop producers, processers, and retailers to develop outcomes-based indicators of agricultural sustainability. The Center has worked with this group for over a year to support the science and data needs. CARS participates in the Executive and Outcomes Indicators Committees. The Sustainability Consortium is an independent organization of diverse global participants contributing to a more sustainable world through better products, consumption, and supply chains. We are developing and promoting science and integrated tools that improve informed decision making for product sustainability.

Dr. Matlock provides support for food and agricultural producers and suppliers in the Wal-Mart Sustainable Value Network (SVN) for developing indicators for agricultural sustainability and greenhouse gas reduction across the entire supply chain. This group is an integrator of other activities across the food and agriculture supply chain. The Leonardo Academy initiated a plan to develop an ANSI standard for agricultural sustainability in 2007. The Center realized the importance of this process for influencing the overall effort to develop sustainability measurements. Dr. Matlock served as the Chair of the Standards Committee for the Leonardo Academy ANSI Standard Development program from 2008-2010.

Impact:

CARS has become recognized as a global leader in metric development for agricultural sustainability. Dr. Matlock made over 80 invited presentations in the past two years to agricultural groups to inform them of the challenges and opportunities for sustainable production. The UA Division of Agriculture is now among the leading research organizations in the world in the area of agricultural life cycle analysis (LCA) as a direct result of CARS' work. Currently UA faculty are engaged in LCAs in dairy, pork, beef, corn, rice, soybeans, cotton, and cocoa. These projects represent over $8 million in extramural funding, involving over 15 faculty from across the UA system.

Implementation of Low Impact Development Best Management Practices to Remediate Sediment from Urban Development in Fayetteville, AR

Marty Matlock, Professor

Issue:

Northwest Arkansas is the sixth fastest growing Metropolitan Statistical Area in the US. The cities of Northwest Arkansas include Bentonville, Rogers, Springdale, Fayetteville, and Siloam Springs. These cities are located in both the Illinois and White River Watersheds. These watersheds receive wastewater discharge from most of the metropolitan communities in Northwest Arkansas, and are the source of concern and conflict because of sediment and phosphorus loading to Oklahoma (Illinois River) and Beaver Lake (White River). Low density, automobile-oriented urban development—the prevalent model for new development—is generating sediment loads that are listed as pollutants of concern in both the Illinois and White Rivers. The impact of urbanization on NPS sediment loads occurs in two phases: 1) Direct loading during construction, and 2) Increased peak flows that erode stream banks, beds, and ground surfaces throughout the urban environment and within stream channels downstream of urban systems.

Action:

In the effort to change the prevailing development model towards the integration of urban infrastructure and watershed planning, this project proposes to demonstrate Low Impact Development (LID) BMPs in urban tributaries to the Illinois and White River Systems.

In order to demonstrate a LID model for urban ecologies along urban tributaries to the Illinois and White River Systems we will perform the following tasks**:** 1) Develop municipal planning policies to protect streams from NPS impact from urban development, 2) Design a green neighborhood for Habitat for Humanity to demonstrate the impact and effectiveness of LID technologies in Fayetteville, AR., 3) Measure the impact of LID technologies in reducing sediment loads to the White River in Northwest Arkansas, and 4) Develop and Implement Educational Workshops for LID technologies.

Impact:

Fayetteville, AR sits on the watershed divide of the headwater streams of the Illinois and White River watersheds, and is rapidly urbanizing. Streams in the headwaters of these rivers provide critical ecological services for treating and removing pollution from the urban watershed. BMPs in ecological engineering alone, however, will not change nonpoint source problems as environmental planning and urban planning disciplines—each with their own BMPs and optimization tendencies—are conventionally practiced as parallel and separate fields. This project offers an integrated development model that embeds ecological metrics into urban planning templates, land-use policy, and infrastructure design. This project is only in its second year, and has already been recognized by numerous awards for excellence in design.

Development and Assessment of an Allothermal Auger Gasification System to Convert Biorenewable Resources to Syngas

Samy Sadaka, Assistant Professor, Extension

Issue:
Gasification can be accomplished using any of a variety of agents; air, oxygen or steam under elevated temperatures; anywhere between 700 to 1400 °C. Air gasification is the most widely used technology since there is no cost associated with steam or oxygen production, nor the complication of multiple reactors. The major drawback of air gasification is the high concentration of nitrogen (50% or more) in the producer gas, which make it incompatible for pipeline transportation due to its low energy density (4-7 MJ/m^3).

Action:
Oxygen and/or steam can be used as gasification medium to produce medium heating value gas (10-15 MJ/m^3) suitable for limited pipeline distribution and as synthesis gas for conversion to synthetic fuel. Therefore, an auger gasification system was designed and tested to convert various types of biomass including woody biomass, switchgrass and poultry manure to syngas containing medium BTU. The gas can be combusted separately or mixed with propane.

ICooperating Scientists or Institutions: Include extension component. Note if a regional or national collaborative project.

