# Department of Biological and Agricultural Engineering

# 2016 Annual Report

UofA
DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

UNIVERSITY OF ARKANSAS
COLLEGE OF ENGINEERING

# 2016 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**
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*Associate Vice President for Agriculture Research*

**Cooperative Extension Service**
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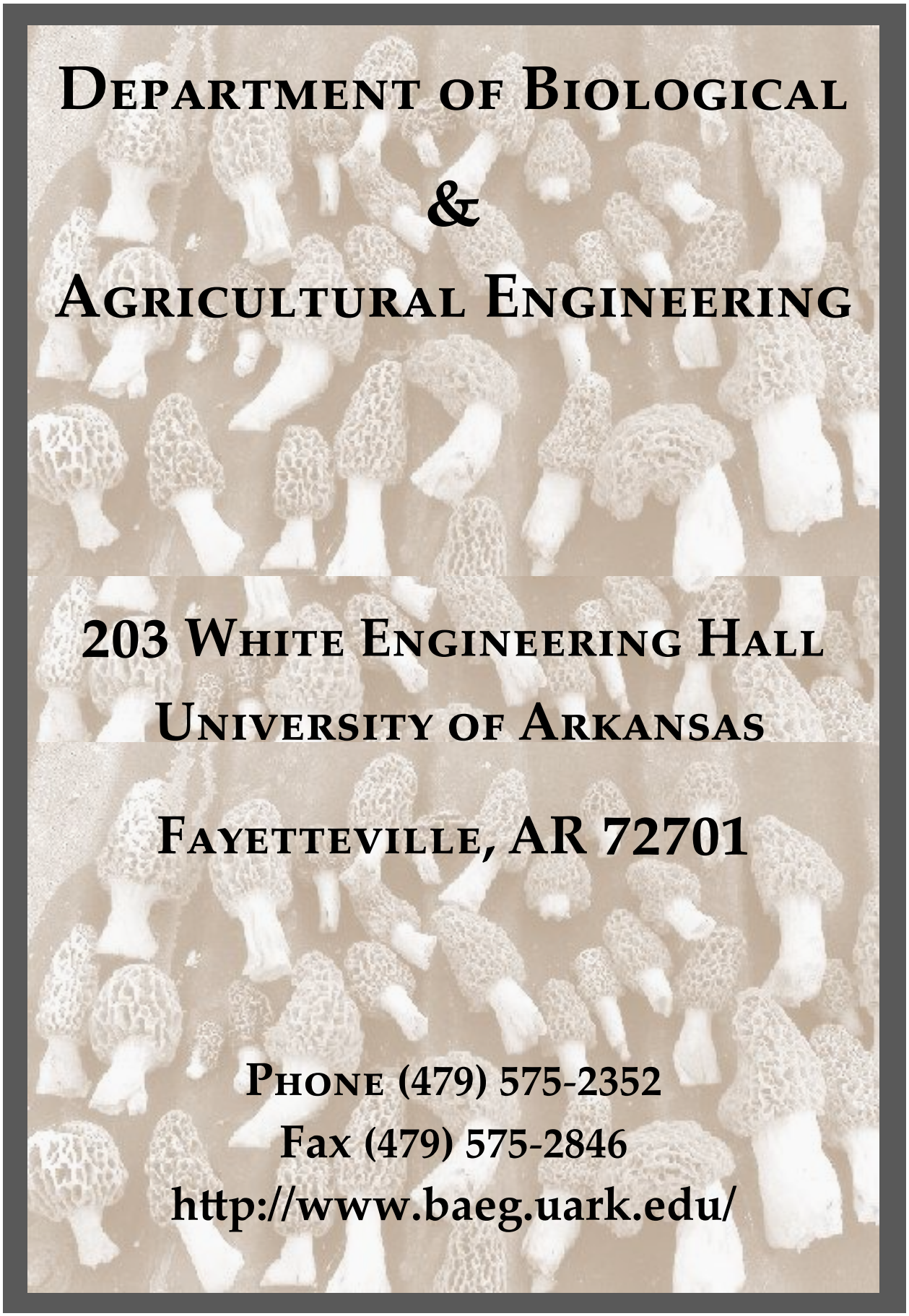
*Interim Associate Vice President for Agriculture Extension*

**College of Engineering**
John English
*Dean*

**University of Arkansas**
Joseph E. Steinmetz
*Chancellor*

Jim Coleman
*Provost and Vice Chancellor for Academic Affairs*



# Department of Biological & Agricultural Engineering


203 White Engineering Hall
University of Arkansas

Fayetteville, AR 72701

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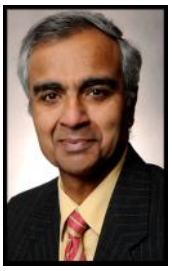
# FOREWORD

## FROM THE DEPARTMENT HEAD



Lalit R. Verma,
Professor and Department Head

It is a pleasure to share the accomplishments of our faculty, students and staff during the past year. Our mission is "*to develop and disseminate engineering knowledge to address problems dealing with sustainable food, water and energy systems.*" This mission aligns well in addressing the grand challenges facing our society. The Biological Engineering curriculum prepares engineers to solve problems in sustainable water, food and energy systems. The program grew and continues to attract incoming engineering freshmen wishing to "make a difference by working to design engineering solutions for water, food and energy systems." Our department is unique as it is housed in the Engineering College with majority of support budget provided by the UA System's Division of Agriculture for our agricultural research and extension programs and academic programs funded by the UA College of Engineering. Some faculty is off-campus in the state office of the UA System Division of Agriculture's Cooperative Extension Service in Little Rock and at the Rice Research and Education Center in Stuttgart. BAE faculty are engaged in providing engineering expertise for critically relevant issues to our state and nation, dealing with challenges in sustainable water, food and energy systems in support of the Arkansas agriculture enterprise.

Five outstanding alumni were inducted in the Arkansas Academy of Biological and Agricultural Engineering (AABAE) on April 8th. They are Mr. Ray Avery, P.E., Dr. Indrajeet Chaubey, Mr. Frederick "Anthony" Doss, P.E., Mr. Drake McGruder, and Dr. Chris Pixley. Mr. Mike Jones, (BSAGE 1967, MSAGE 1968) of was recognized as a Distinguished Alumnus and Dr. Chris Pixley (BSBAE 2002) was recognized as an Early Career Alumnus of the College of Engineering.

Ms. Linda Pate was honored with the UA Division of Agriculture's *Non-Classified Support Personnel Award*. Drs. Ben Runkle, Jun Zhu and Yi Liang were recognized with the departmental faculty awards for teaching, research, and service to students, respectively at the College of Engineering Spring Faculty meeting. Dr. Jin-Woo Kim received the Distinguished Achievement Award for Research from the University of Arkansas Alumni Association. He also received the College of Engineering's "*The Most Engaging Research Faculty Award*" which celebrates a faculty member who excels in collaborative and interdisciplinary research.

There are 128 undergraduates (sophomores to seniors) and 19 graduate students. Our goal is to increase enrolment in Biological Engineering graduate programs. One of our senior design teams of Christian Heymsfield, Kyle Lawrence, J. Dillon Madden and Paul Naegle, mentored by Dr. Tom Costello and Dr. Julie Carrier presented "*Design of On-Farm Processes for Cacao Bean Fermentation and Drying*" and was awarded second place in the G.B. Gunlogson Student Design Competition at the 2016 Annual International Meeting of the American Society of Agricultural and Biological Engineers (ASABE) in Orlando, Florida. The Senior Design Expo, under Dr. Tom Costello's leadership, was again very successful. Twenty students in five teams showcased their senior design projects on May 5th in the BENG Design Expo. Ms. Christian Heymsfield was recognized as the "*Most Outstanding Graduating Senior*" in Biological Engineering in the College of Engineering. He is working on a M.S. degree in Biological Engineering with Dr. Yi Liang.
This annual report provides an overview of the programs, contributions and accomplishments of our faculty, students and staff. Your support of our efforts is deeply appreciated and please contact us with any suggestions or questions you may have.

Thank you

Lalit R. Verma, Ph.D., P.E.
Professor and Department Head
www.bio-ag-engineering.uark.edu.

- Sammy Sadaka received the Gamma Sigma Delta Extension Teaching Award of Excellence. Gamma Sigma Delta Arkansas Chapter . University of Arkansas
- Julian Abram received the Employee of the First Quarter Award.
- Jin-Woo Kim receives The Most Engaging Research Faculty Award from College of Engineering.
- Yanbin Li, Marty Matlock and Scott Osborn were honored as faculty inventors at the fourth annual Inventors Appreciation Banquet and inducted into the National Academy of Inventors.
- Scott Osborn was named "Engineer of the Year" by the Arkansas section of the American Society of Agricultural and Biological Engineers.
- Scott Osborn received the Director's Service Award for service to UA Freshman Engineering Program.
- Scot Osborn received the Eminent Engineer, Tau Beta Pi, University of Arkansas.
- Arkansas Water Resource Center under Director Brian Haggard was awarded the Beaver Lake Watershed Guardian Award.
- Yanbin Li received ASABE 2016 Superior Paper Award
- Yanbin Li received IAFP 2016 John N. Sofos Most-cited JFP Research Publication Award.
- Benjamin Runkle received the College of Engineering Outstanding Teaching award for Biological and Agricultural Engineering.
- Jun Zhu received the College of Engineering Outstanding Research award for Biological and Agricultural Engineering
- Yi Liang received the College of Engineering Outstanding Service to students award for Biological and Agricultural Engineering.
- Karl VanDevender received the John W. White Outstanding Extension State Faculty award.

ALUMNI ACCOMPLISHMENTS

- Ray Avery, Indrajeet Chaubey, Anthony Doss, Drake McGruder, Chris Pixley were inducted into the Arkansas Academy of Biological and Agricultural Engineering

# Significant Accomplishments in 2016

## Students

- Christian Heymsfield, Kyle Lawrence, J. Dillon Madden and Paul Naegle. 2016. Design of On-Farm Processes for Cacao Bean Fermentation and Drying. Second Place. 2016 ASABE Gunlogson National Student Design Competition. Presented July 19, 2016, at the ASABE International Meeting in Orlando, Florida. Faculty mentors: D. Julie Carrier and Thomas A. Costello.
- Lizhou Xu, Ph.D. Student in Biosystems Engineering, won the ASABE 2016 Superior Paper Award, July 17-20, 2016, Orlando, FL. The paper is: Xu, L.Z., Z. Callaway, R.H. Wang, H. Wang, M.F. Slavik, A. Wang, and Y. Li*. 2015. A fluorescent aptasensor coupled with nanobeads-based immunomagnetic separator for simultaneous detection of four foodborne pathogenic bacteria. Transactions of the ASABE 58(3):891-906.
- Zhuo Zhao, M.S. Student in Biological Engineering, won the 2nd place of AOCABFE 2016 Graduate Research Papers Competition, July 17-20, 2016, Orlando, FL. The paper is: Zhao, Z., L.Z. Xu, Q.Q. Hu, R. Wang, H. Wang, and Y. Li*. 2016. 2016. A portable and automatic biosensing instrument for simultaneous detection of foodborne pathogens using nanobead-based magnetic separation and quantum dot-labeled fluorescent measurement". ASABE Paper No. 162461406, the ASABE 2016 Annual International Meeting, July 17-20, 2016, Orlando, FL.
- Mitchel, A. and A. Smith. Best Paper Award – Process Design and Improvement, FEP Honors Research Symposium, Fayetteville, Arkansas. Evaluating Labs and Methods for Testing Nitrate Concentrations in Surface Water, 8th Annual Freshman Engineering Program Honors Research Symposium, Fayetteville, Arkansas. 2016. Brain Haggard Mentor.
- Lord (Reavis), M. and B. Haggard, 1st Place Graduate Student Poster Competition – Geosciences Subdivision, Arkansas Academy of Science, Annual Meeting, Fayetteville, Arkansas. 2016. Floodplain soils: a potential source of phosphorus to the Illinois River? Arkansas Academy of Science Annual Meeting, Fayetteville, Arkansas.
- Adrian Beirise, graduate student, won Best Graduate Student Poster award at the annual Institute of Biological Engineering conference in Greenville, SC, 2016.

**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; improve irrigation efficiency practices, novel irrigation system design, and improved energy efficiency and alternative energy sources for irrigation; develop alternative irrigation systems for rice; water policy research; solar power; pumping plant telematics; improve irrigation systems using embedded systems and mobile apps; develop curricula and training materials for educational programs in irrigation 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 con-siderations; 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, bionanotechnology, and bio-abio interfacing technology.*

**Yanbin Li, Ph.D., P.E.**
*Distinguished Professor, Tyson Endowed Chair in Biosensing Engineering*
B.S. Ag.E. (1978) Shenyang Agricultural University, China
M.S. Ag.E. (1985) University of Nebraska, Lincoln
Ph.D. Ag.E. (1989) Pennsylvania State University
*Research Areas: Biosensor and bioinstrumentation, microbial predictive engineering, quantitative risk assessment, and food safety engineering.*

**Yi Liang, Ph.D.**
*Associate 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; linkages among technology, economics and societal values.*

**Marty D. Matlock, Ph.D., P.E., B.C.E.E.**
*Professor*
Area Director, Center for Agricultural and RuralSustainability
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.*

**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: Grain and Food Processing, dissolved oxygen and ozone technologies for water and wastewater treatment*

**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 con-servation*

**Benjamin Runkle, Ph.D.**
*Assistant Professor*
B.S.E.. Princeton University
M.S., University of California, Berkeley
Ph.D., University of California, Berkeley
*Research Areas: Wetland ecohydrology, Surface water nutrient fluxes and source partitioning. Land-atmosphere exchange of carbon dioxide, methane, and water vapor.*

**Bailey Sullivan, Ph.D.**
*Instructor*
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: Utilization of molecular methods to investigate the fate and transport of soil and water contaminants including antibiotics, antibiotic resistant bacteria, and antibiotic resistance genes.*

**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 University, 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*

Bradley J. Austin
*Post Doctoral Associate*

Prathamesh Bandekar
*Research Associate*

Holly Beason
*Administrative Support Supervisor, Extension*

Amber Friday-Brown
*Administrative Specialist III*

Eric Cummings
*Program Associate*

*Janelle Mott Delany*
*Fiscal Manager*

Staci Hudspeth
*Department Fiscal Manager*

Jerry Jackson
*Skilled Tradesman*

James McCarty
*Research Associate*

Linda Pate
*Department Administrative Manager*

William Benjamin Putman V
*Research Associate*

Heather Sandefur
*Research Associate*

Lee Schrader
*Program Assistant*

Jiacheng Shen
*Post Doctoral Associate*

Arvind Sinha
*Post Doctoral Associate*

Kosana Suvocarev
*Post Doctoral Associate*

Erin Scott
*Program Associate*

Anthony Taylor
*Administrative Specialist III*

Karen Withers
*Administrative Office Supervisor, Extension*

Ronghui Wang
*Post Doctoral Associate*

## BAEG Advisory Board
## 2016-2017 Members

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*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
## 2016-2017 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)*

Glenn Davis
B.S. ('67)

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)*

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)*

William Hix Smith, JR
*B.S. ('67)*

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

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

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

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

Marcus Tilly
*B.S. ('00)*

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*

*John Westerman*
*B.S. ('94)*

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*

Carl L. Griffis
*B.S. ('63), M.S. ('65), Ph.D. ('68)*

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

## 2016 Academy Inductees

Ray Avery
B.S. ('03) M.S. ('07)

