2013

Annual Report, 2013

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

2013 Annual Report

UNIVERSITY OF ARKANSAS
DIVISION OF AGRICULTURE

COOPERATIVE EXTENSION
1914-2014
100
SMITH-LEVER ACT
EXTENDING KNOWLEDGE CHANGING LIVES

UNIVERSITY OF ARKANSAS

2013 Annual Report
Department of Biological and Agricultural Engineering

Lalit R. Verma
Department Head

University of Arkansas
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
John English
Dean

University of Arkansas
G. David Gearhart
Chancellor

Sharon Gaber
Provost and Vice Chancellor for Academic Affairs

Department of Biological & Agricultural Engineering

203 White Engineering Hall
University of Arkansas
Fayetteville, AR 72701

Phone (479) 575-2352
Fax (479) 575-2846
http://www.baeg.uark.edu/

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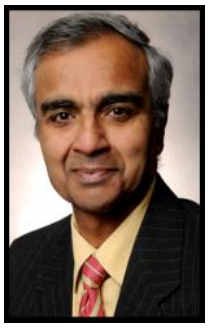
FOREWORD

FROM THE DEPARTMENT HEAD



It is a pleasure to share the accomplishments and activities of our faculty, staff and students in our 2013 Annual Report. It has been a busy and productive year for our academic, research and extension programs. Our Department of Biological and Agricultural Engineering is truly unique as it resides in the UA System Division of Agriculture as well as two University of Arkansas colleges: the Dale Bumpers College of Agricultural, Food and Life Sciences and the College of Engineering. Research and teaching faculty are located on campus while our extension colleagues are in the state office of the UA System Division of Agriculture's Cooperative Extension Service, and at the Rice Research and Education Center in Stuttgart. Our academic, research and extension programs address problems important and relevant to our state and nation. They deal with challenges in sustainable food, agriculture, water and energy systems in support of the Arkansas agriculture enterprise. Our faculty, staff and students continue to be engaged in delivering superior engineering programs in support of the missions of the University of Arkansas and UA System Division of Agriculture.

Our mission is "*to develop and disseminate engineering knowledge to address problems dealing with sustainable food, water and energy systems.*" Our faculty is delivering the Biological Engineering curriculum of sustainable food, water and energy systems. The addition of Dr. Rusty Bautista, an academic year instructor, has been very helpful. Mr. Randy Andres joined us in October as the instrumentation program associate. He joins our lab staff in support of departmental programs. We had 88 undergraduates (sophomores to seniors) and 21 graduate students. One senior design team "Design of a Low-Cost Prosthetic Foot for the Dominican Republic" won first place in the ASABE International competition in July 2013.

In January, Dr. Yanbin Li was recognized with the Spitze Land Grant University Faculty Award for Excellence. Dr. Dharmendra Saraswat garnered the Gamma Sigma Delta Extension Faculty Award for Merit. Both the John Imhoff Outstanding Faculty awardees at the 2013 Engineering Alumni Awards Event were from our department: Dr. Scott Osborn for outstanding teaching and Dr. Jin-Woo Kim for outstanding research. Also, Dr. Dennis Gardisser was recognized with a Distinguished Engineering Alumni Award on April 13. Drs. Brian Haggard and Marty Matlock have been appointed by Governor Mike Beebe to serve on the Illinois River Study Committee to oversee a two-year study.

The senior design expo was held on May 1 with 31 students in eight senior design teams showcasing their projects. Drs. Julie Carrier, Tom Costello and Jin-Woo Kim were recognized with the departmental faculty awards for teaching, service to students, and research, respectively, on May 3. There were 30 graduates of the B.S. in Biological Engineering at the 2013 commencement on May 11. Two outstanding alumni, Mr. Hix Smith Jr. and Mr. Marcus Tilley, were inducted in the Arkansas Academy of Biological and Agricultural Engineering on April 12. The faculty engaged in annual summer retreat, to review our programs and plan for the coming year during in June. We implemented monthly departmental seminars in 2013 and brought back alumni Mr. Mark Christie of Tyson Foods; Mr. Rusty Tate of Garver; and Ms. Toni Peacock McCrory of Wal-Mart, to speak to our students and faculty. We are thankful to Mark, Rusty and Toni for taking the time to share their experiences with us.

Dr. Scott Osborn was awarded the 2013 Presidential Citation by American Society of Agricultural and Biological Engineers for his extraordinary service and invaluable contributions to the society. Dr. Dharmendra Saraswat and his team were recognized with the 2013 ASABE Educational Aids Blue Ribbon Award, and Dr. Scott Osborn received ASABE President's Citation for his professional service. The Arkansas Section of ASABE celebrated its 50th Anniversary in Little Rock on October 5 with technical presentations and a panel discussion. Mr. Colby Reaves was recognized as our Outstanding Senior at this event. The dinner banquet address was given by Arkansas Agriculture Secretary Mr. Butch Calhoun. I began my term as ASABE President on July 24, 2013, at the Annual International Meeting of the American Society of Agricultural and Biological Engineers in Kansas City. This opportunity is providing valuable interaction with various constituents and has allowed me to engage in both short and long-term challenges that our profession faces in the global arena. I am excited that our BAE programs at the U of A are addressing the grand challenges that we face in achieving sustainable food, water, and energy. Our profession is critically important to addressing these challenges.

Please take some time to review our programs (www.baeg.uark.edu) and continue to support our efforts. I hope 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. We would love to share our activities with you and help answer any questions you may have.

Lalit R. Verma,

Professor and Department Head

- Julie Carrier was named Outstanding Teacher by the College of Engineering.
- Julie Carrier serves as advisor for the Society of Women Engineers
- Thomas Costello was recognized for his Outstanding Service to Students by the College of Engineering.
- Brian Haggard organized the Annual Research and Watershed Conference sponsored by AWRC.
- Jin-Woo Kim was named Outstanding Researcher by the College of Engineering.
- Jin-Woo Kim was elected General Chair for the 9th IEEE International Conferences for Nano/Molecular Medicine and Engineering. The conference will be held in Hawaii in 2015. He is also an active member of the Steering Committee for the IEEE-NANOMED conference.
- Jin-Woo Kim and Scott Osborn received John Imhoff Outstanding Faculty Awards.
- Yanbin Li received the Spitze Land Grant University Faculty Award for Excellence.
- Marty Matlock was keynote speaker at the International Conference on Challenges in Sustainable Agriculture.
- Marty Matlock presented a workshop on sustainable agriculture to Senate and House staff in Washington DC.
- Scott Osborn was awarded the 2013 Presidential Citation for Merit by ASABE.
- Dharmendra Saraswat received the 2013 Gamma Sigma Delta Extension Faculty Award for Merit.
- Dharmendra Saraswat led a team to develop the 'Corn Advisor' app for use on smartphone and tablet.
- Dharmendra Saraswat presented an android app development workshop at the 2013 international annual ASABE meeting.
- The Corn Advisor App was recognized with the 2013 ASABE Educational Aids Blue Ribbon Award. The team was comprised of Dharmendra Saraswat, Leo Espinosa (Extension Soil Scientist) and Jason Kelley (Extension Wheat and Feed Grain Agronomist).

ALUMNI ACCOMPLISHMENTS

- Sujit Ekka named the International Jennings Randolph Fellow by the American Public Works Association.
- Dennis Garisser received the College of Engineering's Distinguished Alumni Award.
- Naresh Pai received Honorable Mention for his dissertation from the Universities Council on Water Resources.
- Hix Smith Jr. and Marcus Tilley were inducted into the Arkansas Academy of Biological and Agricultural Engineering.

Significant Accomplishments in 2013

Students

- Nadia Bhatti was named Outstanding Senior in BAEG for 2013.
- Zachary Callaway won the Vivione Biosciences Poster Award for Rapid Detection Methods at the Arkansas Association of Food Protection 2013 annual meeting.
- Gurdeep Singh placed third in ASABE's 2013 Boyd-Scott Graduate Research Award competition.
- Kalavathy Rajan won second place in the A2C poster competition. Her advisor was Dr. Julie Carrier.
- Mahmoud Sharara won first place in the A2C poster competition. His advisor was Dr. Samy Sadaka.
- The senior design team of Brent Danley, Thomas Jenkins, John Mazurkiewicz, Kristin Perrin, and Ryan Yarnall won first place in the 2013 G.B. Gunlogson Student Environmental Design "Open" Competition at the 2013 annual international ASABE conference. Their advisor was Dr. Thomas Costello.

Rusty Bautista, Ph.D.
Instructor
B.S. Ag. E. (1981) University of the Philippines at Los Baños College, Philippines
M.S. Ag. E. (1993) University of the Philippines at Los Baños College, Philippines
Ph.D. Ag. E. (1998) Iwate University, Japan

Danielle Julie Carrier, Ph.D.
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, biomass saccharification, inhibitory product characterization, compound fractionation and purification and biorefinery co-products development.

Thomas A. Costello, Ph.D., 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 engineering, agricultural engineering, bio-energy, alternate energy, energy conservation, development and evaluation of economical BMP's for improved water quality, air quality and sustainability of agricultural production.

Brian E. Haggard, Ph.D.
Professor
Director, Arkansas Water Resources Center
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, water quality chemistry, algal nutrient limitation, pollutant transport in aquatic systems, water quality monitoring and modeling.

Christopher Henry, Ph.D., P.E.
Assistant Professor, Extension
B.S. (1996) Kansas State University
M.S. (1998) Kansas State University
Ph.D. (2009) University of Nebraska
Research Areas: 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, 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.

Jin-Woo Kim, Ph.D.
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: Biotechnology engineering, biomedical engineering, biocatalysis technology, environmental biotechnology, nucleic acid technology, and nano-biotechnology.

Yanbin Li, Ph.D., P.E.
Professor, Tyson Endowed Chair in Biosensing Engineering
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, biomedical engineering, biosensor technologies, microbial predictive modeling, quantitative risk assessment, and antimicrobial technologies.

Yi Liang, Ph.D.
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: 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, Ph.D., P.E.
Professor
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; linkages among technology, economics and societal values.

DEPARTMENTAL RESOURCES

FACULTY

Marty D. Matlock, Ph.D., P.E., B.C.E.E.
Professor
Area Director, Center for Agricultural and Rural Sustainability
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, ecological watershed modeling, biological assessment and monitoring, ecosystem design and management.

Robert Morgan, Ph.D.
Adjunct Faculty
Manager of Environmental Quality, Beaver Water District
B.S. Civil Eng. (1973) University of Arkansas
M.S. Civil Eng. (2003) University of Arkansas
Ph.D. (2007) University of Arknasas

Scott Osborn, Ph.D., 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, dissolved oxygen and ozone technologies, Biological Modeling, drying and energy processes.

Sammy Sadaka, Ph.D., P.E., P.Eng.
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, grain drying and storage; gasification, pyrolysis, biodrying, energy conservation

Dharmendra Saraswat, Ph.D.
Associate Professor / Extension Engineer—Geospatial
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: Geospatial analysis, mobile-, web-, and cloud-based system design and development, precision agriculture for nursery plants and row crops, bio-Energy, and watershed modeling.

Karl VanDevender, Ph.D., P.E.
Professor, Extension Engineer
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, Ph.D., P.E.
Professor
Department Head
B.Tech Ag.E. (1972) Agricultural University, India
M.S. Ag.E. (1973) Montana State University
Ph.D. Engineering (1976) University of Nebraska
Administration of the Department of Biological and Agricultural Engineering.

Jun Zhu, Ph.D.
Professor
B.S. Civil Eng. (1982) Zhejiang Univeristy, China
M.S. Civil Eng. (1985) Zhejiang University, China
Ph.D. in Ag. E. (1995) University of Illinois
Research Areas: Air and water quality related to animal agriculture and value added products production from agricultural renewable resources (bio-energy and chemicals).

Julian Abram
Program Technician

Randy Andress
Program Associate

Prathamesh Bandekar
Program Associate

Rusty Bautista
Instructor

Holly Beason
Secretary II, Extension

Eric Cummings
Program Associate

Staci Hudspeth
Department Fiscal Manager

Kyle Wesley Hunter
Scientific Research Tech

Jerry Jackson
Research Lab Technician

Mansoor Leh
Post Doctoral Associate

Betty Martin
Program Technician

James McCarty
Program Associate

Linda Pate
Department Administrative Manager

Rifati Raindriati
Administrative Specialist III

Lee Schrader
Program Assistant

Karen Withers
Administrative Office Supervisor, Extension

Erin Scott
Program Associate

Ronghui Wang
Post Doctoral Associate

BAEG Advisory Board
2013-2014 Members

Mark Christie
Manufacturing Services
Tyson Foods

Allen Fortenberry
Chief Executive Officer
Beaver Water District

Tyler Gipson
Hydraulic Engineer
US Army Corps of Engineers

Kevin J. Igli
SVP and Chief EHS Officer
Tyson Foods

Kyle Krueger
Garver Engineering

Jeff Madden
Director of Engineering
Riceland Foods, Inc.

Toni Peacock McCrory
Sr. Manager
EH&S Compliance Systems (Enviance)
Wal-Mart

Robert Morgan
Manager of Environmental Quality
Beaver Water District

Chris Pixley
VP of Operations
Pacific Vet Group-USA

Randy Young
Executive Director
Arkansas Natural Resources Commission

Academic Advisory Committee
2013-2014 Members

Mark Christie
Tyson Foods, Inc

Anthony Doss
Tyson Foods, Inc

Toni Peacock
Stormwater Project Manager, Walmart

Christopher Pixley
VP of Operations
Pacific Vet Group-USA

Rusty Tate
Garver Engineering

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)

Greg Baltz
B.S. ('80)

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)

Shawn Brewer
B.S. ('94), M.S. ('98)

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)
COE Young Alumni 2008

Darrell Holmes
B.S. ('81)

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

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

Jeff Keeter
B.S. ('84)

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. ('58), M.S. ('61)

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

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

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

Richard M. Rorex
B.S. ('78), M.S. ('81)
COE Distinguished Alumni 2011

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

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

Billy Staton
B.S. ('91), M.S. ('95)

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

Albert E. "Gene" Sullivan
B.S. ('59)
COE Distinguished Alumni 2007

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

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

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

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
COE Distinguished Alumni 2012

Dawn Wheeler-Redfearn
B.S. ('99), M.B.A. ('00)
COE Distinguished Alumni 2008

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

Billy Bryan
B.S. ('50) M.S. ('54) Posthumously

Albert H. Miller
Posthumously

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

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

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

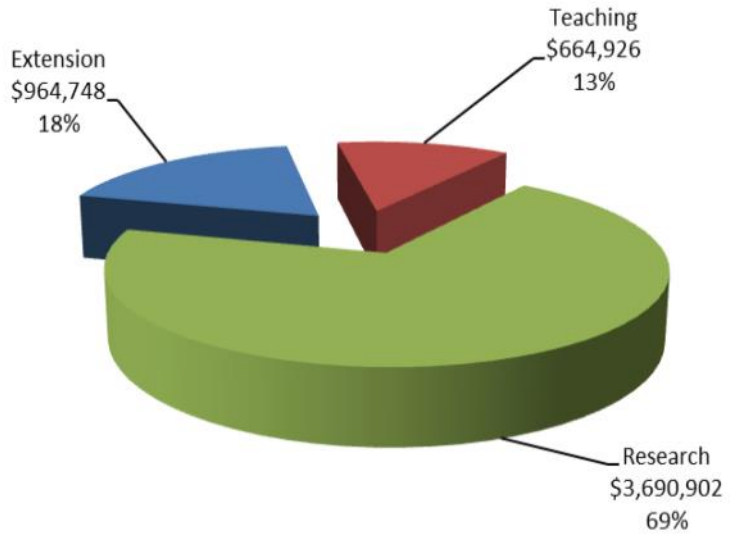
2013 Academy Inductees

William Hix Smith, Jr.
B.S. ('67)