Funding Sources: DOE: Project Title: MidSouth/Southeast Bioenergy. Award **Number: GO88036**

Impact:
The developed auger system converts woody biomass, straws, switchgrass and/or animal manure) to combustible gas. Therefore, poultry producers can utilize this technology on farm for heat and power generation by utilizing biorenewable resources. The developed system if scaled up, and commercialized can provide a low cost heat and power generation on the poultry farms.

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Spatial Optimization of Impact of Modeled Best Management Practices on Water Quality (Co-Investigator: Dr. Mike Daniels, U of A CES)

Dharmendra Saraswat, Assistant Professor, Extension

It is known that when faced with the task of nonpoint source (NPS) pollution control, conservation agencies and policy makers generally have two overarching goals: pollutant mitigation and allocating limited resources for various reduction strategies. For reducing pollution in surface and ground waters, numerous field-based best management practices (BMPs) have been recommended. However, their implementation is always limited by the availability of amount of conservation dollars. In such situations, a comparison of effectiveness between various BMP solutions can guide conservation agencies in deciding the optimum solutions. In this study, Genetic algorithm (GA) was integrated with SWAT model for the optimization of large number of BMP scenarios The GA was run for sediment, TP, and TN scenarios and maps showing BMP allocation for low, average, and highest cost were produced.

In general, it was found that higher cost resulted in greater pollutant reduction. However, the relation between cost and pollutant reduction was not proportional. At higher costs, the gain in pollutant reduction was not found greater as compared to average cost investment. This highlights the need for strategic placement of BMPs and targeting those areas where maximum return on investment can be achieved. Overall, the results from this integrative methodology provide access to important information regarding tradeoffs among competing objectives (pollutant reduction in water bodies and BMP cost investment). For maximum pollutant reduction, the algorithm was able to search for BMP solution that reduced sediment, total phosphorus, and total nitrogen loss by 27.1%, 56.8%, and 32.7%. However, the corresponding cost investments were also high.

Automation of plant inventory processes using an aerial systems approach (Co-Investigator: Dr.(s) Jim Robbins, U of A CES; Reza Ehsani, U of Florida; and J. Owen, Virginia Tech (formerly, Oregon State University))

Dharmendra Saraswat, Assistant Professor, Extension

Collection of real-time inventory data is expensive, time consuming, and often imprecise. As a result, nurseries and Christmas tree growers often use estimates to determine current availability. A multi-institutional and multi-state team from the University of Arkansas, University of Florida and Oregon State University has been engaged in developing a cost-effective, low altitude aerial imagery system, to automate inventory processes at shade tree nurseries, container nurseries, and Christmas tree farms. The object based analysis of imagery (OBIA) obtained at altitudes ranging from 35′ to 115′ above ground resulted in count accuracy of 83 to 99 per cent for certain container-grown plants (Pyrus and Barberry). The results indicate the potential of pursuing OBIA approach for conducting inventory for nursery crops and Christmas trees farms.

Marginal Land Identification in L'Anguille River Watershed Through Spatial Analysis

Dharmendra Saraswat, Assistant Professor, Extension

Marginal lands for crop production are characterized by low fertility and vulnerability to deterioration via erosion, steep terrain, and poor soil quality. However, identifying marginal lands in a watershed is a challenging task. Rough terrain or a large study area may make an *in situ* study too difficult and impractical. Aerial photographs alone may not provide enough information to classify a land area when factors like slope and soil properties need to be taken into account. Geographic Information System (GIS) analysis can address many of these challenges.

The focus of this study is the L'Anguille River watershed (LRW) in eastern Arkansas. The Arkansas Department of Environmental Quality (ADEQ) 303(d) list (2010), a list of impaired water bodies in Arkansas, lists the entire L'Anguille River (98 miles) as impaired due to siltation/turbidity, pathogen indicators (bacteria), dissolved oxygen, total dissolved solids, sulfates, and chlorides. Agriculture was cited as the primary source of impairments by ADEQ. Also the practices of straightening and dredging channels in LRW lead to an increase of turbidty which has a negative impact on the water quality (Audubon Arkansas & ASWCC, 2005).

Determining the amount and location of marginal lands available within the LRW could aid conservation agencies in targeting best management practices for maximizing its water quality benefits and potential locations for growing biofuel crops.

Eight criteria, based on literature review and the specific needs of LRW, were used to define marginal land within the watershed. The criteria were based on the following variables: pH, drainage, water table, erosion, slope, flooding, and wetlands. Marginal land was divided into three categories based on the characteristics of the criteria: biological, environ-ecological, and physical. GIS software was used to analyze the watershed under the criteria and produce maps displaying the spatial distribution of marginal land. Under the current criteria 82% of the entire watershed is considered marginal. Knowing how much marginal land exists in the watershed will be beneficial for planning implementation of biofuel crops to LRW.