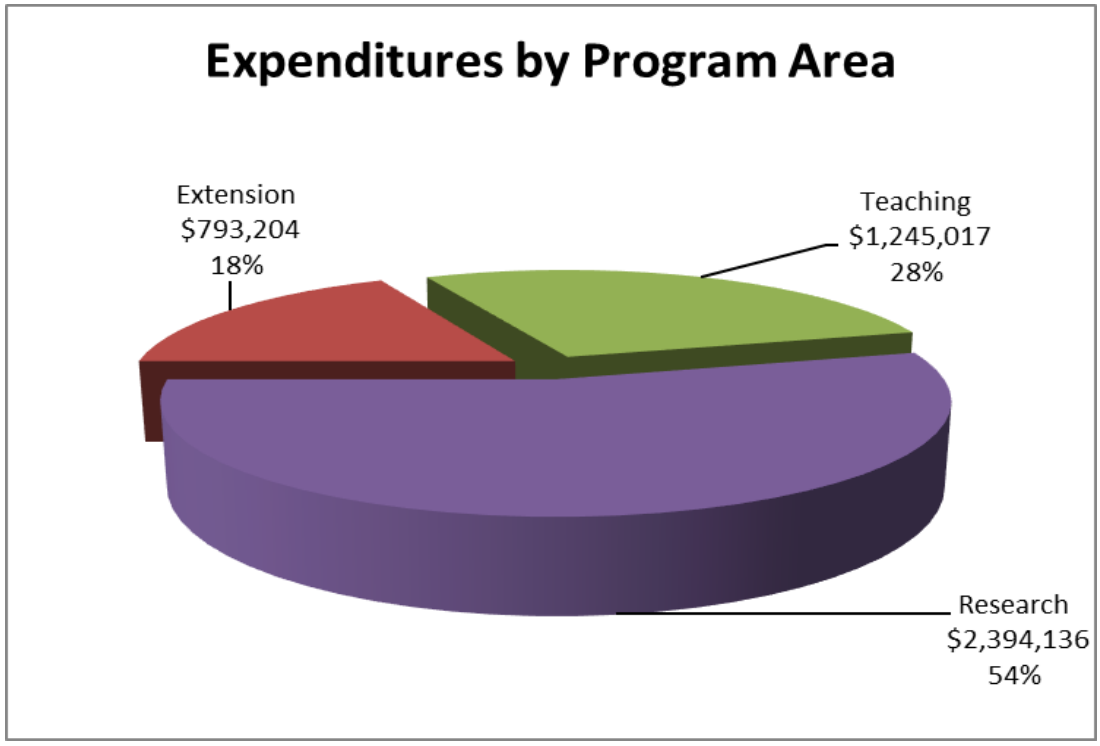
Indrajeet Chaubey
M.S. ('94)

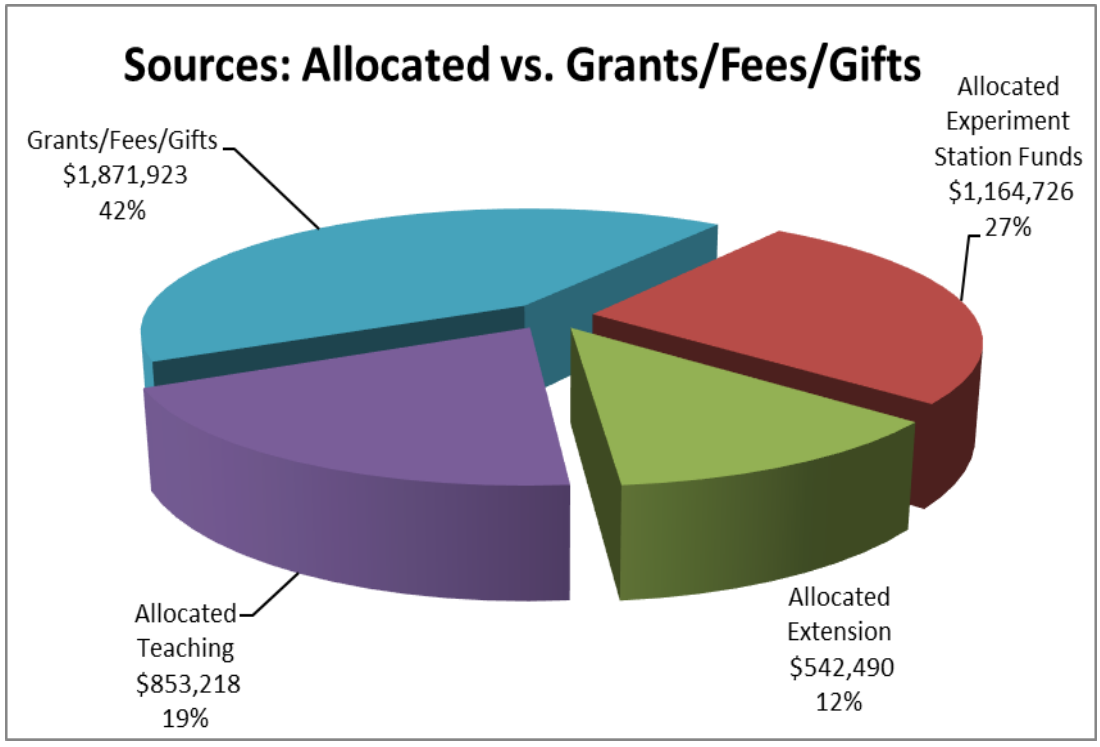
Anthony Doss
B.S. ('94)

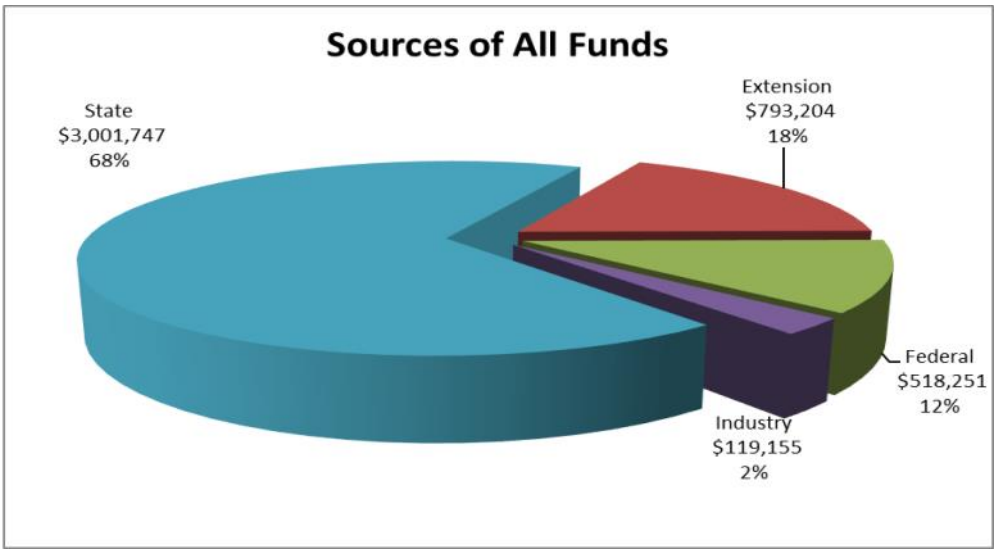
Drake McGruder
B.S. ('06)

Chris Pixley
B.S. ('02) Ph.D. ('13)

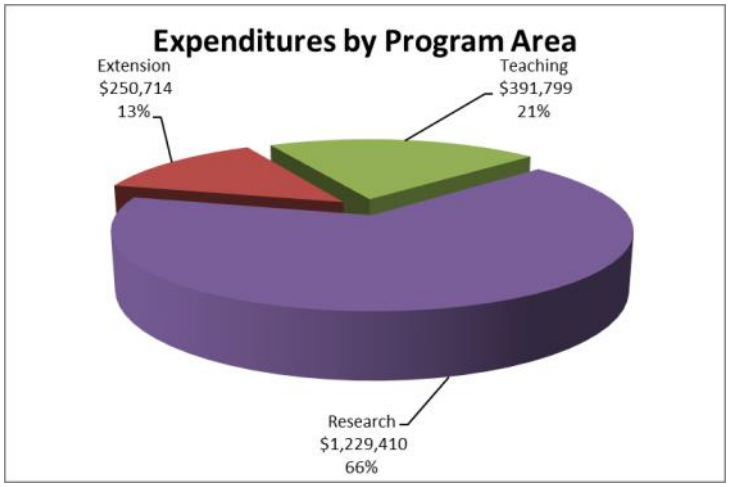
# TOTAL EXPENDITURES, JULY 1, 2015 TO JUNE 30, 2016
# $4,432,357

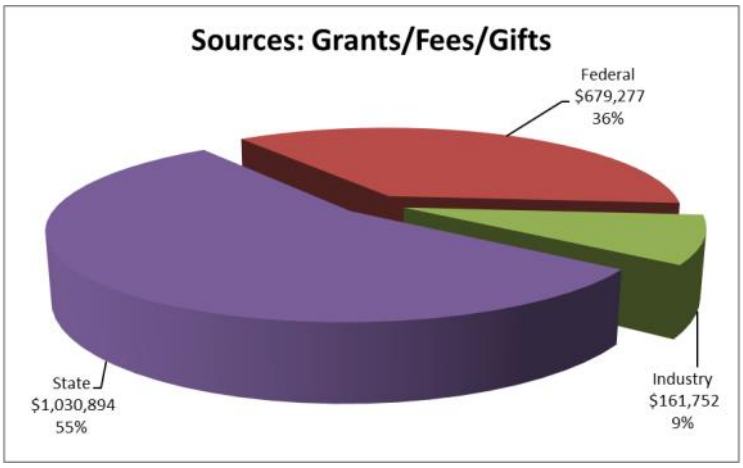





## GRANTS/FEES/GIFTS
## $1,871923



## 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.

In 2012, the Biomedical Engineering program was separated and the revised curriculum in Biological

## DEPARTMENT OF BIOLOGICAL & AGRICULTURAL ENGINEERING

Engineering of *"Healthy Planet Healthy People"* was designed to address the challenges in sustainable food, water and energy systems.

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

Fayetteville is the third-largest city in Arkansas and county seat of Washington County. The city is centrally located within the county and has been home of the University of Arkansas since the institution's founding in 1871. Fayetteville is on the outskirts of the Boston Mountains, deep within the Ozarks. Known as Washington until 1829, the city was named after Fayetteville, Tennessee, from which many of the settlers had come. It was incorporated on November 3, 1836 and was rechartered in 1867. The four-county Northwest Arkansas Metropolitan Statistical Area is ranked 105th in terms of population in the United States with 463,204 in 2010 according to the United States Census Bureau. The city had a population of 73,580 at the 2010 Census.[5] At 1,400 feet of elevation, it is also one of the highest major US cites between the western Great Plains and the Appalachian Mountains.

Fayetteville is home to the University of Arkansas, the state's largest university. When classes are in session, thousands of students on campus dramatically change the city's demographics. Thousands of Arkansas Razorbacks alumni and fans travel to Fayetteville to attend football, basketball, and baseball games. The University's men's track and field program has won 41 national championships to date. Fayetteville was named the third best place to live in the United States in the 2016 U.S. News Best Places To Live Rankings, and one of the best places to retire in the South. Forbes also ranked Fayetteville as the 24th-best city for business and careers in 2016. Lonely Planet named Fayetteville among its top 20 places to visit in the South in 2016. Based in nearby Bentonville,

the Walmart corporation has dominated Fayetteville's economy. The city hosts the Wal-Mart Shareholders Meetings each year at the Bud Walton Arena.

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.

# Teaching Program

## Undergraduate Program

### Scholarship Recipients for 2016

**Arkansas Academy of Biological & Agricultural Engineering Scholarship**

Trent Woessner
Kami Parmenter
Bailey Keller

**Biological & Agricultural Engineering Departmental Scholarship**

McKenna Belcher

**Billy Bryan Scholarship**

Ryan Clark

**J.A. Riggs Tractor Company Scholarship**

Dustyn Perkins
Jillian Schneider

**Xzin McNeal Scholarship**

Jillian Schneider
Brooke Benham
Madeline Ludwig
Thomas Helvick
His-Cheng Su

**John W & Trannye Odom White Scholarship**

Nichol Ghanfili

**Mike & Yvonne Jones Scholarship**

Brooke Benham
Megan Rasmussen

**Beaver Water District**

Andrew Stephens

### Graduates for 2016

**Bachelor of Science in Biological**

**Spring 2016**
Jenna Bruick
Andrew Dugan
Scott Gilrein
Shane Harris
Nelson Heringer
Christian Heymsfield
Jacob Hickman
Michael Hoppe
Caleb Jones
Kyle Lawrence
Jeffrey Madden
Angelica Makuch
Paul Naegle
Savanna Royals
Cody Vaughn

**Summer 2016**

**Fall 2016**
Nichole Ghanfili
Chao Li

### Biological Engineering Student Club

**2016-2017 Officers**

Will Richardson—*President*

Alex Parr—*Vice President*

Brooke Benham—*Treasurer*

Brandon Taylor—*Secretary*

Madeline Ludwig—*Public Relations*

*Advisor: Dr. Scott Osborn*

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 2016-2017 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**<br>1 GNEG 1111 Introduction to Engineering I<br>3 ENGL 1013 Composition I<br>3 CHEM 1103 University Chemistry I (ACTS Equivalency = CHEM 1414 Lecture<br>4 MATH 2554 Calculus I (ACTS Equivalency = MATH 2405)<br>4 PHYS 2054 University Physics I (ACTS Equivalency = PHYS 2034)<br>15 Semester hours | **Second Semester**<br>1 GNEG 1121 Introduction to Engineering II<br>3 ENGL 1023 Technical Composition II<br>4 Freshman Engineering Science Electives *<br>4 MATH 2564 Calculus II (ACTS Equivalency = MATH 2505)<br>3 U.S. History Requirement<br>15 Semester hours |
| **Sophomore Year** | |
| **First Semester**<br>2 BENG 2632 Biological Engr Design Studio<br>4 MATH 2574 Calculus III (ACTS Equivalency = MATH 2603)<br>4 Sophomore Science Electives **<br>4 BIOL 1543/1541L Principles of Biology and Lab<br>3 MEEG 2003 Statics | **Second Semester**<br>3 BENG 2643 Biological Engineering Design Methods<br>4 MATH 2584 Differential Equations<br>4 BIOL 2013/2011L General Microbiology w/Lab<br>3 MEEG 2403 Thermodynamics (OR CHEG 2313)<br>3 Humanities/Social Science Electives<br>17 Semester hours |
| **Junior Year** | |
| **First Semester**<br>3 BENG 3653 Global Bio-Energy Engineering<br>3 BENG 3663 Biological Engineering Methods II<br>3 BENG 3733 Transport Phenomena in Biological Systems<br>4 CHEM 3603/3601L Organic Chemistry I w/Lab or CHEM 2613/2611L Organic Physiological Chemistry w/Lab<br>3 CVEG 3213, Hydraulics (OR MEEG 3503 OR CHEG 2133)<br>**16 Semester hours** | **Second Semester**<br>3 BENG 3723 Unit Operations in Biological Engr<br>3 BENG 3113 Measurements and Controls for Biological Systems<br>3 BIOL 3863 General Ecology<br>3 CVEG 3223 Hydrology<br>3 Technical Elective<br>16 Semester hours |
| **Senior Year** | |
| **First Semester**<br>2 BENG 4812 Senior Biological Engineering Design I<br>1 BENG 4831 Biological Engineering Professionalism<br>3 BENG 4743, Food and Bio-Product Systems Engineering<br>3 BENG 4933 Sustainable Watershed Engineering<br>3 Humanities/Social Science Electives<br>3 Humanities/Social Science Electives<br>**15 Semester hours** | **Second Semester**<br>2 BENG 4823 Senior Biological Engineering Design II<br>3 BENG 4663 Sustainable Biosystems Design<br>3 Engineering Electives<br>3 Fine Arts Electives (from University/State core list)<br>3 Humanities/Social Science Electives<br>3 Technical Electives<br>**18 Semester hours** |

* The Freshman Engineering Science Elective must be chosen from either CHEM 1123/1121L or PHYS 2074.
** The Sophomore Science Elective must be: PHYS 2074 if CHEM 1123/1121L was chosen as the Freshman Engineering Elective; or CHEM

# 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.

- 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.