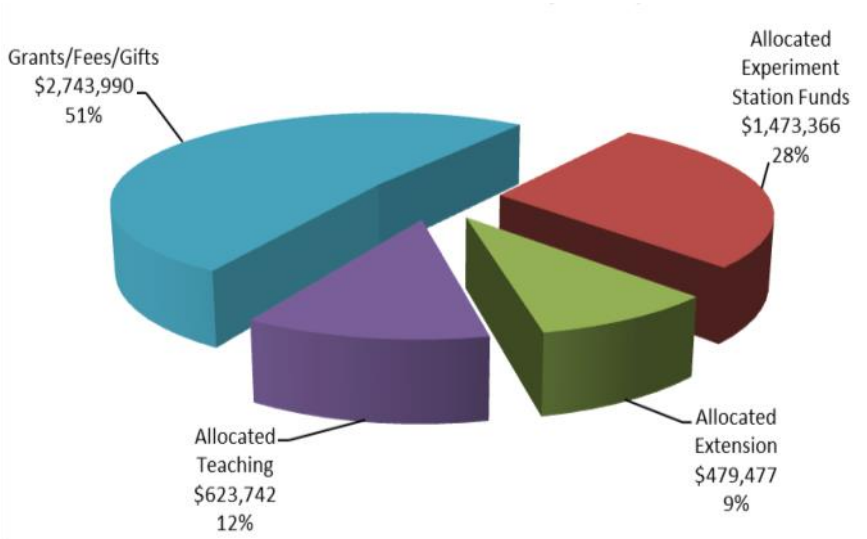
Marcus Tilly
B.S. ('00)

Total Expenditures, July 1, 2012 to June 30, 2013
$5,320,576

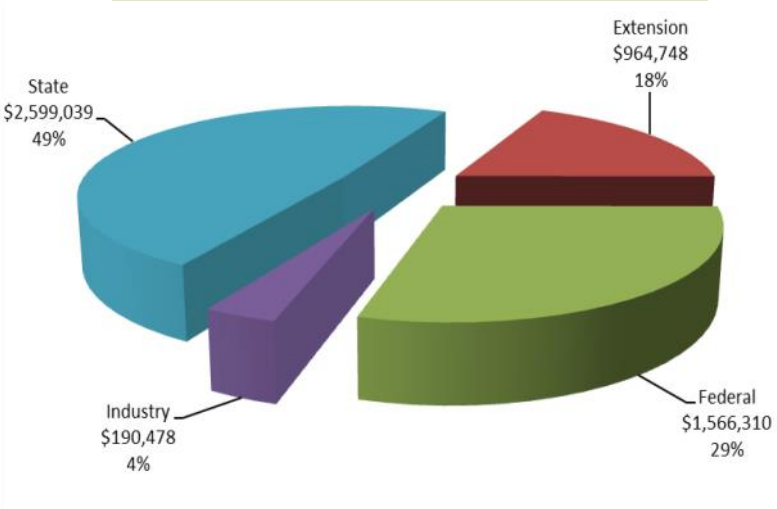
Expenditures by Program Area



Sources:
Allocated vs. Grants/Fees/Gifts

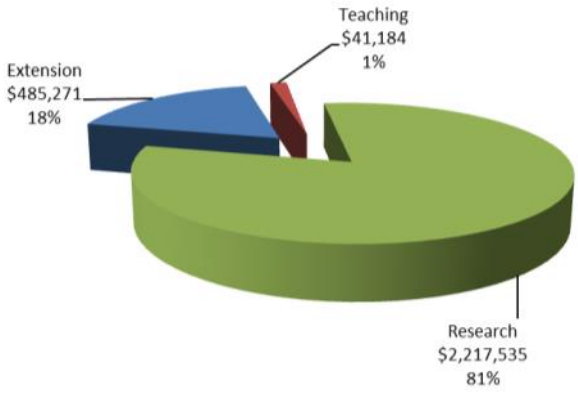


Sources of All Funds

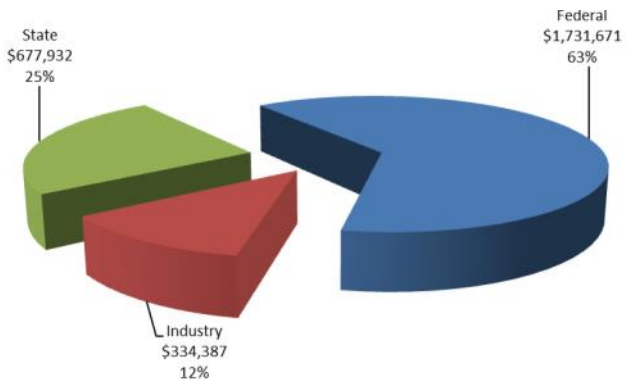


Grants/Fees/Gifts
$2,743,990

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.

The Carnegie Foundation recognized the University of Arkansas as one of 108 elite research universities in the nation for 2011, one of only seven schools in the Southeastern Conference to receive this distinction.

Northwest Arkansas and the University of Arkansas were featured in the July 2013 issue of *U.S. Airways Magazine*. The 11-page section on NWA detailed the many positive impacts provided by the $1 billion Campaign for the 21st Century, one of the largest fund-raising efforts by a U.S. public university, while focusing on the university's future goals.

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.

DEPARTMENT OF BIOLOGICAL & AGRICULTURAL ENGINEERING

The Biological and Agricultural Engineering Department is housed on the second floor of the John A. White Jr. 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 Institute for Nanoscience and Engineering , located at 731 W. Dickson St.

CITY OF FAYETTEVILLE AND NORTHWEST ARKANSAS

The City of Fayetteville recently ranked eighth in the Best Metro on *Forbes Magazine's* "Best Places for Business and Careers," boasting a ranking of 12 and 16 for cost of doing business and job growth for 2007, and rose to fourth in 2009. *Forbes* also listed Fayetteville among the "Top College Sports Towns" (sixth in 2009 and seventh in 2010), and ranked it 15th in "Top 100 Metropolitan Areas in the Nation for Business and Careers."

Kiplinger's 2008 "Best Cities to Work, Live and Play" list featured Fayetteville as its number seven choice. The Milken Institute gave the Fayetteville-Springdale-Rogers area a rank of 26 for "Best-Performing Large Cities for 2011," while *Area Development Magazine* listed the city among its "Top 100 Leading Locations" for the same year. CNBC Best States for Business honored Arkansas State with a rank of #1 in the "Cost of Doing Business" category.

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.

Teaching Program

Undergraduate Program

The department's mission is: *Healthy Planet, Healthy People*. 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; ensure a safe, nutritious food supply; and secure a healthy and safe environment. The department focuses on engineering design that promotes sustainable production, processing and management of food water and energy. A Bachelor of Science degree in biological engineering is a job-ready degree with opportunities in many industries, government agencies, and consulting firms. It is also excellent preparation for medical, veterinary, dental or other health science professional school as well as M.S. and Ph.D. studies in engineering in other areas.

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

The educational objective of the Biological Engineering Program at the University of Arkansas is to prepare students to successfully practice engineering involving the design and management of sustainable food, water, and energy systems.

Diverse applications of biological engineering can be pursued through elective coursework such as:

- Integrating ecological principles into the design of sustainable systems to treat, remediate, and prevent pollution to the environment. Applications include stream restoration, watershed management, water and wastewater treatment design, ecological service management, urban greenway design and enclosed ecosystem design.
- Food processing, food safety and security, biosensing and bioinstrumentation, biotechnology at the micro and nanoscale, developing new products from biomaterials, and biotransformation to synthesize industrial and pharmaceutical products.
- Sustainable design and management of finite resources with a broad perspective local and global and cradle to grave life cycle analysis of resource utilization, and environmental impacts with a view toward long-term prosperity.

The B.S. in Biological Engineering degree can lead to careers in consulting, ecological engineering and design, environmental engineering, sustainable agriculture and food production, low impact development, water quality and watershed management, human health, biotechnology, natural resource engineering, nanotechnology, and biofuels development to name but a few.

BIOLOGICAL ENGINEERING B.S.B.E., EIGHT-SEMESTER DEGREE PROGRAM 2013-2014 COURSE CATALOG

The Bachelor of Science in Biological Engineering program is eligible for students who want to participate in an Eight Semester Degree Program. The plan below lists a semester-by-semester sequence of courses to finish the degree in eight semesters. University core courses for engineering are listed at the bottom of this page. Students may submit a maximum of four (4) hours of "D" in BENG Courses for their degree. Some courses are not offered every semester, so students who deviate from the suggested sequence must pay careful attention to course scheduling and course pre-requisites.

Freshman Year	
First Semester 1 GNEG 1111 Introduction to Engineering I 3 ENGL 1013 Composition I 3 CHEM 1113 University Chemistry for Engineers I (or CHEM 1103) 4 MATH 2554 Calculus I 4 PHYS 2054 University Physics I **15 Semester hours**	**Second Semester** 1 GNEG 1121 Introduction to Engineering II 3 ENGL 1023 Technical Composition II 4 Freshman Engineering Science Electives * 4 MATH 2564 Calculus II 3 U.S. History Requirement **15 Semester hours**
Sophomore Year	
First Semester 2 BENG 2632 Biological Engr Design Studio 4 MATH 2574 Calculus III 4 Sophomore Science Electives ** 4 BIOL 1543/1541L Principles of Biology and Lab 3 MEEG 2003 Statics **17 Semester hours**	**Second Semester** 3 BENG 2643 Biological Engineering Design Methods 4 MATH 2584 Differential Equations 4 BIOL 2013/2011L General Microbiology w/Lab 3 MEEG 2403 Thermodynamics (OR CHEG 2313) 3 Humanities/Social Science Electives **17 Semester hours**
Junior Year	
First Semester 3 BENG 3733 Transport Phenomena in Biological Systems 3 BENG 3653 Global Bio-Energy Engineering 4 CHEM 3603/3601L Organic Chemistry I w/Lab 3 CVEG 3213, Hydraulics (OR MEEG 3503 OR CHEG 2133) 3 ELEG 3903 Electric Circuits and Machines **16 Semester hours**	**Second Semester** 3 BENG 3723 Unit Operations in Biological Engr 3 BENG 3113 Measurements and Controls for Biological Systems 4 CHEM 3613/3611L Organic Chemistry II w/Lab 3 BIOL 3863 General Ecology 3 CVEG 3223 Hydrology **16 Semester hours**
Senior Year	
First Semester 3 BENG 4813 Senior Biological Engineering Design I 3 BENG 4743, Food and Bio-Product Systems Engineering 3 BENG 4933 Sustainable Watershed Engineering 3 Humanities/Social Science Electives 3 Humanities/Social Science Electives **15 Semester hours**	**Second Semester** 2 BENG 4822 Senior Biological Engineering Design II 3 BENG 4663 Sustainable Biosystems Design 3 Engineering Electives 3 Fine Arts Electives (from University/State core list) 3 Humanities/Social Science Electives 3 Technical Electives **17 Semester hours**

* The Freshman Engineering Science Elective must be chosen from either (CHEM 1133/1131L or CHEM 1123/1121L) or PHYS 2074.

** The Sophomore Science Elective must be: PHYS 2074 if (CHEM 1133/1131L or CHEM 1123/1121L) was chosen as the Freshman Engineering Elective; or (CHEM 1133/1131L or CHEM 1123/1121L) if PHYS 2074 was chosen as the Freshman Engineering Science Elective. That is, both courses are required for the degree.

Teaching Program

Undergraduate Program

Scholarship Recipients for 2013

Arkansas Academy of Biological & Agricultural Engineering Scholarship

Katherine McWilliams

Biological & Agricultural Engineering Departmental Scholarship

Brent Danley

Billy Bryan Scholarship

Jackson Daniel
Aaron Thomason

J.A. Riggs Tractor Company Scholarship

Thomas Jenkins

Xzin McNeal Scholarship

Blake Ahrendsen
Adam Burk
Jackson Daniel
Kristin Perrin
Amy Powless
Samantha Puckett
Aaron Thomason
Lauren Wilson

Graduates for 2013

Bachelor of Science in Biological Engineering

Spring 2013

Katherine Atkins
John Cameron Beyers
Adam Burk
Thanh Dai
Noaa Frederick
Nicholas Galuska
Matthew Harrison
Paige Heller
Thomas Jenkins
Nicholas Lombardo
Katherine McWilliams
Sarah Necessary
Sakura Betty Phansiri
Kristin Perrin
Aaron Thomason
Derrick Washington
Katherine Whitbeck
Lauren Wilson
Ryan Yarnall

Summer 2013

Blake Ahrendsen
Nadia Bhatti
John Mazurkiewicz
Amy Powless
William Ben Putman
LaCrea Wilson
Zachary Young

Fall 2013

Brent Danley
Jaime Gile
Nicholas Stoddart
Rakiya Tasiu
Adam Yates

Biological Engineering Student Club

2013-2014 Officers

Colby Reavis—*President*

Russell Bair—*Vice President*

Zach Simpson—*Treasurer*

Katie Smith—*Secretary*

Shelby Paschal—*Public Relations*

Advisor: Dr. Scott Osborn

MASTER OF SCIENCE AND DOCTOR OF PHILOSOPHY 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 Ph.D. 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

In general, admission to the Department of Biological and Agricultural Engineering graduate program is a three-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 department's program, which depends on transcripts, recommendations, a statement of purpose, and the following GPA and test scores.

A. Students with an ABET-Accredited or equivalent Engineering Degree

- Students to a M.S. program from a B.S. degree in engineering or to a Ph.D. program from a B.S. degree in engineering and a M.S. degree:
    1. A score of 301 (1100 for the tests taken prior to August 1, 2011) or above (verbal and quantitative) on the Graduate Record Examination (GRE).
    2. A TOEFL score of at least 550 (paper-based) or 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.
    3. GPA of 3.00 or higher on the last 60 hours of a B.S. degree or B.S. and/or M.S. degrees
    4. B.S. degree in engineering from an ABET (Accreditation Board for Engineering and Technology) accredited or equivalent
- Students to Ph.D. program directly from a B.S. degree in engineering:
    1. A score of 307 (1200 for the tests taken prior to August 1, 2011) or above (verbal and quantitative) on the GRE.
    2. A TOEFL score of at least 550 (paper-based) or 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.
    3. A cumulative GPA of 3.5 or above for undergraduate work.
    4. B.S. degree in engineering from an ABET

accredited program or equivalent.

B. **Students without an Engineering Degree**

- Students to a M.S. program from a non-engineering BS degree:
    1. A score of 301 (1100 for the tests taken prior to August 1, 2011) or above (verbal and quantitative) on the GRE
    2. A TOEFL score of at least 550 (paper-based) or 2013 (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.
    3. GPA of 3.00 or higher on the last 60 hours of a B.S. degree.
    4. Completion of 18 hours of engineering course work (listed below under Degree Requirements). Also see additional information below under the Admission Requirements for Master of Science in Biological Engineering.
- Students to a Ph.D. program from non-engineering B.S. plus M.S. degrees:
    1. A score of 301 (1100 for the tests taken prior to August 1 , 2011 or above (verbal and quantitative) on the GRE.
    2. A TOEFL score of at least 550 (paper-based) or 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.
    3. GPA of 3.00 or higher on the last 60 hours of B.S. and/or M.S. degrees.
    4. Completion of 18 hours of engineering course work (listed below under Degree Requirements). Also see additional information below under the Admission Requirements for Doctor of Philosophy in Biological Engineering.
- Students to a Ph.D. program directly from a non-engineering B.S. degree:
    1. A score of 307 (1200 for the tests taken prior to August 1, 2011) or above (verbal and quantitative) with 155 (700 for the tests taken prior to August 1, 2011) and 4.5 or above in writing on the GRE
    2. A TOEFL score of at least 580 (paper-based) or 237 (computer-based) or 92 (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.
    3. A cumulative GPA of 3.5 or above for undergraduate work.
    4. Completion of 18 hours of engineering course work (listed below under Degree Requirements). Also see additional information below under the Admission Requirements for Doctor of Philosophy in Biological Engineering.