Poultry Farm Energy Use Evaluation to Improve Energy Efficiency

Yi Liang, Assistant Professor

Issue

Energy expenditure is the second highest expense for the contract broiler producers after the house mortgages, and is continuously on the rise. Efforts on improving energy efficiency and/or use of alternative energy sources can help to reduce overall energy consumption. However, making energy related retrofits can be expensive, and financially impossible for some producers. Financial assistance from government programs for energy related projects have been under-utilized in Arkansas, partially due to limited availability and accessibility of energy assessment or audit, which is required in the application to seek cost-share assistance.

Action

The University of Arkansas Poultry Energy Use Evaluation program has conducted farm energy audits for over 30 poultry producers in Arkansas. Upon completion of an on-site evaluation and a review of historical farm utility purchase, a written report is generated, which outlines items that contribute to excessive energy use and recommended improvements. Estimated cost of improvements, the associated energy savings and a cost-recovering/payback period for each of the suggested improvements are also provided.

Impact

This project not only provides a mean for the broiler producers in the concentrated poultry production region in Arkansas to increase their ability to access the government assistance programs in implementing the much-needed energy efficiency improvement, but also helps them to make informed decision on farm renovation. The expected energy savings from the farms that received energy audits would total 22 Billion Btu if the recommended improvements were implemented.

Contacts

Yi Liang, Assistant Professor, BAEG, UAF yliang@uark.edu, 575-4862
Tom Costello, BAEG, UAF
Susan Watkins, Poultry Sciences, UAF

Funding Source

USDA Rural Development
UA-Division of Agriculture

Sealed Poultry Litter Bag Storage: A Promising Innovation

Karl Vandevender, Professor, Extension

Issue

Storing poultry litter is often needed. Usually the cited justification for storage is protecting surface water from rain induced runoff from exposed litter storage piles. While the environmental concerns are pertinent often overlooked is the degradation of litter physical and chemical properties and associated reduction in litter value when exposed to the weather. At times a structure or stacking shed is economically feasible due to the combination of repeated storage need, storage volume, and consistence storage location. An example of this is a stacking shed used on the poultry farm to store the small portion of crusted litter removed after each flock. Often however the volume of litter to be stored and variable storage locations make a storage structure and uneconomical. Therefore a temporary litter storage method is recommended when stacking sheds are not appropriate. However, the use of tarps and other plastic sheet are problematic for various reasons.

Action

This Pilot project initiated investigations into the use of large polyethylene bags to store litter. These bags, or tube, range in size and weight when used for cattle silage and grain storage. For this project 9 mil grain bags 9 foot diameter and up to 200 feet in length were used. In several field trials modified grain handling equipment was used to load the storage bags. These trails demonstrated that the equipment was able to pack the poultry litter in the bags with the resulting storage capacity of approximately 1.5 tons linear foot of bag. An associated storage trail comparing bagged litter to litter stored in an exposed open pile indicated that the bagging not only protected the litter from the weather and prevented runoff, it also appeared to seal the litter preventing nutrient and carbon losses as compared to the litter stored in the open pile. This not only indicates a retention in the fertilizer value of the litter it also indicates the potential **to reduce environmental losses to the air and water. After almost 18 months of storage the polyethylene bag was still providing weather protection.**

When the bag was emptied and land applied the litter was found to be uniform in texture and handled well in the loading and spreading process. In contrast litter that is exposed to the weather for extended periods of time is often crusted on top and higher moisture at the bottom of the pile, which has an adverse impact on litter handling.

At this time additional research and demonstration opportunities are being sought.

Impact

While this is an investigated project and additional research and demonstration is needed to further quantify potential benefits, equipment refinement, and cost effectiveness of the practice it shows great promise to have both environmental and production benefits.

The concept and initial findings were presented at the Southern Region Water Conference "Innovations and Partnerships for Clean Water". In Athens, GA. During September of 2011. The information was the topic of invited presentation at Farm Pilot Project Coordination, Inc. Annual Technology Summit in Saint Petersburg Beach, FL the same month. At both of these conferences representatives of organizations working at the regional and national levels expressed an interest in the concept and project. This interest fosters the idea and hope of collaboration to leverage resources for further research/demonstration/education. An impact that has already taken place is the inclusion of litter bagging into USDA NRCS Arkansas environmental protection cost sharing program. While the initial utilization of this practice has been very limited additional demonstration and extension education should increase its adoption.

Contact

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Cooperators: Rick Harrell, Delta Grain Bags Systems, Inc.

Funding

UA Division of Ag; Delta Grain Bags Systems, Inc.; US DOE

Research Grants

The following grants have been awarded to the faculty during 2010 to fund research in specific areas.