## GRADUATE STUDENTS

*The following students were part of the Graduate program during 2016. 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 |
|---|---|
| Adrian Beirise | Dr. G. Scott Osborn |
| Barrett Carter | Dr. Jun Zhu |
| Jaime Gile | Dr. Brian Haggard |
| Christian Heymsfield | Dr. Yi Liang |
| Vaishali Kandapal | Dr. Chris Henry |
| Kaushik Luthra | Dr. Yi Liang |
| Jay Mishra | Dr. Chris Henry |
| Sakura Phansiri | Dr. G. Scott Osborn |
| Colby Reavis | Dr. Benjamin Runkle |
| Richard Sakul | Dr. Julie Carrier |
| Zachary Simpson | Dr. Brian Haggard |
| Amandeep Singh | Dr. Thomas Costello |
| Gagandeep Singh Ubhi | Dr. Sammy Sadaka |
| Zhuo Zhao | Dr. Yanbin Li |

### MASTER OF SCIENCE IN CELL AND MOLECULAR BIOLOGY

| STUDENT | ADVISOR |
|---|---|
| Charles Armistead | Dr. Jin-Woo Kim |

### DOCTOR OF PHILOSOPHY IN BIOLOGICAL ENGINEERING

| STUDENT | ADVISOR |
|---|---|
| Zachary Callaway | Dr. Yanbin Li |
| Eric Cummings | Dr. Marty Matlock |
| Josef Dalaeli | Dr. Scott Osborn |
| Gurshagan Kandhola | Jin-Woo Kim |
| James McCarty | Dr. Marty Matlock |
| Gurdeep Singh | Dr. Dharmendra Saraswat |
| Meng Xu | Dr. Yanbin Li |

### DOCTOR OF PHILOSOPHY IN CELL AND MOLECULAR BIOLOGY

| STUDENT | ADVISOR |
|---|---|
| Sardar Abdullah | Dr. Yanbin Li |
| Joseph N. Batta-Mpouma | Dr. Jin-Woo Kinm |
| Xiaofan Yu | 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.*

SPRING 2016

SUMMER 2016
Adrian Beirise MSBE
Jamie Gile MSBE
Richard Sakul MSBE
Zachary Simpson MSBE

FALL 2016
Meng Xu Ph.D.
Zhuo Zhao MSBE

## 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 |
|---|---|---|
| Sadar Abdullah | PhD Cell and Molecular Biology | Dr. Yanbin Li |
| Chase Armistead | Master Science Cell and Molecular Biology | Dr. Jin-Woo Kim |
| Maryam Asharour | PhD Chemical Engineering | Dr. Thomas Costello |
| David William Astorino | Master of Science Engineering | Dr. Otto Loewer |
| Joseph N. Batta-Mpouma | Master Science Microelectronics-Photonics | Dr. Jin-Woo Kim |
| Johnny Chamberlain | PhD Environmental Dynamics | Dr. Thomas Costello |
| Sandeep Chalamalasetty | PhD Mechanical Engineering | Dr. Yanbin Li |
| Huang Dai | PhD Zhejiang University | Dr. Yanbin Li |
| Rebecca Gill | PhD Cell and Molecular Biology | Dr. Yanbin Li |
| Austin Lewis | Master of Science ASU University | Dr. Chris Henry |
| Zhishang Li | Master Science Zhejiang University | Dr. Yanbin Li |
| Dustin Lynch | PhD Biology | Dr. Brian Haggard |
| Xiangning Xiao | Master Science Zhejiang University | Dr. Yanbin Li |
| Hou Min Zhong | Master Science Food Science | Dr. Scott Osborn |
| Zeina Al-Dolami | PhD Microelectronics-Photonics | Dr. Jin-Woo Kim |
| Maryam Asharour | PhD Chemical Engineering | Dr. Thomas Costello |
| Hua Bai | PhD Crop, Soil & Environmental Science | Dr. Chris Henry |
| Sandeep Chalamalasetty | PhD Mechanical Engineering | Dr. Yanbin Li |
| Huang Dai | PhD Zhejiang University | Dr. Yanbin Li |
| Lamine Diop | PhD Ohio State University | Dr. Chris Henry |
| Qinqin Hu | PhD Zhejiang University | Dr. Yanbin Li |
| Zhanming Li | PhD Zhejiang University | Dr. Yanbin Li |
| Dustin Lynch | PhD Biology | Dr. Brian Haggard |
| David Lyon | PhD Environmental Dynamics | Dr. Benjamin Runkle |
| Abdollah Mosleh | PhD Microelectronics-Photonics | Dr. Jin-Woo Kim |
| Sangeeta Mukhopadhyay | PhD Food Science | Dr. Scott Osborn |
| Leigh Parette | PhD Poultry Science | Dr. Yanbin Li |
| Zahohui Qian | PhD Zhejiang University | Dr. Yanbin Li |
| Kalavathy Rajan | PhD Food Science | Dr. Julie Carrier & Dr. Thomas Costello |
| John Allen Ramaker | Master of Science Engineering | Dr. Otto Loewer |
| Gillian Simpson | SICCS MSc, University of Hamburg, Germany | Dr. Benjamin Runkle |
| S. Faye Smith | PhD Environmental Dynamics | Dr. Brian Haggard |
| Christopher Van Wanamaker | Master of Science Engineering | Dr. Otto Loewer |
| Annie West | PhD Environmental Dynamics | Dr. Brian Haggard |
| Shantae Wilson | Master Science | Dr. Sammy Sadaka |
| Lizhou Xu | PhD Zhejiang University | Dr. Yanbin Li |
| Xiaofan Yu | PhD Cell and Molecular Biology | Dr., Yanbin Li |

*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 basic circuit analysis, sensor calibration and hardware selection. Basic process monitoring and control methods, including hardware and software. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component. Prerequisite: EPHYS 2054.

**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 basic circuit analysis, sensor calibration and hardware selection. Basic process monitoring and control methods, including hardware and software. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component. Prerequisite: PHYS 2074 and honors candidacy.

**BENG 3653. Global Bio-Energy Engineering (Fa). 3 Hours.**
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: MEEG 2403 or CHEG 2313.

**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).

**BENG 3663. Biological Engineering Methods II (Fa). 3 Hours.**
Modeling biological processes to predict system behavior as part of the design process. Development and use of spreadsheets and script programming code to represent biological phenomena and processes. Introduction to experimental design as applied to biological processes, including data collection and analysis, and elementary statistics. Use of engineering economics to aid comparisons of alternatives. Analysis of engineering designs and management practices to best meet the needs of society and the client in areas of sustainable water, food and energy systems. Lecture 3 hours per week. Prerequisite: PHYS 2054 and MATH 2564.

**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.

**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 3113.

**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.

**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 2632. 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.

**BENG4812 Senior Biological Engineering Design I (Fa)** Initiation of comprehensive two-semester team-design projects to design processes, devices and systems to meet needs of clients in sustainable water, food and energy. Practice in following the design process, including the definition of design objectives and constraints, establishing functions and performance criteria, generating alternatives and evaluating alternatives through analysis, modeling and prototype testing; exploring relevant design considerations including performance, efficiency, costs, environmental impacts, sustainability and stewardship, safety and ethics. Developing analytic capability; and practicing design optimization to find best alternative for the client. Lecture 1 hour, laboratory 3 hours per week. Prerequisite: Instructor consent. Corequisite: Lab component.

**BENG4823 Senior Biological Engineering Design II (Sp)** Completion of comprehensive two-semester team-design projects to design processes, devices and systems to meet needs of clients in sustainable water, food and energy. Focus on building of prototypes or models, system optimization, evaluation and improvement. Final design details packaged to meet the needs of the client. Interaction with appropriate persons from other disciplines. Written and oral reporting. Communications with peers, supervisor, clients and the public. Lecture 1 hour per week, two 2-hour lab periods per week. Prerequisite: BENG 4812. Corequisite: Lab component.

**BENG 4831. Biological Engineering Professionalism (Fa).**

Preparation to be job-ready, employable and successful in transition to a professional career and further study in Biological Engineering. Introduction to job and graduate study searches. Professional and ethical responsibilities; professional registration. Conflict, change and project management. Effective communications and interactions with supervisors, peers, clients, and stakeholders. Two hour discussion section per week. Prerequisite: Senior standing.

**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

**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.

**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)

**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.

**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)** Graduate standing required for enrollment.

**BENG700V Doctoral Dissertation (Sp, Su, Fa) (1-18)** Candidacy is required for enrollment.

# Student Field Industry Tour FALL 2016

Visited the Heifer Ranch in Perryville AR

Visited the Whillock Hydroelectric Power Station in Morrilton AR


Visited Diamond Bear Brewhouse in Little Rock AR

Visit to the Revis Farm. A row crop farm in Lonoak, AR

Visited Hormel (Skippy Peanut Butter) Little Rock, AR

# 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.

## Optimization of Algal Biomass Production Using Swine Wastewater

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 that 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) than any other energy crop. Algae can also utilize nutrients from wastewater or from natural waters containing excess nutrients. This utilization of existing waste or by-product nutrient sources decreases the demand for commercial fertilizers that must be mined and frequently trucked long distances. Algae growth 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. A pilot scale system has been constructed at the UA Biological and Agricultural Engineering Lab where experiments were conducted to explore optimization of production through yield enhancements and water pumping reductions. Tests of the system using undiluted swine effluent were conducted with a reduced flow and a pulsing mode. Additional tests measured the impact of CO2 enrichment of the wastewater using scrubber technology that could reclaim CO2 from biogas.

**IMPACT:**

The current pilot-scale research will help to fine-tune production strategies to identify sustainable niche applications of the technology. Research results will provide data needed to perform objective economic analyses of the life cycle costs and environmental impacts of the proposed technology.

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**COLLABORATING SCIENTISTS:**

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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, Agricultural Experiment Station
University of Arkansas College of Engineering

## WATER QUALITY TRENDS IN STREAM REFLECT CHANGES IN THE RESERVOIR AND WATERSHEDS

BRIAN HAGGARD, PROFESSOR

**ISSUE:**

How does water quality change? It is improving, getting worse, or just staying the same? These are questions that often asked for many reasons, including the State's investment in water-quality monitoring, best management practices, and other voluntary actions. The Arkansas Water Resources Center has been monitoring water quality in almost 20 stream in Northwest Arkansas for the last several years to answer these questions.

**ACTION:**

The Arkansas Water Resources Center, funded by the 319 Nonpoint Source Program of the Arkansas Natural Resources Commission, collected water samples from 20 streams in the Upper Illinois River Watershed and the Upper White River Basin. These water samples were analyzed for chloride, nitrogen, phosphorus, sediment and sulfate at its water quality lab, which is certified by the Arkansas Department of Environmental Quality. The data was organized, and then water quality trends were evaluated using flow-adjusted concentrations and appropriate statistical techniques.

**IMPACT:**

The Arkansas Water Resources Center noticed three distinct findings that were important to the State. First, short-term changes in water quality (measured via flow adjusted concentrations) are influenced by variation in climate and hydrology. Second, the recent reductions in phosphorus from the City of Springdale's wastewater treatment plant has reduced phosphorus concentrations in Spring Creek – however, these improvements have not been observed further downstream in the Illinois River yet. Finally, there is an increasing trend in chloride and sulfate concentrations in these streams – why is an important question, but it might be related to salt use during winter. These data are critical to our understanding of how we influence water quality with what we do in our watersheds.

**CONTACTS:**

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

**COOPERATING SCIENTISTS OR INSTITUTIONS**:

**FUNDING SOURCES:**

## DEMONSTRATING IRRIGATION WATER MANAGEMENT PRACTICES TO ARKANSAS FARMERS

CHRISTOPHER HENRY, ASSISTANT PROFESSOR, EXTENSION

**ISSUE:**
Regional water management programs have identified a number of technologies and management practices that have the potential to reduce the overdraft on the Mississippi Valley Alluvial and Sparta Aquifers, thereby ensuring that soybean producers can achieve sustainable groundwater yields while maintaining overall profitability. In Arkansas groundwater withdraws from the alluvial aquifers are only about 42 percent sustainable and 54.6 percent sustainable from the Sparta/Memphis aquifer.

**ACTION:**
Computerized Hole Selection is the process of using a computer program to determine the proper hole size to use in lay-flat irrigation pipe to maximize the uniformity. CHS is a key component of improving irrigation efficiency for furrow irrigation and is primary component of Irrigation Water Management Planning. It has been well documented that when properly used, CHS can successfully reduce water use by 20% for furrow irrigators.

Training of County Agents, NRCS staff and farmers was conducted by Dr. Henry, Chris Declerk of Delta Plastics and Mike Hamilton, Irrigation Instructor and others between 2012 and 2016. Mr. Hamilton and County Agents then conducted one-on-one training or workshops to train farmers on how to use and implement CHS. Originally the trainings focused around PHAUCET a public CHS computer program. Since 2014 it as focused on Pipe Planner a web-based tool provided to the public free of charge. In 2016 a regional irrigation survey of farmers was conducted to evaluate the adoption of conservation practices in the mid-south region.

**IMPACT:**
County agent-led Computerized Hole Selection (CHS) programming and Irrigation Water Management (IWM) demonstrations have improved the adoption of Computerized Hole Selection by 83%. Efforts since 2012 have successfully increased the adoption of CHS to 41% where previously it was very low (< 5%). These efforts have resulted in water savings of over 21 billion gallons annually in Arkansas. Wide-spread adoption of these CHS practices will have a dramatic impact on the overdraft of Arkansas aquifers and improve the profitability and sustainability of row crop production.

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**FUNDING SOURCES:**
United Soybean Board, Mid-south Soybean Board, Arkansas Soybean Promotion Board, Arkansas Rice Research and Promotion Board and the Arkansas Corn and Grain Sorghum Promotion Board.

## NANOTOOLBOX TECHNOLOGY FOR PROGRAMMABLE SELF-ASSEMBLY OF MULTIFUNCTIONAL HIERARCHICAL STRUCTURES FOR BIOMIMETIC ADVANCED MATERIALS AND DEVICES

JIN-WOO KIM, PROFESSOR

**ISSUE**:
Engineering multiple nanoscale materials into single multifunctional structure with predefined biophysicochemical characteristics has much promise for advanced materials and devices. Geometric factors, such as shape, size, and material compositions, influence the biophysicochemical properties of materials. Hence, the assembly of various nanoparticles (NPs) of different sizes, shapes, and compositions into desired patterns and geometries could realize programmable platforms for a variety of applications, ranging from optoelectronics and nanophotonics to biosensing, biosecurity, and nanomedicine. As a result, there has been considerable interest in the assembly of multifunctional structures with defined shapes, sizes, and functions that incorporate diverse NPs. Particularly, self-assembly has emerged as a powerful and practical strategy for controlled synthesis of such hierarchical structures. However, the accurate, scalable, and high-rate assembly of various nanocomponents into multifunctional architecture with specifically designed shapes and sizes remains difficult to attain.