Finally, 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.

Details concerning admission for both international and domestic students are provided in the University's Graduate School Handbook.

Details concerning other admission requirements can be found in the BAEG Graduate Handbook.

Graduate Students

The following students were part of the Graduate program during 2013. 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

Student	Advisor
Prathamesh Bandekar	Dr. Thomas Costello and Dr. Yi Liang
Eric Boles	Dr. Marty Matlock
Jason Corral	Dr. Brian Haggard
Noaa Frederick	Dr. Julie Carrier
Nathan Holeman	Dr. Thomas Costello
Eeshan Kumar	Dr. Dharmendra Saraswat
Min Lei	Dr. Yi Liang
James McCarty	Dr. Marty Matlock
William Merritt McDougall	Dr. Chris Henry
Sakura Phansiri	Dr. G. Scott Osborn
Caroline Powell	Dr. Marty Matlock
William Putman	Dr. Marty Matlock
Grace Richardson	Dr. G. Scott Osborn
George Sakhel	Dr. Jin-Woo Kim
Richard Sakul	Dr. Julie Carrier
Yixiang Wang	Dr. Yanbin Li
William Morgan Welch	Dr. Brian Haggard

Doctor of Philosophy in Biological Engineering

Student	Advisor
Kris Bunnell	Dr. Julie Carrier
Zachary Callaway	Dr. Yanbin Li
Eric Cummings	Dr. Marty Matlock
Angele Mezindjou Djioleu	Dr. Julie Carrier
John Judkins	Dr. Jin-Woo Kim
Pratyush Rai	Dr. Vajay Vardan
Mahmoud Sharara	Dr. Sammy Sadaka
Gurdeep Singh	Dr. Dharmendra Saraswat
Gagandeep Singh Ubhi	Dr. Sammy Sadaka
Meng Xu	Dr. Yanbin Li

Doctor of Philosophy in Cell and Molecular Biology

Student	Advisor
Sardar Abdullah	Dr. Yanbin Li
Jacob Lum	Dr. Yanbin Li
Xiaofan Yu	Dr. Yanbin Li

Master of Science in Environmental Engineering

Student	Advisor
Amber Brown	Dr. Marty Matlock
Ryan Johnston	Dr. Marty Matlock

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	M.S. Horticulture	Dr. Brian Haggard
Joseph N. Batta-Mpouma	M.S. Microelectronics-Photonics	Dr. Jin-Woo Kim
Luke Brockman	M.S. Biological Engineering	Dr. Yanbin Li
Siva Chalamalasetty	M.S. Microelectronics-Photonics	Dr. Yanbin Li and Dr. Kaiming Ye
John Fohner	M.S. Crop, Soil & Environmental Science	Dr. Brian Haggard
Andreas Haukas	M.S. Biomedical Engineering	Dr. Yanbin Li
Orain Hibbert	M.S. Micoelectronics– Photonics	Dr. Jin-Woo Kim
Jacob Hohnbaum	M.S. Mechanical Engineering	Dr. Jin-Woo Kim
Benjamin Holden	M.S. Engineering	Dr. Yi Liang
Lucas Leshe	M.S. Horticulture	Dr. Sammy Sadaka
Iaryna Masniuk	Ph.D. Biomedical Engineering	Dr. Yanbin Li
Katherine McCoy	M.S. Civil Engineering	Dr. Brian Haggard
Asanka Munasinghe	Ph.D. Microelectronics-Photonics	Dr. Yanbin Li
Irene Pagana	M.S. Food Science	Dr. Julie Carrier
Leigh Parette	Ph.D. Poultry Science	Dr. Yanbin Li
Soloman Parker	M.S. Civil Engineering	Dr. Brian Haggard
Kalavathy Rajan	Ph.D. Food Science	Dr. Julie Carrier
Karl Serbousek	M.S. Engineering	Dr. Otto J. Loewer
Balaji Srinivasan	Ph.D. Mechanical Engineering	Dr. Jin-Woo Kim and Dr. Yanbin Li

Graduate Degrees Earned

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

Summer 2013

Kris Bunnell—Ph.D.
Min Lei—M.S.
Pratyush Rai—Ph.D.

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

BENG2632 Biological Engineering Design Studio (Fa) Application of the engineering design process to projects involving living systems. Projects are team-based open-ended design with hands-on construction and testing of design prototypes. Emphasis is placed on understanding, quantifying and controlling complex interacting living systems involving humans, animals, plants and microbes with the goal of creating economically and ecologically sustainable systems. 4 hours of design studio per week. Pre- or Corequisite: PHYS 2054 and BIOL 1543/1541L, and (GNEG 1111 or GNEG 1103).

BENG2643 Biological Engineering Methods (Sp) Introduction to the tools needed to perform biological engineering design, integrated through projects in the food, energy and/or water area. The tools covered include structured programming language for modeling, statistical analysis, geographic information systems, engineering graphics, and engineering economics. Two hours of lecture and three hours of lab per week. Corequisite: Lab component. Prerequisite: BENG 2632.

BENG3113 Measurement and Control for Biological Systems (Sp) Principles of sensors, instruments, measurements, controls, and data acquisition systems, with emphasis on applications for biological systems. Including sensor calibration and signal conditioning, elementary control algorithms, basic electro-mechanical controls, and digital controls. Autonomous field and process monitoring and controls. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component. Prerequisite: ELEG 3903.

BENG3113H Honors Measurement and Control for Biological Systems (Sp) Principles of sensors, instruments, measurements, controls, and data acquisition systems, with emphasis on applications for biological systems. Including sensor calibration and signal conditioning, elementary control algorithms, basic electro-mechanical controls, and digital controls. Autonomous field and process monitoring and controls. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component. Prerequisite: ELEG 3903

BENG3653 Global Bio-Energy Engineering (Fa) Global energy sources with a focus on renewable energy, solar and biomass derived fuels. Biomass energy production from crops and organic residues or waste products. Conversion of biomass to usable fuels. Utilization of renewable energy in society. Includes detailed systems analyses to examine inputs, efficiencies, usable outputs and by-products. Systems design to select and integrate components which meet client needs while maximizing sustainable global impacts. Three hours of lecture per week. Pre- or Corequisite: BENG 2643 and (MEEG 2403 or CHEG 2313).

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

BENG3733 Transport Phenomena in Biological Systems (Fa) Basic principles governing transport of energy and mass. Estimating transfer of energy (heat) through solid bodies and liquid/gas boundary layers through conduction, convection, and radiation. Modeling the rates at which biological reactions occur (kinetics). Estimating the transfer of diffusing mass (gas or liquid) through solid bodies and liquid/gas boundary layers, including processes such as drying and oxygen diffusion. Three hours lecture per week. Pre- or Corequisite: (CVEG 3213 or MEEG 3503 or CHEG 2133.) Prerequisite: (MEEG 2403 or CHEG 2313) and MATH 2584.

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

BENG4123 Biosensors & Bioinstrumentation (Odd years, Sp) Principles of biologically based sensing elements and interfacing techniques. Design and analysis methods of biosensing and transducing components in bioinstrumentation. Applications of biosensors and bioinstrumentation in bioprocessing, bioenvironmental, biomechanical and biomedical engineering. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component. Prerequisite: BIOL 2013 or BIOL 2533 and BENG 4104.

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

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

BENG452V Special Topics in Biological Engineering (Irregular) Special topics in biological engineering not covered in other courses. May be repeated for up to 8 hours of degree credit.

BENG4663 Sustainable Biosystems Designs (Fa) Process and methodologies associated with measuring, assessing, and designing sustainable systems in water, energy and food. Quantitatively rigorous methodology for life cycle analysis (LCA) for inventory, assessment and impact analyses. Use of other systems analyses and process control theory to evaluate and design sustainable systems. Application of the methods to a project to gain experience in defining, quantifying and utilizing sustainable metrics. Three hours of lecture per week. Prerequisite: BENG 3653 and BENG 4743 and BENG 4933.

BENG4703 Biotechnology Engineering (Fa) Introduction to biotechnology topics ranging from principles of microbial growth, mas balances, bioprocess engineering as well as emerging principles in the design of biologically based microbial and enzymatic production systems. Application areas such as biofuels, and fine and bulk chemical production. Lecture 2 hours, laboratory 3 hours per week. Prerequisite: BENG 2622. Corequisite: Lab component.

BENG4743 Food and Bio-Product Systems Engineering (Fa) Sustainable bio-product engineering through biosystem design, analysis, modeling, control, and optimization. Life cycle phases for bio-products (food, fiber, feed, and fuel). System analysis of inputs and outputs of energy, water and mass for the purpose of producing and processing biomass for human uses. Advanced bioprocess design topics to utilize enzymes, cells, tissues and organisms to create bio-products and methods for deactivating biological agents to preserve the quality and safety of food and other bio-products. Three hours lecture per week. Prerequisite: BENG 3723 and BENG 3733.

BENG4753L Nanotechnology Laboratory (Fa) Provides students with hands-on experience in several major areas of nanotechnology, including nanoscale imaging, synthesis of nanomaterials, nanostructure assembly and manipulation, device and system integration, and performance evaluation. Students can earn credit for only one of the following courses: MEEG 4323L, BENG 4753L, BMEG 4103L, CHEM 4153L, PHYS 4793L. Corequisite: Drill component, junior standing and instructor consent. Prerequisite: MATH 2564, PHYS 2074, CHEM 1123, or CHEM 1133.

This course is cross-listed with MEEG 4323L, CHEM 4153L, PHYS 4793L.

BENG4753M Honors Nanotechnology Laboratory (Fa) Provides students with hands-on experience in several major areas of nanotechnology, including nanoscale imaging, synthesis of nanomaterials, nanostructure assembly and manipulation, device and system integration, and performance evaluation. Students can earn credit for only one of the following courses: MEEG 4323L, BENG 4753L, BMEG 4103L, CHEM 4153L, PHYS 4793L. Corequisite: Drill component, junior standing and instructor consent. Prerequisite: MATH 2564, PHYS 2074, CHEM 1123, or CHEM 1133.

This course is cross-listed with MEEG 4323L, CHEM 4153L, PHYS 4793L.

BENG4813 Senior Biological Engineering Design I (Fa) Design concepts for equipment and processes used in biological, food and agricultural industries. Initiation of comprehensive two-semester team-design projects; defining design objectives, development functional/mechanical criteria, standards, reliability, safety, ethics and professionalism issues. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component. Prerequisite: BENG 3723 ane BENG 3733.

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

BENG4933 Sustainable Watershed Engineering (Sp) Provides students with expertise in using advanced tools in watershed monitoring, assessment, and design. Builds on core competencies in hydrology and hydraulics to allow student to evaluate water used by sector in water management regions; evaluate and quantify water demands by sector with emphasis on irrigation; develop risk-based simulations of hydrologic processes, including precipitation, evapo-transportation, infiltration, runoff, and stream flow; quantify and simulate constituent loading to watersheds using GIS-based models, and understand the applications of these methods in water resource management policy. Three hours lecture per week. Prerequisite: CVEG 3223 or BENG 4903.

BENG500V Advanced Topics in Biological Engineering (Irregular) (1-6) Special problems in fundamental and applied research. Prerequisite: Graduate standing. May be repeated for up to 6 hours of degree credit.

BENG5103 Advanced Instrumentation in Biological Engineering (Even years, Sp) Applications of advanced instrumentation in biological systems. Emphasis on updated sensing and transducing technologies, data acquisition and analytical instruments. Lecture 2 hours, lab 3 hours per week. Corequisite: Lab component. Prerequisite: BENG 3113.

BENG5113 DIGITAL Remote Sensing and GIS (Irregular) Basic digital image processing techniques and geo-spatial analysis applied to monitoring of natural processes and resources. Course topics include introduction to electromagnetic radiation, concept of color, remote sensing systems, and light attenuation by atmosphere, objects and sensors. Advanced topics include data models, spectral transforms, spatial transforms, correction and calibration, geo-rectification, and image classification with hyperspectral and multi-spectral images acquired with aerial and satellite sensors. Raster GIS is integrated into course throughout the semester. Will use software such as ENVI, ArcGIS and ArcView. Requires a class project in the student's area of interest. Lecture 2 hours, lab 3 hours per week. Students may not earn credit for both BENG 5113 and BENG 4133. Corequisite: Lab component. Prerequisite: MATH 2584.

BENG5203 Mathematical Modeling of Physiological Systems (Sp) Application of mathematical techniques to physiological systems. The emphasis will be on cellular physiology and cardiovascular system. Cellular physiology topics include models of cellular metabolism, membrane dynamics, membrane potential, excitability, wave propagation and cellular function regulation. Cardiovascular system topics include models of blood cells, oxygen transport, cardiac output, cardiac regulation, and circulation. Background in biology and physiology highly recommended. Lecture 3 hours per week. Prerequisite: MATH 2584. (Same as BMEG 5203)

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

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

BENG5233 Tissue Engineering (Fa) Introduction to tissue engineering. Topics include quantitative cell and tissue biology, tissue dynamics, cellular-fate processes, coordination of cellular-fate processes, stem cell differentiation and organ regeneration, biomaterials and tissue scaffolding, gene therapy, and clinical implementation of tissue engineered products. Lecture 2 hours, laboratory 3 hours per week. Students may not earn credit for both BENG 5233 and BENG 4233. Corequisite: Lab component. Prerequisite: CHEM 3613.

BENG5243 Biomaterials (Sp) Study of different classes of biomaterials and their interactions with human tissues. From absorbable sutures to Zirconium 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; opthamological 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 BENG 4233. Prerequisite: BENG 3712 or MEEG 2303, and MEEG 3013.

BENG5253 Bio-Mems (Irregular) 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. Prerequisite: MEEG 3503 or CVEG 3213 or CHEG 2133. (Same as MEEG 5253)

BENG5263 Biomedical Engineering Principles (Fa) Engineering principles applied to the design and analysis of systems affecting human health. This is a course focusing on fundamentals of physiological systems and modeling. Topics include: brief overview of anatomy and physiology, bioelectric phenomena and neuronal model, compartmental modeling, cardiovascular system and blood flow, biomechanics, computational biology and signal transduction. Requires a background in circuits, fluid dynamics, mechanics, biology, and/or biochemistry. Lecture 3 hours per week. Students may not earn credit for both BENG 5263 and BENG 4203. Prerequisite: MATH 2584 or equivalent and graduate standing.

BENG5273 Numerical Methods in Biomedical Engineering (Sp) 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 2584.

BENG5283 Electronic Response of Biological Tissues (Irregular) 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 4283 and BENG 5283. Prerequisite: MATH 2584, ELEG 3703 or 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.

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 (Irregular) Application of computer modeling and simulation of discrete-event and continuous-time systems to solve biological and agricultural engineering problems. Philosophy and ethics of representing complex processes in simplified form. Deterministic and stochastic modeling of complex systems, algorithm development, application limits, and simulation interpretation. Emphasis on calibration, validation and testing of biological systems models for the purposes of system optimization, resource allocation, real-time control and/or conceptual understanding. Prerequisite: AGST 4023 or STAT 4003 or INEG 2313.