An Ammonia Emission Mitigation System for Commercial Broiler Houses
Dr. Sreekala Bajwa
USDA-NRI Seed Grant
2009-2011
$97,123

Effect of Genotype on Severity of Charcoal Rot in Soybean
Dr. Sreekala Bajwa
Soybean Promotion Board
2011
$46,000

Evaluation of Plant Fibers for Oil Absorption
Dr. Sreekala Bajwa
Co-E-FEP
2011
$1,000

Value Added Products from Cotton Gin Waste
Dr. Sreekala Bajwa
Cotton Inc.
2011
$18,900

Biobased Products and Bioenergy Multi-University Graduate Program
Dr. Julie Carrier Co-Pi
USDA-HEC
2009-2012
$500,000

Characterization and Quantification of Hemicellulose, Monomers, Oligomers and By-Products from Xylan During Biomass Pre-treatment
Dr. Julie Carrier
CBET-NSF
2008-2012
$296,000

Can Understory from Managed Pine Forests be used as feedstock in the Biochemical Biorefinery?
Dr. Julie Carrier
SunGrant
2009-2012
$70,000

Sweetfum Bark: Extraction, Purification & Determination of Antioxidant
Dr. Julie Carrier and Shiloh Hurd
SURF Grant
2011
$1250

Arkansas AgrAbility Project
Dr. Tom Costello
USDA-NIFA
2010-2015
$720,000

Energy Audits for contract Broiler Production in NW Akransas and NE Oklahoma
Dr. Tom Costello and Dr. Yi Liang
USDA Rural Energy for America
2010-2013
$99,000

Integrated Resource Management Tool to Mitigate Carbon Footprint of Swine Produced in the U.S.
Dr. Tom Costello, Dr. Marty Matlock, Dr. Karl Vandevender & others
USDA-NIFA-AFRI
2011-2017
$5,000,000

Algae as a Biomass Feedstock
Dr. Tom Costello and Dr. Marty Matlock
DOE Mid-South Bioenergy
2010-2012
$25,000

Research Grants

Waste Biomass as a Bioenergy Feedstock
Dr. Tom Costello, Dr. Samy Sadaka, and Dr. Karl Vandevender
DOE Mid-South Bioenergy
2010-2012
$70,000

Monitoring to Support Modeling
Dr. Brian Haggard
ANRC USEPA 319 Program
2011-2013
$175,200

NWA WQ Monitoring
Dr. Brian Haggard
ANRC USEPA 319 Program
2011-2015
$728,000

AWRC Program Administration
Dr. Brian Haggard
USGS 104B Program
2011-2012
$27,870

AWRC Information Transfer
Dr. Brian Haggard
USGS 104B Program
2011-2012
$17,439

Nutrient Criteria Development I
Dr. Brian Haggard
TCEQ
2011
$185,839

Teaching and Learning Scholarship
Dr. Sha Jin
Wally Cordes Teaching and Faculty Support Center
2011
$200

Development of Flagellar Motor Biosensor Prototype for Trace Level TNT Detection
Dr. Jin-Woo Kim & Steve Tung
NSF
2011
$79,953

Integrating Nanotechnology into Undergraduate Engineering education
Dr. Jin-Woo Kim & Min Zou
NSF
2011
$200,000

Multi-Color and Multi-Functional Gold Nano-Agents for Multiplex Cancer Detection and Therapy
Dr. Jin-Woo Kim
ABI
2011
$50,000

Biological Validation of Self-Assembled Multimodal Nanotheranostics
Dr. Jin-Woo Kim & Dr. David Zaharoff
ABI
2011
$47,000

Highly Sensitive Method for Detecting and Separating Pathogens Using Paramagnetic Particles and a Micro-Fluidic System
Dr. Jin-Woo Kim
SURF/ADHE
2011
$2,600

Aptamer Selection for Detection of Bacteria
Dr. Yanbin Li
Nazarbayev University, Kazakhstan
2011
$52,500

Aptamer SPR Biosensor for Rapid Detection of Avian Influenza Virus
Dr. Yanbin Li
ABI
2011
$150,000

Microelectrode-based ELISA for Detection of Avian Influenza Virus
Dr. Yanbin Li
ABI
2011
$150,000

Nanowire Switch and Nanoelectrode/ Nanofluidics Based Biosensor for Rapid Screening of Avian Influenza Virus
Dr. Yanbin Li
USDA-NIFA
2011
$455,308

A Multi-Component Ammonia Emission Mitigation Strategy for Commercial Broiler Houses
Dr. Yi Liang, Dr. Sreekala Bajwa, Dr. Tom Costello. Dr. Dharmendra Saraswat
USDA-NRI
2009-2012
$97,251

Systematic Evaluation of In-House Broiler Litter Windrowing Effects on Production Benefits and Environmental Impact
Dr. Yi Liang, Dr. Karl Vandevender and others
US Poultry & Egg
2011-2012
$40,213

Field testing of ammonia sensor in poultry house with sensor-controlled environment
Dr. Yi Liang
USDA/CSREES SBIR II
2009-2012
$349,793

Measuring and Reducing Swine Greenhouse Gas Footprint in the US
Dr. Marty Matlock
USDA-NIFA
2011-2016
$499,980

Development of Research Ethics Program for undergraduate students
Dr. Marty Matlock
NSF
2011-2013
$98,000