**ACTION**:
To meet the challenge, Dr. Kim's group focuses on a transformative research to develop a nano-building block toolbox ("nanotoolbox") for the programmable self-assembly of advanced biomimetic materials with arbitrary shapes and arbitrary functions. This is accomplished with our novel nano-building block ("nBlock") technology and its further generalization that enable controls over the number, placement, and orientation of bio-functional ligands, including DNA, RNA, and peptide, on various NPs, including metallic NPs, quantum dots, bio-based NPs (*e.g.*, cellulose nanocrystals), *etc*. Since the nBlock technology could incorporate NPs of different composition, generating toolboxes of various NPs with bio-ligands at defined locations and in defined 3D orientations on a NP, it promises not only complicated shapes, but also the ability to tune the function of the assembly. When DNA is used, such well-defined and controlled functionality and directionality of various NP building blocks promise precisely controlled self-organization of structures with greater complexity for "customized" size, shape, and functionality for specific applications.

**IMPACT**:
The ultimate significance of the nanotoolbox technology is that it addresses the urgent need in the field of nanotechnology for functional, reliable and scalable techniques for "programmable and customizable" integrations of highly functional bio-hybrid systems, on the basis of target applications, in desired patterns and geometries at all scales and in all dimensions, beyond the inherent limitations of existing technologies, further driving innovations in novel hybrid fused technologies. The nanotoolbox technology holds high promise to transform many fields of research, ranging from optoelectronics, nanophotonics, and nanomedicine to agriculture, food safety, and biosecurity, contributing to the enhancement of economic well-being and quality of life not only in the State of Arkansas but also in the world, and making significant contributions toward the land grant mission. The research has generated 6 peer-reviewed articles (1 invited article and 1 article featured as a "Back Cover" of the journal issue), 7 conference presentations with 1 plenary talk, 1 patent granted, and 1 patent pending during the year 2016.

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**FUNDING SOURCES**:
National Science Foundation (NSF; award#: CMMI-1235100, ECCS-1128660 and OIIA-1457888)

## Portable Biosensor for In-field Screening of Avian Influenza in Poultry

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 16 countries for human cases with 676 people infected and 398 died since 2003. In the US, a recent outbreak of low pathogenic AI in 2001 and 2002 resulted in the depopulation of over 4.5 million chickens and turkeys and had cost the poultry industry approximately $125 million. World Bank estimated that more than 140 million birds had died or been destroyed due to AI H5N1 and losses to the poultry industry are in excess of $10 billion worldwide. A key in controlling the spread of AI is to rapidly detect the disease, and then eradicate infected animals, quarantine and vaccinate animals. The technology for detection of AI H5N1 is mature, but many tests are complex, some are liable to error, and some can be performed safely only in BSL3 facilities. A simple, rapid, robust and reliable AI test, suitable for use in the field, is urgently needed.

**ACTION:**

A portable biosensor has been developed for in-field sensitive and specific detection of AI virus H5N1 in poultry swab samples. Magnetic nanobeads are coated with specific antibodies to target virus and used in the sampler to separate and concentrate target virus from a poultry swab sample. Red blood cells, as biolabels, are mixed with the captured target virus to form the bio-nanobead-virus-red blood cell complex. A microfluidic biochip is designed and fabricated as a flow-through device to deliver the complex to an embedded interdigitated array microelectrode for impedance measurement. The change in impedance of the bionanobead-virus-red blood cell complex is correlated to the concentration of AI virus H5N1 in the original swab sample. Our results showed that a positive signal was clearly obtained when the concentration of AI virus H5N1 in cloacal swabs was equal to or more than 100 $EID_{50}$/mL. The test on live H5N2 virus in infected chickens indicated the biosensor presented the same results as that by RT-PCR. A US patent has been filed. A research prototype of this biosensor has been designed, fabricated and evaluated with viable AI H5N1 in a BSL-3 lab.

**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:**

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**COOPERATORS:**

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**FUNDING:**

USDA/NIFA, ABI, MoST

## NANOMATERIALS-BASED BIOSENSOR FOR SIMULTANEOUS DETECTION OF MULTIPLE 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 simultaneous detection of multiple major foodborne pathogens.

**ACTION:**

The objective of this project is to develop a portable, automated, nanoparticle-based fluorescent biosensor for rapid and simultaneous detection of multiple bacterial pathogens in foods. The biosensor system consists of a novel magnetic nanobeads bioseparator, novel quantum dots biolabels, and a fluorescent detector. The portable biosensor system is evaluated for the food industry to screen *E. coli* O157, *Salmonella*, and *L. monocytogenes* in poultry, meat and vegetables. The result showed that magnetic immuno-nanobeads could capture target pathogenic bacteria in foods with more than 70% capture efficiency in 15 min, which is advantageous over magnetic immuno-microbeads as well as centrifuge and filtration. Quantum dots nanoparticals were coated with specific aptamers and used as fluorescence labels in the biosensor, which gave more than 100 times fluorescence emission compared to common fluorescent materials used in immunoassays. The fluorescent intensity measured is proportional to the concentration of target bacterial cells in a range of 10 to $10^6$ cfu/ml. A portable and automated instrument, which consists of a nano-bioseparator, a flow-through detection chamber and an optical detector with a laptop, has been designed, fabricated and evaluated for this biosensing technology. The biosensing device is able to provide the required specificity (strain level), sensitivity (10-100 cfu/ml or cfu/g) and time (less than 1 h).

**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.

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**FUNDING:**

USDA/NIFA, ABI, MoST

## Risk Assessment of *Salmonella* and Antibiotics in Poultry Supply Chains in China

YANBIN LI, PROFESSOR, TYSON ENDOWED CHAIR IN BIOSENSING ENGINEERING

**ISSUES:**

Broilers experience high physiological stress during Food safety is becoming an important factor in shaping China's demand in the poultry sector. *Salmonella* is one of foodborne pathogens, which not only can cause serious economic losses to the poultry industry, but also pose a serious threat to human health. In China, approximately 70-80% of foodborne bacterial infections are caused by *Salmonella*. Antibiotics approved for veterinary clinical applications in China are mainly used for the treatment of a variety of mycoplasma infections in poultry. Antibiotics carryover in poultry products not only affect the health of consumers, but also lead to the emergence and spread of bacterial resistance, and ultimately affect human health resources.

**ACTION:**

The project aims to characterize the thermal micro-The objective of this project is to identify food safety challenges, issues, and solutions for poultry supply chains. Foodborne pathogens and antibiotics residues in the poultry supply chain is investigated with in-field testing methods and intervention technologies. Quantitative risk assessment and supply chain management are integrated to provide a powerful way to improve food safety of poultry products. The foodborne pathogens and antibiotic samples in poultry and poultry products are collected to identify food safety problems. A "farm to table" risk assessment strategy are applied to enhance the food safety of poultry products in supply chain management.

**IMPACT:**

The food producers, processors, distributors, and retailors and regulatory agencies in China as well as other countries may apply this novel approach to improve food safety of poultry supply chains. Our society could be benefited from this technology in terms of reducing foodborne pathogens and antibiotics in poultry products. Application of the quantitative risk assessment would enable our poultry products much safer and our global food supply systems more sustainable.

**CONTACTS:**

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**Cooperators**

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**Funding:**

Walmart Foundation

## Trailer Thermal Environment during Commercial Poultry Transport

YI LIANG, ASSOCIATE PROFESSOR, EXTENSION

**ISSUES:**
Commercial broilers loaded on live-haul trucks experience a wider range of environmental conditions than those maintained during the growout period in the production houses. Every year in the U.S., approximately 30 million mature broiler mortalities occur during transport from farms to the slaughtering plants. The acute environmental stresses that cause some chickens to die also contribute to degradation in animal well-being and reduced meat quality for the vast majority of the surviving animals that were concurrently exposed to the stress during transport.

**ACTION:**
The project aims to characterize the thermal micro-environment on commercial live-haul broiler trucks during transport and at holding sheds under different management practices at various seasons. Temperature and relative humidity of the interior of the trailers were monitored over a broad range of outdoor conditions (12 trips total). Data collected during intensive monitoring trips are used to categorize and assess broiler thermal comfort levels spatially (locations on trailer) and temporally (durations), under commonly-employed management practices. For the outdoor temperature range of 5 to 27 C, generally acceptable trailer thermal conditions were observed. Large temperature variation existed across the trailer in transit during the winter trips when ambient temperatures were between 0 and 5 C. Large variation was also found across the trailer during trips monitored when ambient temperatures were in lower 30s C, partially due to the difference of moisture evaporation and wind at different locations on the trailer.

**IMPACT:**
Results from this research will elucidate the prevailing thermal conditions experienced for market broiler transportation and develop an objective measure of broilers' wellbeing under mitigation methods, such as boarding percentage, fan and/or misting while loading in the Southern US.

**CONTACTS:**
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reservoir sediments to reduce the oxygen demand that is

## IMPROVING DRINKING WATER QUALITY AND AVAILABILITY

G. SCOTT OSBORN, ASSOCIATE PROFESSOR

**ISSUE:**

Most of the reservoirs in the U.S. that hold raw water used for 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.

Research being conducted by scientists 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 metal create problems when treating raw water for use as drinking water and can greatly increase the expense for treating the water. 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.

The specific research being conducted uses a new technology developed in the Division of Agriculture 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. A key requirement for implementing this technology is to understand and quantify the rate of oxygen demand exerted by the water body including that from the water itself and also sediment oxygen demand.

Another application of the technology is to use ozone to treat drinking water from impacted reservoirs and help offset the negative impacts of eutrophic waters in a more cost effective manner than the treatment chemicals currently used.

Accomplishments for 2016:

Sediment oxygen demand measured and model validated for Lakes Wedington and Fayetteville in Northwest Arkansas to ease determination of oxygen uptake by sediment. Research presented at Institute of Biological Engineering meeting (won best graduate student poster award). MS Thesis completed for this work.

Ozone disinfection model improved and validated for treating drinking water. Research presented at Institute of Biological Engineering meeting.

Experiments conducted to improve model and operating parameters of ozonation system.

Dissolved air flotation technology being tested to remove suspended organic solids (including algae) from reservoirs prior to intake by drinking water treatment plant on Beaver Lake to determine if potential for formation of disinfection byproducts can be reduced along with cost.

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

## DELTA-FLUX: AN EDDY COVARIANCE NETWORK FOR A CLIMATE-SMART LOWER MISSISIPPI BASIN

BENJAMIN R. K. RUNKLE, ASSISTANT PROFESSOR

**Issue:** The Lower Mississippi River Basin's (LMRB) alluvial plain (known regionally as the Delta) is a highly productive agricultural region characterized by a broad range of cropland, including row crops, pasture, and softwood timber. It also contains swaths of the remaining bottomland hardwoods in the region. Arkansas, Louisiana, and Mississippi together generate $19.5 billion of the United States' $403 billion in agricultural sector output; this production includes 70% of the rice, 40% of the sugarcane, and 19% of the food grains grown in the United States. The LMRB's high level of agricultural productivity, supported by warm, humid conditions and copious water resources, creates an important regional carbon sink through substantial photosynthetic fixation of atmospheric carbon dioxide (CO2) and its subsequent storage as biomass and as soil organic matter, although studies focusing on this region are lacking. The region offers additional opportunities for sequestering carbon into the soil. However, higher soil temperatures and abundant water also facilitate the decomposition of plant residues and the mineralization of soil organic matter through heterotrophic respiration. The balance between soil carbon sequestration and ecosystem respiration therefore requires a significant expansion of observation-based inquiry.

**Action:** Runkle is leading a multi-institute consortium of researchers to measure carbon and water dynamics in this complex region. The group published an overview paper in Agricultural & Environmental Letters arguing for enhanced and networked data collection to improve understanding within the region. The group includes researchers from the University of Arkansas, Monticello, the USDA's Agricultural research Service, the USGS, the University of Louisiana, Monroe, and Indiana University.

**Impact:** The group collectively operates seventeen instrumented field sites including the most characteristic landscapes of the target area: row-crop fields, pasture, grasslands, forests, and marshes. The network participants are committed to open collaboration and efficient regionalization of site-level findings to support sustainable agricultural and forestry management and conservation of natural resources.

In future years the network of observations will set a foundation to regionalize and internationalize the findings to develop optimal agricultural production strategies across a variety of landscape types. These strategies aim to balance both soil carbon sequestration and harvest productivity goals.

The network also offers expanded opportunities for collaboration for members of Runkle's research group, including post-doctoral scientist Kosana Suvočarev and M.S. student Colby Reavis.

Paper reference - **Runkle BRK**, Rigby JR, Reba ML, Anapalli SS, Bhattacharjee J, Krauss KW, Liang L, Locke M, Novick KA, Sui R, **Suvočarev K**, White PM, (2017), Delta-Flux: an eddy covariance network for a climate-smart Lower Mississippi Basin, Agricultural & Environmental Letters, 2:170003. doi:10.2134/ael2017.01.0003.

Support – this work was supported by the University of Arkansas's Center for Agricultural and Rural Sustainability as well as the USGS under Cooperative Agreement G16AP00040 administered by the Arkansas Water Resources Center.

## One-pass Drying of Rough Rice with an Industrial Microwave- Quality and Energy Use Consideration

SAMMY SADAKA, ASSISTANT PROFESSOR , EXTENSION

**ISSUE:**

Convective air-drying method is typically used to dry freshly harvested rough rice to a safe moisture content usually 12% to 13% (wet basis) prior to storage. However, the application of heated air on the rice kernel causes temperature and moisture gradients formation within a kernel, which induces tensile stress at the surface and compressive stress at the interior of the kernel. Stress in rice kernel causes rice fissuring and degradation of mechanical, which ultimately is responsible for the kernel inability to withstanding the processes of hulling and bran removal without breaking. Microwave heating may reduce stresses caused by temperature and moisture gradients within the rice kernel and potentially improve the rice-milling yield because the technology uses volumetric heating method. On commercial drying level, there is a need to investigate the impact of using industrial microwave on rice milling yield, and functional quality indices. The objective for this research was to determine the feasibility of using an industrial-type microwave heating system operated at 915 MHz frequency to achieve one-pass rough rice drying with minimum implications on the rice quality.

**ACTION:**

A 915 MHz industrial microwave dryer (AMTek Microwaves, Cedar Rapids, Iowa) was used for the experiment. The system consists of a transmitter, a waveguide and microwave-heating zone. The system transmitter was a high-powered vacuum tube that worked as a self-excited microwave oscillator that converts high-voltage electric energy to microwave radiation. The system waveguide consisted of a rectangular pipe through which the electromagnetic field propagated lengthwise; it was used to couple the microwave power from the magnetron into the lab oven. The oven was the internal cavity of the microwave unit where the product was placed to provide uniform temperatures throughout and while in use.
development of apps for Galaxy Conference, Rice Expo, and International Master Gardener's Conference.

**IMPACT:**

The findings from this research showed that freshly harvested rough rice could be dried using microwave with minimal reduction in Head Rice yield and Milled Rice Yield. Treatments at 450-600 kJ/kg of rough rice preserved rice quality.

**CONTACT:**

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**COLLABORATORS:**

Griffiths G. Atungulu: Department of Food Science, University of Arkansas Division of Agriculture, Fayetteville, Arkansas, 72703

Stephen Rogers: AMTek Applied Microwaves Technology Inc., 4115 Thomas Dr. S.W. Cedar Rapids, IA, 52404

**Funding Sources:**

This research was supported by the University of Arkansas System Division of Agriculture, Grain Processing Engineering and Rice Processing Program at the University of Arkansas, Food Science Department, and Applied Microwave Technology Inc.

## Fostering Communication and Understanding Within the Manure Management Community

Karl VanDevender, Professor, Extension

**ISSUE:**

"Why do we care?"
The production of animal derived food and products generates manure and mortality byproducts. The management of these byproducts has potentially significant impacts on food production, societal economic wellbeing, human and animal health, as well as environmental quality. Concerns regarding these potential impacts on farmers, neighbors, and consumers has resulted in numerous regulations and policies that livestock producers and those that manage manure and mortality byproducts must adhere too. This in turn presents challenges for regulatory agencies, service organizations, livestock producers, and the general public in understanding and navigating the interactions of the pertinent regulations and policies.