BENG5623 Life Cycle Assessment (Sp) This course will examine the process and methodologies associated with life cycle analysis (LCA). The course will explore the quantitatively rigorous methodology for life cycle inventory (LCI), LCA and life cycle impact assessment (LCIA). This course is offered on-line. The principal instructor will be a UA faculty member.

BENG5633 Linkages Among Technology, Economics and Societal Values (Sp, Fa) Addresses how macro-level change is influenced by the linkages among technology, economics and societal values. Three major course initiatives: 1) Developing a conceptual model for understanding how macro-level change has occurred over history; 2) Examining recorded history in order to develop a contextual appreciation for Society's current situation; and 3) Using statistical data to identify six overriding world trends that are likely to greatly impact society's goal of achieving sustainable prosperity and well-being in the foreseeable future. Prerequisite: Graduate standing or instructor permission. (Same as OMGT 5633)

BENG5703 Design and Analysis of Experiments for Engineering Research (Irregular) Principles of planning and design of experiments for engineering research. Propagation of experimental error. Improving precision of experiments. Analysis of experimental data for optimal design and control of engineering systems using computer techniques. Students must have an introductory background in statistics. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component.

BENG5723 Food Safety Engineering (Even years, Fa) Principles of engineering methods applied to food and safety and sanitation. Principles of engineering methods applied to food safety and security. Discussion of thermal, chemical and electrical pasteurization or sterilization in food processing. Demonstration of monitoring and detecting techniques for food safety, including image analysis, biosensors and modeling. Lecture 3 hours per week. Prerequisite: BENG 4103 and FDSC 4123 (or equivalent).

BENG5733 Advanced Biotechnology Engineering (Odd years, Fa) Applications of the principles of bioprocess/biochemical engineering to microbiological and biomedical problems. Topics include applied enzymology, metabolic engineering, molecular genetics and control, and bioinformatics and nanobiotechnology in addition to classical applied enzyme and cell-growth kinetics and advanced bioreactor design. Prerequisite: BENG 3733 or BENG 4703 or BENG 5743 or equivalent.

BENG5743 Biotechnology Engineering (Fa) Introduction to biotechnology topics ranging from principles of microbial growth, mass balances, bioprocess engineering as well as emerging principles in the design of biologically based microbial and enzymatic production systems. Application areas such as biofuels, and fine and bulk chemical production. Lecture 2 hours, laboratory 3 hours per week. Students may not earn credit for both BENG 5743 and BENG 4703. Prerequisite: Graduate standing. Corequisite: Lab component.

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

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

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

BENG5943 Watershed Eco-Hydrology (Sp) 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. Prerequisite: CVEG 3213 or equivalent.

BENG5953 Ecological Engineering Design (Fa) Design of low impact development techniques to enhance ecological services, reduce peak runoff, and capture sediments, nutrients and other pollutants resulting from urban development. Techniques may include: bioswales, 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 (Sp, Su, Fa) (1-6) Prerequisite: Graduate standing.

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

FACULTY RESEARCH & EXTENSION PROJECTS

We are engaged in research and extension programs which contribute to improving the quality of life, security, economic development, and environmental stewardship for Arkansas and the world. Our engineering expertise is uniquely qualified to solve problems in food, water and energy systems. Biological and agricultural engineers utilize the engineering tools of systems analysis and design to solve complex problems in biological systems, ranging from microbes to the global environment. Our goal is to design sustainable systems that meet our present needs while enhancing the ability of future generations to meet their needs.

Our faculty provide leadership and expertise in several centers and organizations across the university, including:

- Water Resources Center
- Office of Sustainability
- Center for Agricultural and Rural Sustainability
- Watershed Research and Education Center
- Society of Women Engineers (SWE)
- Advancement of Women in Academic Science and Engineering Careers (ADVANCE)
- Bioenergy Consortium
- Institute for Nanoscience and Engineering
- Poultry Center of Excellence
- Community Design Center
- Center for Advanced Spatial Technologies
- Interdisciplinary graduate programs in Cell and Molecular Biology, Microelectronics and Photonics, Public Policy and Environmental Dynamics

The Biological and Agricultural Engineering research program is engaged in designing a sustainable future through innovation in interdisciplinary research in food, water and energy systems.

- Food Systems include: food safety, bio-sensing technology, food and bio-processing, bio-products utilization, microbial risk assessment, antimicrobial technologies, nano-biotechnology, bio/abio interfacing, phytochemical extraction, and bio-driven nanostructures
- Water systems include: watershed ecosystem services, stream bank, lake, and reservoir restoration and management, ecological engineering design, water resources, water quality and non-point source pollution management, watershed modeling and monitoring, irrigation technologies, water management at watershed and ecosystems scales, metrics for sustainable water management, and low-impact development
- Energy systems include: biomass production and post-harvest engineering, energy use at farm level, bio-refineries, thermo-chemical conversion of biomass and by-products, extraction of co-products, pretreatment of feed stock, farm-scale thermochemical reactors, bio-conversion and bio-processing, bio-products, equipment, poultry/animal housing energy efficiency, energy effectiveness analysis

Biological and Agricultural Engineering extension programs offer information and skill-development to assist Arkansans in maintaining and improving their access to sustainable food, water and energy systems. Our programs provide a biological and systems perspective to the state-wide extension team. Expertise exists in nutrient management, design and practices for animal manure management; GIS-coupled sensing, web and mobile-device information delivery, modeling of watersheds, climate-change variables, and biomass resources; air-emission quantification for control and mitigation of air-pollution, poultry-house indoor air-quality; poultry farm energy efficiency, thermal energy-conversion, and residential energy conservation and efficiency.

CONVERSION OF BIOMASS INTO LIQUID FUELS: UNDERSTANDING THE DEPOLYMERIZATION OF HEMICELLULOSE

DANIELLE JULIE CARRIER, PROFESSOR

ISSUE:

To convert biomass into liquid fuels or other biobased products using the biochemical platform, 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 oligomers, furfural, acetic acid and formic acid, and of lignin into phenolic compounds. The listed degradation 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 plethora of degradation compounds, is critical for maximizing biofuel and biobased production yields.

ACTION:

Our group is studying herbaceous and woody biomass. We pretreat and enzymatically hydrolyze biomass and then calculate the resulting sugar release. We also track the release of degradation compounds, and determine their production rates. Our long-term goal is to determine which processing conditions will maximize sugars, but minimize the release of degradation compounds.

IMPACT:

The payoff is quite important in the sense, that an increase of sugar release and a decrease of degradation compounds will set the stage for better use of our biomass resources.

CONTACT:

Danielle Julie Carrier, Professor
Biological and Agricultural Engineering
carrier@uark.edu / 479 575 2542

COOPERATING SCIENTISTS OR INSTITUTIONS:

Drs. Kevin Chambliss and Matt Pelkki

FUNDING SOURCES:

NSF, NSF EPSCoR – P3, DOE and DOT

ALGAE PRODUCTION USING SWINE EFFLUENT AS FERTILIZER

THOMAS COSTELLO, ASSOCIATE PROFESSOR

ISSUE:

Use of conventional fossil fuels (oil, coal, natural gas) is problematic because of uncertain future supplies of these finite resources, rising or uncertain costs of these fuels, concentration of major fuel supplies in parts of the world which are politically unstable, environmental impact of mining and drilling operations, and the cumulative effects of the release of carbon from the consumption of these resources. Biomass represents a renewable fuel source which can be harvested annually from available solar energy with minimal net carbon release. Algae growth can potentially capture many times more energy (per year per acre) that any other energy crop. Algae can also utilize nutrients from waste water or from natural waters containing excess nutrients. This utilization of existing waste or by-product nutrient sources decreases the demand for commercial fertilizers which must be mined and shipped long distances. The production provides biological treatment and water quality improvement of the influent flow. Hence, algae production represents a potentially sustainable energy source .

ACTION:

The UA Biological and Agricultural Engineering Department is continuing to investigate systems to produce algae using wastewater from swine production to yield biomass feedstock for biofuel production. The system grows attached periphytic algae in an open flow way with a continual stream of the inlet swine effluent. Experiments were conducted to assess treatment options to adjust swine effluent water quality to support algal growth. Processes to decrease ammonia concentrations and solids contents were tested. The algae flow way at the UA Swine Grower Unit near Savoy Arkansas was operated in the fall 2013 to begin tests of the full system using undiluted swine effluent treated with alum to settle some solids. More studies will continue on 2014 to document seasonal productivity and operating costs.

IMPACT:

The new algae flow way at Savoy is a premier algae research facility to test inland, freshwater periphytic algal productivity at mid-latitudes. The technology employed is scalable to larger areas that would be needed to produce enough biomass to feed large-scale biofuel refineries. The research will quantify the productivity of the systems and fine-tune production strategies. Research results will provide data needed to perform objective economic analyses of the life cycle costs and environmental impacts of the proposed technology.

CONTACT:

Thomas Costello <tac@uark.edu> and Marty Matlock <mmatlock@uark.edu>
Department of Biological and Agricultural Engineering
479/575-2847

COLLABORATING SCIENTISTS:

Julie Carrier, Department of Biological and Agricultural Engineering

Samy Sadaka, Department of Biological and Agricultural Engineering, UA Division of Agriculture Cooperative Extension Service

Karl VanDevender, Department of Biological and Agricultural Engineering, UA Division of Agriculture Cooperative Extension Service

Wen Zhang, Department of Civil Engineering

Charles Maxwell, Department of Animal Sciences

Greg Thoma, Department of Chemical Engineering

FUNDING SOURCES:

USDA, NIFA/AFRI

University of Arkansas Division of Agriculture, Dale Bumpers College of Agricultural, Food and Life Sciences

University of Arkansas College of Engineering

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 looked 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 levels in area streams, and 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.

CONTACTS:

Brian E. Haggard, Professor and Director, Arkansas Water Resources Center, University of Arkansas, Fayetteville, Arkansas

COOPERATING SCIENTISTS OR INSTITUTIONS:

J. Thad Scott, Assistant Professor, Crop, Soil, and Environmental Sciences Department, University of Arkansas, Fayetteville, Arkansas

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 (USGS) 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 USGS's state cooperative program.

IRRIGATING SMART: CONSERVES WATER, SAVES MONEY, REDUCES ENERGY

CHRISTOPHER HENRY, ASSISTANT PROFESSOR, EXTENSION

ISSUE:
A regional effort to develop resources and train experts was led by the University of Arkansas in cooperation with New Mexico State University, Texas A and M University, Louisiana State University, University of Missouri, and Mississippi State University. The Irrigating Smart: Irrigation Pumping Plant Efficiency Testing developed a series of 12 factsheets and conducted two regional trainings on pump testing in New Mexico and Arkansas in 2013 and a specialize workshop for well drillers offered in Missouri. The program trained over 150 experts from across the country in how to conduct on-farm irrigation pumping plant testing to conserve energy and reduce irrigation costs for growers.

ACTION:
Factsheets were developed on a wide variety of topics, such as using variable frequency drives, air lines, soft starters, pump curves, dual fuel, pump efficiency, flow measurement, safety, natural gas, water horsepower, reading electrical meters, safety, general irrigation conservation suggestions, and the basics of pumping plant evaluations. Many of these are the only such factsheets on their topic publically available from land grant institutions. Additionally, they were developed specifically for application in the southern region. These factsheets were used to train participants at two regional hands-on workshops on performing pumping plant evaluations.
A separate effort focused on training well drillers in the region about well development, screen and gravel pack design and development and how this related to pumping plant performance.

IMPACT:
Paper evaluations were used to measure the degree of learning obtained and measure the degree of action the participants would take as a result of the workshops and exposure to the educational materials. Participants were NRCS engineers and staff, electricians, irrigation companies and dealers, utility staff, state agency personnel, conservation professionals, Extension agents, and some farmers. Ninety-four of the participants indicated that they would use the information gained to assist their clients. These clients represented about 2,739 irrigation pumps currently in service and the monetary value of the potential savings from the information learned to be $717,000. All participants indicated they would recommend pump testing to their clients and about 2/3 indicate they would be purchasing equipment to do pump testing on their own. The cost to get set up for pump testing is between $5,000 and $25,000.

Some comments about the workshops included:

"There is nothing like hearing from experts and seeing firsthand how critical proper pump sizing, pressure losses, etc. are to conserving energy and water resources"

"This training should be provided to every producer in the state" .

CONTACTS:
Chris Henry, University of Arkansas
Blair Stringham, New Mexico State University
Bill Branch, Louisiana State University
Nich Kenny, Texas A and M University
Jason Krutz, Mississippi State University
Lyle Pringle, Mississippi State University
Joe Henggeler, University of Missouri

CONTACT EMAIL AND PHONE:
ghenry@uark.edu / 870-673-2661

COOPERATING SCIENTISTS:
Earl Vories, USDA-ARS, Portageville, MO
Michele Reba, USDA-ARS, Jonesboro, AR

FUNDING SOURCES:
Southern Region Water Quality Initiative
Arkansas Soybean Promotion Board

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. In stead 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 ranging from MEMS/NEMS to biosensing and nanomedicine. However, the major challenges for making this merger feasible are integration and interfacing of the micro- and nano-scale 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 MEMS/NEMS channels and nanoparticles, at the micro/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) an electron tunneling based nanochannel system for DNA sequencing, and (d) a photoacoustic and photothermal biosensing as well as diagnostic systems.

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 3 journal article published or in press and 1 provisional patent pending during the year 2013.

CONTACT:
Jin-Woo Kim, Professor
Department of Biological and Agricultural Engineering
jwkim@uark.edu / 479-575-2351

FUNDING SOURCES:
National Science Foundation (NSF; award #: ECCS-1128660 and ECCS-1137948)

SELF-ASSEMBLY OF MULTIFUNCTIONAL NANOCOMPOSITES FOR MULTIPLEX, MULTIMODAL NANOTHERANOSTICS

JIN-WOO KIM, PROFESSOR

ISSUE:
Many therapeutic and diagnostic – termed "theranostic" – modalities have been developed to detect and treat fatal diseases such as 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 such life-threatening diseases. 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 engineering noninvasive theranostic platforms by uniquely combining novel nanoparticles (NPs) and their composites, and real-time integration of various theranostic modalities for effective diagnosis and treatment. 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 multifunctionalities.

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 sensing and theranostic applications. The research has generated 5 journal articles published or in press and 10 (8 invited) presenta-tions, and 1 pending patent during the year 2013.

CONTACT:
Jin-Woo Kim, Professor
Department of Biological and Agricultural Engineering
jwkim@uark.edu / 479-575-2351

FUNDING SOURCES:
National Science Foundation (NSF; award#: CMMI-1235100)

MICROPLATE-BASED BIOSENSING SYSTEM FOR RAPID DETECTION OF MULTIPLE VIRUSES

YANBIN LI, PROFESSOR, TYSON ENDOWED CHAIR IN BIOSENSING ENGINEERING

ISSUE:

Avian influenza (AI) H5N1 and H7N9 currently poses a potentially serious health threat to animals and human worldwide. Rapid, specific and sensitive detection of avian influenza virus (AIV) is becoming increasingly important and urgent. The technology for diagnosing AI infections is available, such as viral culture, diagnostic test kits, RT-PCR and ELISA methods, but these tests are either poor in specificity, low in sensitivity, time consuming, too expensive, or require a laboratory and a highly trained technician. Therefore, this research provides a microplate-based biosensing system to detect multiple subtypes of AI virus at lower concentrations to meet the needs for rapid response to the potential pandemic of AI as described by CDC, WHO and FAO.