REU SITE: Assessment and Sustainable Management of Ecosystem Services
Dr. Marty Matlock
NSF
2008-2013
$275,000

Development of a water cycle analysis for the us dairy industry
Dr. Marty Matlock
DMI-Walton Family Foundation
2010-2011
$95,000

LCA for US Pork Production for Water
Dr. Marty Matlock
National Pork Board
2011-2014
$850,000

Research Grants

Water Stress Indicators for the US Dairy Industry
Dr. Marty Matlock
DMI
2011-2012
$60,000

SBIR Rapid Response SDOX for Gulf Oil Spill
Dr. Scott Osborn
NSF
2010-2011
$175,000

SBIR Portable Oxygenation
Dr. Scott Osborn
NSF
2010-2012
$308,000

Retention Pond
Dr. Scott Osborn
Wal-Mart Foundation
2011
$42,000

Gasification of Algae
Dr. Samy Sadaka, Dr. Tom Costello, Dr. Marty Matlock, & Dr. Karl Vandevender
NIFA
2011
$4,900,000

Gasification of Switchgrass
Dr. Samy Sadaka
SERA
2011
$7,000

Development of Comprehensive Watershed Modeling for 12-digit Hydrologic Unit Code "HUC" in Selected Priority Watersheds in Arkansas- Phase II
Dr. Dharmendra Saraswat & others
EPA/ANRC
2011-2013
$170,393

Enhancement of Riparian Buffer Inventorying Algorithm for Field Use
Dr. Dharmendra Saraswat
EPA/ANRC
2011-2013
$98,059

Enhancing NHDPlus Data for Bayou Bartholomew Watershed
Dr. Dharmendra Saraswat
ADEQ
2011
$10,000

Ongoing Planning Support, Data Management, and Continuing Review of the Arkansas Non-Point Source Adaptive Management Plan and Completion of the 2012-2015 Adaptive Management Plan
Dr. Dharmendra Saraswat & others
EPA/ANRC
2011
$21,700

Field Scale Evaluation of Precision Agriculture Sensors for Corn Production
Dr. Dharmendra Saraswat & others
2011-2012
$35,900

Production of Syngas and Bio-Oil from Poultry Manure-Forest Floor Residues
Dr. Karl Vandevender, Dr. Tom Costello, and Dr. Samy Sadaka
DOE
2010-2011
$57,000

Production of Syngas and Bio-Oil from Woody Biomass
Dr. Karl Vandevender, Dr. Tom Costello, & Dr. Samy Sadaka
DOE
2010-2011
$49,585

Alternative Uses for Animal Manure
Dr. Karl Vandevender & others
CSREE Southern Region Extension Water Quality Program
2010-2011
$49,585

Systematic Evaluation of In-House Broiler Litter Windrowing Effects on Production Benefits and Environmental Impact
Dr. Karl Vandevender, Dr. Yi Liang, & others
US Poultry and Egg
2010-2011
$40,213

Determination of Soil Compaction Effects on Cotton Yield in Mid-South Soil Conditions
Dr. Karl Vandevender & others
Cotton, Inc.
2011
$15,000

Biological Validation of Self-Assembled Multimodal Nanotheranostics
Dr. David Zaharoff & others
ABI
2011-2012
$47,000

Chitosan-based Delivery and Immunopotentiation of Cancer Vaccines
Dr. David Zaharoff & others
NIH
2010-2013
$510,032

Neoadjuvant Chitosan/IL-12 Immunotherapy for Control of Breast Cancer Metastasis
Dr. David Zaharoff
Women's Giving Circle
2011-2012
$15,000

Pilot investigation of neoadjuvant chitosan/IL-12 immunotherapy prior to resection
Dr. David Zaharoff
ABCRP (NIH)
2011-2012
$73,086

Creating a Scientific Self to Promote Biomedical Research Career Options for Underrepresented Minorities and Women
Dr. David Zaharoff
NIH
2012-2016
$996,092

PUBLICATIONS

BOOKS

Bajwa, S. G., and J. A. Apple. 2011. Non-linear modeling of quality of cooked ground beef patties with visible-NIR spectroscopy. In: Food Engineering, B. C. Siegler (Ed). Nova Science Publishers, Inc., Hauppauge, New York. ISBN 978-1-61728-913-2. (Accepted)

Bajwa, S. G. and S. S. Kulkarni. 2011. Hyperspectral Data Mining. In. Hyperspectral Remote Sensing of Vegetation, P.S. Thenkabail, J. G. Lyon and A. Huete (Eds). ISBN 978-1-4398453-7-0, CRC Press.

Gollany, H.T., R.F. Follett, **Y. Liang.** 2011 CQESTR Simulations of Soil Organic Carbon Dynamics. In: Managing Agricultural Greenhouse Gases. *Eds*: M.A. Liebig, R.F. Follett and A.J. Franzluebbers. Elsevier Inc. (accepted)

Luoni, S., J. Huber, K. **M. Matlock**. 2010**. Low Impact Development: a design manual for urban areas.** UA Press. UA Community Design Center, Fayetteville, AR. **ISBN:** 978-0-9799706-1-0.