**ACTION:**

"What have we done?"
In keeping with the land grant mission of dispersal of research based information, a series of functional relationships among regulatory agencies, service organizations, livestock producers have been developed and maintained over the years. These relationships serve both as access to information and conduits to the dispersal of knowledge. At times this manifests itself as an independent consultant providing input into the dialog between a regulatory agency, a design engineer, and a livestock producer seeking an acceptable management system and necessary permit to operate. At other times the interactions involve multiple organizations and result in the implementations with state wide impacts.

**IMPACT:**

"What is the payoff?"
The results of these land grant institution facilitated interactions are a more informed manure/mortality management community that has an increased capacity to make and implement beneficial policies and practices. The recipients of these benefits are livestock producers, regulatory agencies, service organizations, neighbors, and consumers of animal based products.

**CONTACT:**

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Cell: 501-944-1016

**COLLABORATING SCIENTISTS**:

Includes Various University of Arkansas Division of Agriculture Departments, The Arkansas Natural Resources Conservation Commission, The National Resource Conservation Service, The Arkansas Department of Environmental Quality, and Various organizations representing livestock producers.

**FUNDING SOURCES:**

Various general base state and federal funds.

## Anaerobic digestion of poultry litter

Jun Zhu, Professor

RESEARCH:

More progresses were made on the digestion of poultry litter using anaerobic digestion, with focus on determining kinetic parameters of the digestion process using batch data, which is a bottleneck because past research in this area has not been successful. The kinetic parameters are determined usually from a continuous operation of digestion, which is more difficult and complex than batch operation in laboratory scale. Our study for the first time has made headways in this subject field by developing a novel method to determine those parameters from data of batch experiments. The potential impact of this research includes the following aspects.

- Developing new digestion technology for poultry producers to alleviate the nutrient issues associated with poultry litter
- Reducing potential pollution to surface and ground water resources as a result of land application of poultry litter
- Educating poultry producers to embrace sustainable production practices in their facilities

TEACHING:

I am the instructor for the course, "Sustainable Biosystems Engineering" (BENG4663), a core course for senior majoring in Biological Engineering. The impact of the course can be seen from students learning the comprehensive concepts and designs of sustainable biosystems, which include the following aspects.

- Grasping a fundamental understanding on contemporary sustainability issues in agricultural production
- Applying analysis techniques such as life cycle analysis to real sustainability scenarios
- Using life cycle assessment knowledge to study and evaluate the rice production process from beginning to end against sustainability indices, which is a major industry in Arkansas agriculture
- Strengthening their competitiveness in job hunting and career development

ADMINISTRATION:

I have 30% administration appointment in the Center for Agricultural and Rural Sustainability (CARS) serving as an Area Director in the organization (with other two area directors). I have been striving for rebuilding CARS and bringing it to a new level. To date, my work has achieved the following impacts.

- Publishing a Year-in-Review brochure documenting CARS achievements in the past years which receives good responses from all concerned parties
- Continuing service to CARS members for their work in agricultural sustainability
- Maintaining the CARS impact on a national sustainable organization, i.e., Field to Market, by our strong involvement in its decision-making process
- Reaching out to stakeholders by CARS members via presentations and better interactions

**CONTACTS:**

Jun Zhu, Professor, Biological and Agricultural Engineering, junzhu@uark.edu, 479-575-2883


**Congratulations to the Class of 2016!**

Undergraduate:

Jason Angel

Jenna Bruick

Andrew Dugan

Scott Gilrein

Shane Harris

Nelson Heringer

Christian Heymsfield

Jacob Hickman

Michael Hoppe

Caleb Jones

Kyle Lawrence

Jeffrey Madden

Angelica Makuch

Paul Nagle

Savanna Royals

Cody Vaughn

# Research Grants

*The following active grants during 2016 fund research in specific areas.*

**Reduced Carbon Footprint for U.S. Swine Production**
*Dr. Thomas Costello (Co-PI)*
USDA/NIFA/AFRI
2016
$35,000

**AWRC Program Administration**
*Dr. Brian Haggard*
USGS
2016
$9860

**AWRC Information Transfer**
*Dr. Brian Haggard*
USGS
2016
$2,599

**Innovative Crop ET Measures**
*Dr. Brian Haggard*
COE ERISF
2016
$9,794

**WFWR Water Quality Sampling**
*Dr. Brian Haggard*
BWA
2016
$12,023

**PVIA Water Quality Sampling**
*Dr. Brian Haggard*
PVIA
2016
$40,000

**AGFC Lake Water Analysis**
*Dr. Brain Haggard*
AGFC
$6,022

**USFS Lake Water Quality Sampling**
*Dr. Brian Haggard*
USFS
$12,093

**Improving Yield and Yield Stability for Irrigated Soybeans**
*Dr. Chris Henry*
Soybean Promotion Board
2016
$60,451

**Improving Irrigation Scheduling and Efficiency in Corn and Grain Sorghum**
*Dr. Chris Henry*
Arkansas Corn and Grain Sorghum Promotion Board
2016
$97,288

**Promoting the use of Multiple Inlet in Arkansas Rice Production**
*Dr. Chris Henry*
Arkansas Rice Promotion Board
2016
$49,096

**Promoting the use of Multiple Inlet in Arkansas Rice Production**
*Dr. Chris Henry*
Arkansas Rice Promotion Board
2016
$88,500

**Calibration and Evaluation of an Advance Sensor for Furrow Irrigation**
Dr. Chris Henry
Cotton Incorporated
2016
$12,500

**Center for Advanced Surface Engineeirng**
*Dr. Jin-Woo Kim*
NSF-OIA
2016
$327,827

**Engineering Nano-building Block Toolboxes for Programmable Self-Assembly of Nanostructures with Arbitrary Shapes and Functions**
*Dr. Jin-Woo Kim*
*NSF*
2016
$116,000

**Development of an Electron Tunneling Based Nanochannel System for DNA Sequencing**
*Dr. Jin-Woo Kim (Co-PI)*
NSF
2016
~$54,000

**Inhibition of Enzymes with Pine Prehudrolysatres**
*Dr. Jin-Woo Kim (PI)*
NSF-EPSCoR
2016
$87,098

**Poultry Excellence in China– Improving Food Safety in Poultry Supply Chain**
*Dr. Yanbin Li*
Walmart Foundation
$68,750

**Bio-nanogate based Aptasensor for Rapid Detection of Avian Influenza Viruses**
*Dr. Yanbin Li*
ABI
2016
$25,000

**Nano-biosensors for Food Safety**
*Dr. Yanbin Li*
Ocean Nanotech LLC
2016
$3,000

**Characterizing Thermal micro-Environment during Poultry Transportation**
*Dr. Yi Liang*
U.S. Poultry & Egg Association
2015-2016
$59,000

**Evaluating Housing Environment and Energy Saving through Waste Heat Recovery in Poultry Barns**
*Dr. Yi Liang*
NRCS CIG sub-award from University of Missouri
2016
$18,350

**Developing a design language for Ecosystem Services**
*Dr. Marty Matlock*
USEPA
2016
$20,000

**Facilitation of USRSB Metrics Development**
*Dr. Marty Matlock*
USRSB
2016
$75,000

**Development of a Life Cycle Inventory for US Corn**
*Dr. Marty Matlock*
NCGA
2016
$50,000

**Development of a Life Cycle Inventory for US Beef**
*Dr. Marty Matlock*
Resilience Inc.
2016
$160,000

**Measuring and Reducing Poultry Greenhouse Gas Footprint in the US**
*Dr. Marty Matlock (Co-PI)*
USPEF
2016
$35,000

**Metrics for Sustainable Ag in HI**
*Dr. Marty Matlock*
HI Dept. of Agriculture
2016
$70,000

**Development of a Food Hub Master Plan for Sustainable Ag in HI**
*Dr. Marty Matlock*
Hi Dept. of Agriculture
2016
$160,000

**Integrated Assessment of Monarch Butterfly Habitat Loss**
*Dr. Marty Matlock*
BASF
2016
$0

**Development of a Life Cycle Inventory for Agriculture**
*Dr. Marty Matlock*
USDA
2016
$50,000

**Greenhouse Gas Management for Great Lakes Dairy Industry**
*Dr. Marty Matlock (Co-PI)*
USDA-AFRI
2016
$200,000

# Research Grants

**REU Sites: Ecosystem Services**
*Dr. Marty Matlock (Co-PI)*
NSF
2016
$81,000

**Measuring and Reducing Swine Greenhouse Gas Footprint in the US**
*Dr. Marty Matlock (Co-PI)*
ISDA-NIFA
2016
$75,000

**A Retrospective Analysis of US Poultry Production**
*Dr. Marty Matlock (Co-PI)*
USPEF
2016
$60,500

**Innovative crop evapotransp. measurements for sustainable water use**
*Dr. Benjamin Runkle*
UA COE ERISF
22016
$23,622

***Water efficient irrigation strategies in Arkansas rice production***
*Dr. Benjamin Runkle*
USDA-NRCS
2016
$75,000

**Prevention of mycotoxin development and quality degradation in rice during on-farm, in-bin drying and storage**
*Dr. Sammy Sadaka (Co-PI)*
Corn and Grain Sorghum Promotion Board
2016
$3,000

**Development of effective strategies for simultaneous drying and decontamination of corn to maintain quality and prevent mycotoxin development**
*Dr. Sammy Sadaka (Co-PI)*
Rice Promotion Board
2016
$3,000

**Improving germination rate of soybean seed dried using recently-introduced in-bin drying systems**
*Dr. Sammy Sadaka (Co-PI)*
Soybean Promotion Board
2016
$1,680

**Development of On-line Instructional Program for Nutrient Management Training Required by ANRC Titles XX, XXI and XXII**
*Dr. Karl VanDevender (Co-PI)*
ANRC
2016
$184,198

**UA Sustainable Nutrient Management**
*Dr. Karl VanDevender*
*CES Subcontract of UA AES grant from NRCS*
2016
$18,333

## *Books, Book Chapters*

Wang, R., and **Y. Li**. 2016. Chapter 4. Biosensors for Rapid Detection of Avian Influenza Viruses. P. 61-84, In: Steps Forwards in Diagnosing and Controlling Influenza, M. Baddour (ed). InTech, Rijeka, Croatia. ISBN 978-953-51-2733-8.

Rodriguez Lopez M, **Runkle BRK,** Roski S, Stover J, Gottschick M, Jantke K, Rolfe D: Sustainable Internationalization? Measuring the Diversity of Internationalization at Higher Education Institutions, (2016) ed., W. Leal Filho & M Zint, The Contribution of Social Sciences to Sustainable Development at Universities, World Sustainability Series, Springer International Publishing, Switzerland, pp 21-37, (http://link.springer.com/chapter/10.1007%2F978-3-319-26866-8_2).

## *Peer-Reviewed Journal Articles*

Liang, Y., R. Bautista, and **T. A. Costello**. 2016. "Validating a multi-port, averaging pitot tube for measuring fan airflow rates". Applied Engr. in Agric. 32(4): 409-415.

**Callaway, Z**., Y. Wang, B. Zhang, T. Zhang, **T. A. Costello**, M. F. Slavik and Y. Li. 2016. "A portable impedance biosensing system for rapid detection of avian influenza virus". Trans. of ASABE 59(2):421-428.

**Sharara, M. A**., S. S. Sadaka, **T. A. Costello**, K. W. VanDevender, D. J. Carrier, M. Popp, G. Thoma and A. Djioleu. 2016. "Combustion kinetics of swine manure and algal solids." J. Thermal Analysis Calorimetry 123(1):687-696.

Johnson, T., L. Edgar, **B. Haggard**, and K. Rucker. 2015. Student perceptions of the [state] water resources center, water resources and water issues. Natural Sciences Education 44:136-142. [Not Included with Volume and Page Number in 2015 FSR]

McCarty, J.A., **B.E. Haggard**, M.D. Matlock, N. Pai, and D. Saraswat. 2016. Post-model validation of a deterministic water model using measured data. Transactions ASABE 59(2):497-508.

McCarty, J.A., and **B.E. Haggard**. 2016. Can we manage nonpoint source pollution using nutrient concentrations during seasonal baseflow? Agricultural and Environmental Letters 1:160015

Reavis, M.A. and **B.E. Haggard**. 2016. Are floodplain soils a potential phosphorus source when inundated that can be effectively managed? Agricultural and Environmental Letters 1:160036

**Henry, C G.**, Hirsh, S. L., Anders, M. M., Vories, E. D., Reba, M. L., Watkins, K.B., and Hardke, J. T. 2016. Annual Irrigation Water Use for Arkansas Rice Production. *J. Irrig. Drain Eng*., 10.1061/(ASCE)IR.1943-4774.0001068 , 05016006.

**Henry, C. G.,** G.S. Sartori. L. Espinoza, P. Francis, J. Gaspar, A. P. Horton, S. M. Hirsh. 2016. Deep Tillage and Gypsum Amendment on Fully, Deficit Irrigated and Dryland Soybeans. Accepted for publication in the Agronomy Journal.

Durso, L. M., D. N. Miller, D. D. Snow, **C.G. Henry,** M. Santin-Duran and B. L. Woodbury. 2016. Evaluation of fecal indicators and pathogens in a beef cattle feedlot vegetative treatment system. Accepted for publication in the Journal of Environmental Quality as a Technical Report. *J. Environ. Qual.* doi:10.2134/jeq2016.05.0192

Kotagiri, K., Sakon, J., Han, H., Zharov, V.P. & **Kim, J.-W.** Fluorescent ampicillin analogues as multifunctional disguising agents against opsonization. *Nanoscale* **8**, 12658-12667 (2016). DOI: 10.1039/C5NR08686H. ***Invited*** *paper for a special issue: Nanoscale approaches for cancer diagnosis and treatment [JIF: 7.394]*

Lim, K.-T., Seonwoo, H., Choi, K.S., Jin, H., Jang, K.-J., Kim, J., **Kim, J.-W.**, Kim, S.Y., Choung, P.-H. & Chung, J.H. Pulsed-electromagnetic-field-assisted reduced graphene oxide substrates for multidifferentiation of human mesenchymal stem cells. *Adv. Healthcare Mater.* **5**, 2069-2079 (2016). DOI: 10.1002/adhm.201600429. – This article was **featured as** a **"Back Cover"** of the journal issue. *[JIF: 5.76]*

Seonwoo, H., Bae, W.-G., Park, S., Kim, H.-N., Choi, K.S., Lim, K.-T., **Kim, J.-W.**, Kim, J. & Chung, J.H. Hierarchically micro- and nanopatterned topographical cues for modulation of cellular structure and function. *IEEE Transactions on NanoBioscience* (2016). DOI: 10.1109/TNB.2016.2631641. *[JIF: 1.969]*

Lim, K.-T., Jin, H., Seonwoo, H., Kim, J., **Kim, J.-W.**, Renji, C., Choung, P.-H. & Chung, J.H. Physical stimulation-based osteogenesis: effect on secretion *in vitro* by fluid dynamic shear stress of human alveolar bone-derived mesenchymal stem cells. *IEEE Transactions on NanoBioscience* (2016). DOI: 10.1109/TNB.2016.2627053. *[JIF: 1.969]*

Lee, S., Kang, H., Do, Y., Lee, G., **Kim, J.-W.** & Han, H. High-precision THz dielectric spectroscopy of Tris-HCl buffer. *J. Opt. Soc. Korea* 20, 431-434 (2016). *[JIF: 0.827]*

Guo, J., Z.M. Li, K. Huang, **Y. Li,** and J.P. Wang. 2016. Morphological analysis of *Escherichia coli* treated with non-thermal plasma. Journal of Applied Microbiology (in press; available online October 28, 2016). doi:10.1111/jam.13335

Hu, Q.Q., Y.C. Fu, X.H. Xu, Z.H. Qiao, R.H. Wang, Y. Zhang, and **Y. Li**. 2016. A colorimetric detection of acrylamide in potato chips based on nucleophile-initiated thiolene Michael addition. Analyst 141:1136-1143. doi:10.1039/c5an01989c

Karash, S., R. Wang, L. Kelso, H. Lu, T. Huang, and **Y. Li**. 2016. Rapid detection of avian influenza virus H5N1 in chicken tracheal samples using an impedance aptasensor with gold nanoparticles for signal amplification. Journal of Virological Methods 236:147-156.