ACTION:

The main innovation of this research is to put the impedance measurement into microplate format with the network-like thiocyanuric acid/gold nanoparticles for enhancing detection signals. The technology combined the advantages from microplate and impedance measurement as a practical method for rapid, specific, sensitive and high throughput detection of AIVs. The specific tasks have been completed, including (1) immobilization of AIV antibodies on the microelectrode surface; (2) selection of DNA aptamers to specifically bind H5/H7 AI virus; (3) synthesis and characterization of colloidal gold nanoparticles, and conjugation of the selected aptamer on the gold nanoparticles; and (4) proof of concept by detecting killed AIV H5N1 in buffer solution using the developed biosensing system.

IMPACT:

This biosensing system would provide the poultry industry with a very needed technology for rapid, sensitive and specific screening of AI H5N1, H7N9 and other viruses in poultry. This will help the poultry industry be better prepared for AI, 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 animals and human. The biosensing system developed in this research can also be applied to the detection of other animal diseases.

CONTACT:

Yanbin Li, Professor, Department of Biological & Agricultural Engineering, Center of Excellence for Poultry Science, yanbinli@uark.edu / 479-575-2881

COOPERATORS:

Ronghui Wang (Poultry Science Dept.), Huaguang Lu (Penn State University)

FUNDING:

ABI

PORTABLE BIOSENSOR FOR IN-FIELD DETECTION OF AVIAN INFLUENZA

YANBIN LI, PROFESSOR, TYSON ENDOWED CHAIR IN BIOSENSING ENGINEERING

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 648 people infected and 384 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 EID50/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, fabricated and evaluated with viable AI H5N1 in a BSL-3 lab. Field tests are being tested.

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.

CONTACT:

Yanbin Li, Professor
Department of Biological & Agricultural Engineering
Center of Excellence for Poultry Science
yanbinli@uark.edu / 479-575-2881

COOPERATORS:

Billy Hargis (Poultry Science Dept), Steve Tung (Mechanical Engineering Dept), Luc Berghman (Texas A&M University), , Huaguang Lu (Penn State University), Tony Huang (Penn State University), Maohua Wang (China Agricultural University), and Ming Liao (South China Agricultural University)

FUNDING:

USDA/NIFA, ABI, MoST

ENGINEERED B-CELL BASED BIOSENSOR FOR DETECTION OF FOODBORNE PATHOGENS

YANBIN LI, PROFESSOR, TYSON ENDOWED CHAIR IN BIOSENSING ENGINEERING

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 methods in detection of major foodborne pathogens.

ACTION:

The specific aims of this project include were (1) Select and/or develop membrane engineered B cells containing surface antibodies against *E. coli* O157:H7; (2) Construction of a fluorescent indicators for Ca2+ based on a pair of fluorescent proteins and transfection of the plasmid into the selected B-cells; and (3) Demonstrate and evaluate the proposed engineered B-cell biosensor for detection of *E. coli* O157:H7 in a range from 100 to 106 cfu/ml within 15 min without sample pre-enrichment.

In this research, the B-cells (B lymphocytes) were engineered with the genetically encoded fluorescent Ca2+ reporter (FCR) for the rapid and sensitive detection of pathogens. The FCR consisted of a pair of fluorescent proteins (FPs) engineered for fluorescence resonance energy transfer (FRET) which carry calcium probes with more specialized calcium-binding proteins. A rise in Ca2+ concentration in the B-cell cytoplasm lead to an increase in fluorescence emission from fluorescent protein 1 and a decrease of fluorescence protein 2 owing to the FRET. The genetically encoded FCR sensitively reported fluctuations of the cytoplasmic Ca2+ concentration. The B-cell membrane could be further engineered with receptors (such as antibodies) specifically against target pathogens. Briefly, when the target pathogen is attached to its specific receptors on B-cell surface, the cross-linking of B-cell receptors (BCRs) will produce a signal, and the signaling pathways will be activated, resulting in the release of Ca2+ within seconds. The elevated intracellular Ca2+ concentration will activate FCR to report the fluorescence signal change and indicate the presence of target pathogen.

IMPACT:

The food industry and federal regulatory agencies may 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:

Yanbin Li, Professor
Department of Biological & Agricultural Engineering
Center of Excellence for Poultry Science
yanbinli@uark.edu / 479-575-2881

COOPERATORS:

Byung-Whi Kong (Poultry Science Dept.) and Ronghui Wang (Poultry Science Dept.)

FUNDING:

ABI

SPRINKLERS COOL BROILERS AND CONSERVE WATER

YI LIANG, ASSOCIATE PROFESSOR, EXTENSION

ISSUES:

Tunnel ventilation and evaporative cooling system are the current methods used by poultry industry to overcome heat stress during hot and humid weather. The high moisture, as a result of inlet air saturation, is counterproductive to the bird's natural ability to cool itself by evaporative heat loss through the air a bird breaths out. A second challenge with recirculating cool cell system is the significant water usage that is directly correlated to outside temperature and air movement.

ACTION:

Low pressure overhead sprinklers spray variable amount of water intermittently as large water droplets into the barn according to the total live weight of the birds and thermal conditions inside the house, beginning flock age of 21 days under normal stocking density. The sprayed water does not cool the barn air, but rather wet the birds' feathers, absorbing heat directly from the birds as water evaporates into the air moving at 500+ feet per minute. Two sprinkler systems were used either as primary cooling supplemented by evaporative cooling pads, or as the only cooling method during five summer flocks in 2009, 2010 and 2011. Cooling water usage of each flock averaged 7,000, 21,000 or 32,000 gallon from sprinkler-only, sprinkler-cool_pads combination or cool_pads only houses, respectively. Equivalent livability, feed conversion, weight gain, litter moisture conditions were achieved during the field trials. This technology was demonstrated in a field day at the Broiler Research Farm of Division of Agriculture in 2009, and presented at the Poultry Federation Spring Symposium in 2012, International Poultry Scientific Forum in 2012. A fact sheet summarizing the concept of sprinkler cooling, the difference of sprinklers versus foggers, and its general layout and operations was published in 2012. A peer-reviewed journal publication is in press in 2014.

IMPACT:

Drought conditions during the 2012 summer was a wake-up call for many producers regarding the need to better conserve water yet maintain good bird performance. Sprinkler systems were installed on 200 growers' farms in Arkansas. In 2013, 12 production complexes of several commercial poultry companies approved the use of sprinkler technology as a stage of bird cooling in summer. The growers were satisfied with the performance of their flocks used sprinklers and the tremendous water savings. Growers who face water shortage, or who use city or rural water could benefit from reduced water footprint at their farm. With an estimated 17,000 poultry houses in the state of Arkansas and Oklahoma, water footprint of poultry live production can be greatly reduced if each house uses 50,000 gallon less water each summer for bird cooling.

CONTACTS:

Yi Liang, Department of Biological and Agricultural Engineering
yliang@uark.edu / 479-575-4862

COOPERATORS:

Susan Watkins, Department of Poultry Science,
swatkin@uark.edu / 479-575-7902

FUNDING:
Division of Agriculture, University of Arkansas

Sustainable Metrics for Agriculture

Marty Matlock, Professor and Area Director, Center for Agricultural and Rural Sustainability

ISSUE:
Agricultural producers are under increased pressure to demonstrate sustainability of their practices to the public, either from regulatory agencies such as USEPA, support agencies such as NRCS, or customers such as consumer packaged goods manufacturers. The frameworks for demonstrating sustainable practices are not well defined. My research through the Center for Agricultural and Rural Sustainability has focused on defining effective metrics for sustainable agricultural production outcomes.

ACTION:
I have worked with Field to Market: The Keystone Alliance for Sustainable Agriculture as well as the Stewardship Index for Specialty Crops to define appropriate metrics for sustainable agriculture. I have worked with these groups to benchmark production metrics for cotton, wheat, soybeans, and corn across the US, and to create a framework for setting goals for reduction of impacts. I have received competitive funding from USDA and other agricultural research sources to develop and implement Life Cycle Assessments of the impacts of pork and dairy production on greenhouse gas emission, water use, and feed production efficiency.

IMPACT:
Field to Market published the Benchmark for US Agriculture in 2006, with a 2011 update. They developed a fieldprint calculator tool for farmers to inform their efforts. I am implementing a pilot from FAO for Cotton Incorporated.

CONTACTS:
Marty D. Matlock, PhD, PE, BCEE
Professor of Ecological Engineering
Biological and Agricultural Engineering Department
Executive Director, UA Office for Sustainability
Area Director, Center for Agricultural and Rural Sustainability
233 Engineering Hall
University of Arkansas
Fayetteville, AR 72701

479-575-2849 (office)
479-935-6013 (cell)
mmatlock@uark.edu

COOPERATING SCIENTISTS OR INSTITUTIONS:
National collaboration, University of Wisconsin, NC State, Purdue, Virginia Tech.

FUNDING SOURCES:
USDA NIFA; National Pork Board; Dairy Management, Inc.; Cotton Incorporated; National Corn Growers Association

IMPROVING DRINKING WATER QUALITY AND AVAILABILITY

G. SCOTT OSBORN, ASSOCIATE PROFESSOR

ISSUE:

Most of the reservoirs in the U.S. that hold raw water processed into drinking water were built 40 to 50 years ago. These reservoirs typically have a lifespan of 50 years. Therefore, much of this nations drinking water supply is nearing the end of its effective life. Because of land unavailability, urbanization, ecological concerns and cost, it is very difficult to build new drinking water reservoirs. Therefore, it is imperative for researchers and engineers to create methods to extend the life of our existing reservoirs.

ACTION:

Research being conducted by enigneers in the University of Arkansas Division of Agriculture has the goal of developing reservoir treatment technology to solve current problems that impair drinking water quality. One of the greatest problems managers of drinking water reservoirs face is the buildup of nutrients (nitrogen and phosphorus) in these water bodies. Water flowing into the reservoirs naturally contains nutrients and organic matter that is absorbed as rain falls in the watershed, flows across the surface into streams and into the reservoir. Water can be contaminated with excess nutrients from fertilizer, animal waste, and wastewater treatment plant effluent if not properly managed. Excess nutrients can cause problems when reaching reservoirs by causing algae blooms. Algae can rapidly remove dissolved oxygen from the water causing fish kills that will create food for bacteria that will cause even further oxygen removal from the water. Water without oxygen will also allow metals such as iron and manganese to dissolve in water. These dissolved metals create problems when treating raw water and can greatly increase treatment expense. The nitrogen contained in water can be removed through natural ecological processes, but phosphorus is very difficult to remove from the reservoir once it enters the water body. As reservoirs age, more and more phosphorus will build up in the reservoir eventually overwhelming its ability to retain quality water. The key to improving water quality and extending the life of a reservoir is to not only reduce the amount of new nutrients entering the reservoir, but to create conditions to allow natural processes to remove the nitrogen and convert the phosphorus to a chemical state that is not available to algae. It is also desirable to remove the phosphorus from the reservoir.

IMPACT:

The specific research being conducted uses a new technology to oxygenate reservoir sediments to reduce the oxygen demand that is exerted on the water and reduce the likelihood that the oxygen is removed from water. This technology can also be used to float existing algae that are distributed throughout the entire water body to the surface so it can be removed. By physically removing the algae, phosphorus is removed from the reservoir and is no longer available for future algae growth.

CONTACT:
Scott Osborn, Associate Professor
Department of Biological and Agricultural Engineering, gsosborn@uark.edu / 479-575-2877

CARBONIZATION OF SWITCHGRASS TO PRODUCE SOLID BIOFUEL

SAMMY SADAKA, ASSISTANT PROFESSOR, EXTENSION

ISSUE:

Switchgrass is a North American native grass that has been promoted as a model bioenergy crop because of its high-yield potential, low input requirements on marginal soils, and potential for soil carbon sequestration. As a bioenergy feedstock, switchgrass has a gross calorific value between 18 and 19 MJ kg−1, an energy value comparable to that of hardwoods (19–21 MJ kg−1). Several barriers faced the utilization of switchgrass as the sole source of fuel in existing combustors including the high moisture and ash contents in biomass, which cause ignition and combustion problems. In addition, the low melting point of the ash causes fouling and slagging problems. As a result, raw switchgrass is not a readily acceptable feedstock in present power plants that were built to accommodate coal and peat.

ACTION:

The UA Biological and Agricultural Engineering Department is continuing to utilize modern technologies to convert switchgrass to solid fuel (biochar). Biochar from switchgrass was produced via carbonization process. Switchgrass samples were carbonized in a batch reactor under reactor temperatures of 300, 350 and 400 °C for 1, 2 and 3 h residence times in a limited oxygen environment. Biochar heating value (HV) and fixed carbon content increased from 17.6 MJ kg−1 to 21.9 MJ kg−1 and from 22.5% to 44.9%, respectively, by increasing carbonization temperatures from 300 °C to 400 °C and residence times from 1 h to 3 h. A biomass discoloration index (BDI) was created to quantify changes in biochar colors as affected by the two tested parameters. The maximum BDI of 77% was achieved at a carbonization temperature of 400 °C and a residence time of 3 h .

IMPACT:

The produced switchgrass biochar via carbonization technology could lead to producing a valuable solid biofuel increasingly approaching the composition of lignite coals. Hence, the solid fuel may be utilized in the existing power plants during co-firing process. The newly originated Biomass Discoloration Index could be used to compare various biochar produced via thermochemical treatments. Research results provided a need to explore the land application of this biochar as a soil amendment .

CONTACT:

Samy Sadaka, Assistant Professor, Biological & Agricultural Engineering Department. Little Rock State Office, Little Rock, AR. 501-303-0522. ssadaka@uaex.edu

Collaborating Scientists:
Mahmoud Sharara, Department of Biological and Agricultural Engineering, UA Division of Agriculture.
Andrew Wright, Department of Biological and Agricultural Engineering, UA Division of Agriculture.

FUNDING SOURCES:

United States Department of Agriculture (USDA) and Sun Grant.

FLAG THE TECHNOLOGY CLOUD TOOL (FITCLOUD)

DHARMENDRA SARASWAT, ASSOCIATE PROFESSOR / EXTENSION ENGINEER—GEOSPATIAL

ISSUE:

Flag the Technology (FTT) program was launched on a statewide basis in 2011. The program involved distribution of four different types of color coded bicycle-type flags, with each color representing the technology of the crop planted, near entry area or near field borders of many Arkansas soybean and rice fields. The program was initiated because of a need to identify planted fields in such a way that protects the grower, his workers, or a custom applicator from improper herbicide application. It has been adopted by other states as well as endorsed by the Southern Weed Science Society. Despite a tremendous success of the program within a short span of time, some challenges have also been reported. Use of similar colored flags by producers to mark structures like culverts, risers or variety changes, etc. in the field have been reported. Concerns regarding stolen or removed flags and difficulty in spotting fields with different technologies by aerial applicators have also been raised during producer's meetings.

ACTION:

To respond to the challenges, development of a cloud based tool, Flag the Technology Cloud (FTTCloud), was undertaken during 2012. The primary purpose of the tool is to prevent misapplication of pesticides by identifying fields that represent a particular herbicide technology which The tool enables producers and their consultants to interactively register fields under various herbicide technologies. The service providers can also easily locate registered fields of their clients before undertaking pesticide application missions.

IMPACT:

The first version of FTTCloud has been developed by duly incorporating suggestions received from associated extension specialists and county extension agents. A full demonstration of FTTCloud was conducted before the members of Arkansas Soybean Board on and during the row-crop in-service training of 2013. The tool will be released during early 2014 .

CONTACTS:

PI: Dharmendra Saraswat, Ph.D., Associate Professor/ Extension Engineer-Geospatial, University of Arkansas Division of Agriculture- Cooperative Extension Service, Department of Biological and Agricultural Engineering, dsaraswat@uaex.edu
501-681-5987 (mobile)

COLLABORATORS:

Bob Scott, Ph.D. Professor, Crop, Soil, and Environmental Sciences, U of A.