Matlock, M. and R. Morgan, 2011. *Ecological Engineering Design: Restoring and Conserving Ecosystem Services.* John Wiley and Sons, NY, NY. 410 pgs. March 2011. **ISBN-10:** 0470345144 **ISBN-13:** 978-0470345146

Popp, J., M. Jahn, N. Kemper, and **M. Matlock,** Eds. 2012. *The Role of Biotechnology in Feeding 9.25 Billion People*. Cambridge University Press, Cambridge, MA. Feb. 2012

BOOK CHAPTERS

Tung, S., **Kim, J.-W.** & R. Pooran. 2011. Application of bacterial flagellar motors in microfluidic systems. *In:* CMOS Bio-Microsystems: Where Electronics Meets Biology. K. Iniewski (ed). John Wiley & Sons, Inc.

Jones, Carol, Mark Casada and **Otto J. Loewer**. 2012 (in press for publication in 2012). Chapter 10. Drying, Handling and Storage of Raw Commodities Stored Product Protection (David Hagstrum, Tom Phillips and Gerrit Cuperus co-editors). Kansas State University

Saraswat, D., and N. Pai. 2011. Chapter 8: Spatially distributed hydrologic modeling in Illinois River Drainage Area in Arkansas Using SWAT. 196-210. In *Soil Hydrology, Land Use, and Agriculture*, 196-210. M. Shukla, ed., Wallingford, Oxon OX10 8DE, UK: CAB International.

PUBLICATIONS

REFEREED ARTICLES

Bajwa, S. G., D. S. Bajwa, G. Holt, T. Coffelt, and F. Nakayama. 2011. Properties of thermoplastic composites with cotton and guayule biomass residue as fiber fillers. *Industrial Crops and Product.* 33(3):747-755

Leh, M. D., **S. G. Bajwa**, and I. Chaubey. 2011. Impact of land use change on erosion risk: an integrated remote sensing, GIS and modeling methodology. *Land Degradation and Development (Online)*

Martin E, Bunnell K , Lau C, Pelkki M, Patterson D, Clausen E, Smith J and **Carrier DJ**. (2011). "Hot water and dilute acid pretreatment of high and low specific gravity *Populus deltoids* clones." (2011). *Journal of Industrial Microbiology* 38:355-361.

Martin E, Cousins S, Talley S, West C, Clausen E and **Carrier DJ**. (2011)."The effect of pre-soaking coupled to pretreatment on the extraction of hemicellulosic sugars and flavonoids from switchgrass (*Panicum virgatum*, var. Alamo) leaves and stems." *Transactions of ASABE* 54: 1953-1958.

Nesbitt E, Thiers P, Gao J, Shoemaker S, Garcia-Perez M, **Carrier J**, Doran-Peterson J, Morgan J, Wang G, Wensel P and Chen S. (2011). "China's vision for renewable energy: the status of bioenergy and bioproduct research and commercialization," *Industrial Biotechnology* 7: 336-348.

Sandefur, H.N., R.Z. Johnston, M.D. Matlock**, T. A. Costello**. 2011. 1Hydrodynamic regime considerations for the cultivation of periphytic biofilms in artificial growth systems. Submitted to: J. Applied Phycology.

Sandefur, H. N., M. D. Matlock, **T.A. Costello**. 2011. "Seasonal Productivity of a Periphytic Algal Community for Biofuel Feedstock Generation and Nutrient Treatment." Ecological Engineering 37:1476-1480.

Warren, A. J., J. L. Gattis, L. K. Duncan, **T. A. Costello**. 2011. "Analysis of Deceleration in Through Lane Before Right Turn." J. Transp. Res. Board 2223: 113-119.

Brion, G., K.R. Brye, **B.E. Haggard**, C. West, and V. Brahana. 2011. Land-use effects on water quality of a first-order stream in the Ozark Highlands, Mid-Southern United States. River Research and Applications 27(6): 772-790

David, M.M., and **B.E. Haggard**. 2011. Development of regression-based models to predict fecal bacteria numbers at select sites within the Illinois River Watershed, Arkansas and Oklahoma, USA. Water, Air and Soil Pollution 215: 525 -547

Drake, W.M., J.T. Scott, M.A. Evans-White, **B.E. Haggard**, A.N. Sharpley, and C.W. Rogers. 2011. Light and periphyton stoichiometry control biological phosphorus storage in nutrient-rich headwater streams. Journal of Limnology

Huffhines, B., K.R. Brye, **B.E. Haggard**, and R.A. Morgan. 2011. Net nutrient uptake in the White River, Northwest Arkansas, downstream of a municipal wastewater treatment plant. Journal of Environmental Protection 2: 255-270.

Rogers, C.W., A.N. Sharpley, **B.E. Haggard**, J.T. Scott, and B.M. Drake. 2011. Physicochemical characterization of sediment in northwest Arkansas streams. Journal of Environmental Protection 2:629-638.