Lei, C.Y., H. Dai, Y.C. Fu, Y.B. Ying, and **Y. Li**. 2016. Colorimetric sensor array for thiols discrimination based on urease-metal ion pairs. Analytical Chemistry 88(17):8542-8547. doi:10.1021/acs.analchem.6b01493

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Analytical Methods 8:8079-8083. doi:10.1039/C6AY02371A
Li, Z.M., Z.Z. Ye, Y.C. Fu, Y.H. Xiong and **Y. Li**. 2016. A portable electrochemical immunosensor for rapid detection of trace aflatoxin $B_1$ in rice. Analytical Methods 8:548-553. doi:10.1039/C5AY02643A
Ning, F.J., T.T. Qiu, Q. Wang, H.L. Peng, **Y. Li**, X.Q. Wu, Z. Zhang, L.X. Chen, and H. Xiong. 2017. Dummy-surface molecularly imprinted polymers on magnetic graphene oxide for rapid and selective quantification of acrylamide in heat-processed (including fried) foods. Food Chemistry 221:1797-1804. doi.org/10.1016/j.foodchem.2016.10.101
Wang, L.J., R. Wang, F. Chen, T.S. Jiang, H. Wang, M.F. Slavik, H. Wei, and **Y. Li**. 2017. QCM-based aptamer selection and detection of *Salmonella* Typhimurium. Food Chemistry 221:776-782. dx.doi.org/10.1016/j.foodchem.2016.11.104
Wang, R.H., L.J. Wang, Z. Callaway, H.G. Lu, T.J. Huang, and **Y. Li**. 2017. A nanowell-based QCM aptasensor for rapid and sensitive detection of avian influenza virus. Sensors an Actuators B: Chemical 240:934-940. doi.org/10.1016/j.snb.2016.09.067
Xu, L.Z., R.H. Wang, L. Kelso, Y.B. Ying, and **Y. Li**. 2016. A target-responsive and size-dependent hydrogel aptasensor embedded with QD fluorescent labels for rapid detection of avian influenza virus H5N1. Sensors and Actuators B: Chemical 234:98-108.
Xu, L.Z., Z. Lu, L.L. Cao, H.Y. Pang, Q. Zhang, Y.C. Fu, Y.H. Xiong, Y.Y. Li, X.Y. Wang, J.P. Wang, Y.B. Ying, and **Y. Li**. 2016. In-field detection of multiple foodborne pathogens in food products using a portable fluorescent biosensing system. Food Control (in press, available online December 18, 2016). dx.doi.org/10.1016/j.foodcont.2016.12.018
Xu, M., R.H. Wang, and **Y Li**. 2016. Rapid detection of *Escherichia coli* O157:H7 and *Salmonella* Typhimurium in foods using an electrochemical immunosensor based on screen-printed interdigitated microelectrode and immunomagnetic separation. Talanta 148:200-208. doi:10.1016/j.talanta.2015.10.082
Xu, M., R. Wang, and **Y. Li**. 2016. An electrochemical biosensor for rapid detection of *E. coli* O157:H7 with highly efficient bi-functional glucose oxidase-polydopamine nanocomposites and Prussian blue modified screen-printed interdigitated electrode. Analyst 141:5441-5449. doi:10.1039/C6AN00873A
Xu, M., R. Wang, and **Y. Li**. 2017. Electrochemical biosensors for rapid detection of *E. coli* O157:H7- A review. Talanta 162:511-522.
Zhang, B.H., R.H. Wang, Y.X. Wang, and **Y. Li**. 2016. LabVIEW -based impedance biosensing system for detection of avian influenza virus. International Journal of Agricultural and Biological Engineering 9(4)116-122.
Fanatico, A.C., J.A. Mench, G.S. Archer, **Y. Liang**, V. B. Brewer, Owens, C.M., and A. M. Donoghue. 2016. Effect of artificial agroforestry structures for range enrichment on the performance and behavior of free-range meat chickens. Poultry Science. Accepted.
Rajaei-Sharifabadi, H.; Greene, E.; Piekarski, A.; Lassiter, K.; Cook, D.; Falcon, D.; Nguyen, P.; Gramlich, W.; Vizzier-Thaxton, Y.; **Liang, Y.**; Ellestad, L.; Porter, T.; Donoghue, A.; Bottje, W.; Dridi, S. 2016. Noni modulates the hypothalamic expression of stress- and metabolic-related genes in broilers exposed to acute heat stress; Poultry Science. Submitted.
Rajaei-Sharifabadi, H.; Greene, E.; Piekarski, A.; Falcon, D.; Nguyen, P.; Ellestad, L.; Donoghue, A.; Bottje, W.; Porter, T. E.; **Liang, Y.;** Dridi, S. 2016. Surface Wetting Strategy Prevents Acute Heat Exposure-Induced Alterations of Hypothalamic Stress- and Metabolic-Related Genes in Broiler Chickens, Journal of Animal Science. Submitted.
Sandefur, H.N., Asgharpour, M., Mariott, J., Gottberg, E., Vaden, J., **Matlock, M.** and Hestekin, J., 2016. Recovery of nutrients from swine wastewater using ultrafiltration: Applications for microalgae cultivation in photobioreactors. Ecological Engineering, 94, pp.75-81.
Atungulu, G. G., Zhong, H., **Osborn, G.S.,** Siebenmorgen, T. J., Mauromoustakos, A. 2016. Simulation and validation of on-farm in-bin drying and storage of rough rice. *Applied Engineering in Agriculture*. In Press 32 (6):881-897.
Richardson, G.A., **Osborn, G.S**. 2016. Can Resuspension and Oxygenation of Lake Sediment Decrease SOD? *Trans. ASABE,* Submitted for review 7/18/16.
Olatunde, G., G. Atungulu and **S. Sadaka**. 2016. CFD Modeling of Airflow Distribution in Rice Bin Storage System with Different Grain Mass Configurations. Biosystems Engineering Journal. Vol. 151: 286-297. [Impact Factor: 2.063].
**Sadaka, S.,** G. Ubhi and G. Atungulu. 2016. Effects of Initial Moisture Content and Heating Rate on Wheat (OAKES) Drying Kinetic Parameters. International Journal of Engineering Sciences and Research Technology. Vol. 5(9): 42-54. [Impact Factor: 4.116].
Okeyo, A., G. Olatunde, G. Atungulu, **S. Sadaka** and T. McKay. 2016. Infrared Drying Characteristics of Long-grain Hybrid, Long-grain Pureline, and Medium-grain Rice Cultivars. Journal for Cereal Chemistry. Available online: http://aaccipublications.aaccnet.org/doi/abs/10.1094/CCHEM-07-16-0181-R. [Impact Factor: 1.260].
Atungulu, G., G. Olatunde, D. Smith, **S. Sadaka**, and S. Rogers. 2016. Optimization of Process Parameters in Rough Rice Drying Using Industrial Microwave. . B.R. Wells Arkansas Rice Research Studies 2015. PP: 353-361. http://arkansasagnews.uark.edu/634.pdf
Atungulu, G., Z. Young, S. Thote, H. Zhong, and **S. Sadaka**. 2016. Improving Germination Rate of Soybean Seed Dried Using Recently Introduced In-Bin Drying Systems. Arkansas Soybean Research Studies 2014. 184-188. http://arkansasagnews.uark.edu/631.pdf
Atungulu, G., D. Smith, S. Wilkson, H. Zhong, **S. Sadaka** and S. Rogers. 2016. Assessment of One-Pass Drying of Rough Rice with an Industrial Microwave System on Milling Quality. Applied Engineering in Agriculture. Vol. 32(3): 417-429. [Impact Factor: 0.717].
**B. Sullivan**, C. Vance, T. Gentry, and R. Karthikeyan. Effects of chlorination and ultraviolet light on environmental tetracycline-resistant bacteria and tet(W) in water. Journal of Environmental Chemical Engineering

Shen, J. and **J. Zhu**. 2016. Kinetics of batch anaerobic co-digestion of poultry litter and wheat straw including a novel strategy of estimation of endogenous decay and yield coefficients using numerical integration. *Bioprocess and Biosystems Engineering* Accepted. DOI 10.1007/s00449-016-1630-9.

Ye, J., Z. Song, L. Wang, and **J. Zhu**. 2016. Metagenomic analysis of microbiota structure evolution in phytoremediation of a swine lagoon wastewater. *Bioresource Technology* 219: 439-444.

Shen, J. and **J. Zhu**. 2016. Optimization of methane production in anaerobic co-digestion of poultry litter and wheat straw at different percentages of total solid and volatile solid using a developed response surface model. *J. Environ. Sci. Health Part A* 51(4): 325-334. DOI: 10.1080/10934529.2015.1109395.

Lin, H, X. Wu, **J. Zhu**. 2016. Kinetics, equilibrium and thermodynamics of ammonium sorption from swine manure by natural chabazite. *Separation Science and Technology* 51(2): 202-213.

Lin, H, X. Wu, C. Nelson, C. Miller, **J. Zhu**. 2016. Electricity generation and nutrients removal from high strength liquid manure by air-cathode microbial fuel cells. *J. Environ. Sci. Health Part A* 51(3): 240-250.

Gaspar, J. **C. G. Hen**ry, P. B. Francis, L. Espinoza, M.

## *Other Peer-Reviewed Publications*

Ismanov, S. Hirsh, A. Horton and H. James. 2016. The Effects of Deep Tillage and Gypsum Amendment, Across a Range of Irrigation Deficit for Furrow Irrigated Soybeans in Three Different Arkansas Soil Types. Arkansas Soybean Research Studies 2014. Research Series 631. University of Arkansas, Division of Agriculture, Arkansas Agricultural Experiment Station. May 2016. pp 150-155.

**Henry, C. G.** W. M. McDougall, and M. L. Reba. 2016. A Study of Arkansas Irrigation Pumping Plant Efficiency. Arkansas Soybean Research Studies 2014. Research Series 631. University of Arkansas, Division of Agriculture, Arkansas Agricultural Experiment Station. May 2016. pp 156-158.

**Henry, C.,** C. Declerk, R. Wimberly, M. Daniels, A. Sharpley, C. Hallmark, and J. Hesselbein. 2016. Arkansas Discovery Farms: Improving Irrigation Efficiencies in Soybean with Pipe Planner Design and a Surge Valve. Arkansas Soybean Research Studies 2014. Research Series 631. University of Arkansas, Division of Agriculture, Arkansas Agricultural Experiment Station. May 2016. pp 172-175

Batta-Mpouma, J., Sakhel, G., Sinha, A., Han, H., Zharov, V.P. & and **Kim, J.-W.** 2016. "Inertial Force-Driven Synthesis of Near-Infrared Plasmonic Nanosphere Composites," in *Proceedings of IEEE International Conference on Nanotechnology (IEEE-NANO)*, August 22-25, Sendai, Japan.

Callaway, Z., R. Wang, and **Y. Li**. 2016. Modeling of the binding kinetics of bacteria with magnetic nanoparticles in bioreaction and magnetic separation processes. ASABE Paper No. 162459905, the ASABE 2016 Annual International Meeting, July 17-20, 2016, Orlando, FL. doi: 10.13031/aim.20162459905

Zhao, Z., L.Z. Xu, Q.Q. Hu, R. Wang, H. Wang, and **Y. Li**. 2016. A portable and automatic biosensing instrument for simultaneous detection of multiple pathogens using nanobead-based magnetic separation and quantum dot-based fluorescent measurement. ASABE Paper No. 162461406, the ASABE 2016 Annual International Meeting, July 17-20, 2016, Orlando, FL. doi:10.13031/aim.20162461406. *ASABE-AOC Graduate Research Paper Award, 2nd Place.*

## *Non-Refereed Publications and Articles*

Scott, E.E., Z.P. Simpson, and **B.E. Haggard**. 2016. Constituent loads and trends in the Upper Illinois River Watershed and Upper White River Basin. AWRC Technical Report MSC 377, 89 pp.

Cummings, E., E.E. Scott, M. Matlock and **B.E. Haggard**. 2016. Dissolved oxygen monitoring in Kings River and Leatherwood Creek. AWRC Technical Report MSC 378, 23 pp.

Scott, J.T., **B.E. Haggard**, Z. Simpson, and M. Rich. 2016. Beaver Lake numeric cholorophyll-a and Secchi transparency standards, Phases II and III: Uncertainty analysis and trends analysis. AWRC Technical Report MSC 380, 21 pp.

**Haggard, B.E.,** J.T. Scott, and M.A. Evans-White. 2016. Database analysis to support nutrient criteria development (Phase I). AWRC Technical Report MSC 381, 183 pp.

**Haggard, B.E.**, J.T. Scott, M.A. Evans-White, L.B. Massey and E. M. Grantz. 2016. Database analysis to support nutrient criteria development (Phase II). AWRC Technical Report MSC 382, 368 pp.

Scott, J.T., **B.E. Haggard** and E.M. Grantz. 2016. Database analysis to support nutrient criteria development (Phase III). AWRC Technical Report MSC 383, 445 pp.

**Haggard, B.E.**, Joint Study Committee, 2016. Final report to the Governors from the Joint Study Committee and Scientific Professionals: Summary, technical summary and recommendations.

Kandpal, V. and **C.G. Henry.** 2016. A Review of Improving Efficiencies in Furrow Irrigation. Presented at the 2016 ASABE Annual International Meeting, Orlando, Florida, July 17-20. Paper Number 2462974. ASABE St. Joseph, MI.

**Henry, C. G.,** K. B. Watkins, R. U. Mane and G. L. Stark. 2016. Vertical Hollow Shaft Motors for Irrigation: Does Premium Efficiency Payback? Presented at the 2016 ASABE Annual International Meeting, Orlando, Florida, July 17-20. Paper Number 2459984. ASABE St. Joseph, MI.

Smith, D. G. Atungulu, G. Olatunde, **S. Sadaka** and S. Rogers. 2016. Characterization of Temperature, Moisture Content and Quality Profiles of Rice dried Using Microwaves for Multiple Bed Thicknesses. ASABE Annual International Meeting, Orlando, Florida July 17-20, 2016. Paper No. 2461803.

Olatunde, G., G. Atungulu and **S. Sadaka**. 2016. CFD modeling of airflow distribution in rice bin storage system with different grain mass configurations. ASABE Annual International Meeting, Orlando, Florida July 17-20, 2016. Paper No. 2459964.
Olatunde, G., G. Atungulu, D. Smith, **S. Sadaka** and S. Rogers. 2016. One-pass Drying of Rough Rice with an Industrial Microwave- Quality and Energy Use Consideration. ASABE Annual International Meeting, Orlando, Florida July 17-20, 2016. Paper No. 2460409.