APPS FOR INFORMATION DISSEMINATION

DHARMENDRA SARASWAT, ASSOCIATE PROFESSOR / EXTENSION ENGINEER—GEOSPATIAL

ISSUE:

More than 3 out of 5 mobile subscribers in the US (61%) owned a smartphone as per recent industry estimate (Nielsen, 2013. The availability of wide variety of mobile devices (smartphones, tablets, etc.) has beginning to transform traditional one-way flow of information from research labs, to extension stations, and finally to end-users, as suggested by increasing usage of "apps" (short for "application") that does not limit information flow in one direction. Increasing usage of smartphones and other mobile devices for personal and business usage offers a great potential to provide producers with an expedited update of current production recommendations thereby reducing the risk of using out-of date information that may result in penalties, loss of yield potential, or unnecessary expenses. However, there are several scientific innovations that are needed in smartphone applications design and the associated web-based backend that will facilitate faster, robust, and more reliable systems. Along with smartphones, increasing popularity of tablet devices offer scope to develop electronic books (e-books) for providing an alternative media for delivering science based information. It calls for selection of appropriate design tools to efficiently produce e-books.

ACTION:

To harness the immense potential of providing latest information to end users in a timely and efficient manner, several projects related to design, development, and delivery of apps were initiated during the year. Two major mobile operating systems, iOS (from Apple) and Android (from Google), were targeted for developing native apps. Dissemination of current information concerning Corn, Soybean, and Cotton remained the focus of app development. Android and iOS version of apps named "Corn Advisor" and "Manure Valuator" were launched during the year. "Hort Plant" was another app launched for iOS devices and became the most downloaded app (close to 2000 downloads) in a short span of four months. An irrigation scheduler for Soybean has also been developed for both Android and iOS platform and currently undergoing final testing. Another app development effort was directed towards developing a crowdsourcing based weed identification and treatment app for both corn and soybean weeds for Android and iOS based smartphones. First version of the app has been completed for both Android and iOS platform. Preliminary testing is underway. Major extension conferences were brought to stakeholders through development of apps for Galaxy Conference, Rice Expo, and International Master Gardener's Conference.

IMPACT:

Apps were demonstrated during various meeting and the final design of some of them have greatly benefitted from the feedback received from extension specialists and county extension agents. A total of 3675 downloads for six apps launched during the year took place. Efforts made in app development has helped train two graduate students, two undergraduates, and three high school students. One graduate student was hired by Industry considering his demonstrated skills for mobile apps design. Several news outlets have covered the news of release. Arkansas Farm Bureau did a special video story on these apps.

CONTACTS:

PI: Dharmendra Saraswat, Ph.D., Associate Professor/Extension Engineer-Geospatial, University of Arkansas Division of Agriculture- Cooperative Extension Service, Department of Biological and Agricultural Engineering, dsaraswat@uaex.edu , 501-681-5987 (mobile)

COLLABORATORS:

Nilanjan Banerjee, Ph.D. Assistant Professor, Computer Science and Software Engineering, University of Maryland, Baltimore.
Leo Espinoza, Ph.D., Associate Professor, Crop, Soil, and Environmental Sciences, UACES.
Jason Kelley, Ph.D., Associate Professor, Crop, Soil, and Environmental Sciences, UACES.
Christopher Henry, Ph.D., Assistant Professor, Biological and Agricultural Engineering, U of A.

FUNDING SOURCE:

Arkansas Soybean Promotion Board and Arkansas Corn and Grain Sorghum Promotion Board

SWAT2009_LUC: Evaluating land Use Land Cover Categorical Uncertainty

Dharmendra Saraswat, Associate Professor / Extension Engineer—GeoSpatial

ISSUE:

The use of models for various decision-making calls for scrutiny over its output uncertainty. One of the sources of output uncertainty is the error in input data. The soil and water assessment tool (SWAT) model uses various input datasets including the land use land cover (LULC) map of the study area. The contribution of LULC data error to SWAT output uncertainty is currently unknown and could have important implication on overall model uncertainty.

ACTION:

We have developed a new algorithm that uses published LULC errors and propagates it through the SWAT model. This algorithm was used to understand the uncertainty in the Illinois River watershed SWAT model developed in 2010. This algorithm was integrated within a free and standalone graphical user interface tool titled SWAT2009_LUC. A paper describing this new development has been published by the Transactions of the ASABE journal during 2013 .

IMPACT:

The algorithm will allow water quality modelers to quantify SWAT model uncertainty resulting from LULC errors. The algorithm has been incorporated in a tool that can be installed on windows based computer for free. Results showed that at monthly time-scale, the Illinois River watershed SWAT model output could vary from 0% to 19.9% when the LULC is perturbed within its published error range. These results demonstrate the importance of LULC-related uncertainty in SWAT model and highlight the need for evaluating uncertainty from all input data source. The full impact of this research could be realized in next few years in assessing the errors associated with environmental impacts of land use under climate change scenarios.

CONTACTS:

PI: Dharmendra Saraswat, Ph.D., Associate Professor/ Extension Engineer-Geospatial, University of Arkansas Division of Agriculture- Cooperative Extension Service, Department of Biological and Agricultural Engineering, dsaraswat@uaex.edu , 501-681-5987 (mobile)

FUNDING SOURCE:

Arkansas Natural Resources Commission through 319(h) program of the Environmental Protection Agency (EPA).

MANURE VALUATOR APP AUTOMATES CALCULATING MANURE VALUE

KARL VANDEVENDER, PROFESSOR, EXTENSION

Issue: "Why do we care?"
The need to be able to estimate the value of manure as crop nutrient source is the result of increased use of manure to replace crop nutrients that have traditionally been supplied by commercial inorganic fertilizers. As with inorganic fertilizers, the goal is to meet the crop nutrient needs while avoiding the expense and potential environmental concerns of over application of nutrients.

Action: "What have we done?"
To answer this need, the University of Arkansas Division of Agriculture has released an app named Manure Valuator that will help producers calculate the dollar and nutritive value of manure applied to a specific field and then share the results via email. The app is now available for free at iTunes and Google Play Store for use on both iOS (iphone and iPad) and Android devices.

The app is based on a simple premise that the monetary value of manure is linked to the market value of the inorganic Nitrogen (N), Phosphorus (P), and Potassium (K) fertilizer that the manure is replacing. This means the value of manure depends largely on the crop N,P,K fertilizer recommendation, the manure N,P,K content, and the amount applied.

The App allows the user to enter the cost of their local commercial fertilizer source on either a dollar per ton or dollar per pound basis. If dollar per ton values are entered the App converts them to dollars per pound of Nitrogen (N), Phosphorus (P), and Potassium (K).

The user then enters the crops N,K,P needs, ideally based on a recent soil test recommendations available thought the University of Arkansas County Extension Office.

The user then selects one of 18 different choices of dry and liquid manure. If desired, the default N,P,K values can be modified to better reflect the manure to be applied.

After the desired manure application rate is entered the App calculates the N,P,K fertilizer replacement value for the specific field crop based on N,P,K recommendation, manure source, and manure application rate. At this time any input value can be modified to evaluate the impact on the resulting calculated values.

Impact: "What is the payoff?"
The ability of the Manure Valuator app to estimate the value of a specific source of manure applied at a specific rate, to a particular field, to meet the crop's specific nutrient needs allows users to better manage their monetary, manure, inorganic fertilizer resource while meeting their crop production goals while minimizing the risk of over application of nutrient.

Contacts:
Dharmendra Saraswat, Associate Professor - Extension Engineer, dsaraswat@uaex.edu, 501-671-2191
Karl VanDevender, Professor – Extension Engineer, kvan@uaex.edu, 501-671-2244

Funding Sources:
The funding for the app was provided by the Arkansas Corn and Grain Sorghum Board and Arkansas Soybean Promotion Board.

Research Grants

The following active grants during 2013 fund research in specific areas.

Second Generation Biofuels: The Need to Minimize Water Usage during Processing
Dr. Julie Carrier
Arkansas Department of Higher Education (ADHE)
2013
$2,215

Decreasing Severity of Switchgrass Pretreatment Through Biological Pretreatment
Dr. Mark Wilkins and Dr. Julie Carrier
Sun Grant Board of Trustees, Oklahoma State University
2012-2013
$53,944

All Natural Antimicrobials
Dr. Phil Crandall and Dr. Julie Carrier
SBIR USDA
2012-2016
$450,000

Reduced Carbon Footprint for Swine Production
Dr. Thomas Costello and others
USDA NIFA/AFRI
2012-2013
$2,000,000

Gasification of Algae
Dr. Thomas Costello, Dr. Marty Matlock, Dr. Karl Vandevender, Dr. Samy Sadaka, and others
NIFA
2011-2015
$4,900,000

Nutrient Criteria Development Support
Dr. Brian Haggard and others
TCEQ
2012-2013
$428,928

Program Administration / Management Description
Dr. Brian Haggard
USGS
2013-2014
$55,525

AWRC Information Transfer Program
Dr. Brian Haggard
U.S. Geological Survey
2013-2014
$1,634

AGFC Statement of Work—Monitoring Water Resources to Evaluate the Possible Effects of Natural Gas Production on Water Resources
Dr. Brian Haggard
Arkansas Game and Fish Commission
2013-2014
$89,842

Wister Lake Water Quality Model Development
Dr. Brian Haggard and Dr. Thad Scott
Poteau Valley Improvement Authority
2013-2016
$273,546

Statistical Analysis to Support Numeric Nutrient Criteria Development Contract
Dr. Brian Haggard and Dr. Thad Scott
Texas Commission on Environmental Quality
2013-2015
$300,000

Irrigation Pumping Plant Efficiency
Dr. Chris Henry and Dr. Samy Sadaka
Soybean Promotion Board
2013-2014
$44,800

Improving Yield and Yield Stability for Irrigated Soybeans
Dr. Chris Henry and others
Soybean Promotion Board
2013-2014
$154,783

Demonstration and Validation of Irrigation Management Tools to Preserve Water Availability for Row Crop Agriculture
Dr. M. Reba and Dr. Chris Henry
Arkansas NRCS CIG
2013-2016
$75,000

Improving Irrigation Scheduling and Efficiency in Corn and Grain Sorghum
Dr. Chris Henry, Dr. D. Saraswat, and Dr. B. Watkins
Arkansas Corn and Grain Sorghum Promotion Board
2013-2014
$96,760

Promoting the use of Multiple Inlet in Arkansas Rice Production
Dr. Chris Henry, Dr. D. Saraswat and others
Arkansas Rice Promotion Board
2013-2014
$43,632

Evaluating Intermittent Flood Potential in Arkansas
Dr. Chris Henry and Dr. M. Anders
Arkansas Rice Promotion Board
2013-2014
$64,350

Increasing Water Use Efficiency for Sustainable Cotton Production
Dr. Chris Henry and Dr. Leo Espinoza
Cotton State Support Committee
2013-2014
$31,500

Economics of Irrigation Technology Adoption for the Arkansas Delta Landscape
Dr. Chris Henry and others
Arkansas Water Resources Center (AWRC)
2013-2015
$24,600

ABI: Acquisition of a Low-Cost, User-Friendly and Robust ICP-MS for Biomedical Researchers
Dr. Jin-Woo Kim
Arkansas Biosciences Institute
2013-2014
$155,100

Development of an Electron Tunneling Based Nanochannel System for DNA Sequencing
Dr. Jin-Woo Kim and Dr. Steve Tung
NSF
2012-2015
$359,717

Development of Flagellar Motor Biosensor Prototype for Trace Level TNT Detection
Dr. Jin-Woo Kim and Dr. Steve Tung
NSF
2011-2013
$79,953

Engineering Nano-Building Block Toolboxes for Programmable Self-Assembly of Nanostructures with Arbitrary Shapes and Functions
Dr. Jin-Woo Kim and D2r Russell Deaton
NSF
2012-2015
$412,789

Integrating Nanotechnology into Undergraduate Engineering Education at the University of Arkansas
Dr. Jin-Woo Kim and others
NSF
2011-2013
$200,000

Integrating Nanotechnology into Honors Education
Dr. Jin-Woo Kim and others
Honors College
2012-2013
$25,000

Printed Microelectrode for Biosnesors to Detect E. coli
Dr. Yanbin Li
New Concepts LLC
2012-2013
$30,000

Energy Audits for Contract Broiler Production in NW Arkansas and NE Oklahoma
Dr. Yi Liang, Dr. Thomas Costello, and Dr. S. Watkins
USDA Energy for Rural America
2012-2013
$2,000,000

Energy Balance Analysis of a Poultry Processing Plant
Dr. Yi Liang and Dr. D. Nutter
U.S. Poultry and Egg Association
2012-2013
$39,224

Development of Research Ethics Program for Undergraduate Students
Dr. Marty Matlock and others
NSF
2011-2013
$98,000

REU Sites: Ecosystem Services
Dr. Marty Matlock and Dr. Michelle Evans-White
NSF
2011-2014
$247,000

REU Site: Assessment and Sustainable Management of Ecosystem Services
Dr. Marty Matlock
NSF
2013
$85,655

Measuring and Reducing Swine Greenhouse Gas Footprint in the US
Dr. Marty Matlock and Dr. G. Thoma
USDA-NIFA
2011-2016
$5,000,000

Research Grants

Measuring and Managing the Water Footprint of US Swine
Dr. Marty Matlock and Dr. Rick Ulrich
NPB
2011-2013
$450,000

Improving Surface Water Quality by Reducing SOD and Removing Nutrients
Dr. G. S. Osborn
U.S. Geological Survey
2013-2014
$14,400

Cloud Based Streambank Delineator and Conservation Practice Mapper
Dr. Dharmendra Saraswat and Dr. Mike Daniels
EPA/ANRC
2013-2014
$133,957

Arkansas Captains and Corporals Program
Dr. Mike Daniels, Dr. Dharmendra Saraswat and others
EPA/ANRC
2012-2014
$189,808

Technological Aids for Information Dissemination to Soybean Producers
Dr. Dharmendra Saraswat
AR Soybean Promotion Board
2012-2013
$37,318

Flag the Technology GPS/GIS Support
Dr. Dharmendra Saraswat and Dr. Bob Scott
AR Soybean Promotion Board
2012-2013
$39,000

Smartphone Apps for Information Dissemination to Corn Producers
Dr. Dharmendra Saraswat and others
AR Corn and Grain Sorghum Board
2012-2013
$36,000

Field Scale Evaluation of Precision Agriculture Sensors for Corn Production
Dr. Dharmendra Saraswat and others
AR Corn and Grain Sorghum Board
2012-2013
$36,000

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

Development of Comprehensive Watershed Modeling for 12-digit Hydrologic Unit Code "HUC" in Selected Priority Watersheds in Arkansas- Phase III
Dr. Dharmendra Saraswat and others
EPA/ANRC
2013-2016
$297,542

Enhancement of Riparian Buffer Inventorying Algorithm for Field Use
Dr. Dharmendra Saraswat and others
Arkansas Natural Resources Commission
2011-2013
$98,059

The Arkansas Watershed Steward Program
Dr. Karl VanDevender and others
EPA 319th via ANRC
2013-2015
$189,808

Demonstration and Monitoring the Sustainable Management of Nutrients on C&H Farms in Big Creek Watershed
Dr. Karl VanDevender and others
State Legislature
2013-2014
$340,510

PUBLICATIONS

BOOKS AND BOOK CHAPTERS

Frederick N, Zhang N, Djioleu A, Ge X, Xu J and **Carrier DJ**. (2013). "*The effect of washing dilute acid pretreated poplar biomass on ethanol yields*." In Sustainable Degradation of Lignocellulosic Biomass - Techniques, Applications and Commercialization. Anuj K.Chandel and Silvio Silvério da Silva Editors. InTech Publishers, Janeza Trdine 9, 51000 Rijeka, Croatia. Pp. 105-118.