Scott, J.T., **Haggard, B.E.**, Sharpley, A.N., and Romeis, J.J. 2011. Long-term phosphorus trends are correlated with changes in water quality monitoring and watershed management. Journal of Environmental Quality 40(4): 1249-1256.

Toland, D.C., **Haggard, B.E.**, and Boyer, M.E. 2011. Evaluation of nutrient concentration in runoff water from green roofs, conventional roofs and urban streams. Transactions of the American Society of Agricultural and Biological Engineers

Jin, S, Ellis, E., Veetil. JV, Yao, H. and Ye. K. (2011) Visualization of human immunodeficiency virus protease inhibition using a novel Förster resonance energy transfer molecular probe. *Biotechnol. Prog.* 27 (4), 1107-1114.

Jin, S., Veetil, V.J., Garrett, R., Ye, K. (2011) Construction of a panel of glucose indicators by site-directed mutagenesis. *Biosensors and Bioelectronics*, 26, 3427-3431.

Zhu,Y., Dong, Z., Wejinya, U.C., **Jin, S.,** and Ye, K. (2011) Determination of mechanical properties of soft tissue scaffolds by atomic force microscopy nanoindentation. *J. Biomechanics*. 44, 2356-2361.

Kim, J.-W., Kim, J.-H. & Deaton, R. DNA-linked nanoparticle building blocks for programmable matter. *Angewandte Chemie International Edition* **50**, 9185-9190 (2011) [*Impact Factor: 12.730*]. This article was not only selected as "**Hot Paper**" by the journal's editors but also featured as a "**Back Cover**" of the journal issue.

de la Zerda, A., **Kim, J.-W.**, Galanzha, E. I., Gambhir, S. S. & Zharov, V. P. Advanced contrast nanoagents for photoacoustic molecular imaging, cytometry, blood test, and photothermal theranostics. *Contrast Media & Molecular Imaging* **6**, 346-369 (2011) [*Impact Factor: 4.02*].

Limayem, A., Hanning, I., Muthaiyan, A., Illeghems, K., **Kim, J.-W.**, Crandall, P. G., O'Bryan, C. A. & Ricke, S. C. Alternative antimicrobial compounds to control potential *Lactobacillus* contaminants that occur in yeast-based fuel bioethanol fermentations. *Journal of Environmental Sciences* **46**, 709-714 (2011) [*Impact Factor: 1.513*].

Huang, H., C. Ruan, J. Lin, M. Li, L. M. Cooney, W. F. Oliver, **Y. Li**, A. Wang. 2011. Magnetic nanoparticles based magnetophoresis for efficient separation of food-borne pathogens. Transactions of the ASABE 54(3): 1015-1024.

Jiang, X., R. Wang, Y. Wang, X. Su, Y. Ying, J. Wang and **Y. Li**. 2011. Evaluation of different micro/nanobeads used as amplifiers in a QCM immunosensor for more sensitive detection of *Escherichia coli* O157:H7. Biosensors & Bioelectronics 29:23-28.

Li, D., Y. Feng, L. Zhou, Z. Ye, J. Wang, Y. Ying, C. Ruan, R. Wang and **Y. Li**. 2011. Label-free capacitive immunosensor based on quartz crystal Au electrode for rapid and sensitive detection of *Escherichia coli* O157:H7. Analytica Chimica Acta 687(1):89-96.

Li, D., J. Wang, R. Wang, **Y. Li**, D. Abi-Ghanem, L. Berghman, B. Hargis and H Lu. 2011. A nanobeads amplified QCM immunosensor for the detection of avian influenza virus H5N1. Biosensors & Bioelectronics 26:4146-4154.

Li, M., L. Cooney, A. Pradhan, A. Mauromoustakos, P. Crandall, M. Slavik, and **Y. Li**. 2011. A predictive model for the inactivation of *Listeria innocua* in cooked poultry products during postpackage pasteurization. Journal of Food Protection 74(8): 1261-1267.

Li, M., A. Muthaiyan, C.A. Bryan, J.E. Gustafson**, Y. Li**, P.G. Crandall, and S.C. Ricke. 2011. Use of natural antimicrobials from a food safety perspective for control o*f Staphylococcus aureus.* Current Pharmaceutical Biotechnology 12(8):1240-1254.

Wang, H., **Y. Li**, and M. Slavik. 2011. Rapid detection of *Listeria monocytogenes* in different food samples using magnetic nanobeads and quantum dots based fluorescent biosensor. Biological Engineering Transactions 4 (4):183-194.

Wang, H., **Y. Li,** Andrew Wang, and M. Slavik. 2011. Quantum dot labeled fluorescence immunoassay for simultaneous detection of three pathogens in food samples. Journal of Food Protection 74(12):2039-2047.