## *Published Abstracts of Conference Presentations*

Kandhola, G., Rajan, K., Carrier, D.J., & **Kim, J.-W.** 2016. Fungal -Organosolv Delignification of *Pinus taeda* Softwood for Enhanced Enzymatic Hydrolysis and Lignin Extraction. 2016 ASABE Annual International Meeting, July 17-20, Orlando, FL.
Fu, Y.C., Z.Y. Liu, Q.J. Xie, S.Z. Yao, **Y. Li**, Y.B. Ying. 2016. Bio-inspired protein-polymer composite adhesive as ultra-highly efficient immobilization matrix for electrochemical biosensing. Presented at Biosensors 2016, May 25-27, 2016, Gothenburg, Sweden. Paper No. P3.132.
Lei, C.Y., Z.H. Qiao, Y.C. Fu, and **Y. Li**. 2016. A colorimetric assay of lipopolysaccharides based on unmodified gold nanoparticles and lipopolysaccharides-binding peptide. Presented at Biosensors 2016, May 25-27, 2016, Gothenburg, Sweden. Paper No. P2.154.
Qiao, Z.H., C.Y. Lei, Y.C. Fu, and **Y. Li**. 2016. An immunomagnetic optical sensor for the detection of *E. coli* O157:H7 based on silver nanoparticles-urease signal amplification. Presented at Biosensors 2016, May 25-27, 2016, Gothenburg, Sweden. Paper No. P1.095.
Wang, R., L.J. Wang, L.Z. Xu, and **Y. Li**. 2016. Development of a QCM based SELEX for DNA aptamer selection. Presented at Biosensors 2016, May 25-27, 2016, Gothenburg, Sweden. Paper No. P1.212.
Xu, L.Z., R. Wang, L.C. Kelso, and **Y. Li**. 2016. Exploring size-dependent properties of a target-responsive hydrogel aptasensor embedded with QDs for rapid fluorescent detection of viruses. Presented at Biosensors 2016, May 25-27, 2016, Gothenburg, Sweden. Paper No. P1.189.
Aldridge, D. J., K. D. Christensen, S. E. Watkins, Y. Vizzier-Thaxton and **Y. Liang**. 2016. Characterizing the broiler transport thermal environment. Abstract in 2016 International Poultry Scientific Forum, January 2016, Atlanta, GA, Poultry Science Society
Smith, D. G. Atungulu, G. Olatunde**, S. Sadaka** and S. Rogers. 2016. Characterization of Temperature, Moisture Content and Quality Profiles of Rice dried Using Microwaves for Multiple Bed Thicknesses. ASABE Annual International Meeting, Orlando, Florida July 17-20, 2016. Paper No. 2461803. http://elibrary.asabe.org/newresults.asp
Olatunde, G., G. Atungulu and **S. Sadaka.** 2016. CFD modeling of airflow distribution in rice bin storage system with different grain mass configurations. ASABE Annual International Meeting, Orlando, Florida July 17-20, 2016. Paper No. 2459964. http://elibrary.asabe.org/newresults.asp
Olatunde, G., G. Atungulu, D. Smith, **S. Sadaka** and S. Rogers. 2016. One-pass Drying of Rough Rice with an Industrial Microwave- Quality and Energy Use Consideration. ASABE Annual International Meeting, Orlando, Florida July 17-20, 2016. Paper No. 2460409. http://elibrary.asabe.org/newresults.asp

## *Extension Publications and Literature*

**Haggard, B.E.** AWRC Monthly Water Newsletter – Arkansas Water Currents https://watercurrents.uark.edu/
**Haggard, B.E.** AWRC Annual Summary AS-2015 http://arkansas-water-center.uark.edu/publications/annualsummary.php
**Haggard, B.E.** AWRC Annual Technical Report MSC.102.2015 http://arkansas-water-center.uark.edu/publications/annualreports104b.php
**Haggard, B.E.** AWRC Data Reports (numerous data reports published see web link) http://arkansas-water-center.uark.edu/publications/water-data-reports.php
Austin, B.J., J.T. Scott, M. Daniels, and **B.E. Haggard**. 2016. Water quality reporting limits, method detection limits, and censored values: What does it all mean? AWRC Fact Sheet FS-2016-01
Austin, B.J., A. Sinha, N. Stone, W.R. Green, M. Daniels, and **B.E. Haggard**. 2016. How to collect your water sample and interpret the results for the fish pond analytical package. AWRC Fact Sheet FS-2016-02
**Liang, Y.** and T.A. Costello. 2016. Saving Energy with Ventilation Heat Recovery in Poultry Barns. University of Arkansas Division of Agriculture, CES Factsheet, FSA1077
Sadaka, S., **Osborn, G.S.** 2016. Preparing for Grain Drying and Storage Season. UA Division of Agriculture Extension Publication. FSA1059.
**Sadaka, S**. and G. Atungulu. 2016. An Overview of On-Farm Natural Air-Drying of Grain. FSA 1062. https://uaex.edu/publications/pdf/FSA-1060.pdf
**Sadaka, S.** and W. McGraw. 2016. Tractor Safety-Tips for Arkansas Producers. FSA1026. https://uaex.edu/publications/pdf/FSA-1026.pdf
**Sadaka, S.,** G. Atungulu and G. Olatunde. 2016. Safe Grain Storage Period. FSA1058. https://uaex.edu/publications/pdf/FSA1058.pdf
**Sadaka, S.** and M. Sharara. 2016. Carbon Footprint- Tips for Arkansas Producers. 2016. FSA1057. https://uaex.edu/publications/pdf/FSA-1057.pdf
**Sadaka, S.** and W. McGraw. 2016. Safe Operation of On-Farm Augers. FSA1079. https://uaex.edu/publications/pdf/FSA-1079.pdf
Sadaka, S., G. Atungulu and G. Olatunde. 2016. Understanding Grain Shrinkage and Expansion. FSA1078. https://uaex.edu/publications/pdf/FSA-1078.pdf
**VanDevender, Karl** Dairy Farm Added to the Arkansas

Discovery Farms Program Dairy E-News, July. http://uaex.edu/farm-ranch/animals-forages/dairy-cattle/DairyJuly16.pdf
**VanDevender, Karl** Cattle Traffic Areas: Thinking and Planning Ahead for Wet Weather, Dairy E-News, December. http://uaex.edu/farm-ranch/animals-forages/dairy-cattle/DairyDec16%20rev.pdf

## *Professional Presentations*

### Invited presentations

**Haggard, B**. 2016. Bacteria Monitoring in Arkansas. Joint House and Senate Committee on Agriculture, Forestry and Economic Development, Arkansas Legislature, Little Rock, Arkansas.
**Haggard, B.** and R. Benefield. 2016. EPA Region 6 Illinois River TMDL Model & the Arkansas-Oklahoma Joint Stressor Response Study. Environmental Issues Committee, Arkansas Farm Bureau, Little Rock, Arkansas.
**Haggard, B.** & R. Krop. 2016. Anatomy of Successful Watershed Protection. Northwest Arkansas Forests and Drinking Water Regional Partnership Workshop, Fayetteville, Arkansas.
**Haggard, B.** 2016. Water Quality Trends and Numeric Criteria at Beaver Lake. Beaver Lake Watershed Symposium, Beaver Watershed Alliance, Lowell, Arkansas.
**Haggard, B.** 2016. Illinois River TMDL – what's happened, and where we are going? Agricultural Nutrient Policy Council, Annual Board Meeting, Bentonville, Arkansas.
**Henry, Chris**, Keynote speaker for the 2nd Annual Delta States Irrigation Conference. Memphis, TN, January 12, 2016.
**Henry Chris**, Invited speaker to the University Council on Water Resources Conference, June 21-23, 2016. Pensacola Beach, Florida. Presentation Title: Irrigation Water Management from the Pump to the Tail Ditch.
**Kim, J.-W.** 2016. Engineering Programmable Nanoscale Building Blocks for Advanced Nanotheranostics. IEEE International Conference on Nano/Molecular Medicine and Engineering (IEEE-NANOMED), October 30-November 2, Macau, China ("Plenary Talk").
**Kim, J.-W.** 2016. Building Blocks of Bio/Nano Technology for Advanced Materials and Devices. August 26, Chonnam National University, Gwangju, Korea ("Invited Lecture")
**Li, Y.** 2016. Biosensing technologies for smart agriculture. An invited presentation for ICSaid 2016, Beijing, China, October 27-29, 2016.
**Li, Y.** 2016. Research and applications of biosensing technology in agriculture and food. An invited presentation for Symposium of Agricultural Mechanization at Shenyang Agricultural University, Shenyang, China, June 15, 2016.
**Liang**, Y. 2016. Thermal micro-environment during poultry transportation. Animal Care and Handling Conference organized by North American Meat Institute. Kansas City, MO. October 13, 2016. Invited Talk.
**Osborn, G.S.,** C. Brewer. Arkansas Commercialization Retreat. WinRock Conference Center, Petit Jean, AR. June 26, 2016. (invited)
**Osborn, G. S.** BlueInGreen: A Case Study in Faculty Entrepreneurship. Science Seminar Series. Northeastern State University, Tahlequah, OK, 10/19/16. (invited).
**Osborn, G.S.**, Presented seminar to BAEG Faculty and Graduate Students for Research Colloquium, Entrepreneurship.
**Osborn, G.S.,** Presented overview of BlueInGreen as panel member to Business Leaders of Arkansas program (invited).
**Osborn, G.S.,** Presented aquaponics design system in lab to Arkansas Green Builders Association meeting (invited).
**Matlock, Marty,** January 26, 2016 International Poultry Exposition, Atlanta, GA Sustainability Frameworks for Poultry: The role of Life Cycle Assessment – Moderator/ Keynote Speaker
**Matlock, Marty,** February 29, 2016 US Roundtable for Sustainable Beef Indicator Working Group, Austin, TX, Water Quality and Quantity Indicators for Sustainable Beef - Keynote Speaker
**Matlock, Marty,** March 3, 2016 Commodity Classic, New Orleans, LA, Receive the USB Freedom to Operate Award
**Matlock, Marty,** March 12-19, 2016 US State Department Agricultural Science Speaker Series, Paris and Toulouse, France. Delivered nine keynote presentations to government, civil society, academic, and agricultural groups.
**Matlock, Marty,** April 4, 2016 National Institute of Animal Agriculture Annual Meeting, Kansas City, MO. Aquaculture Sustainability Indicators and Metrics for US Production - Keynote Speaker
**Matlock, Marty,** April 15, 2016 World Wildlife Fund Program Meeting, Boston MA. The Role of Big Data in Agricultural Sustainability Invited
**Matlock, Marty,** May 25, 2016 US Poultry and Egg Federation Environmental Program Meeting, Atlanta, GA. The Science of Sustainability: Frameworks for Continuous Improvement - Invited
**Matlock, Marty,** June 1, 2016 US Roundtable for Sustainable Beef, Kansas City, MO. Priority Indicators for Sustainable Beef - Invited
**Matlock, Marty,** June 19-26, 2016, U.S. – China Sustainable Soybean Trade Summit, Beijing and Shanghai, China. The Soybean Sustainability Assurance Protocol and US Agriculture - Keynote Speaker
**Matlock, Marty,** July 12, 2016 US Roundtable for Sustainable Beef General Assembly, Denver, CO. The Top Six Priority Indicators for US Sustainable Beef - Keynote Speaker
**Matlock, Marty,** July 19, 2016 American Society of Agricultural and Biological Engineers International Meeting Final Review of ANSI 629: Framework for Continuous Improvement in Sustainable Agriculture, and Common Sustainability Metrics across US Agriculture Sectors – Session Moderator, Keynote
**Matlock, Marty,** August 23, 2016 US Roundtable for Sustainable Beef Indicator Working Group Meeting, Chicago, IL Reconciling Metrics Across the US Beef Supply Chain - Facilitator
**Matlock, Marty,** August 29, 2016 Agribeef World Headquarters, Boise, ID The Business Case for Sustainability: A Corporate Framework for Continuous Improvement - Keynote Speaker

# PUBLICATIONS

**Matlock, Marty,** September 1, 2016 The USDA Committee for Agriculture for the 21st Century, Washington, DC. Final Review and Draft of A National Policy Strategy for Agricultural Producer Co-Existence - Inivited

**Matlock, Marty,** October 5, 2016 Global Roundtable for Sustainable Beef, Banff, CA. The Science of Sustainability: LCA and Indicators- Facilitator

**Matlock, Marty,** October 27, 2016 Consumer Goods Forum, Paris, France. US Sustainable Agriculture: The Story of Continuous Improvement - Invited

**Matlock, Marty,** November 3, 2016 BASF Global Sustainability Forum, Raleigh Durham, NC. An Integrated Land-Based Strategy for Monarch Butterfly Conservation - Keynote

**Matlock, Marty,** November 9-12, 2016 Keck Foundation Exploration Workshop – The National Academies of Sciences, Irvine, CA. Recovering Phosphorus from Deep Ocean Waters: Ecological and Technological Opportunities. - Inivted

**Matlock, Marty,** December 6, 2016 US Roundtable for Sustainable Beef Indicator Working Group Meeting, Denver, CO. Selecting and Reconciling Metrics for High Priority Indictors in Sustainable Beef – Facilitation and Presentation

**Matlock, Marty,** December 20, 2016 The Dairy Research Institute, Chicago, IL. International Frameworks for Sustainable Dairy Production – Invited

**VanDevender, K.** Poultry Litter as a Crop Nutrient Source: Maximizing its Practical and Economic Value. Arkansas Association of Conservation Districts Annual Meeting. 2/16-17/2016. North Little Rock, AR.

**Zhu, Jun** Invited by the College of Chemical Engineering in Zhejiang University of Technology to give a seminar series (including four presentations) on sustainability and renewable technologies from July 3 through 15, 2016, in Hangzhou, China.

## Submitted/selected oral or poster presentations

Patterson, S., **B. Haggard** and T. Scott. 2016. Characterizing sediment-water nutrient interactions following an in-lake alum treatment in a shallow, polymictic reservoir. Oklahoma Clean Lakes and Watershed Association Annual Meeting, Oklahoma.

**Haggard, B.**, T. Scott and S. Patterson. 2016. In-reservoir Management Reduces Phosphorus Flux from Sediments and [Maybe] Cyanobacteria Occurrence. University Council on Water Resources Annual Meeting, Florida.

Austin, B., E. Scott, L. Massey, M. Evans-White, S. Entrekin, and **B. Haggard**. 2016. Monitoring water resources of the Gulf Mountain Wildlife Management Area to evaluate possible effects of natural gas development. National Water Quality Monitoring Conference, Tampa, Florida.

Scott, E., B. Smith, M. Leh, B. Arnold, and **B. Haggard**. 2016. Monitoring Pathogens in the Upper Illinois River Watershed, Northwest Arkansas. National Water Quality Monitoring Conference, Tampa, Florida.

Simpson, Z., and **B. Haggard**. 2016. Optimizing flow-adjustment of concentrations for trend analysis. National Water Quality Monitoring Conference, Tampa, Florida.

Lord, M. and **B. Haggard**. 2016. Floodplain soils: a potential source of phosphorus to the Illinois River? Arkansas Academy of Science Annual Meeting, Fayetteville, Arkansas.

Simpson, Z., and **B. Haggard**. 2016 Nutrient trends in Beaver Lake tributaries, 2009-2016. Beaver Lake Watershed Symposium, Beaver Watershed Alliance, Lowell, Arkansas.

McLaughlin, H. and **B. Haggard**. 2016. Water quality monitoring along the West Fork of the White River. Beaver Lake Watershed Symposium, Beaver Watershed Alliance, Lowell, Arkansas.

**Henry, C**, A. McClung and J. Gaspar. 2016. Evaluating Cultivar Response to Water Struss using Subsurface Drip Irrigation (SDI). Oral presentation at the Rice Technical Working Group Meeting, March 1-4, 2016 in Galveston, TX.

**Henry, C.G.** and D. Saraswat. 2016. Multiple Inlet Irrigation for Rice made Mobile. Oral presentation at the Rice Technical Working Group Meeting, March 1-4, 2016 in Galveston, TX.