D. Saraswat. 2013. *"Chapter 6 - Featured Digital Tools Available for Watershed Management."* In Arkansas Watershed Steward Handbook. Publication No AG1290 Public Policy Center, University of Arkansas Cooperative Extension Service.

PEER-REVIEWED JOURNAL ARTICLES

Bunnell K, Rich A, Luckett C, Wang Y, Martin E and **Carrier DJ**. (2013). "Plant maturity effects on the physiochemical properties and dilute acid hydrolysis of switchgrass hemicellulose." *Sustainable Chemistry and Engineering* 1:649–654.

Lau C, Clausen E, Lay J, Gidden J and **Carrier DJ**. (2013). "Separation of xylose oligomers using centrifugal partition chromatography with a butanol-methanol-water system." *Journal of Industrial Microbiology* 40:51-62.

Arora A, Martin E, Pelkki M and **Carrier DJ**. (2013). "The effect of formic acid and furfural on the enzymatic hydrolysis of cellulose powder and dilute acid-pretreated poplar hydrolysates." *Sustainable Chemistry and Engineering* 1: 23-28.

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Kotagiri, N.,PhD Lee, J. S.Post-Doc & **Kim, J.-W.** Selective pathogen targeting and macrophage evading carbon nanotubes through dextran sulfate coating and PEGylation for photothermal theranostics. *Journal of Biomedical Nanotechnology* 9, 1008-1016 (2013). *[JIF: 4.268]*

Judkins, J.,MS Lee, H. H., Tung, S. & **Kim, J.-W.** Diffusion of single-walled carbon nanotubes under physiological conditions. *Journal of Biomedical Nanotechnology* 9, 1065-1070 (2013). *[JIF: 4.268]*

Lee, J.S.Post-Doc, Song, J.J., R. Deaton, & **Kim, J.-W**. Assessing the detection capacity of microarrays for bio/nano-sensing platforms. *BioMed Research International 2013*, 310461 DOI:10.1155/2013/310416 (2013). *[JIF: 2.880]*

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Gasification of Raw and Torrefied Cotton Gin Wastes in an Auger System. 2013. **Samy Sadaka**. Applied Engineering in Agriculture. Vol. 29(3): 405-414.

Pai, N and **D. Saraswat**. 2013. Impact of Land Use and Land Cover Categorical Uncertainty on SWAT Hydrologic Modeling. Trans ASABE. 56(4): 1387-1397.

OTHER PEER-REVIEWED PUBLICATIONS

Liang, Y., **R. Bautista**, G. Dabhadka, **T.A. Costello**. 2013. "Validating an Averaging Pitot Tube for Measuring Fan Air Flow Rates". 2013 ASABE Annual International Meeting, Paper No. 131585272.

Evans-White, M.A., **B.E. Haggard**, and J.T. Scott. 2013. A review of stream nutrient criteria development in the United States. Journal of Environmental Quality 42(4):1002-1014

Hu, Q., X.H. Xu, M.Z. Li, Y. Zhang, and **Y. Li**. 2013. Rapid detection of acrylamide in food using a fluorescent sensing method based on functional CdSe/ZnS quantum dots. The Proceedings of IEEE Sensors 2013 Conference, November 3-6, 2013, Baltimore, MD. Paper No. 7198.

Xu, L.Z., X.H. Xu, H. Xiong, L.X. Chen, and **Y. Li**. 2013. Identification of adulterated vegetable cooking oils using fluorescence quenching method with aqueous CTAB-Coated CdSe/ZnS quantum dots as probes. The Proceedings of IEEE Sensors 2013 Conference, November 3-6, 2013, Baltimore, MD. Paper No. 7114.

Zhang, B.H., R. Wang, Y. Wang, and **Y. Li**. 2013. A portable impedance biosensor for detection of multiple avian influenza viruses. The Proceedings of IEEE Sensors 2013 Conference, November 3-6, 2013, Baltimore, MD. Paper No. 7505.

Burn it Down, Clean it Up. Avoiding Crop Injury Due to Sprayer Contamination. Gus Wilson, Wes Kirkpatricks, Chuck Capps, Andy Wangilder, Tom Barber, Ples Spradley and **Samy Sadaka**. FSA2170.

NON-REFEREED PUBLICATIONS AND ARTICLES

Kris Bunnell and **Danielle Julie Carrier**. (2013) Separation of phytochemicals and xylose oligomers using centrifugal partition chromatography (CPC), 8th International Starch Conference, University of Illinois, June 2-3, 2013

Giovannetti, J., L.B. Massey, **B.E. Haggard**, and **R.A. Morgan**. 2013. EXECUTIVE SUMMARY Land use effects on stream nutrients at Beaver Lake Watershed, Northwest Arkansas. Journal of the American Water Works Association 105(1):31-32

Gross, J. and **C.G. Henry**. 2013. Feeding Cattle without the Feedlot. Presented at the 2013 ASABE International Meeting. Kansas City, MO. ASABE St. Joseph, MI.

J.W. Kim: "Any which way you can: Nano-toolboxes for programmable self-assembly", Materials Views, http://www.materialsviews.com/any-which-way-you-can-nano-toolboxes-for-programmable-self-assembly/ (March 12, 2013).

Sarkisov, S.S., M. Czarick III, B.D. Fairchild, **Y. Liang**, T. Kukhtareva and M.J. Curley. 2013. Organic polymer-metal nano-composites for sensing of chemicals in agriculture. Annual Conference of International Society of Optical Engineering, San Diego, CA. January 2013.

Bautista, R., Y. Liang, T.A. Costello and A. Mauromoustakos. 2013. Geospatial analysis of energy usage of selected poultry farms in Arkansas. The 13th Annual American Ecological Eng. Soc. Meeting. East Lansing, MI.

Liang, Y. R. Bautista, T.A. Costello and S.E. Watkins. 2013. Energy audits of contract broiler farms in NW Arkansas and NE Oklahoma. Final report to USDA Rural Development.

Liang, Y. 2013. An ammonia emission mitigation system for commercial broiler houses. Final report to USDA NIFA Award No: 2009-35112-05240.

12-17 Ag Professional- Smartphone app determines dollar value of manure (**Dharmendra Saraswat**)

12-16 Beef Magazine- How to Calculate Manure and Fertilizer Equivalents with New App (**Dharmendra Saraswat**)

12-13 Mid-South Farmer- Making Manure and Fertilizer Equivalent Calculations Easy (**Dharmendra Saraswat**)

12-5 UAEX News- Manure Valuator app automates calculating manure value (**Dharmendra Saraswat**)

10-16 Ashley News Observer - Government shutdown impacting agriculture (Scott Stiles, Tom Troxel, **Dharmendra Saraswat**, Yeshi Wamishe, Bob Scott)

10-11 Agfax - Shutdown trammels research and markets, changes editorial plans (Scott Stiles, **Dharmendra Saraswat**, Yeshi Wamishe, Bob Scott)

PUBLICATIONS

10-11 Pork Network - Federal shutdown trammels research, markets (Scott Stiles, **Dharmendra Saraswat**, Tom Troxel, Yeshi Wamishe, Bob Scott)

10-11 Cattle Network - Federal shutdown trammels research, markets (Scott Stiles, **Dharmendra Saraswat**, Yeshi Wamishe, Bob Scott)

10-11 Dairy Herd Network - Federal shutdown trammels research, markets (Scott Stiles, **Dharmendra Saraswat**, Yeshi Wamishe, Bob Scott)

8-26 RFD-TV- New apps (**Dharmendra Saraswat**)

8-22 Mountaineer-Echo - Corn Advisor, Hort Plants apps available through iTunes (**Dharmendra Saraswat,** Jim Robbins, Leo Espinoza, Jason Kelley)

8-15 Mena Star - Agriculture apps available through iTunes (**Dharmendra Saraswat**, Jim Robbins, Leo Espinoza, Jason Kelley)

8-14 Grand Prairie Herald - Corn producers, home gardeners have new apps available (**Dharmendra Saraswat**, Jim Robbins, Leo Espinoza, Jason Kelley)

8-12 West Memphis Evening Times - Agricultural apps available at iTunes (**Dharmendra Saraswat**, Jim Robbins, Jason Kelley, Leo Espinoza)

8-11 Pine Bluff Commercial - Corn advisor, Hort Plants apps available through iTunes (**Dharmendra Saraswat**, Jim Robbins, Jason Kelley, Leo Espinoza)

8-1 Arkansas Farm Bureau – Rice Expo to offer sneak preview of U of A ag apps (**Dharmendra Sarawwat**, Mike Hamilton)

7-29 Arkansas Business – Arkansas farmers find apps, wireless essential to agricultural sector (**Dharmendra Saraswat**, Mike Hamilton)

7-24 Farm Industry News – 10 technologies changing farm machinery (**Dharmendra Saraswat**)

2-8 Mid-America Farmer-Grower – 'Corn advisor' app released by University of Arkansas Division of Agriculture (**Dharmendra Saraswat**)

2-5 Delta Farm Press – 'Corn Advisor' app released (**Dharmendra Saraswat**)

1-29 Drovers – 'Corn Advisor' app released by University of Arkansas (**Dharmendra Saraswat**)

1-29 Dairy Herd-Corn advisor app (**Dharmendra Saraswat**)

1-29 Pork Network-Corn Advisor app available (**Dharmendra Saraswat**)

1-29 Agfax-Corn Advisor app puts expertise on smart phones and tablets (**Dharmendra Saraswat**)

PUBLISHED ABSTRACTS OF CONFERENCE PRESENTATIONS

Heeren, D.M., G.A. Fox, D.E. Storm, **B.E. Haggard**, C.J. Penn, and T. Halihan. July 21-24, 2013. Impact of Measurement Scale on Infiltration and Phosphorus Leaching in Ozark Floodplains. ASABE Annual International Meeting, Paper No. 1621213, Kansas City, MO.

J.-W. Kim. 2013. Nano-Building Block Toolboxes ("Nanotoolboxes") for Programmable Self-Assembly of Nanocomposites with Arbitrary Shapes and Functions, Conference on Programmable Self-Assembly of Matter: Towards Rationally Designed Micro- and Nanoscale Systems, June 30-July 2, New York University, New York, NY.

N. KotagiriPhD and **J.-W. Kim**. 2013. Stealth Nanotube Theranostic Agents with Immunological Disguising Proteins, IEEE International Conference on Nano/Molecular Medicine and Engineering (IEEE-NANOMED), November 10-13, Phuket, Thailand.

J.-W. Kim. 2013. Stealth Nanotube Theranostic Agents, IEEE International Conference on Nano/ Molecular Medicine and Engineering (IEEE-NANOMED), November 10-13, Phuket, Thailand.

J.-W. Kim. 2013. Self-Assembling Multifunctional Nanocomposites for Nanotheranostics of Circulating Tumor and Other Pathological Cells in Vivo. Nano Science and Technology Institute (NSTI) Nanotech Conference & Expo 2013, May 12-16, Washington, DC.

PUBLICATIONS

EXTENSION PUBLICATIONS AND LITERATURE

Patterson, S.D., **B.E. Haggard**, and M.E. Boyer. 2013. Ecological Design in the Ozarks – Workshop and Lake Frances Charrette. Arkansas Water Resources Center Technical Publication MSC 368, 23 pp.

Massey, L.B., J.A. McCarty, **M.D. Matlock**, A.N. Sharpley, and **B.E. Haggard**. 2013. Water-quality monitoring for selected priority watershed in Arkansas, Upper Saline, Poteau and Strawberry Rivers. Arkansas Water Resources Center Technical Publication MSC 369, 72 pp.

Massey,L.B. and **B.E.Haggard**. 2013. AWRC Annual Summary, Arkansas Water Resources Center MSC299NL40, 2 pp.

Stone, N., J.L. Shelton, **B.E. Haggard**, and H.K. Thomforde. 2013. Interpretation of Water Analysis Reports, Southern Region Aquaculture Center SRAC Publication Number 4606

Gross, J. **C. Henry** and R. Stowell. 2013. Vegetative Treatment Systems Manual. University of Nebraska-Lincoln., Lincoln, Nebraska, 35pp.

Henry, C., M. Daniels and J. Hardke. 2013. Water Management Chapter in Arkansas Rice Production Handbook. MP 192. The University of Arkansas Cooperative Extension Service, Little Rock. 20 pp.

Henry, C.G. and B. Stringham. 2013. How to Read Electric Meters. Irrigating Smart Factsheet Series. LSU AgCenter Publication 3241-I

Henry, C.G., J. H. Massey, H. C. Pringle, L. J. Krutz, B. Stringham. 2013. Tips for Conserving Irrigation Water in the Southern Region. Irrigating Smart Factsheet Series. LSU AgCenter Publication 3241-K

Sheffield, R. E., **C.G. Henry** and D. Bankston. 2013. Measuring Irrigation Flow. Irrigating Smart Factsheet Series. LSU AgCenter Publication 3241-L

Henry, C. G., R. E. Sheffield, N. Kenny. 2013. Irrigation Pumping Plant Safety. Irrigating Smart Factsheet Series. LSU AgCenter Publication 3241-M

Henry C. G. and B. Stringham. 2013. Variable Frequency Drives for Irrigation Pumping Plants. Irrigating Smart Factsheet Series. LSU AgCenter Publication 3241-B.

Tabler, G.T., **Y. Liang**, H.M. Yakout, J. Wells and W. Zhai. 2013. Evaporative cooling systems: How and why they work. Fact sheet 2774. Extension Service of Mississippi State University.

Tabler, G.T., **Y. Lia**ng, H.M. Yakout, J. Wells and W. Zhai. 2013. Intestinal health and necrotic enteritis in broilers. Factsheet 2771. Extension Service of Mississippi State University.

Tabler, G.T., J. Wells, W. Zhai , H.M. Yakout, and **Y. Liang.** 2013. What causes footpad dermatitis in poultry? Factsheet 2769. Extension Service of Mississippi State University.

Saraswat, D., N.Pai, and M. Daniels. 2013. Watershed Prioritization for Managing Nonpoint Source Pollution in Arkansas. (Fact Sheet- FSPPC116).

PROFESSIONAL PRESENTATIONS

Carrier, D.J., Plenary lecture Windsor - Solvent-free extraction and centrifugal partition chromatography separation Natural Health Product Research Society of Canada, 10th NHP Research Conference, May 15th, 2013 Windsor, Ontario, Canada

Carrier, D.J., Indian Society of Agricultural Engineering Jan 2013 Hyderabad, India Deconstruction of Biomass in a Fermentable Sugar Stream

Carrier, D.J., Indian Agricultural Research Institute Jan 2013 Hyderabad, India Nutraceuticals from Biomass

Carrier, D.J., Plenary lecture Association of Microbiologist of India November 2013 Rohtak, India Production of a Fermentable Sugar Stream and Extraction of Valuable Phytochemicals

Carrier, D.J., Separation of phytochemicals and xylose oligomers using centrifugal partition chromatography (CPC), 8th International Starch Conference, University of Illinois, June 2013.

Haggard, B. and T. Scott. 2013. Final Project Update - Red River Regional Project. States Only Meeting, U.S. Environmental Protection Agency Regional Technical Assistance Group, Dallas, Texas.

PUBLICATIONS

Haggard, B. 2013. Conserving Our Two Watershed – Introduction to the Beaver Lake and Illinois River Watersheds. The League of Women Voters of Washington County, Public Library, Fayetteville, Arkansas.