Wang, R., J. Lin, Lassiter, K., J. Lum, B. Srinivasanm L. Lin, H. Lu, B. Hargis, W. Bottje, S. Tung, L. Berghman and **Y. Li.** 2011. Evaluation of a portable impedance biosensor for detection of avian influenza virus. Journal of Virological Methods 178:52-58.

Gollany**,** H. T., R. W. Rickman, **Y. Liang**, S. L. Albrecht, S. Machado, and S. Kang. 2011. Predicting agricultural management influence on long-term soil organic carbon dynamics: Implications for biofuel production. Agronomy J. 103:234–246.

Loewer, Otto J. 2011. "Leadership and Sustainability in the Emerging Chaos: Understanding the Linkages among Technology, Economics and Societal Values. The International Journal of Science in Society. Volume 2, Number 3, p. 111-134. Common Ground Publishing LLC, Champaign, IL.

Ludwig, A., **M. D. Matlock,** B. Haggard, I. Chaubey. 2011. Periphyton nutrient limitation and maximum potential productivity in the Beaver Lake Basin, USA. *Journal of the American Water Resources Association.* In Print

Wolchok J, Tresco PA, "Using growth factor conditioning to modify the properties of a cell derived biomaterial isolated from open celled foams", Biomaterials, Under Review.

PUBLICATIONS

INVITED LECTURES

Bajwa, S. G., D. S. Bajwa, G.H. Holt., R. Srinivasan, T. Coffelt, F. Nakayama, and R. Gesch. 2011. Recycling of ligno-cellulosic and polyethylene wastes from agricultural operations in thermoplastic composites. In. *Proc. of Second International Conference on Recycling and Reuse of Materials and Their Products* (ICRM-2011). 5-7 August 2011. Kottayam, Kerala, India.

Bajwa, S. G., D. Saraswat, L. Espinoza, and T. Griffin. 2011. Precision Agriculture in Arkansas. *NCERA180 Multistate Committee Meeting*, Little Rock, AR. 23-25 March 2011.

Carrier, D. J., 2011 Presented invited lectures at the University of Minnesota, Maine and University of Arkansas Monticello.

Carrier, D.J., 2011 Laboratory Group presented at 33rd Symposium for Fuels and Chemicals in Seattle, WA (5 posters); at American Society of Agricultural and Biological Engineering annual meeting in Louisville, KY (3 orals); ASSET EPSCOR Heber Springs, AR (4 posters); at S-1041 Symposium on Bioenergy in Stillwater, OK (4 posters); and, American Institute of Chemical Engineers (1 poster, 1 oral).

Carrier, D.J., 2011 Selected to participate in the NSF funded Women International Research Engineering Summit in Orlando, FL

Haggard, B., S. Entrekin, M. Evans-White, S. Filipek, J. Funkhouser, and L. Massey. Evaluating Water Resources and Impacts from Natural Gas Development, Gulf Mountain Wildlife Management Area. Arkansas Chapter, American Fisheries Society, Little Rock, Arkansas – Feb 2011

Haggard, B. Occurrence and Transport of Pharmaceuticals in Effluent-Driven Streams. Southern Region Water Conference, Athens, Georgia – September 2011

Haggard, B., L. Massey, and B. Bailey. Water Quality Trends across Select 319 Monitoring Sites in Northwest Arkansas. USEPA Region 6 Invited Presentation, Dallas, Texas – November 2011

Jin, S., and Ye, K. "Building 3D Tissue engineered scaffolds for soft tissue regeneration". Materials Research Society fall November 28 - December 2, 2011 Boston. [Plenary speaker]

Jin, S. "Value of Hela cells for Biomedical Engineering research" April 7, 2011 Cox College, MO.

Kim, J. -W. 2011. Self-Assembled Nanocomposites as Advanced Theranostic Nanoagents for Circulating Tumor Cells. IEEE International Conference on Nano/Molecular Medicine and Engineering (IEEE-NANOMED) and Biotronics, Jeju, Korea. [Refereed]

Kim, J. -W. 2011. Biology with Engineering at the Small Scale. Department of Biosystems & Biomaterials Science and Engineering, Seoul National University, Korea.

Kim, J. -W. 2011. Nanoparticles and Nano-Ensembles for Multi-Modal Diagnosis and Therapy. 6th IEEE International Conference on Nano/Micro Engieered and Molecular Systems (IEEE-NEMS), February 20-23, Kaohsiung, Taiwan. [Refereed]

Li, Y. 2011. Impedance biosensors for in-field rapid screening of avian influenza H5N1 in poultry. Invited presentation at 2011 International Symposium on Applications of Nanotechnology and Biosensors in Food and Agriculture, April 14-17, 2011, Hangzhou, China.

Li, Y. 2011. Nanotechnology-based biosensors for rapid detection of bacteria and virus in agriculture and food. Invited lecture at Nanchang University, April 24, 2011, Nanchang, China.

Li, Y.. 2011. Applications of biosensing technology in agriculture and food. Invited presentation at Chinese Society of Agricultural Engineering 2011 Annual Meeting, October 22-24, 2011, Chongqing, China.

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