**Henry, C. G.,** K. B. Watkins, R. U. Mane and G. L. Stark. 2016. Vertical Hollow Shaft Motors for Irrigation: Does Premium Efficiency Payback? Oral presentation at the 2016 ASABE Annual International Meeting, Orlando, Florida, July 17-20.

J. Batta-Mpouma, G. Sakhel, A. Sinha, H. Han, V.P. Zharov, and **J.-W. Kim.** 2016. Inertial Force-Driven Synthesis of Near -Infrared Plasmonic Nanosphere Composites. IEEE International Conference on Nanotechnology (IEEE NANO), August 22-25, Sendai, Japan.

G. Kandhola, K. Rajan, D.J. Carrier, and **J.-W. Kim.** 2016. Fungal-Organosolv Delignification of *Pinus taeda* Softwood for Enhanced Enzymatic Hydrolysis and Lignin Extraction. 2016 ASABE Annual International Meeting, July 17-20, Orlando, FL.

J. Hockman, A. Sinha, and **J.-W. Kim.** 2016. Tuning Optoelectronic Properties of Single-Walled Carbon Nanotubes by Selective Adsorption of Sodium Dodecyl Sulfate (SDS). Arkansas NSF EPSCoR Annual State Meeting, May 24-25, Little Rock, AR.

J. Batta-Mpouma, G. Sakhel, A. Sinha, V.P. Zharov, and **J.-W. Kim.** 2016. Inertial Force-Driven Synthesis of Gold Nanosphere Composites with Tunable Near-Infrared Plasmon. Arkansas NSF EPSCoR Annual State Meeting, May 24-25, Little Rock, AR.

K. Rajan, A. Djioleu, E.M. Martin, and **J.-W. Kim.** 2016. Synthesis of Cellulose Nanoparticles from Lignocellulosic Feedstock: A Roadmap. Arkansas NSF EPSCoR Annual State Meeting, May 24-25, Little Rock, AR.

G. Kandhola, K. Rajan, D.J. Carrier, and **J.-W. Kim.** 2016. Fungal-Organosolv Delignification of *Pinus taeda* Softwood for Enhanced Enzymatic Hydrolysis and Cellulose Extraction. Arkansas NSF EPSCoR Annual State Meeting, May 24-25, Little Rock, AR.

Callaway, Z., R. Wang, and **Y. Li**. 2016. Modeling of the diffusion and binding kinetics of bacteria with magnetic nanoparticles in bioreaction and magnetic separation processes. ASABE Paper No. 162459905. Presented at ASABE 2016 Annual International Meeting, July 17-20, 2016, Orlando, FL.

Fu, Y.C., Z.Y. Liu, Q.J. Xie, S.Z. Yao, **Y. Li**, Y.B. Ying. 2016. Bio-inspired protein-polymer composite adhesive as ultra-highly efficient immobilization matrix for electrochemical biosensing. Presented at Biosensors 2016, May 25-27, 2016, Gothenburg, Sweden. Paper No. P3.132.

He, J.X., Y.X. Cui, R. Wang, L. Kelso, and **Y. Li**. 2016. Preparation and application of diethylstilbestrol-imprinted magnetic molecularly polymers based on the sol-gel method. Presented at IAFP 2016 Annual Meeting, July 31-August 3, 2016, St. Louis, MO. Paper No. P3-78.

Hu, Q.Q., R. Wang, and **Y. Li**. 2016. An aptamer based magnetic separation and fluorescent sensor for rapid and specific detection of acrylamide in thermally processed foods. ASABE Paper No. 162450689. Presented at ASABE 2016 Annual International Meeting, July 17-20, 2016, Orlando, FL.

Lei, C.Y., Z.H. Qiao, Y.C. Fu, and **Y. Li**. 2016. A colorimetric assay of lipopolysaccharides based on unmodified gold nanoparticles and lipopolysaccharides-binding peptide. Presented at Biosensors 2016, May 25-27, 2016, Gothenburg, Sweden. Paper No. P2.154.

**Li, Y.**, Z. Zhao, Z. Callaway, L.Z. Xu, and R. Wang. 2016. Portable biosensors for in-field detection of pathogenic bacteria in foods and mycotoxin in grains. Presented at IBE 2016 annual meeting, April 7-9, 2016, Greenville, SC.

Qiao, Z.H., C.Y. Lei, Y.C. Fu, and **Y. Li**. 2016. An immunomagnetic optical sensor for the detection of *E. coli* O157:H7 based on silver nanoparticles-urease signal amplification. Presented at Biosensors 2016, May 25-27, 2016, Gothenburg, Sweden. Paper No. P1.095.

Wang, H, Q.Q. Hu, R. Wang, **Y. Li**, and M.T. Kidd. 2016. Rapid detection of *Campylobacter jejuni* in poultry products using a piezoelectric immunosensor integrated with magnetic immunoseparation. Presented at IAFP 2016 Annual Meeting, July 31-August 3, 2016, St. Louis, MO. Paper No. P1-76.

Wang, L.J., R. Wang, F. Chen, H. Wang, M. Slavik, H. Wei, and **Y. Li**. 2016. Development of a sensitive aptamer-based PCR with magnetic immunoseparation for detection of *Salmonella* Typhimurium in ground turkey. Presented at IAFP 2016 Annual Meeting, July 31-August 3, 2016, St. Louis, MO. Paper No. P1-99.

Wang, R., X.F. Yu, T. Huang, and **Y. Li**. 2016. A nanowell-based immunosensor for rapid and sensitive detection of *E. coli* O157:H7. Presented at IAFP 2016 Annual Meeting, July 31-August 3, 2016, St. Louis, MO. Paper No. P2-46.

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Wang, Y.H., M.H. Wang, J.H. Lin, and **Y. Li**. 2016. A magnetophoretic system for continuous-flow immunoseparation of avian influenza virus. ASABE Paper No. 162461403. Presented at ASABE 2016 Annual International Meeting, July 17-20, 2016, Orlando, FL.

Xiao, X.N., W. Wang, Y.C. Fu, W.H. Fang, and **Y Li**. 2016. Modeling of the cross-contamination of *Vibrio parahaemolyticus* in shrimp peeling process. Presented at IAFP 2016 Annual Meeting, July 31-August 3, 2016, St. Louis, MO. Paper No. P1-150.

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Wang, R., L.J. Wang, S. Ang, and **Y. Li**. 2016. An aptasensor for rapid detection of avian influenza virus based on nanoporous gold film modified electrode. Presented at ABI (Arkansas Biosciences Institute) 2016 Fall Research Symposium, September 13, 2016, Little Rock, AR.

Aldridge, D. J., K. D. Christensen, S. E. Watkins, Y. Vizzier-Thaxton and **Y. Liang**. 2016. Characterizing the broiler transport thermal environment. Presented in 2016 International Poultry Scientific Forum, January 2016, Atlanta, GA, Poultry Science Association.

Aldridge, D. J., K. D. Christensen, S. E. Watkins, and Y. Vizzier-Thaxton, and **Y. Liang**. 2016. Interpreting thermal micro-environment using video recordings during live haul. Presented in 2016 Poultry Science Annual Meeting. New Orleans, LA. Poultry Science Association.

Beirise, A.(graduate student), **Osborn, G.S.** 2016. Evaluating a Measure-Calculate Method for Determining Sediment Oxygen Demand. Presented at Institute of Biological Engineering Annual Meeting, Greenville, SC.

Phansiri, S.B. (graduate student), **Osborn, G.S.**, J. Hart. 2016. Dissolved Ozone Output Modeling for the HyDOZ ® System. Presented at Institute of Biological Engineering Annual Meeting, Greenville, SC.

**Runkle BRK**, Suvočarev K, Smith SF, Reba M. "Alternate Wetting and Drying as an effective management practice to reduce methane in Arkansas rice production", poster presentation at the 36th Meeting of the Rice Technical Working Group, Galveston, TX, Mar 1-4, 2016.

# Publications

Cresto Aleina F, **Runkle BRK**, Brücher T, Kleinen T, Brovkin V. (2016), Upscaling methane emission hotspots in boreal peatlands, presentation at the European Geophysical Union General Assembly, Vienna, Austria, April 17-22, 2016, Session BG2.15/SSS6.14, EGU2016-6927.

Simpson G, Eckhardt T, Kutzbach L, **Runkle BRK** (2016) Small-scale evapotranspiration in the polygonal tundra of the Lena Delta, Siberia, for presentation ICOP International Conference on Permafrost, 20-24 June 2016, Potsdam, Germany

Cresto Aleina F; **Runkle BRK**; Winkler A; Knoblauch C; Kutzbach L (2016) Modeling and upscaling methane emission hotspots in the polygonal tundra, for presentation ICOP International Conference on Permafrost, 20-24 June 2016, Potsdam, Germany

Wille C, Winkler A, **Runkle BRK**, Kutzbach L (2016) Temporal and spatial extrapolation of $CO_2$ fluxes of polygonal tundra by modeling ecosystem photosynthesis-respiration flux parameters with NDVI and reanalysis data, for presentation ICOP International Conference on Permafrost, 20-24 June 2016, Potsdam, Germany

Suvočarev K, Reba M, **Runkle BRK** (2016) for presentation at the 32nd Conference on Agricultural and Forest Meteorology, 22nd Symposium on Boundary Layers and Turbulence, and Third Conference on Biogeosciences, Salt Lake City, Utah, 20-24 June 2016.

**Runkle BRK,** Paddy Rice Research Group, Global Research Alliance talk, July 14, 2016, at Stuttgart meeting, and field site presentation. Talk titled: "Alternate Wetting and Drying as an Effective Management Practice to Reduce Methane in Arkansas Rice Production"

**Runkle BRK**, Presentation at Ameriflux PI meeting, Golden Colorado, September, 2016: Neighboring fields, neighboring towers: Testing climate-smart irrigation strategies to reduce methane emissions from rice fields

Fong B, **Runkle BRK**, Reba M, Presentation at Ameriflux PI meeting, Golden Colorado, September, 2016: Drivers of $CO_2$ and $CH_4$ exchange in mid-South US rice (Oryza sativa) agriculture

**Runkle BRK**, Oct 21, Geosciences colloquium, "How well can climate-smart irrigation strategies reduce methane emissions from rice fields?"

Reba ML, Fong B, **Runkle BRK**, Suvocarev K, Adviento-Borbe A: Winter fluxes from Eastern Arkansas Rice-Waterfowl Habitats, Presented at American Geophysical Union Fall Meeting, Dec., 2016, San Francisco, CA

Suvocarev K, Reba M, **Runkle, BRK**: Surface renewal: micrometeorological measurements avoiding the sonic anemometer, Presented at American Geophysical Union Fall Meeting, Dec., 2016, San Francisco, CA

**Runkle BRK**, Suvocarev K, Reba ML, Novick KA, White P, Anapalli S, Locke MA, Rigby J, Bhattacharjee J, Variation in agricultural CO2 fluxes during the growing season, collected from more than ten eddy covariance towers in the Mississippi Delta Region, Presented at American Geophysical Union Fall Meeting, Dec., 2016, San Francisco, CA

Fong B, Adviento-Borbe A, Reba ML, **Runkle BRK**, Chamber and eddy covariance comparisons of alternate wetting and drying and continuous flood irrigation in mid-South rice, Presented at American Geophysical Union Fall Meeting, Dec., 2016, San Francisco, CA

Roby M, Reavis C, Reba M, Suvocarev K, **Runkle BRK**, Testing the reduction of methane emissions from alternate wetting and drying in rice fields: two years of eddy covariance measurements from Arkansas, Presented at American Geophysical Union Fall Meeting, Dec., 2016, San Francisco, CA

Hyunh KT, Suvocarev K, Reavis C, **Runkle BRK**, Variano E; The Role of Surface Water Flow in Gas Fluxes from a Subtropical Rice Field, Presented at American Geophysical Union Fall Meeting, Dec., 2016, San Francisco, CA

ElSayed, E., R. Shiv and **Sadaka, S**. 2016. Role of Activated Rice Husk Biochar in the Removal of Emerging Organic Contaminants from Wastewater Irrigated Soils. CSBE/SCGAB. July 3- 6, 2016 - Halifax, Nova Scotia, Canada.

**Sadaka, S.** 2016. Drying Rough Rice in a Fluidized Bed Dryer Subjected to Intermittent Regime. ASABE Annual International Meeting, Orlando, Florida July 17-20, 2016.

**Sadaka, S.** 2016. Effects of Mixing High Moisture Rough Rice with Heated Husk on Dried Rice Quality. ASABE Annual International Meeting, Orlando, Florida July 17-20, 2016.

**Sadaka, S.** 2016. Development and Valuation of an On-Farm Fluidized Bed Drying System. CSBE/SCGAB. July 3-6, 2016 - Halifax, Nova Scotia.

**Sadaka, S.** 2016. On-Site Utilization of Crude Glycerin for Synthetic Gas Production and Potential Electricity Generation. CSBE/SCGAB. July 3- 6, 2016 - Halifax, Nova Scotia.

Shen, J., **J. Zhu**. 2016. Kinetics of biogas production in batch anaerobic co-digestion of poultry litter and wheat straw mixed with municipal wastewater. ASABE Annual International Meeting paper#: 162458093, Orlando, FL. July 17-20, 2016.

Shen, J., **J. Zhu**. 2016. Biogas production in a biofilm reactor of a two-phase anaerobic digestion system from hydrolysate derived from poultry litter at different organic loadings and retention times. ASABE Annual International Meeting paper#: 162460548, Orlando, FL. July 17-20, 2016.

Shen, J., **J. Zhu**. 2016. Development of a novel strategy for estimation of endogenous decay and yield coefficients in batch biogas production of anaerobic co-digestion of poultry litter and wheat straw using numerical integration. ASABE Annual International Meeting paper#: 162457488, Orlando, FL. July 17-20, 2016.

## *Other Creative Endeavors*

Chris Henry and Dharmendra Saraswat developed a mobile application for Multiple Inlet for Rice Irrigation. It is available on Google Play for android devices. The application provides a map for the user to draw field boundaries, levee boundaries, and pipe location. The user enters in the flow rate for the well and the application determines the pipe size, length, number of rolls required and provides a gate punch and setting plan for the field. Multiple fields can be entered and saved and the user can have the plan emailed to them and saved as a pdf. The iOS version of this application is under development.
UA Irrigation Water Management Team. 2016. Rice Irrigation. Mobile Application Software.

## US Patents issued.

**Osborn, G. S**., C. T. Thompson, M. D. Matlock. 2016. U.S. Patent 9,315,402. Systems and Methods for Wastewater Treatment. Issued 4/19/2016. UA Disclosure Ref. No. 11-14. Patentee– The Board of Trustees of the University of Arkansas.

**Osborn, G.S.,** M.D. Matlock, S.S. Teltschik. 2016. EU-Germany Patent 60 2006 047 803.8. System and Method for Dissolving Gases in Fluids and For Delivery of Dissolved Gases. UA Disclosure Ref. No. 04-24. Patentee– The Board of Trustees of the University of Arkansas.

Linguist, L. K., C. T. Thompson, C. B. Milligan, **G. S. Osborn**. U.S. Patent 9,340,438. Systems and Methods for Delivering Dissolved Gases into Force-Main and Gravity Sewers. Issued 5/17/2016. UA Disclosure Ref. No. 15-08. Patentee– The Board of Trustees of the University of Arkansas.

**Osborn, G.S.** US Patent 9,248,415. Systems and Methods for Maximizing Dissolved Gas Concentration of a Single Species of Gas from a Mixture of Multiple Gases. Issued 2/2/2016. UA Disclosure Ref. No. 11-20. Patentee– The Board of Trustees of the University of Arkansas.

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