Haggard, B. 2013. Water Quality Monitoring in the Beaver Lake Watershed. Beaver Lake Watershed Symposium, Beaver Watershed Alliance, Huntsville, Arkansas

Haggard, B. 2013. How Do You Validate a Watershed Model without Calibration Data. U.S. Environmental Protection Agency Modeling Workshop, Dallas, Texas.

Haggard, B. 2013. Watershed Scale Phosphorus Management – the Movement of Phosphorus Downstream. ASA, CSSA, and SSA International Annual Meeting, Tampa, Florida.

Haggard, B. 2013. Great Plains Water Resources. Iowa Water Conference, Ames, Iowa.

J.-W. Kim. 2013. Stealth Nanotube Theranostic Agents, IEEE International Conference on Nano/ Molecular Medicine and Engineering (IEEE-NANOMED), November 10-13, Phuket, Thailand (as a "Keynote Speaker").

J.-W. Kim. 2013. Self-Assembling Multifunctional Nanocomposites for Nanotheranostics of Circulating Tumor and Other Pathological Cells in Vivo. Nano Science and Technology Institute (NSTI) Nanotech Conference & Expo 2013, May 12-16, Washington, DC.

J.-W. Kim. 2013. Nano-Building Block Toolboxes ("Nano-Toolboxes") for Programmable Self-Assembly of Multifunctional Nanocomposites, May 6-7, The State University of New York at Korea (SUNY-Korea), Incheon, Korea.

J.-W. Kim. 2013. Nano-Building Block Toolboxes ("Nano-Toolboxes") for Programmable Self-Assembly of Multifunctional Nanotheranostic Agents, March 27-30, City University of Hong Kong, Hong Kong, China.

J.-W. Kim. 2013. Nano-Building Block Toolboxes ("Nano-Toolboxes") for Programmable Self-Assembly of Multifunctional Nanocomposites with Arbitrary Sizes and Shapes. Invited Seminar at the Arkansas Biosciences Institute Fall Research Symposium, October 15, Little Rock, AR.

J.-W. Kim. 2013. Programmable Self-Assembly of Plasmonic Nanoagents. Biomedical Engineering Seminar, University of Memphis, September 6, 2013, Memphis, TN.

J.-W. Kim. 2013. Nano-Building Block Toolboxes ("Nano-Toolboxes") for Programmable Self-Assembly of Nanostructures with Arbitrary Shapes and Functions. Invited Seminar at Center for Functional Nanomaterials, March 17-19, Brookhaven National Laboratory (BNL), Upton, New York.

J.-W. Kim. 2013. Nano-Building Block Toolboxes ("Nano-Toolboxes") for Programmable Self-Assembly of Nanostructures. February 8, 2013, Sigma Xi Chapter Meeting, University of Arkansas, Fayetteville.

Li, Y. 2013. Biosensor methods for rapid screening of avian influenza H5N1 in poultry. An invited presentation at Huazhong Agricultural University, June 24, 2013, Wuhan, Hubei Province, China.

Liang, Y. 2013. Cooling chickens and turkeys using air velocity, sprinklers and cool cell pads. Annual Poultry Innovation Conference, London, Ontario. Canada. November 2013.

Matlock, M. 2013. Frameworks for Sustainability in Agriculture, NC State's Sustainable Agriculture Executive Course, Bayer Crop Sciences, Raleigh, NC. (as a "Keynote Speaker").

Matlock, M. 2013. Water Resource Sustainability, National Prok Board Environmental Committee, Dallas, TX. (as a "Keynote Speaker").

Matlock, M. 2013. A Framework for Sustainable Agriculture, National Pork Board, Des Moines, IA. (as a "Keynote Speaker").

Matlock, M. 2013. The role of animal agriculture in feeding 10 billion people sustainably, Global Food and Feed Congress, Sun City, South Africa. (as a "Keynote Speaker).

Matlock, M. 2013. Metrics for Water Sustainability in US Dairy Production, US Dairy Summit, Washington DC. (as a "Keynote Speaker").

Matlock, M. 2013. Metrics for Sustainable Agriculture: Measuring what Matters, Center for Food Integrity, McDonald's Campus, Chicago, IL. (as a "Keynote Speaker").

Matlock, M. 2013. The Advantages and Risks of Nutrient Trading for Managing Non-Point Sources of Water Pollution, Senate Subcommittee on Water and the Environment, Washington, DC.

Matlock, M. 2013. Key Performance Indicators, Metrics and Benchmarks for Sustainable Soybean Production, Ohio Soybean Alliance, Columbus, OH. (as a "Keynote Speaker").

Matlock, M. 2013. Key Performance Indicators for Sustainable Agriculture, National Pork Board, Des Moines, IA. (as a "Keynote Speaker").

Matlock, M. 2013. Key Performance Indicators for Sustainable US Soybeans, United States Soybean Export Council, The Hague, Netherlands. (as a "Keynote Speaker").

Matlock, M. 2013. Key Performance Indicators, Metrics and Benchmarks for Sustainable Soybean Production, Provimi Animal Nutrition Seminar, Barcelona, Spain. (as a "Keynote Speaker").

Matlock, M. 2013. Key Performance Indicators, Metrics and Benchmarks for Sustainable Soybean Production, European Soybean Buyers Association Annual Meeting, Istanbul, Turkey. (as a "Keynote Speaker").

Matlock, M. 2013. Frameworks for Sustainability in Agriculture, Ohio Farm Bureau Annual Meeting, Columbus, OH. (as a "Keynote Speaker").

Osborn, G.S. 2013. Invited panelist for BENG Graduate Seminar to discuss careers in Biological Engineering.

Osborn, G.S. 2013. Invited presenter to Freshman Engineering Honors Colloquium "Economically Removing Nutrients from Surface Water" based on work from AWRC-NIWR project.

D. Saraswat. 2013. Geospatial Technologies for Assisting Communities and Mitigating Environmental Concerns. In GIS Day Events organized at University of Arkansas, Fayetteville, November 20.

D. Saraswat. 2013. Unmanned Aerial Vehicles for Precision Agriculture Research- Opportunities & Challenges. Delivered via internet to Indian Council of Agricultural Research (ICAR) Summer School on "Machinery for Natural Resource Management and Technologies", Ludhiana, Punjab, India, September 14.

J. Robbins and **D. Saraswat**. 2013. FAA Certificate of Authorizations (COAs) Process. In Arkansas Aerospace Alliance-Unmanned Aerial System Forum, Little Rock, AR, September 13.

Saraswat, D. 2013. StreBand DSS: A Riparian Buffer Decision Support System for Planners. In Arkansas Non Point Source Annual Stakeholder Meeting, Little Rock, AR, September 18.

Saraswat, D., K. VanDevender, and J. Robbins. 2013. U of A Agriculture Related Websites and Mobile Apps. 2013 Rice Expo, Stuttgart, AR, August 2.

Saraswat, D. 2013. Use of Watershed Models for Assessing Environmental Impacts of Biofuel Crops-Challenges & Opportunities. In 47th Annual Convention of Indian Society of Agricultural Engineers & International Symposium on Bioenergy-Challenges & Opportunities. Hyderbad, India, January 28-30.

Saraswat, D. 2013. Mobile Resources for Corn and Grain Sorghum Producers. Arkansas Corn and Grain Producer Conference. Jonesboro, January 8 (repeated at Dumas on January 10).

Oral or Poster Presentations

Philip G. Crandall, Dinesh Babu, **Danielle Julie Carrier**, Matthew Pelkki and Elizabeth Martin, Sweetgum bark : Production of Extract and Evaluation of its Antimicrobial Properties Institute for Food Technology, Chicago July 2013.

Kris Bunnell and **Danielle Julie Carrier**, Pretreatment kinetics of switchgrass. hemicelluloses 35th Symposium on Biotechnology for Fuels and Chemicals. Portland May. 2013.

Kala Rajan and **Danielle Julie Carrier**, Significance of inhibitors produced during dilute acid pretreatment of wheat straw. 35th Symposium on Biotechnology for Fuels and Chemicals. Portland May. 2013.

PUBLICATIONS

Angele Djioleu and **Danielle Julie Carrier**, Effects of hardwood mixtures on xylose and glucose yields during dilute acid pretreatment and enzymatic hydrolysis. 35th Symposium on Biotechnology for Fuels and Chemicals. Portland May. 2013.

Noaa Frederick and **Danielle Julie Carrier**, The effect of washing dilute acid pretreated Populus deltoides biomass on ethanol yields. 35th Symposium on Biotechnology for Fuels and Chemicals. Portland May. 2013.

Kala Rajan and **Danielle Julie Carrier**. 2nd generation biofuels: Production of inhibitors during dilute acid pre-treatment of wheat straw. American Society of Agricultural and Biological Engineers (ASABE) Annual Meeting, Kansas City, MO July 2013.

Angele Djioleu and **Danielle Julie Carrier**. Effect of Dilute Acid Switchgrass Hydrolysates on β-glucosidase activity American Society of Agricultural and Biological Engineers (ASABE) Annual Meeting, Kansas City, MO July 2013.

Holeman, N., **M. D. Matlock**, **D. C. Carrier**, C. V. Maxwell, W. Zhang and **T. A. Costello**. 2013. "Design of a Swine Wastewater Treatment Facility to Produce Periphytic Algae as a Biomass Energy Feedstock". Presented at the Institute of Biological Engineering Conference, Raleigh, NC, March 7-9, 2013.

Corral, J. and **B. Haggard**. 2013. Does Lake Frances Influence Phosphorus Transport in the Illinois River? Arkansas Water Resources Center Annual Research Meeting, Fayetteville, Arkansas.

Corral, J. and **B. Haggard**. 2013. The Influence of a Small Impoundment on Phosphorus Concentrations in the Illinois River. ASABE International Annual Meeting, Kansas City, Missouri.

Haggard, B., I. Bailey and D. Zaharof. 2013. What happens when you mix chitosan and poultry litter? The Livestock & Poultry Learning Center, From Waste to Worth: 'Spreading' Science & Solutions, Denver, Colorado.

Haggard, B. and T. Scott. 2013. Phosphorus concentrations have been declining in the Illinois River. The Livestock & Poultry Learning Center, From Waste to Worth: 'Spreading' Science & Solutions, Denver, Colorado.

Haggard, B., J. Metrailer, D. Philipp, V. Skinner, T. Scott, and A. Sharpley. 2013. A nutrient mass balance of the Watershed Research and Education Center: where, when and how much? American Water Resources Association Spring Specialty Conference Agricultural Hydrology and Water Quality, St. Louis, Missouri.

Welch, M. and **B. Haggard**. 2013. Does Sampling Method Influence the Relation between Constituent and Discharge? Arkansas Water Resources Center Annual Research Conference, Fayetteville, Arkansas

Welch, M. and **B. Haggard**. 2013. Are Concentration – Discharge Relations Influenced by Water Sample Collection Methods? ASABE International Annual Meeting, Kansas City, Missouri.

Brockman, L., R. Wang, J. Lum, L. Kelso and Y. Li*. 2013. Nanobead and aptamer based QCM biosensor for rapid detection of avian influenza virus. Presented at IBE 2013 Annual Meeting, March 7-9, 2013, Raleigh, NC. Paper No. 13.

Callaway, Z., Y. Fu, R. Wang, J. Lum, and **Y. Li**. 2013. Modeling the electro-magnetic properties of avian influenza virus in a flow cell with an interdigitated nanoelectrode using Comsol. ASABE 2013 Annual International Meeting, July 21-24, 2013, Kansas City, MO. ASABE Paper No. 131620936.

Hu, Q., X.H. Xu, M.Z. Li, Y. Zhang, and **Y. Li**. 2013. Rapid detection of acrylamide in food using a fluorescent sensing method based on functional CdSe/ZnS quantum dots. IEEE Sensors 2013 Conference, November 3-6, 2013, Baltimore, MD. Paper No. 7198.

Wang, L., R Wang, **Y. Li**, B.W. Kong, K. Ye and S. Jin. 2013. Engineering B-cell biosensors for specific, sensitive and rapid detection of E. coli O157:H7. Presented at IBE 2013 Annual Meeting, March 7-9, 2013, Raleigh, NC. Paper No. 12.

Wang, H., **Y. Li**, and M. Slavik. 2013. Rapid detection of *Campylobacter jejuni* in poultry products using quantum dots and nanobeads based fluorescent immunoassay. Presented at IAFP 2013 Annual Meeting, July 28-31, 2013, Charlotte, NC. Paper No. P2-108.

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Xu, L.Z., X.H. Xu, H. Xiong, L.X. Chen, and **Y. Li**. 2013. Identification of adulterated vegetable cooking oils using fluorescence quenching method with aqueous CTAB-Coated CdSe/ZnS quantum dots as probes. IEEE Sensors 2013 Conference, November 3 -6, 2013, Baltimore, MD. Paper No. 7114.

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Liang, Y., **R. Bautista**, G. Dabhadka and T**.A. Costello**. 2013. Validating an averaging Pitot tube for measuring fan air flow rates. ASABE Annual meeting, Paper No. 131585272.

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Sarkisov, S.S., M. Czarick III, B.D. Fairchild, **Y. Liang**, T. Kukhtareva and M.J. Curley. 2013. Organic polymer-metal nano-composites for sensing of chemicals in agriculture. Annual conference of International Society of Optical Engineering, San Diego, CA. January 2013.

Richardson, G. R. and **G. S. Osborn**. 2013. Reducing Sediment Oxygen Demand in Eutrophic Lakes. Presentation ASABE International Meeting. Kansas City, MO. Presentation 131606450.

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Submitted Abstract for consideration of presentation for 2014 ASABE Meeting. **Osborn, G.S**. Dissolved Air Flotation for Removal of Algae and Nutrients from Surface Water.

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Grain Drying in an Auger System. 2013 ASABE. Annual International Meeting. Jul 21-24, 2013. Kansas City, Missouri. **Samy Sadaka.**

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Swine manure gasification. 2013 ASABE. Annual International Meeting. Jul 21-24, 2013. Kansas City, Missouri. Mahmoud Sharara and **Samy Sadaka.**

PUBLICATIONS

OTHER CREATIVE ENDEAVORS

G.S Osborn, Founder and Board Member of BlueInGreen, LLC, a company formed to commercialize UA owned inventions from my research. In 2013, BlueInGreen directly employed 16 people including the CEO, 5 full-time engineers, 1 part-time engineer, 1 full-time technician, 3 part-time undergraduate engineering students, sales staff, and support staff. BlueInGreen has generated approximately $8.7 million in revenue since its creation in 2004.

G.S Osborn, Featured article "BlueInGreen: Pioneers in Water Treatment" from Arkansas Engineer Magazine, College of Engineering at the University of Arkansas, Spring 2013. Water Quality issue.

G. S. Osborn, BlueInGreen work subject of 3 UA press releases: emergency response for Hurricane Sandy in Virginia; ribbon cutting for SDOX unit to treat water at Lake Tenkiller dam; treating odor issues in sewer pipes in Houston, TX.

G.S. Osborn, Local television and newspaper coverage of BlueInGreen systems at Lake Tenkiller (Tulsa World). Article in Arkansas Democrat-Gazette about SDOX technology saving fish at Lake Tenkiller.

Development of Equilibrium Moisture Content Excel Sheet. **Samy Sadaka.**

Development of an Excel Sheet to decide if farmers need to heat drying air or no. "Will Natural Air-Drying Occur?. **Samy Sadaka.**

Manure Valuator Mobile App, IOS and Android App, **Saraswat, VanDevender**

PATENTS

Su, X., Z. Ye, Q. Sun and **Y. Li**. 2013. Versatile Multichannel Capillary Biosensor System. US. Patent No. 8,545,773, October 1, 2013.

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